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*Declaration of James Kelley, Ph.D.*

**Volume 3 of 3**

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# Natural Resource Mitigation Plan

# Master Plan Update Improvements
# Seattle-Tacoma International Airport

Port of Seattle

December 2000

Parametrix, Inc.

# NATURAL RESOURCES MITIGATION PLAN

# SEATTLE-TACOMA INTERNATIONAL AIRPORT

# MASTER PLAN UPDATE IMPROVEMENTS

Prepared for

**PORT OF SEATTLE**
Seattle-Tacoma International Airport
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December 2000
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AR 009657

# LIST OF ACRONYMS

| Abbreviation/ Acronym | Formal Name |
|---|---|
| ACOE | U. S. Army Corps of Engineers |
| AMA | Aircraft Movement Area |
| AOA | Airport Operation Area |
| ARFF | Airport Rescue and Fire Fighting |
| ASDE | Airport Surface Detection Equipment |
| ASR | Airport Surveillance Radar |
| ASTM | American Society for Testing Materials |
| BMPs | Best Management Practices |
| BOD | Biochemical Oxygen Demand |
| cfs | Cubic feet per second |
| CWA | Clean Water Act |
| cy | Cubic yard |
| DNR | Washington Department of Natural Resources |
| DO | Dissolved oxygen |
| Ecology | Washington State Department of Ecology |
| EIS | Environmental Impact Statement |
| EPA | U.S. Environmental Protection Agency |
| ESA | Endangered Species Act |
| FAA | Federal Aviation Administration |
| FEIS | Final Environmental Impact Statement |
| FEMA | Federal Emergency Management Agency |
| FIRM | Flood Insurance Rate Map |
| FSEIS | Final Supplemental Environmental Impact Statement |
| FW | Farmed wetland |
| GIS | Geographical Information System |
| HPA | Hydraulic Project Approval |
| HSPF | Hydrologic Simulation Program–FORTRAN |
| ILA | Interlocal Agreement |
| IWS | Industrial Water System |
| IWTP | Industrial Waste Treatment Plant |
| JARPA | Joint Aquatic Resource Permit Application |

AR 009658

| Abbreviation/ Acronym | Formal Name |
|---|---|
| KCSWM | King County Surface Water Management |
| LWD | Large woody debris |
| MSE | Mechanically Stabilized Earth |
| NAVAIDS | Navigation Aids |
| NEPA | National Environmental Policy Act |
| NEPL | North Employees' Parking Lot |
| NPDES | National Pollutant Discharge Elimination System |
| NRMP | Natural Resource Mitigation Plan |
| OHW | Ordinary High Water |
| OHWM | Ordinary High Water Mark |
| PGIS | Pollution Generating Impervious Surface |
| Port | Port of Seattle |
| RDF | Regional Detention Facility |
| RM | River Mile |
| ROW | Right-of-way |
| RSA | Runway Safety Areas |
| SASA | South Aviation Support Area |
| SCS | Soil Conservation Service |
| SDS | Stormwater Drainage System |
| SEPA | State Environmental Policy Act |
| SMP | Stormwater Management Plan |
| SR | State Route |
| STEP | South Terminal Expansion Project |
| STIA | Seattle-Tacoma International Airport |
| STS | Satellite Transit Shuttle |
| SWPPP | Stormwater Pollution Prevention Plan |
| TESC | Temporary Erosion and Sediment Control |
| USDA-WSD | United States Department of Agriculture-Wildlife Services Division |
| USFWS | U.S. Fish and Wildlife Service |
| USGS | U.S. Geologic Survey |
| VFR | Visual Flight Rule |
| WAC | Washington Administrative Code |

AR 009659

| Abbreviation/ Acronym | Formal Name |
|---|---|
| WDFW | Washington Department of Fish and Wildlife |
| WHMP | Wildlife Hazard Management Plan |
| WQC | Water Quality Certification |
| WQS | Water Quality Standard |
| WSD | Wildlife Science Division |
| WSDOT | Washington State Department of Transportation |

AR 009660

# EXECUTIVE SUMMARY

As currently configured, Seattle-Tacoma International Airport (STIA) is unable to efficiently meet existing and future regional air travel demands. In response to growth forecasts for passenger and cargo volumes at STIA, a variety of facility improvements are planned to meet travel demands in the Puget Sound Region and to reduce the aircraft arrival delays during poor weather. These improvements were developed through a master planning process, then updated to reflect revised growth forecasts for passenger use. Some of the planned improvements will cause unavoidable impacts to wetlands, streams, floodplains, and drainage channels within the project area. This *Natural Resource Mitigation Plan* (NRMP) describes the mitigation actions that the Port of Seattle (Port) will implement to mitigate for unavoidable wetland and stream impacts associated with Master Plan Update improvements.

The STIA Master Plan Update improvements will affect wetlands, streams, floodplain, drainage channels, and stormwater in the Miller and Des Moines Creek basins. To construct the projects, fill material would be placed in approximately 980 linear ft of Miller Creek, approximately 5.24 acre-ft of the Miller Creek 100-year floodplain, approximately 18.37 acres of wetland, and about 1,290 linear ft of drainage channel. In addition, new impervious surfaces will affect stormwater runoff and water quality conditions.

Consistent with federal and state mitigation requirements, this plan describes actions the Port will take to:

- Avoid and minimize impacts to wetlands and streams by reducing impact areas through the use of retaining walls to minimize fill impacts, locate stormwater detention in uplands, and avoid wetlands in borrow areas.
- Restoring temporary impacts to wetlands caused by project construction, including construction stormwater management.
- Compensating for the impact by providing in-kind mitigation that replaces ecological functions lost by filling wetlands and streams.

Compensatory mitigation will restore and enhance ecological and hydrologic functions to over 134 acres of property. About 67 acres of this mitigation occurs on-site, restoring natural wetland and stream conditions to currently developed portions of the Miller and Des Moines Creek basins. Elements of the on-site mitigation will:

- Restore and enhance wetlands riparian to Miller and Des Moines creeks,
- Restore and enhance salmon habitat
- Enhance stream buffers,
- Remove existing land uses that are detrimental to adjacent wetlands and streams,
- Protect water quality and stream hydrology.

An additional 65 acres of mitigation to replace wildlife habitat function will occur at a mitigation site in Auburn, where existing degraded wetlands and abandoned farmland will be restored to a high quality, diverse wetland ecosystem.

A complete description of the goals and objectives of each mitigation project are described in this report. For each mitigation element, an engineering and landscape design is presented and discussed. The NRMP plan also provides detailed performance and monitoring standards, which as permit requirements, will be enforced by permitting agencies to assure that the projects are constructed, evaluated, and adaptively managed. Monitoring and adaptive management will assure that the hydrologic and ecological benefits described in the plan are ultimately achieved.

Overall, the Master Plan Update improvements design and mitigation will protect wetlands and aquatic resources. The substantial mitigation compensates for identified impacts to hydrology (peak flow and low flow), water quality, wetlands (temporary, permanent filling, and indirect), and streams. This mitigation prevents cumulative impacts, attributable to the proposed actions, from occurring.

AR 009662

Introduction

# 1. INTRODUCTION

In response to growth forecasts for passenger and cargo volumes at Seattle-Tacoma International Airport (STIA), a variety of facility improvements are planned to meet the air transportation needs of the Puget Sound Region and to reduce the aircraft arrival delays during poor weather. These improvements were developed through a master plan process, then updated to reflect revised growth forecasts for passenger use. Some of the planned improvements will cause unavoidable impacts to wetlands, streams, floodplains, and drainage channels within the project area. This Natural Resource Mitigation Plan (NRMP) describes the mitigation actions that the Port of Seattle (Port) will implement to mitigate for potential unavoidable wetland and stream impacts associated with Master Plan Update improvements. Actions taken to mitigate potential stormwater and water quality impacts due to the proposed projects are summarized in this report (Chapter 6); however, the Stormwater Management Plan (SMP) is described in detail in the *Comprehensive Stormwater Management Plan for Seattle-Tacoma International Airport Master Plan Update Improvements* (Parametrix 2000a). The mitigation plan describes actions that will be implemented upon receipt of, and according to any special conditions of, the Clean Water Act (CWA) Section 404 Permit approval and Section 401 Water Quality Certification (WQC).

The mitigation plan includes two major elements: (1) mitigation actions (described in Chapters 1 through 7 of this document), and (2) detailed plan sheets that graphically depict the mitigation design (included as Appendices A through E of this report). Compensatory mitigation has been proposed to occur on approximately 134 acres, with about 67 acres of on-site mitigation within the Miller and Des Moines Creek basins, and about 65 acres of off-site mitigation at the Auburn mitigation site. Mitigation designs have been revised in response to: (1) comments received on the Public Notice of September 1999 regarding the type and amount of mitigation, and (2) issues raised by the Washington State Department of Ecology (Ecology), the U.S. Fish and Wildlife Service (USFWS), the U.S. Environmental Protection Agency (EPA), the Washington State Department of Fish and Wildlife (WDFW), the City of Auburn, and the U.S. Army Corps of Engineers (ACOE) on previous drafts of the mitigation plan. The plan describes specific actions taken to:

- *Avoid and minimize* impacts to wetlands and streams.
- *Replace wetland functions on-site* to the maximum extent practicable, by restoring and enhancing wetlands in the Miller and Des Moines Creek basins, where compatible with airport operations and where restoration will reduce wildlife attractants near the airport.
- *Enhance and restore stream habitat functions* through buffer restoration and instream habitat enhancement.
- *Restore wetland functions and create new, high quality wetlands off-site* to replace avian habitat functions in compliance with Federal Aviation Administration (FAA) Advisory Circular 150/5200-33.

AR 009664

The mitigation plan includes both in-basin and out-of-basin mitigation projects, and includes the following projects:

*In-Basin*

- Vacca Farm Restoration: Miller Creek Channel Relocation and Enhancement, Wetland and Floodplain Restoration, and Lora Lake Buffer Enhancement
- Miller Creek Instream Habitat, Wetland, and Riparian Buffer Enhancements
- Restoration of Temporary Construction Impacts
- Replacement of Drainage Channels Adjacent to Miller Creek
- Tyee Valley Golf Course Wetland Mitigation and Des Moines Creek Riparian Buffers
- Trust funds for stream restoration projects

*Out-of-Basin*

- Wetland Mitigation in Auburn

## 1.1 PURPOSE AND NEED FOR THE PROJECT

As currently configured, STIA is unable to efficiently meet existing and future regional air travel demands. The airfield operates inefficiently during poor weather because it accommodates aircraft in a single arrival stream only. As a result, significant arrival delay occurs during poor weather. Aircraft are either held on the ground in their originating city, slowed en route, or they are placed in holding patterns to await clearance to land at STIA. These conditions result in inefficient operation of the existing airfield, as described in (FAA 1996,1997a).

With or without airport improvements, airport activity is expected to increase as a result of regional population growth. As aviation demand grows, aircraft operating delay will increase exponentially. The increased passenger, cargo, and aircraft operations demands will place increasing burdens on the existing terminal and support facilities. Without improvements, the roadway system, terminal space, gates, cargo, and freight processing space would become more inefficient and congested, and the quality of service reduced.

While STIA currently has sufficient operation capability during good weather conditions, the existing runway capabilities cause arrival delays during poor weather. For instance, when weather worsens from Visual Flight Rule 1 (VFR 1) to VFR 2, average arrival delay increases by more than ten fold (from 1 minute to 11.4 minutes). Delays further worsen when Instrument Flight Rule (IFR 1/2/3) conditions occur. In these cases, average arrival delay increases more than twenty fold over VFR 1 (from 1 minute to 21.7 minutes). Because these statistics represent averages, some flights experience less delay, while others experience greater delays. The Federal Aviation Administration's (FAA's) National Plan of Integrated Airport Systems concludes that when annual average delays exceed 9 minutes, an airport is experiencing severe delay.

Using average aircraft operating costs developed by the FAA, STIA aircraft delays are estimated to cost the airlines about $42 million annually under 1992 demand levels. When annual aircraft operations reach 425,000, delay costs are anticipated to exceed $176 million annually. Without the third parallel runway, at this level of activity, average VFR 2 arrival delay would exceed 40 minutes and IFR delay would exceed 70 minutes. A third parallel runway, located 2,500 ft west of the existing 16R/34L runway, would permit staggered dual-stream arrivals in poor weather conditions. It would decrease average arrival delays by about 80 percent, as compared to taking no action, and result in a saving of $132 million per year.

Based on this analysis, and as a result of planning for the Master Plan Update improvements, regional officials have identified the following needs for STIA:

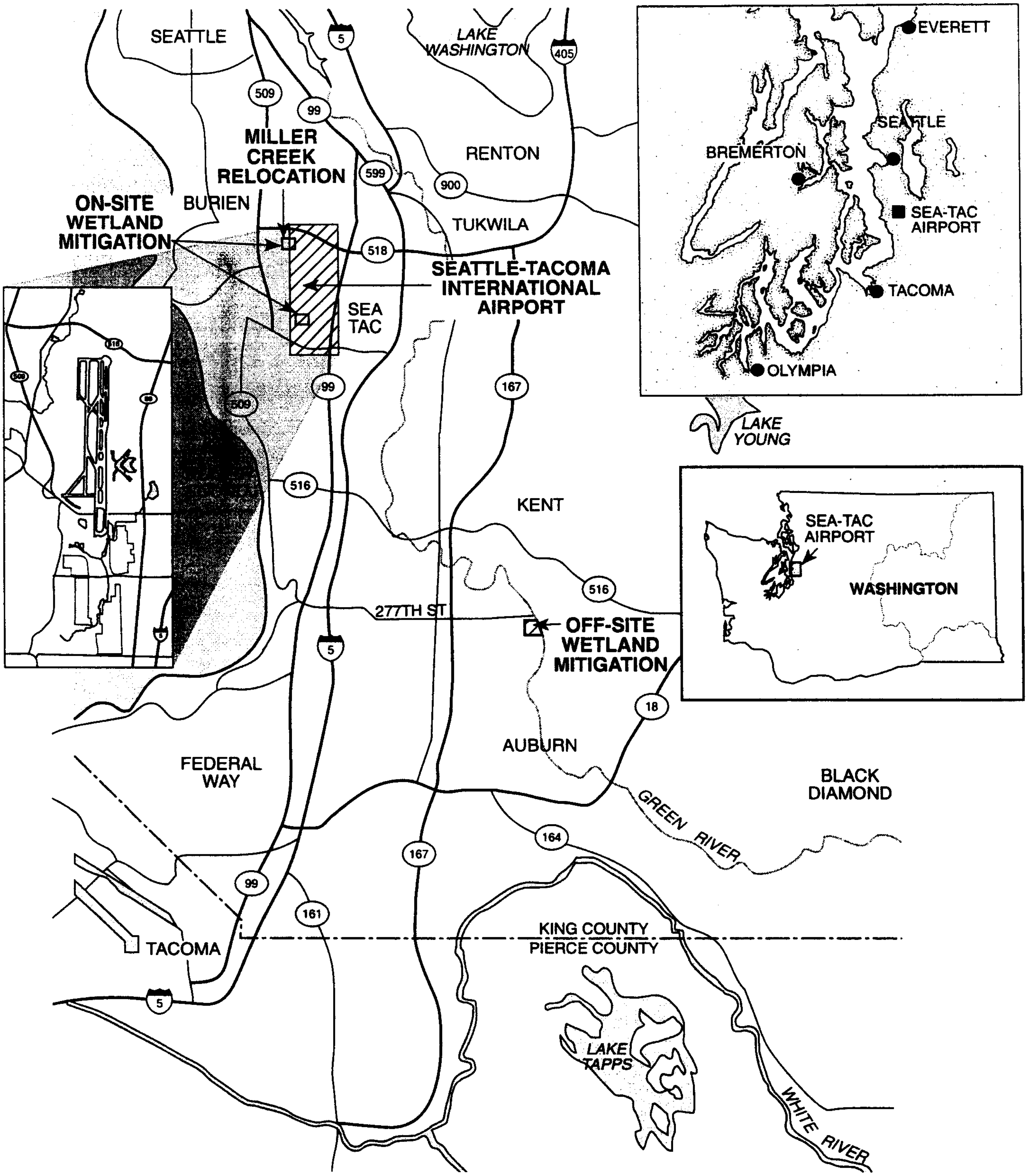
- Improve the poor weather airfield operating capability (over 85 percent of total STIA delays are incurred by aircraft arriving during poor weather).
- Provide sufficient runway length to accommodate warm weather operations and payloads for aircraft types operating to the Pacific Rim.
- Provide Runway Safety Areas (RSAs) that meet FAA standards.
- Provide efficient and flexible land-side facilities to accommodate future aviation demand.

## 1.2 PROJECT LOCATION

STIA is located within the City of SeaTac in King County, Washington, situated 12 miles south of downtown Seattle (Sections 20, 21, 28, 29, 32, and 33, Township 23N, Range 4E; and Sections 4 and 5, Township 22N, Range 4E, W.M.) (Figure 1.2-1). On-site mitigation projects are located in the vicinity of STIA, while the out-of-basin mitigation project is located southeast of STIA in the City of Auburn, Washington (see Figure 1.2-1).

Mitigation for the Master Plan Update improvements is proposed on land currently owned by the Port within the acquisition area at STIA (Figure 1.2-2), or at the site in Auburn, Washington, which the Port has owned since 1995 (see Figure 1.2-1). The Auburn mitigation site is located on the west side of the Green River and south of South 277th Street (SE¼ Section 31, Township 22N, Range 4E SE, W.M.).

The Port is also proposing to establish two trust funds to be used to support local stream restoration efforts in both the Des Moines and Miller Creek basins. Stream restoration projects may occur on property not owned by the Port.

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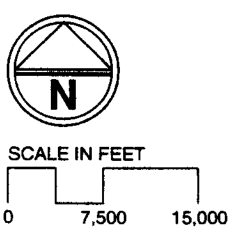
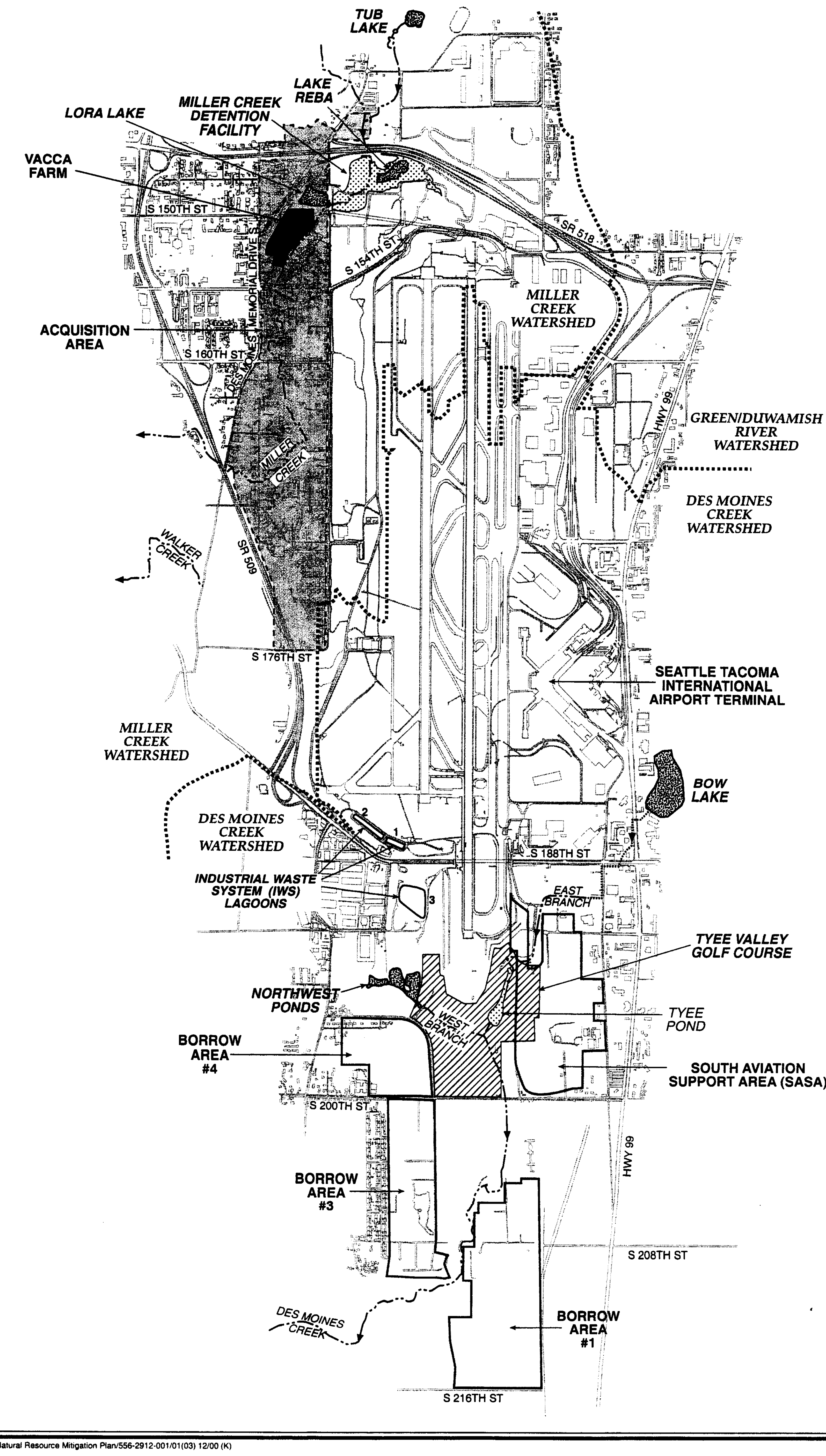



**Figure 1.2-1**
**Location of Seattle-Tacoma International Airport and Off-Site Wetland Mitigation Site**



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- Approximate Aquisition Area
- Water Features
- Stream
- Current Watershed Boundaries
- Detention Facility
- Tyee Valley Golf Course
- Vacca Farm
- Piped Stream

**Figure 1.2-2**
**Locations of Existing Water Features, Stormwater Facilities, Watershed Boundaries, and Aquisition Area of STIA**

AR 009668

## 1.3 PROJECT DESCRIPTION

The Master Plan Update improvements include construction activities that will fill approximately 18.37 acres of wetlands in the Miller Creek[1] and Des Moines Creek watersheds. Master Plan Update improvements are summarized in Table 1.3-1. Elements of the project that will result in wetland, floodplain, stream, and drainage channel impacts include the following:

- Adding an 8,500-ft-long third parallel runway (16X/34X) with associated taxiway and navigational aids
- Establishing standard RSAs for existing runways 16R/34L and 16L/34R
- Relocating South 154th Street north of extended RSAs and the new third runway
- Developing the South Aviation Support Area (SASA) for cargo and/or maintenance facilities
- Using on-site borrow sources for the third runway embankment
- Relocating, redeveloping, and expanding support facilities (passenger terminal facilities, stormwater facilities [including outfalls], electrical substations, utility corridors, etc.)

These elements of the project are described more fully below.

**Table 1.3-1. Proposed Master Plan Update improvement projects at Seattle-Tacoma International Airport.**

| Project | Description |
|---|---|
| **Runway and Taxiway Projects** | |
| Property Acquisition, Street and Utility Vacation | Includes purchasing property and demolishing existing structures between existing STIA boundary west to Des Moines Memorial Drive and SR 509. Required for third runway embankment fill and construction impact mitigation. Acquisition and demolition is also required for the south runway protection zone (RPZ). |
| Embankment Fill | Embankment for third runway, constructed using imported fill. Approximately 16.5 million cubic yards (cy) will be placed over a 5- to 7-year period. Existing roads and streets under embankment footprint will be removed. |
| Interconnecting Taxiways | New connecting taxiways between existing runway and third runway. Project is located on existing airfield, requiring only minimal grading. |
| Runway 16X/34X | Paving of third runway after completion of embankment fill. |
| Extension of Runway 34R by 600 ft | Extend runway by 600 ft for improved warm weather and large aircraft operations. Project is located at the southern end of the east runway. |
| Additional Taxiway Exits on 16L/34R | Construction of new ramps to the existing terminal apron. |
| Dual Taxiway 34R | Improvements to taxiways serving the SASA area and south apron. |
| **Borrow Sites** | |
| Borrow Sites | Sources of fill for third runway embankment, located on STIA property south of the airport. Approximately 6.7 million cy of material to be excavated from three sites and transported across airport property to the embankment. |

AR 009669

[1] References to Miller Creek watershed include Walker Creek.

Table 1.3-1. **Proposed Master Plan Update improvement projects at Seattle-Tacoma International Airport (continued).**

| Project | Description |
|---|---|
| **Runway Safety Areas (RSAs)** | |
| Runway 34R Safety Fill | Extend runway safety fill to meet FAA standards. |
| RSAs 16R/16L | Extend safety fills by 1,000 ft to meet FAA standards. |
| Relocation of Displaced Threshold on Runway 16L | Airfield taxiway improvements. The runway threshold (i.e., the emergency landing pad at end of runway pavement) to be relocated onto new RSA. |
| Miller Creek Sewer Relocation | Relocate sewer for third runway embankment and runway safety fills. New sewer to run along new alignment of South 154th Street. |
| **FAA Navigation Aids (NAVAIDS)** | |
| New Airport Traffic Control Tower | New air traffic control tower to be located in existing developed area near terminal. |
| Relocate Airport Surveillance Radar (ASR), Airport Surface Detection Equipment (ASDE), NAVAIDS | Existing radar and navigation equipment will be relocated to allow construction of third runway. |
| **Airfield Building Improvements** | |
| New Snow Equipment Storage | New building to house snow removal equipment. |
| Weyerhaeuser Hangar Relocation | Relocate existing hangar on west side of airfield to allow construction of third runway. New hangar will be located near south end of third runway. |
| **Terminal/Air Cargo Area Improvements** | |
| Relocation of Airborne Cargo | Relocate existing cargo building from air traffic control tower site to north cargo area. Located in existing developed area near terminal. |
| Central Terminal Expansion | Passenger terminal remodel. Located in existing developed area at terminal. |
| South Terminal Expansion Project (STEP) | Passenger terminal remodel. Located in existing developed area to the south of the main passenger terminal. |
| Northwest Hangar Relocation | Relocate Northwest hangar to site now occupied by Delta hangar. Located in existing developed area. |
| Satellite Transit Shuttle (STS) System Rehabilitation | Remodel and upgrade underground transit system linking terminal to satellites. |
| Redevelopment of North Air Cargo | New or expanded air cargo facilities along Air Cargo Road at north end of airport. |
| Expansion of North Unit Terminal (North Pier) | Addition to new passenger terminal located north of existing terminal. Located in existing developed area (Doug Fox parking lot and airport access freeway). |
| New Airport Rescue and Fire Fighting Facility (ARFF) | Replaces facility displaced by new North Terminal. The new facility will be located to the north of the North Terminal. |
| Cargo Warehouse at 24th Avenue South | New air cargo facility located north of SR 518 on 24th Avenue South. |
| Westin Hotel | New hotel located immediately north of main passenger terminal. Located in existing developed area at terminal. |
| **Roads**[1] | |
| Temporary SR 518 and SR 509 Interchanges | Temporary access ramps to serve construction of third runway embankment and runway safety fill; to be removed after project completion. |

**Table 1.3-1. Proposed Master Plan Update improvement projects at Seattle-Tacoma International Airport (continued).**

| Project | Description |
|---|---|
| **Roads[1] (continued)** | |
| 154th/156th Street Relocation | Relocate public roadway to allow construction of third runway embankment and runway safety fills. Existing road to be demolished. |
| 154th/156th Street Bridge Replacement | Relocate existing South 156th Street bridge over Miller Creek to accommodate the third runway footprint and South 154th/156th Street relocation. In-water work associated with this project is limited to the removal of the existing bridge and bank restoration. |
| Improvements to Main Terminal Roads | Transportation circulation, seismic and other improvements to roadway systems serving terminal. |
| Improved Access and Circulation Roadway Improvements | Improvements to existing roadway system serving passenger terminal, garage, and air cargo facilities. |
| North Unit Terminal Roadways | Improvements to existing roadway system to serve the new North Terminal and garage. |
| Improvements to South Access Connector Roadway (South Link) | Improvements to existing roadway system serving passenger terminal, garage, and air cargo facilities. Will connect terminal and garage area to South Access roadway and SR 509 extension south of airport. |
| **Parking** | |
| Main Parking Garage Expansion | Expand parking facility at main passenger terminal on north and south sides (existing developed areas), and add floors to portions of existing garage. |
| The North Employees Parking Lot (NEPL), Phase 1 | New parking facility for employees, located north of SR 518. |
| North Unit Parking Structure | Construction of new garage serving new North Terminal facility. Facility will be located at existing Doug Fox parking lot. |
| **The South Aviation Support Area (SASA)** | |
| The SASA and Access Taxiways | New airport support facility for cargo and/or maintenance, located at the south end of the airport south of the Olympic Tank Farm and South 188th Street. Airplane access will be by new parallel taxiway constructed along Runway 34R. |
| Relocation of Existing Facilities to the SASA | Airport operation support facilities will be relocated to the SASA once SASA site development is completed. Many of these facilities must be relocated from their present locations due to main terminal expansion (i.e., STEP and North Terminal), including Northwest hangar, ground support equipment, ground and corporate aviation facilities, new airport maintenance building, and United maintenance complex. |
| **Stormwater Facilities[2]** | |
| SASA Detention Pond | Create regional stormwater detention pond for the SASA project and other sites. Pond is 33.4 acre-ft and discharges to Des Moines Creek. |
| NEPL Vault | A 13.9 acre-ft vault to retrofit the NEPL; discharges to Miller Creek via Lake Reba. |
| Third Runway Vaults and Ponds | Stormwater detention vaults and ponds at the north, west, and south sides of the airport, discharging to Miller, Walker, and Des Moines Creeks. |
| STIA Retrofit Facilities | Detention vaults or ponds to provide flow control retrofitting for existing STIA discharges to Des Moines Creek. Vaults to be constructed in combination with third runway facilities when possible. |
| Cargo Vault | Detention vault for North Cargo Facility (4.5 acre-ft discharging to Miller Creek via Lake Reba). |

Table 1.3-1. **Proposed Master Plan Update improvement projects at Seattle-Tacoma International Airport (continued).**

| Project | Description |
|---|---|
| **Natural Resources** | |
| Miller Creek Relocation | Approximately 980 ft of Miller Creek immediately downstream of the Miller Creek Detention Facility will be relocated to accommodate third runway embankment and runway safety fill. |
| Miller Creek Buffer and Wetland Enhancement | Establish a 100-ft buffer (average) along approximately 6,500 linear ft of Miller Creek and riparian wetlands associated with Miller Creek within the acquisition area. Enhance approximately 7.4 acres of existing wetlands along the stream. |
| Miller Creek Floodplain and Wetland Restoration | Excavate approximately 9,600 cy from the Vacca Farm site adjacent to Miller Creek to compensate for approximately 8,500 cy of floodplain fill for third runway embankment and north safety fill. Restore and enhance approximately 17 acres of stream habitat, floodplain wetlands, aquatic habitat in Lora Lake, and buffers at Vacca Farm. |
| Miller Creek Instream Habitat Enhancement | Project 1: South of the Vacca Farm site, approximately 235 ft of channel. Remove rock riprap, footbridges, and trash. Place large woody debris (LWD) throughout this section of the stream. Plant riparian areas along the stream with native wetland and upland plant species. |
| | Project 2: Approximately 150 ft upstream of South 160th Street, approximately 235 ft of channel. Install LWD in the stream channel, grade a small section of the west bank of the stream to create a gravel bench in the floodplain, remove two rock weirs to improve fish passage, and plant the upland area with native trees and shrubs. |
| | Project 3: Immediately downstream of South 160th Street, approximately 380 ft of channel. Grade a section of the east bank, remove a rubber-tire bulkhead and install LWD in the stream and on its banks. Plant buffer areas with native trees and shrubs. |
| | Project 4: Miller Creek immediately upstream of 8th Avenue South, approximately 420 ft of channel. Grade portions of both banks. Remove footbridges and portions of concrete block walls. Install LWD in the stream and on its banks. Plant buffer areas with native trees and shrubs. |
| | In addition to these specific enhancements, debris such as tires, garbage, and fences will be removed throughout the entire stretch of Miller Creek from the Vacca Farm site south to Des Moines Memorial Drive. In areas where access is readily available, LWD will be selectively placed throughout the stream to improve instream habitat conditions. |
| Drainage Channels Relocation | Relocate a minimum of 1,290 linear ft of drainage channels to accommodate the third runway embankment. Plant buffers along the drainage channels with native grass and shrubs. |
| Restoration of Temporarily Impacted Wetlands | Approximately 2.05 acres of wetland located west of the third runway embankment, north of relocated South 154th Street, and west of the Miller Creek relocation project, will be temporarily filled or disturbed during embankment construction. When construction activities are completed, remove fill material, restore pre-disturbance topography, and plant wetlands with native shrub vegetation. |
| Tyee Valley Golf Course Wetlands Enhancement and Des Moines Creek Buffer Enhancement | Restore approximately 4.5 acres of emergent wetland area and approximately 1.6 acres of buffer located within Tyee Valley Golf Course to a native shrub vegetation community. The enhancement actions would be integrated into plans to construct a Regional Detention Facility (RDF) on the golf course (King County Capital Improvement Project Design Team 1999). The enhancement would convert the existing turf wetland to native shrub wetland community. |
| | Enhance approximately 3.4 acres (average 100 ft wide) of buffer and 1.0 acre of existing wetland along Des Moines Creek. |

AR 009672

Table 1.3-1. Proposed Master Plan Update improvement projects at Seattle-Tacoma International Airport (continued).

| Project | Description |
| --- | --- |
| Wetland Habitat (including Avian Habitat) near the Green River in Auburn | Restore wetland functions to a 67-acre parcel near the Green River in the City of Auburn. Create and/or restore approximately 17.2 acres of forest, 6.0 acres of shrub, 6.2 acres of emergent, and 0.60 acre of open-water wetland. Enhance protective buffers totaling about 15.90 acres. |

1 Temporary roads used to haul fill material from three on-site borrow areas to construction sites are included in the analysis of the borrow areas and not listed here.

2 Des Moines Creek Basin Plan Committee will construct a Regional Detention Facility (RDF) on Tyee Golf Course to provide regional flow control. This project would eliminate the need for STIA retrofit facilities described above. As this is a cumulative action subject to future federal action, it is not a Master Plan Update improvement.

### 1.3.1 Runways and Taxiways

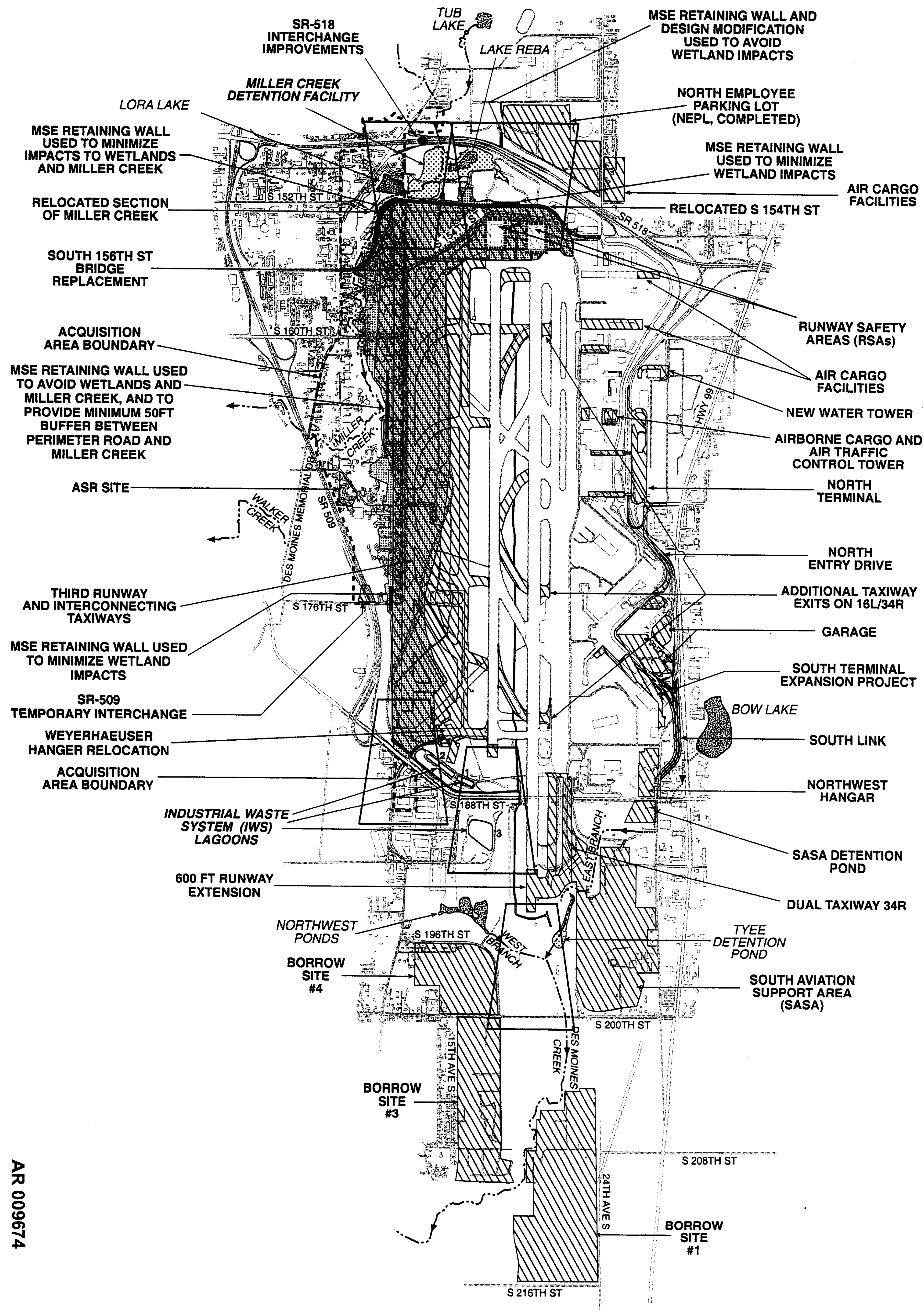
To overcome aircraft arrival congestion during poor weather conditions, the Port proposes to build a new 8,500-ft runway on approximately 16.5 million cubic yards (cy) of fill on the west side of the existing STIA airfield (Figure 1.3-1). The existing airfield plateau will be extended west over 12th Avenue South. The current location of 12th Avenue South will be the approximate centerline of the new runway. To construct the third runway and extend the airfield plateau, a large embankment with four mechanically stabilized earth (MSE) retaining walls will be constructed. The MSE retaining walls are located at the northern, central, and southern portions of the embankment (see Figure 1.3-1), and have been designed to avoid and minimize direct impacts from the embankment to Miller Creek and associated wetlands. Security and emergency access roads will be constructed around the runway perimeter. New and relocated interconnecting taxiways will also be constructed.

To accommodate the third runway embankment, stormwater management facilities, and a neighborhood noise abatement area, the Port has purchased land west of the existing runway. Most of this land consists of private residences. In this report, this area is referred to as the "acquisition area." The acquisition area is generally bounded by State Route (SR) 518 to the north, South 176th Street to the south, Des Moines Memorial Drive to the west, and 12th Avenue South to the east (see Figure 1.3-1). Several parcels in and adjacent to the acquisition area are voluntary acquisitions and may or may not be acquired by the Port. However, no additional action, other than demolitions, will be taken in the voluntary acquisition areas. At the north end of the third runway, South 154th Street would be relocated to accommodate the new runway (see below).

### 1.3.2 Runway Safety Area Extensions / South 154th Street Relocation

RSA extensions are necessary for the existing runways and the new third runway to ensure that they meet current FAA standards. The RSA extensions are to be created at the north end of the existing airport runways south of SR 518, and at the southern end of the new third runway. The RSA extensions at the north end of the two existing runways, as well as the new third runway construction, will require relocating South 154th Street (Figure 1.3-2). The relocated road section will be located approximately 55 to 650 ft north of the current alignment. The new alignment will be north and west of the third runway embankment, connecting with South 156th Street at Des Moines Memorial Drive. In addition, a portion of an existing sewer line will be relocated to parallel the new road alignment.

AR 009673




AR 009674

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**Figure 1.3-1 Master Plan Update Improvement Projects at STIA**

South 156th Street currently crosses over Miller Creek on an existing timber bridge. The existing bridge will be replaced with a new bridge that spans the stream and floodplain of Miller Creek as part of the South 154th Street relocation (see Figure 1.3-2).

An MSE retaining wall will be constructed along the north side of the relocated road to minimize filling of the forested wetlands located north of the roadway (see Figure 1.3-2). The MSE wall at this location will extend up to approximately 50 ft in height.

### 1.3.3 The South Aviation Support Area (SASA)

The SASA (see Figure 1.3-1) will provide space for aircraft maintenance/support and air cargo facilities. The FEIS for the Master Plan Update improvements identified several existing uses that would be moved to the SASA, primarily due to the expansion of the Main Terminal. These uses include Northwest Airlines aircraft maintenance and hangar, the U.S. Post Office airmail facility, and possibly Airborne cargo. The SASA will also allow for the expansion of air cargo and aircraft maintenance requirements of airlines and other tenants. The SASA facility will accommodate:

- Relocated line maintenance and cargo facilities that must be moved prior to the expansion of passenger terminal facilities
- Line maintenance requirements
- Aircraft maintenance facilities in response to existing and/or future market demands
- Expansion of cargo handling and maintenance capabilities
- Other aircraft support facilities

### 1.3.4 On-Site Borrow Source Areas

On-site borrow areas are proposed to be excavated as a source of fill to be used to construct portions of the runway embankment. Three on-site borrow areas are located on airport property between 24th Avenue South and 15th Avenue South, and between South 196th and South 216th Streets (see Figure 1.3-1). These borrow areas are planned to supply approximately 6.7 million cy of fill material. Current engineering estimates suggest that Borrow Site 1 will supply up to 4.2 million cy, and Borrow Sites 3 and 4 will supply 2.5 million cy.

An additional 2.4 million cy is available from on-site sources within the third runway footprint. This fill material will be obtained through excavation at the south end of the third runway, where materials are stockpiled and where the existing ground elevation is above the final grade for the runway. The fill material from these sources has been tested for structural integrity and found to be suitable for use in the RSAs and portions of the infield.

AR 009675

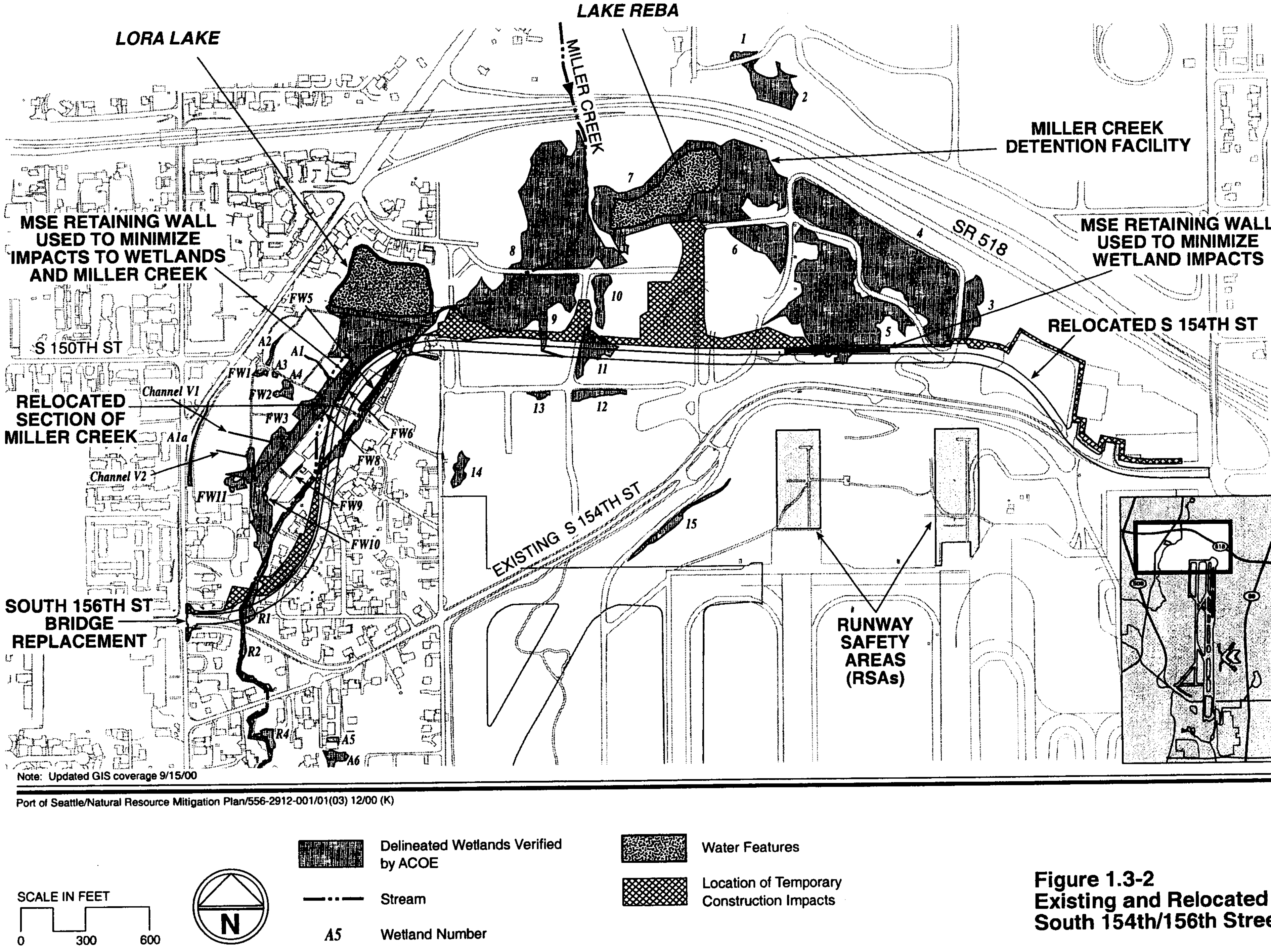



**Figure 1.3-2**
**Existing and Relocated South 154th/156th Street**

### 1.3.5 Other Support Facilities

Stormwater, electrical, water, sewer, and other utilities must be provided to new or reconstructed airport facilities. Utilities that will result in unavoidable wetland impacts include the placement of stormwater detention facilities for the runway embankment, relocation of a sewer line, and the SASA detention pond. These wetland impacts are discussed in more detail in Chapter 3 of this report, and in the *Wetland Functional Assessment and Impact Analysis* (Parametrix 2000b).

## 1.4 RESPONSIBLE PARTIES

The Port is the applicant and owner of this project. The name and phone number of the Port representative in charge of environmental permitting and compliance for the project is: Ms. Elizabeth Leavitt, Manager-Aviation Environmental Programs; Port of Seattle; P.O. Box 68727; Seattle, WA 98168-0727; (206) 433-7203.

## 1.5 DOCUMENT ORGANIZATION

The organization of this document is based on the *Guidelines for Developing Freshwater Wetlands Mitigation Plans and Proposals* (Ecology 1994a). Following the introduction to the project and mitigation actions in Chapter 1, Chapter 2 describes existing ecological conditions, and in particular, existing conditions of wetlands and streams within the project area. Chapter 3 summarizes the direct and indirect impacts of the project to wetlands and other Waters of the U.S. (described in detail in Parametrix 2000b).

Chapter 4 provides a summary of the mitigation and performance monitoring plan. The mitigation sequencing approach and specific mitigation projects are described. The overall monitoring approach, methods, and schedules required to assure the ecological benefits of the mitigation is summarized. A description of the adaptive management approach that will be used to implement maintenance and contingency measures at the mitigation sites is also provided. Chapter 4 also describes the integrated weed management strategy that will be used to control invasive non-native species. Finally, Chapter 4 summarizes the relationship between the *Wildlife Hazard Management Plan* (WHMP) for controlling wildlife hazards near the airport, and each mitigation project.

Chapter 5 provides detailed mitigation plans, performance standards, monitoring approach, and implementation schedules for the on-site mitigation in the Miller and Des Moines Creek basins. Chapter 5 also describes mitigation to replace functions of drainage channels, mitigation for temporary construction impacts, and the monitoring of wetlands adjacent to the construction projects.

The stormwater management plan that is proposed to avoid, minimize, and mitigate for impacts to water quantity and/or quality in Miller and Des Moines Creeks is described in Chapter 6. Chapter 7 describes the mitigation plans, performance standards, monitoring approach, and schedules for the off-site wetland mitigation in Auburn.

Appendices A through E provide detailed plan drawings of key elements of each mitigation project. Appendix F includes the restrictive covenant language for mitigation sites. Appendix G contains the report on indirect hydrology impacts and mitigation at Borrow Area 3 produced by Hart Crowser (Hart Crowser 2000e). Appendix H includes samples of data sheets that would be used collecting information on wetlands during the monitoring period.

Natural Resource
Assessment

# 2. EXISTING CONDITIONS IN THE PROJECT AREA

This chapter describes the wetlands, streams, floodplains, and drainage channels in areas that will be temporarily or permanently impacted as a result of Master Plan Update improvements. The wetlands within the project area are described in detail in the *Wetland Delineation Report for Seattle-Tacoma International Airport Master Plan Update Improvements* (Parametrix 2000c), and the *Wetland Functional Assessment and Impact Analysis Report* (Parametrix 2000b). Additional detailed information on species listed under the Endangered Species Act is provided in the *Biological Assessment* (FAA 2000). Detailed information on existing ecological conditions relevant to the mitigation design at each site is included with the descriptions of each mitigation project in Chapters 5 and 7.

## 2.1 WETLANDS

Wetland delineations have been completed throughout the project area (FAA 1996; Parametrix 2000c). ACOE has verified the wetland delineations on all properties within the acquisition area, with the exception of parcels containing Wetland A20.

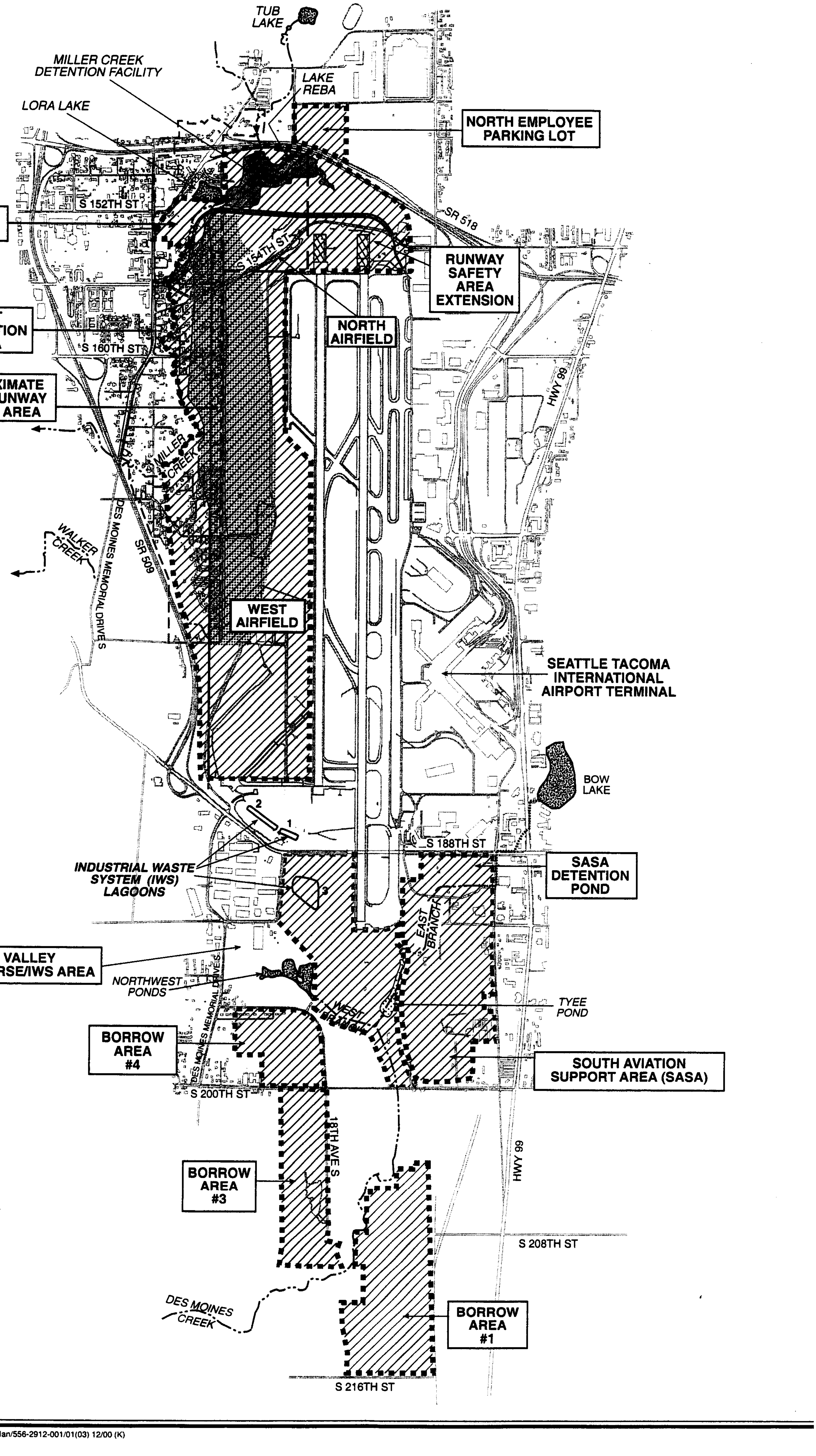
### 2.1.1 Wetland Delineation Methodology

Parametrix staff completed field investigations to identify and delineate wetlands in the acquisition area between March 1998 and November 2000. During these site visits, they inspected the project area (Figure 2.1-1) for wetland characteristics and related drainage features. Project staff identified and delineated wetlands in the project area using the Routine Determination Method outlined in the *Washington State Wetland Identification and Delineation Manual* (Ecology 1997) and the *U.S. Army Corps of Engineers Wetland Delineation Manual* (Environmental Laboratory 1987). The delineation methodology incorporated the following regulatory guidance letters and memoranda: ACOE Regulatory Guidance Letters 82-2, 86-9, and 90-7 (ACOE 1982, 1986, 1990); 3-92 Memorandum (ACOE 1992); 5-94 Public Notice (ACOE 1994); Ecology, 3/95 Public Notice (Ecology 1995).

To be considered a wetland, under normal circumstances, an area must have hydrophytic (wetland) vegetation, hydric soils, and wetland hydrology (Ecology 1997; Environmental Laboratory 1987). Areas that do not exhibit indicators for one or more of these three parameters are generally not regulated wetlands. However, in some cases when normal circumstances do not hold, all three parameters may not be present. Additional evaluations were completed to identify wetlands in disturbed and farmed areas (Parametrix 2000c).

ACOE made site visits to confirm wetland identifications and boundary delineations between July 1998 and November 2000. Modifications to delineated wetland boundaries that were requested by ACOE during those site visits have been made and are reflected in the mapping and analysis presented in this report. A summary of all the wetlands identified in the study area is presented in Table 2.1-1.

AR 009679

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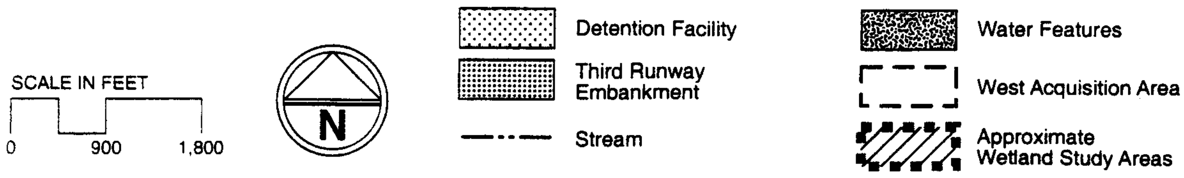



**Figure 2.1-1**
**Wetland Study Area for the Master Plan Update at STIA**

Table 2.1-1. Summary of wetland and other Waters of the U.S. areas in the Seattle-Tacoma International Airport Master Plan Update Area.

| Wetland [1] | Classification [2] | Area (Acres) | Drainage Basin |
|---|---|---|---|
| **North Employee Parking Lot Area** | | | |
| 1 | Forest | 0.07 | Miller |
| 2 | Forest | 0.73 | Miller |
| | Subtotal | 0.80 | |
| **Runway Safety Area Extension** | | | |
| 3 | Forest | 0.56 | Miller |
| 4 | Forest | 5.00 | Miller |
| 5 | Forest/Scrub-Shrub | 4.63 | Miller |
| 6 | Scrub-Shrub | 0.86 | Miller |
| | Subtotal | 11.05 | |
| **Third Runway Project Area** | | | |
| North Airfield | | | |
| 7[3] | Forest/Open Water/Emergent | 6.68 | Miller |
| 8 | Scrub-Shrub/Emergent | 4.95 | Miller |
| 9 | Forest/ Emergent (40/60) | 2.83 | Miller |
| 10 | Scrub-Shrub | 0.31 | Miller |
| 11 | Forest/Emergent (80/20) | 0.50 | Miller |
| 12 | Forest/Emergent (20/80) | 0.21 | Miller |
| 13 | Emergent | 0.05 | Miller |
| 14 | Forest | 0.19 | Miller |
| West Airfield | | | |
| 15 | Emergent | 0.28 | Miller |
| 16 | Emergent | 0.05 | Miller |
| 17 | Emergent | 0.02 | Miller |
| 18 | Forest/Scrub-Shrub/Emergent (50/20/30) | 3.56 | Miller |
| 19 | Forest | 0.56 | Miller |
| 20 | Scrub-Shrub/Emergent (90/10) | 0.57 | Miller |
| 21 | Forest | 0.22 | Miller |
| 22 | Scrub-Shrub/Emergent (90/10) | 0.06 | Miller |
| 23 | Emergent | 0.77 | Miller |
| 24 | Emergent | 0.14 | Miller |
| 25 | Forest | 0.06 | Miller |
| 26 | Emergent | 0.02 | Miller |
| W1 | Emergent | 0.10 | Miller |
| W2 | Forest/Emergent (20/80) | 0.22 | Miller |
| | Other Waters of the U.S. | 0.02 | Miller |
| Vacca Farm Site | | | |
| FW1 | Farmed Wetland | 0.03 | Miller |
| FW2 | Farmed Wetland | 0.09 | Miller |

AR 009681

Table 2.1-1. **Summary of wetland and other Waters of the U.S. areas in the Seattle-Tacoma International Airport Master Plan Update Area (continued).**

| Wetland [1] | Classification [2] | Area (Acres) | Drainage Basin |
|---|---|---|---|
| FW3 | Farmed Wetland | 0.59 | Miller |
| FW5 | Farmed Wetland | 0.08 | Miller |
| FW6 | Farmed Wetland | 0.07 | Miller |
| FW8 | Farmed Wetland | 0.03 | Miller |
| FW9 | Farmed Wetland | 0.01 | Miller |
| FW10 | Farmed Wetland | 0.02 | Miller |
| FW11 | Farmed Wetland | 0.11 | Miller |
| | Other Waters of the U.S. | 0.02 | Miller |
| West Acquisition Area | | | |
| 35a-d | Forest/Emergent (40/60) | 0.67 | Miller |
| 37a-f | Forest/Emergent (70/30) | 5.73 | Miller |
| 39 | Forest/Scrub-Shrub/Emergent (25/50/25) | 0.90 | Miller |
| 40 | Scrub-Shrub | 0.03 | Miller |
| 41a and b | Emergent/Open Water | 0.44 | Miller |
| 44a and b | Forest/Scrub-Shrub (70/30) | 3.08 | Miller |
| A1 | Forest/Scrub-Shrub/Emergent (15/15/70) | 4.66 | Miller |
| A2 | Scrub-Shrub | 0.05 | Miller |
| A3 | Scrub-Shrub | 0.01 | Miller |
| A4 | Scrub-Shrub | 0.03 | Miller |
| A5 | Emergent | 0.03 | Miller |
| A6 | Forest | 0.16 | Miller |
| A7 | Forest | 0.30 | Miller |
| A8 | Forest/Scrub-Shrub (30/70) | 0.38 | Miller |
| A9 | Scrub-Shrub | 0.04 | Miller |
| A10 | Scrub-Shrub | 0.01 | Miller |
| A11 | Scrub-Shrub | 0.02 | Miller |
| A12 | Scrub-Shrub | 0.11 | Miller |
| A13 | Forest | 0.12 | Miller |
| A14a and b | Forest/Scrub-Shrub/Emergent (50/25/25) | 0.19 | Miller |
| A15 | Emergent | 0.04 | Miller |
| A16 | Scrub-Shrub/Emergent (20/80) | 0.09 | Miller |
| A17 | Forest/Scrub-Shrub/Emergent (20/80) | 2.66 | Miller |
| A18 | Scrub-Shrub | 0.01 | Miller |
| A19 | Emergent | 0.04 | Miller |
| Lora Lake | Open Water | 3.06 | Miller |
| | Other Waters of the U.S. | 0.33 | Miller |
| Riparian Wetlands | | | |
| R1 | Emergent | 0.17 | Miller |
| R2 | Scrub-Shrub/Emergent (70/30) | 0.12 | Miller |
| R3 | Scrub-Shrub | 0.02 | Miller |
| R4 | Emergent | 0.11 | Miller |
| R4b | Forest/Emergent (25/75) | 0.11 | Miller |

Table 2.1-1. **Summary of wetland and other Waters of the U.S. areas in the Seattle-Tacoma International Airport Master Plan Update Area (continued).**

| Wetland [1] | Classification [2] | Area (Acres) | Drainage Basin |
|---|---|---|---|
| R5 | Emergent | 0.05 | Miller |
| R5b | Forest/Emergent (25/75) | 0.07 | Miller |
| R6 | Forest/Emergent (25/75) | 0.21 | Miller |
| R6b | Emergent | 0.09 | Miller |
| R7 | Forest/Emergent (25/75) | 0.04 | Miller |
| R7a | Emergent | 0.04 | Miller |
| R8 | Scrub-Shrub/Emergent (40/60) | 0.40 | Miller |
| R9 | Forest | 0.38 | Miller |
| R9a | Forest/Scrub-Shrub/Emergent (25/50/25) | 0.74 | Miller |
| R10 | Scrub-Shrub | 0.04 | Miller |
| R11 | Emergent | 0.42 | Miller |
| R12 | Forest | 0.03 | Miller |
| R13 | Emergent | 0.12 | Miller |
| R14a | Scrub-Shrub/Emergent (25/27) | 0.13 | Miller |
| R14b | Emergent | 0.08 | Miller |
| R15a | Forest/Scrub-Shrub/Emergent (25/65/10) | 0.79 | Miller |
| R15b | Forest/Emergent (25/75) | 0.25 | Miller |
| R17 | Forest | 0.31 | Miller |
| | Subtotal | 51.33 | |
| **Borrow Area 1** | | | |
| 32 | Emergent | 0.09 | Des Moines |
| 48 | Forest/Emergent (20/80) | 1.58 | Des Moines |
| B1 | Forest/Scrub-Shrub (30/70) | 0.27 | Des Moines |
| B4 | Scrub-Shrub | 0.07 | Des Moines |
| B11 | Emergent | 0.18 | Des Moines |
| B12 [4] | Scrub-Shrub | 0.63 | Des Moines |
| B14 | Scrub-Shrub/Emergent (70/30) | 0.78 | Des Moines |
| B15 a and b [4] | Scrub-Shrub | 2.05 | Des Moines |
| | Other Waters of U.S. | 0.01 | Des Moines |
| | Subtotal | 5.66 | |
| **Borrow Area 3** | | | |
| 29 | Forest | 0.74 | Des Moines |
| 30 | Forest/Scrub-Shrub (80/20) | 0.88 | Des Moines |
| B5 | Forest/Scrub-Shrub (40/60) | 0.08 | Des Moines |
| B6 | Forest/Scrub-Shrub (30/70) | 0.55 | Des Moines |
| B7 | Forest/Scrub-Shrub (30/70) | 0.03 | Des Moines |
| B9 | Forest | 0.05 | Des Moines |
| B10 | Forest | 0.02 | Des Moines |
| | Subtotal | 2.35 | |

AR 009683

**Table 2.1-1. Summary of wetland and other Waters of the U.S. areas in the Seattle-Tacoma International Airport Master Plan Update Area (continued).**

| Wetland [1] | Classification [2] | Area (Acres) | Drainage Basin |
|---|---|---|---|
| **South Aviation Support Area (SASA)/Tyee Valley Golf Course** | | | |
| 28 [4] | Scrub-Shrub/Emergent/Open Water (50/30/20) | 35.45 | Des Moines |
| 52 | Forest/Scrub-Shrub/Emergent (80/20/20) | 4.70 | Des Moines |
| 53 | Forest | 0.60 | Des Moines |
| G1 | Emergent | 0.05 | Des Moines |
| G2 | Emergent | 0.02 | Des Moines |
| G3 | Emergent | 0.06 | Des Moines |
| G4 | Emergent | 0.04 | Des Moines |
| G5 | Emergent | 0.87 | Des Moines |
| G6 | Emergent | 0.01 | Des Moines |
| G7 | Forest/Scrub-Shrub (30/70) | 0.50 | Des Moines |
| G8 | Emergent | 0.04 | Des Moines |
| WH | Open Water | 0.25 | Des Moines |
| DMC | Forest/Scrub-Shrub/Emergent | 1.08 | Des Moines |
| | Subtotal | 43.67 | |
| **IWS Area** | | | |
| IWS a and b | Forest | 0.67 | Des Moines |
| | Subtotal | 0.67 | |
| **South Aviation Support Area Detention Pond** | | | |
| E1 | Forest | 0.23 | Des Moines |
| E2 | Forest | 0.04 | Des Moines |
| E3 | Forest | 0.06 | Des Moines |
| | **Subtotal** | **0.33** | Des Moines |
| **TOTAL** | | **115.86** | |

1 Wetlands are labeled according to the following protocol:
- Wetlands with only numerical designations (e.g., Wetland 35 or Wetland 44) were described by Shapiro and Associates, Inc. (FAA 1995).
- Wetlands with an 'A' designation (e.g., Wetland A5 or A10) are wetlands occurring within the west acquisition area.
- Wetlands with an 'R' designation (e.g., Wetland R5 or R6) are riparian wetlands occurring within the west acquisition area.
- Wetlands with a 'W' designation (e.g., Wetland W1 or W2) are wetlands occurring within the west airfield area.
- Wetlands with a 'G' designation (e.g., Wetland G5 or G6) are wetlands occurring within the Tyee Valley Golf Course or the SASA areas.
- Wetlands with an 'E' designation (e.g., Wetland E1 or E2) are wetlands occurring within the SASA detention pond area.
- Wetlands with an 'IWS' designation (e.g., IWSa and IWSb) are wetlands occurring near the IWS lagoon.
- Wetlands with a 'B' designation (e.g., Wetland B5 or B10) are wetlands occurring within the borrow sites.
- Wetland numbers followed by a small case letter designate subsections of a larger wetland (i.e., Wetland 35a, or 35b) where constructed features (i.e., driveways) fragment a larger wetland.

2 Numbers indicate approximate percentage of cover by respective wetland classes (Cowardin et al. 1979).

3 Includes Lake Reba.

4 Portions of the wetland area are estimated.

AR 009684

### 2.1.2 Wetland Descriptions

About one hundred seventeen wetlands totaling about 115 acres were identified within the study area in the Miller and Des Moines Creek basins (see Table 2.1-1; Figures 2.1-2, 2.1-3, and 2.1-4). These wetlands range in size from 0.01 to about 35 acres (see Table 2.1-1), and include slope, depressional, and riparian wetlands (Brinson 1993). Palustrine forested, scrub-shrub, emergent, and open-water wetland classes are present within the project area (see Table 2.1-1). A detailed description of all wetlands found within the study area is provided in the *Wetlands Delineation Report* (Parametrix 2000c). Many of the wetlands in the project area are small, degraded by past and ongoing human disturbance, and isolated from other wetlands by areas of unsuitable habitat (e.g., roadways, buildings). Ecological functions of wetlands within the study area are described in the *Wetland Functional Assessment and Impact Analysis Report* (Parametrix 2000b). Mitigation for impacts to the ecological functions that the wetlands provide will be mitigated as described in this document (see Chapter 5).

## 2.2 STREAMS

Several stream systems (Walker, Miller, Des Moines, and Gilliam Creeks) occur in the project area. These have been evaluated as part of the environmental review for the Master Plan Update improvements (FAA 1996, 1997; KCSWM 1987; Hillman et al 1999; Parametrix 2000d). The following sections describe these stream systems. Additional detailed information on existing ecological conditions in the streams is provided in the *Biological Assessment* (Parametrix 2000d), as well as in the detailed mitigation plan descriptions in Chapter 5.

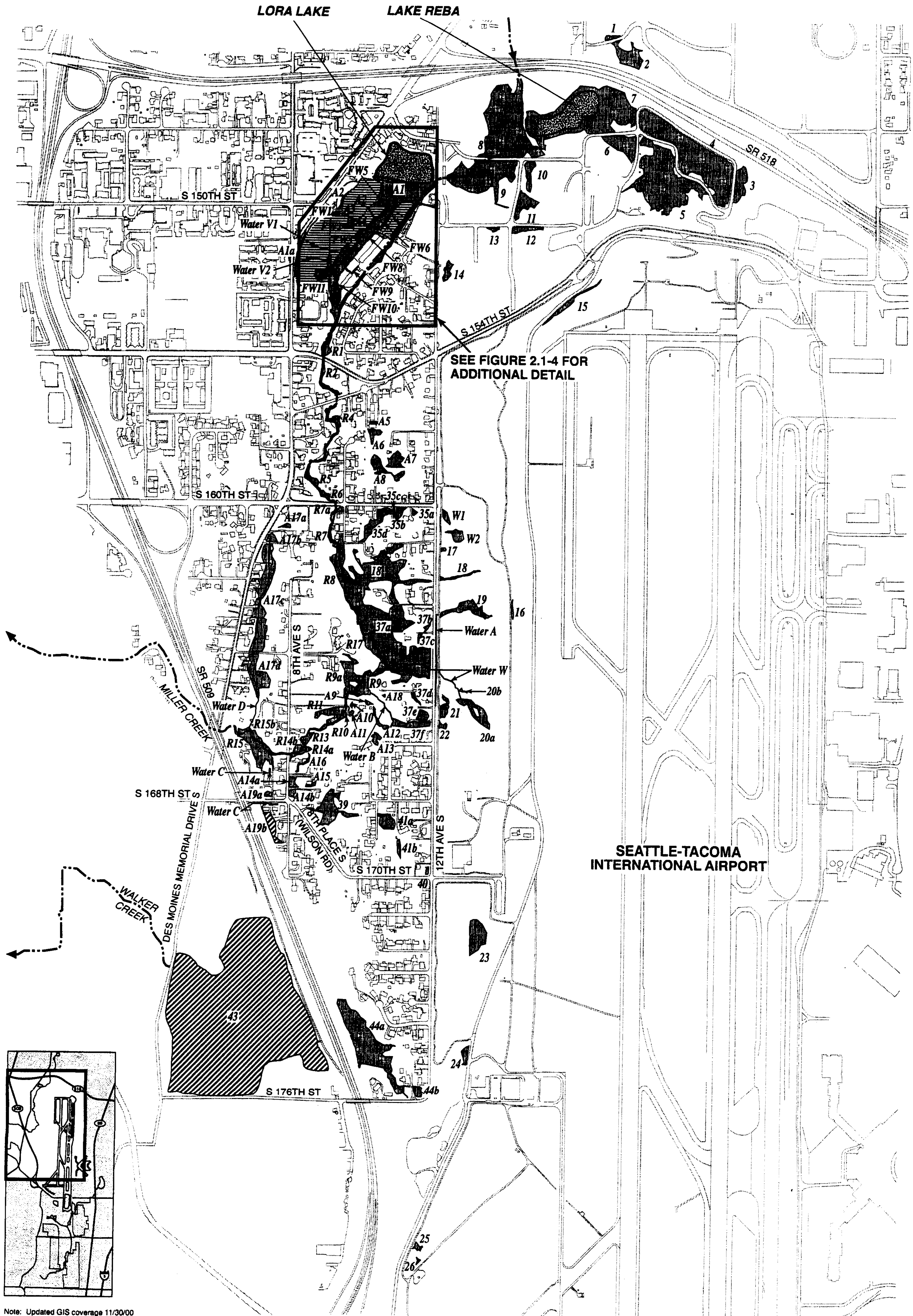
### 2.2.1 Miller Creek Basin

Miller and Walker Creeks, the two streams located in the Miller Creek basin, are near or within the project area. Miller Creek originates at Arbor Lake (near the corner of 5$^{th}$ Avenue, south of South 124$^{th}$ Street) and flows approximately 5.3 miles to Puget Sound. Walker Creek originates in Wetland 43 west of SR 509 (U.S. Geologic Survey [USGS] Des Moines Quadrangle 1995) and flows into Miller Creek approximately 500 ft upstream of its mouth at Puget Sound (Figure 2.2-1). While a portion of the Walker Creek drainage basin is located within the study area, the stream itself is located approximately 1,000 ft downslope of, and west of, the project area.

#### 2.2.1.1 Miller Creek

Miller Creek is located in southwest King County and has a basin size of approximately 8 square miles. The Miller Creek basin lies within the Cities of SeaTac and Burien. Flows in Miller Creek originate at three locations: (1) the Arbor, Burien, Tub, and Lora Lakes complex; (2) Lake Reba; and (3) seeps located on the west side of STIA. Miller Creek generally flows south and southwest toward Puget Sound. On the west side of the airport, a number of drainage channels convey water from the plateau and hillslope to the stream. These channels (King County 1990) have been ditched, and function primarily as surface or groundwater conveyance channels.

AR 009685




Note: Updated GIS coverage 11/30/00

Port of Seattle/Natural Resource Mitigation Plan/556-2912-001/01(03) 12/00 (K)

**AR 009686**

SCALE IN FEET

0 400 800

N

Water Features

Delineated Wetlands Verified by ACOE

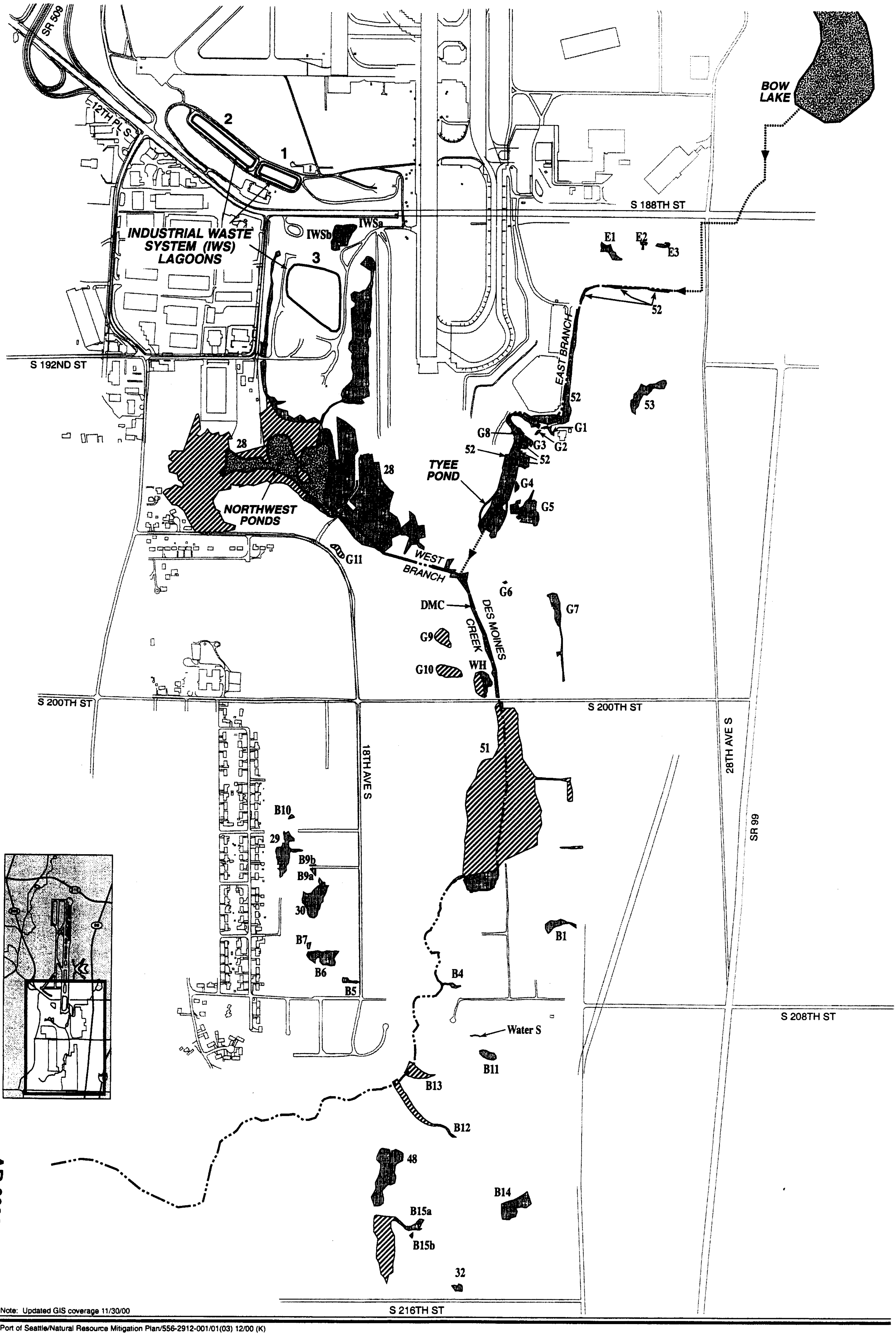
Wetlands Not Verified by ACOE

Prior Converted Cropland

Stream

*41a* Wetland Number

**Figure 2.1-2**
**Wetlands in the Miller Creek Basin Near STIA**




Note: Updated GIS coverage 11/30/00

Port of Seattle/Natural Resource Mitigation Plan/556-2912-001/01(03) 12/00 (K)

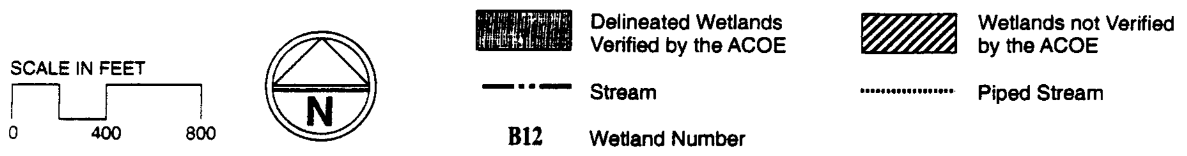
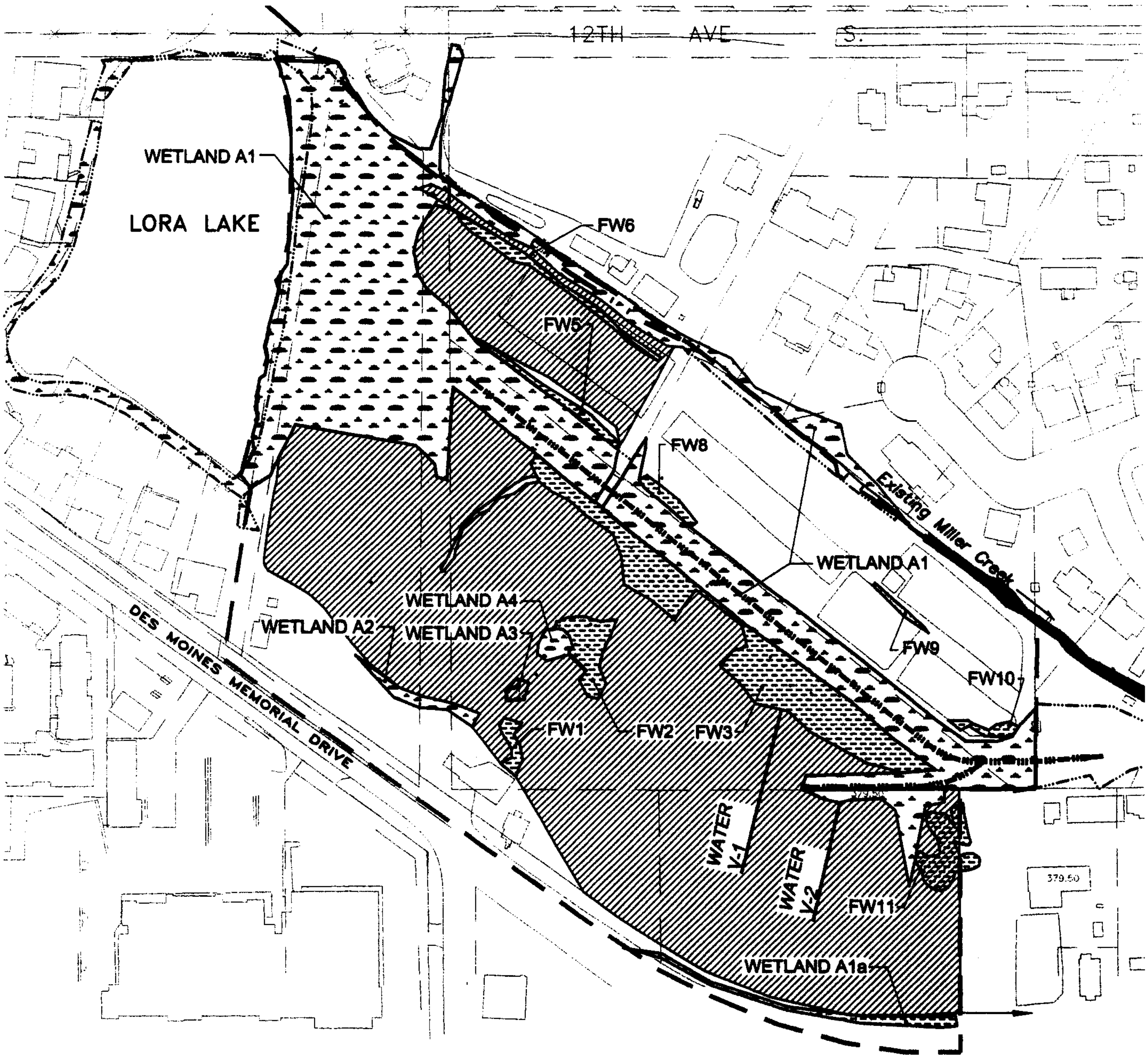



**Figure 2.1-3**
**Wetlands in the Des Moines Creek Basin Near STIA**

AR 009687




AR 009688

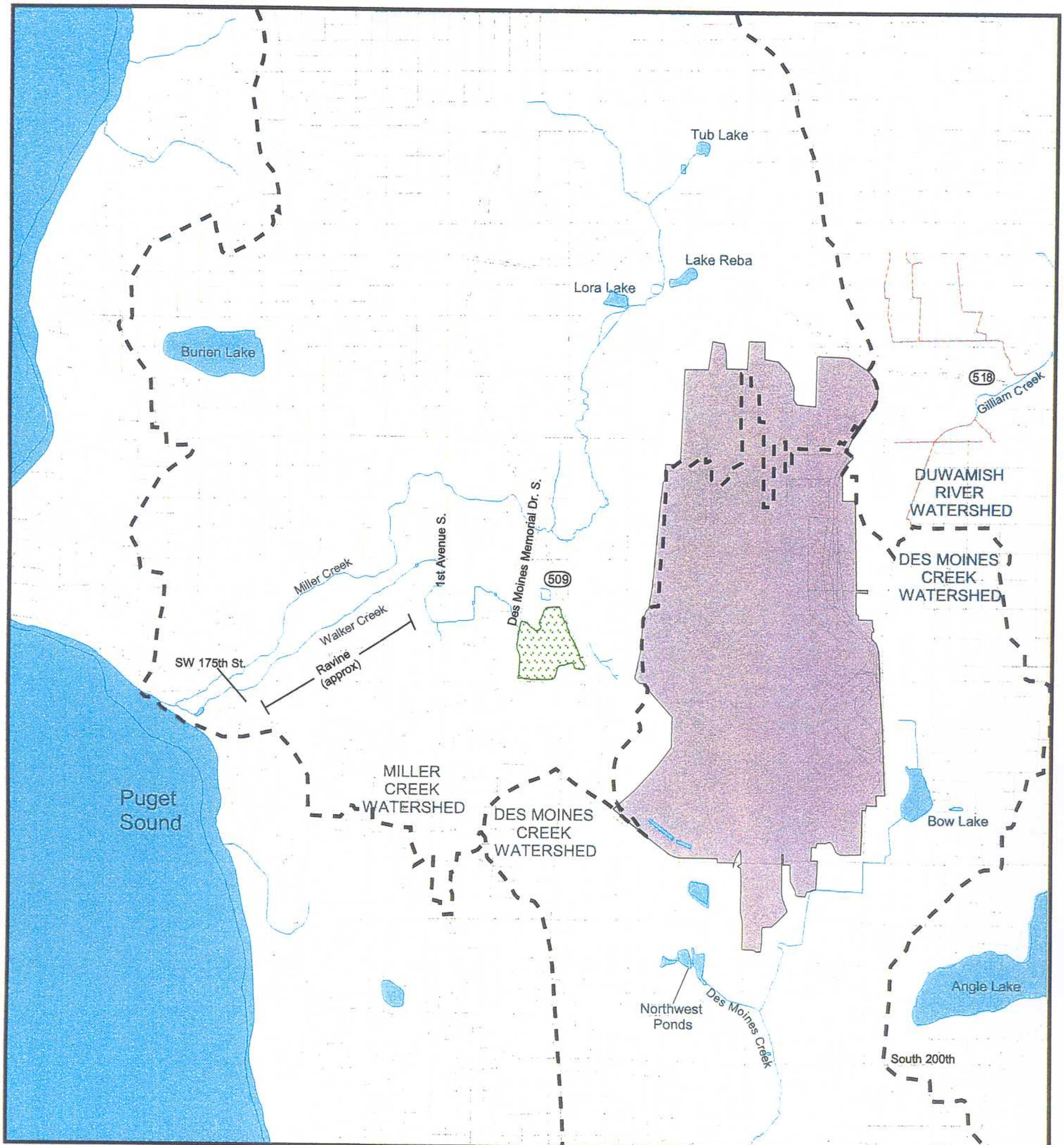
FILE: 291203_F2.2-5
DATE: 11/27/00

0 100 200
SCALE IN FEET

N

LEGEND:
Detail Area
Drainage Ditch
Vegetated Wetlands
Farmed Wetlands (FW), 14 Day Inundation (Observed, 3/98)
Prior Converted Wetlands

**Figure 2.1-4**
**Jurisdictional Wetlands on the Vacca Farm Site**




Parametrix, Inc./Sea-Tac Airport Stormwater Management Plan/556-2912-001(28) 6/00 File: k:\gis\2912\Arcview\Figure232.apr

Source: Roads based on King County data. Water bodies derived from USGS hypsography data. Estimated wetland boundaries are based on field reconnaissance by Parametrix, Inc. Land use data interpreted from 1993 STIA aerial photograph (Walker and Assoc. 1993).

Note: Subbasin boundaries shown outside of STIA area are for illustration and reference only.

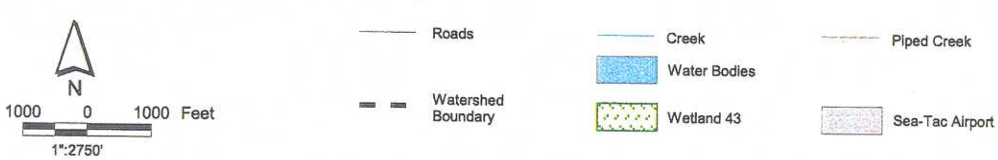



**Figure 2.2-1**
**Location of Miller Creek, Walker Creek, and Des Moines Creek Near STIA**

AR 009689

Most of the 5,050-acre Miller Creek watershed is developed with residential and commercial properties. Approximately 62 percent of the land use in the basin is residential, 15 percent is commercial, 3 percent is STIA[2] (excluding the Industrial Water System (IWS) drainage area, which treats stormwater runoff prior to being discharged to Puget Sound), and the remaining 20 percent is undeveloped (Montgomery Water Group 1995). Much of the undeveloped land in the watershed is owned by the Port. Commercial land uses are scattered along Des Moines Way, Ambaum Boulevard, and First Avenue South. Some agricultural uses are also found in the upper watershed. Although urbanization throughout the basin has altered the stream and riparian ecosystems, Miller Creek continues to support fish and wildlife species.

**Stream Classification**

WDFW has classified the lower reaches of Miller Creek as Class II salmon-bearing waters. Miller Creek is designated as an extraordinary (Class AA) quality water body by the Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201). However, Miller Creek has failed to meet some of the state water quality standards (FAA 1996). Occasional violations of Class AA water quality standards for pH, dissolved oxygen, and ammonia have also occurred in the basin (FAA 1996). Runoff from residential, commercial, and agricultural properties has contributed to water quality degradation. Pollutants such as nutrients, organics, metals, fecal coliform bacteria, and suspended solids commonly associated with urban runoff, have been found in Miller Creek and contribute to occasional violations of state and federal water quality standards.

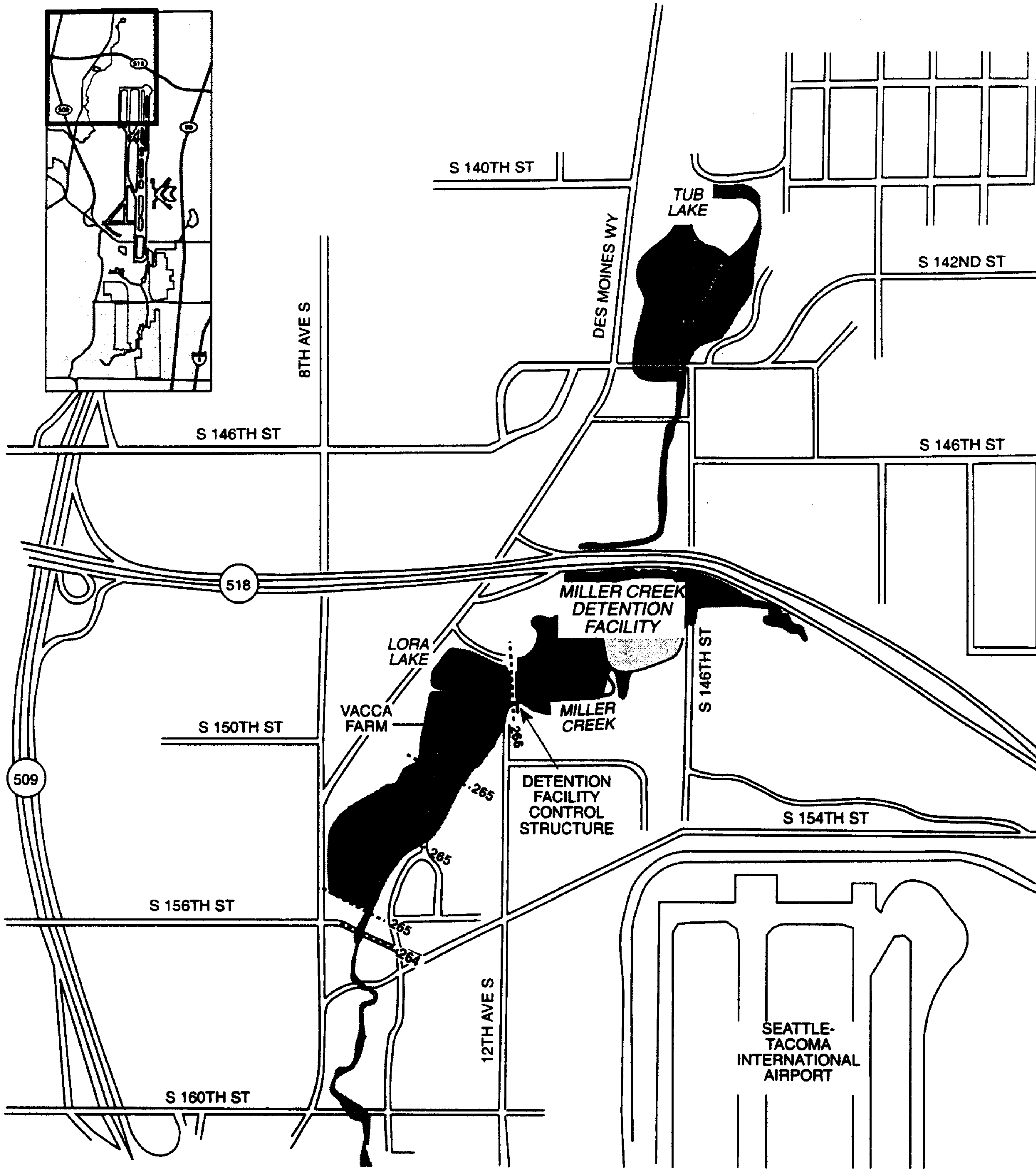
The floodplain in the stream reach between South 156$^{th}$ Street and South 160$^{th}$ Street is relatively confined to the channel ravine and is approximately 60 to 100 ft wide. In the stream reach south of South 160$^{th}$ Street, the floodplain is approximately 80 to 150 ft wide in the upper reaches. However, further downstream, it widens to approximately 200 to 250 ft.

Urbanization and agriculture have significantly altered the floodplains associated with Miller Creek. The wetland filling, riparian vegetation removal, culvert installation, and streambank armoring have reduced stream channel and floodplain capacities. Increased development and impervious surface areas in the basin result in increased stormwater runoff rates and volumes.

The 100-year floodplain in the vicinity of the Vacca Farm site is several acres in size (Figure 2.2-2). The wetland area and poor drainage that existed prior to land agricultural drainage activities are evident from the 100-year floodplain estimated by the Federal Emergency Management Agency (FEMA). The approximate 100-year flood elevations, determined by FEMA as part of its study, vary from 266 ft at the Miller Creek detention facility outlet, to approximately 265 ft at the downstream end of the Vacca Farm site (see Figure 1.2-2). A floodway has also been delineated and mapped in a portion of the floodplain.

The floodplain in the reach between South 156$^{th}$ Street and South 160$^{th}$ Street is relatively confined to the channel ravine and is approximately 60 to 100 ft wide. In the reach south of South 160$^{th}$ Street, the floodplain is approximately 80 to 150 ft wide in the upper reaches. However, further downstream, it widens to approximately 200 to 250 ft.

[2] This area will increase to 9 percent with acquisition of west side property.




Source: FEMA 1995



N

NOT TO SCALE

100-year Flood Elevation (approximately 265.4 ft)

Floodway

100-Year Floodplain

**Figure 2.2-2**
**Miller Creek**
**100-Year Floodplain**

**Miller Creek Tributary Drainage Channels**

Five intermittent water drainage channels (referred to as Waters A, B, C, D, and W) are located within the Miller Creek basin in the acquisition area on the west side of the existing runway (see Figure 2.1-2). These channels are regulated as Waters of the U.S. by ACOE, and portions of them are mapped by the *King County Sensitive Areas Portfolio* (King County 1990).

Water A is an approximately 814-ft-long by 5-ft-wide (0.09-acre) drainage ditch. This ditch collects surface water runoff from 12th Avenue South, the airport security road, and several upslope wetlands (Wetlands 19, 21, and 22). A portion of Water W, which originates in Wetland 20, also drains westward into Water A. These waters drain into Wetland 37 through a culvert under 12th Avenue South and convey channelized flow through a continuation of Water W for approximately 494 feet (0.03 acre) to Miller Creek. Water A and portions of Water W are mapped in the King County sensitive area map folio (King County 1990) as an unclassified stream.

Water B is an approximately 314-ft-long by 4-ft-wide (0.03-acre) incised channel that conveys water from the west end of Wetland 37f northwest to riparian Wetland R9, which, in turn, drains to Miller Creek.

Water C is a discontinuous ditch that flows through culverts or cement-lined channels on Parcel 251. The exposed ditch totals approximately 170 linear feet (0.01 acre) from South 168th Street to Miller Creek.

Water D is a intermittent stream that begins east of Des Moines Memorial Drive and north of South 160th Street. The channel flows approximately 1,830 linear feet (0.16 acre) through several sections of Wetland A17 and enters Miller Creek on Parcel 243, approximately 200 feet upslope of Des Moines Memorial Drive.

### 2.2.1.2 Walker Creek

Walker Creek is the major tributary of Miller Creek and originates in Wetland 43 west of SR 509. Several small seep areas located east of SR 509 feed into Wetland 43. Walker Creek flows for approximately 1.3 miles southwest and generally parallel to Miller Creek before joining Miller Creek less than 500 ft upstream of Puget Sound (see Figure 2.2-1). Land use in the Walker Creek basin consists of residential and commercial development in densities similar to those described for Miller Creek. A small portion of Port property drains to Walker Creek. However, no portion of the active runway, airfield, or airport operations area drains to Walker Creek.

The contributing basin to Walker Creek, including Wetland 43, is shown in Figure 2.2-1. Stream flow rates are typically highest between October and April during the wet season and lowest between May and September (FAA 1996). Walker Creek receives stormwater runoff originating from residential and commercial development within the basin, which has likely increased the frequency and magnitude of peak flows. Upstream of Southwest 175th Street, the Federal Emergency Management Agency (FEMA) classified the floodplain as areas where the 100-year flood depth is less than 1.0 ft, or the drainage area is less than 1 square mile. FEMA also mapped a more extensive (several acres) floodplain from the confluence of Walker and Miller Creeks to Puget Sound.

In the lower gradient upper reaches, Walker Creek flows through confined rockery hardened banks, several culverts, and along roadside ditches. As the gradient increases, Walker Creek flows through a ravine (downstream of 1st Avenue South); however, field evaluations of this area could not be conducted due to limited access to private property. As the gradient decreases below the ravine and above the confluence with Miller Creek, the stream is again confined by urban development, including yards, ditches, and culverts. Walker Creek has riparian cover along most of its length. Trees and shrubs are the dominant vegetation type, however mowed lawn is also common along the banks (Hillman et al. 1999).

Walker Creek is unclassified by King County, however, it would likely be classified as a DNR type 3 stream due to stream size and salmonid use. No studies have measured water quality in Walker Creek; it is likely that the stream has pollutant loads typical of streams in Puget Sound lowland urbanized watersheds, and similar to Miller Creek. Walker Creek supports coho and chum spawning, although a recent survey found that approximately 75 percent of the coho spawning in the stream were from hatcheries (Hillman et al. 1999). The stream has limited large woody debris, undercut banks, or other types of cover features (Hillman et al. 1999), which in turn limits fish habitat in the stream.

### 2.2.2 Des Moines Creek Basin

The Des Moines Creek drainage basin consists of about 3,525 acres situated primarily south and southeast of the airport (see Figure 1.2-2). The Des Moines Creek watershed is largely urbanized and includes portions of the Cities of Des Moines, Normandy Park, SeaTac, and Burien. STIA occupies approximately 23 percent of the watershed (excluding other Port properties such as Tyee Valley Golf Course and noise abatement areas). The area directly southeast of the airport, once residential, has largely been purchased by the Port as part of the Noise Remedy Program. The Tyee Valley Golf Course occupies the area immediately south of the airport. The remainder of the watershed is mixed residential, commercial, and industrial uses.

#### 2.2.2.1 Des Moines Creek

The east branch of Des Moines Creek originates from Bow Lake, and the west branch originates from the Northwest Ponds. From the confluence of the two branches on the Tyee Valley Golf Course, Des Moines Creek extends about 3.5 miles southeast to Puget Sound. In that distance it drops about 300 ft in elevation. Two unnamed tributaries enter the stream at about river miles (RMs) 0.7 and 1.9 (Williams et al. 1975).

Des Moines Creek is designated as an extraordinary (Class AA) quality water body by the Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201). From the west branch downstream of the Northwest Ponds, it is a Class II salmon-bearing stream.

#### 2.2.2.2 Drainage Channel

A small drainage channel (Water S) is present in Borrow Area 1, South of South 208th Street and east of Des Moines Creek (see Figure 2.1-3). Water S, classified as a Water of the U.S., contains intermittent flow, but does not contain wetland soil or vegetation. Water S is a 90-ft-long by 3-ft-wide (0.01-acre) channel that conveys water from a small spring into a 4-inch drainage pipe.

### 2.2.3 Gilliam Creek

Gilliam Creek[3] is a small stream that receives runoff from STIA, and discharges to the Green/Duwamish River in the vicinity of the city of Tukwila (see Figure 2.2-1). This stream is used primarily by resident fish because of migration barriers that limit anadromous fish passage (Taylor Associates 1996 in City of Tukwila 1997). Gilliam Creek, which has been impacted by development, is extensively culverted and receives stormwater runoff that causes high peak flows and low base flows. Access by fish to the lower reaches of Gilliam Creek is restricted by a culvert and flap gate where the stream drains into the Green/Duwamish River. Culverts limit adult salmonid access to much of this tributary, although juvenile chinook and coho salmon have been reported in the stream. The resident fishes expected to inhabit this stream and long piped sections include cutthroat trout (*Oncorynchus clarki clarki*), western brook lamprey (*Lampetra richardsoni*), carp (*Cyprinus* sp.), peamouth (*Mylocheilus caurinus*), largescale sucker (*Catostomus macrocheilus*), threespine stickleback (*Gasterosteus aculeatus*), and sculpin (*Cottus* sp.).

About 50 percent of Gilliam Creek is contained in culverts, and much of the remainder of the stream flows in constructed ditches. Riparian vegetation is lacking along most of the stream corridor or is predominantly herbaceous and provides little shade.

Urban developments within the watershed have altered native soils and vegetation, resulting in increased scour and sedimentation in Gilliam Creek. Changes such as stream channelization and the removal of large woody debris have increased stream degradation and fine sediment input. Scour and erosion characterize the upper reaches of the stream, resulting in downstream sedimentation in the lower reaches. Base flow measurements of water quality indicated that concentrations in Gilliam Creek do not meet Washington State Class A water quality standards for pH, dissolved oxygen, dissolved copper, dissolved lead, dissolved zinc, and fecal coliform bacteria (Herrera and RW Beck 2000).

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[3] Gilliam Creek is described in this section. Master Plan Update improvements do not add new impervious area or alter any wetlands or stream channels in this basin. For these reasons, no natural resource mitigation in this basin is necessary.

**Natural Resource Impacts**

# 3. NATURAL RESOURCE IMPACTS SUMMARY

The STIA Master Plan Update improvements will affect wetlands, streams, floodplain, drainage channels, and stormwater in the Miller and Des Moines Creek basins. To construct the projects, fill material would be placed in approximately 980 linear ft of Miller Creek, approximately 5.24 acre-ft of the Miller Creek 100-year floodplain, approximately 18.37 acres of wetland, and about 1,290 linear ft of drainage channel. In addition, new impervious surfaces will affect stormwater runoff and water quality conditions. The impacts of these actions, which are the basis for the mitigation described in Chapters 4, 5, and 7 of this report, are described in the FSEIS (FAA 1997a) for the project. Wetland and stream impacts resulting from STIA Master Plan Update improvements are summarized in the discussion that follows. Detailed analyses of these impacts are presented in the following documents:

- *Wetland Functional Assessment and Impact Analysis* (Parametrix 2000b)
- *Comprehensive Stormwater Management Plan for Seattle-Tacoma International Airport Master Plan Improvements* (Parametrix 2000a)
- *Final Supplemental Environmental Impact Statement for the Proposed Master Plan Update Development Actions at Seattle-Tacoma International Airport* (FAA 1997a).

## 3.1 WETLANDS

The FSEIS for the Master Plan Update improvements identified 12.23 acres of wetland that would be directly affected by Master Plan Update improvements (FAA 1997a; Parametrix 1996a). These determinations represented the best available information at the time of publication. Information supporting these determinations was obtained through field delineations and aerial photographic interpretation. Aerial photographic interpretation was used in the west side acquisition area where the Port lacked the access to properties necessary to conduct wetland delineations and subsequent agency review.

Since the publication of the FSEIS, the Port has purchased property and delineated wetlands that are subject to temporary or permanent impacts from the runway embankment, construction activities, and stormwater management (see *Wetland Delineation Report*, Parametrix 2000c). All wetlands within the acquisition area have been delineated.

Permanent wetland impact from Master Plan Update improvements would affect about 18.37 acres (Table 3.1-1, Figures 3.1-1 and 3.1-2, and the *Wetland Functional Assessment and Impact Analysis* [Parametrix 2000b]). Mitigation for these impacts is described in Chapters 4 (overview), 5 (in-basin for non-habitat wetland functions), and 7 (out-of-basin for habitat mitigation).

Permanent wetland impacts (fill and potential indirect) include approximately 8.17 acres of forest, 2.98 acres of shrub, and 7.22 acres of emergent habitat. Lower quality wetlands (Category III and Category IV) account for about 50 percent of the wetlands impacted by fill (Table 3.1-2). The remaining wetland impact areas affect higher quality Category II wetlands. All impacted wetlands have been subjected to significant historical or ongoing disturbances that have reduced their ecological value and ecosystem function (Parametrix 2000b).

**Table 3.1-1. Summary of wetland impacts for Seattle-Tacoma International Airport Master Plan Update improvements by construction project (all values are in acres).**

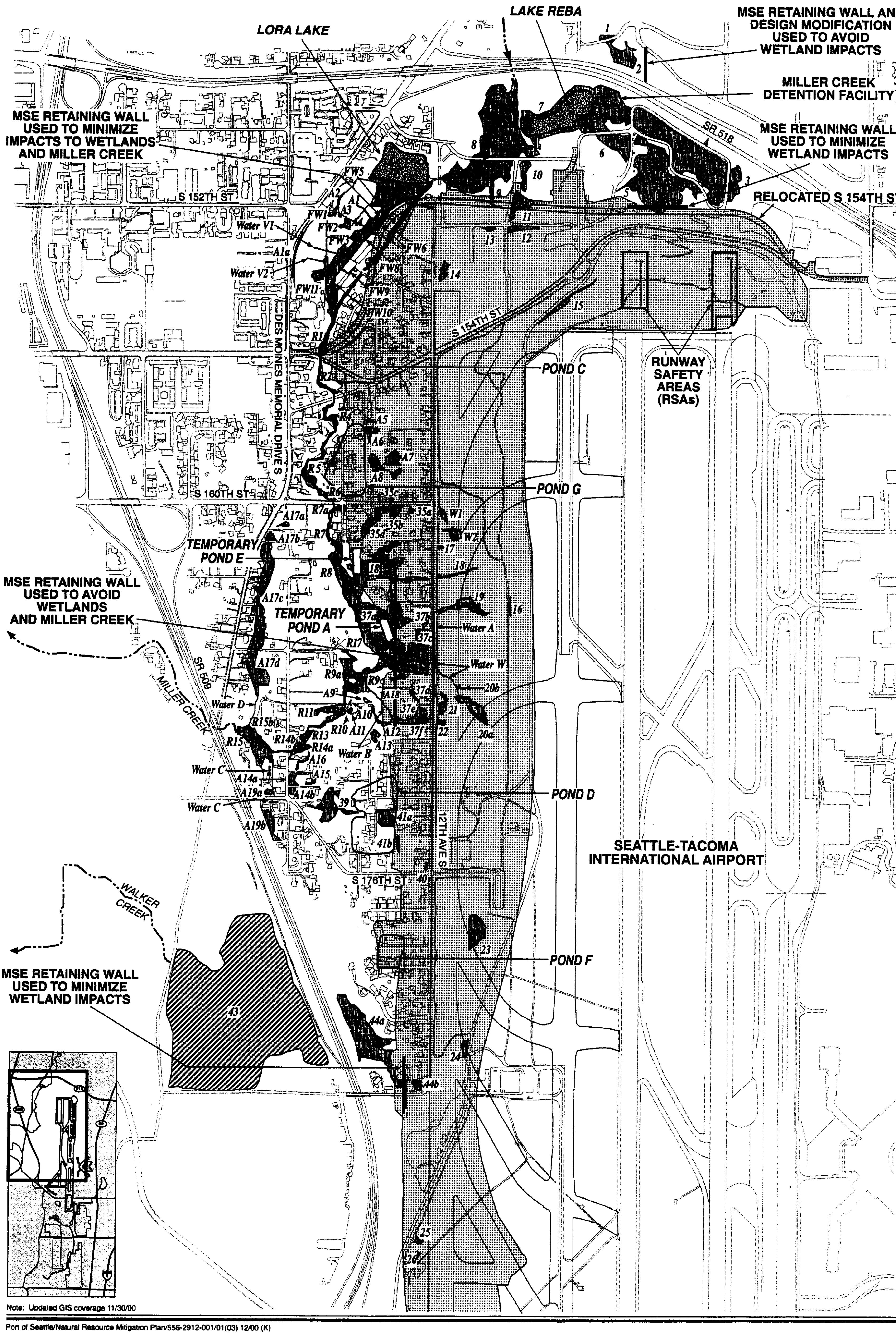
| Wetland Number | Vegetation Type [1] | Indirect Impact (acres) | Direct Impact (acres) | Total Impact (acres)[2] | Vegetation Types Impacted (acres) | | |
|---|---|---|---|---|---|---|---|
| | | | | | Forested | Shrub | Emergent |
| **Runway Safety Area Extension** | | | | | | | |
| 5 | Shrub | 0.00 | 0.14 | 0.14 | 0.07 | 0.07 | 0.00 |
| | **Subtotal** | **0.00** | **0.14** | **0.14** | **0.07** | **0.07** | **0.00** |
| **Third Runway Project Area** | | | | | | | |
| North Airfield | | | | | | | |
| 9 | Forested/Emergent | 0.00 | 0.03 | 0.03 | 0.01 | 0.00 | 0.02 |
| 11 | Forested/Emergent | 0.16 | 0.34 | 0.50 | 0.40 | 0.00 | 0.10 |
| 12 | Forested/Emergent | 0.00 | 0.21 | 0.21 | 0.04 | 0.00 | 0.17 |
| 13 | Emergent | 0.00 | 0.05 | 0.05 | 0.00 | 0.00 | 0.05 |
| 14 | Forested | 0.00 | 0.19 | 0.19 | 0.19 | 0.00 | 0.00 |
| West Airfield | | | | | | | |
| 15 | Emergent | 0.00 | 0.28 | 0.28 | 0.00 | 0.00 | 0.28 |
| 16 | Emergent | 0.00 | 0.05 | 0.05 | 0.00 | 0.00 | 0.05 |
| 17 | Emergent | 0.00 | 0.02 | 0.02 | 0.00 | 0.00 | 0.02 |
| 18 | Forested/Shrub/ Emergent | 0.55 | 2.29 | 2.84 | 1.28 | 0.75 | 0.81 |
| 19 | Forested | 0.00 | 0.56 | 0.56 | 0.56 | 0.00 | 0.00 |
| 20 | Shrub/Emergent | 0.00 | 0.57 | 0.57 | 0.00 | 0.51 | 0.06 |
| 21 | Forested | 0.00 | 0.22 | 0.22 | 0.22 | 0.00 | 0.00 |
| 22 | Shrub/Emergent | 0.00 | 0.06 | 0.06 | 0.00 | 0.01 | 0.05 |
| 23 | Emergent | 0.00 | 0.77 | 0.77 | 0.00 | 0.00 | 0.77 |
| 24 | Emergent | 0.00 | 0.14 | 0.14 | 0.00 | 0.00 | 0.14 |
| 25 | Forested | 0.00 | 0.06 | 0.06 | 0.06 | 0.00 | 0.00 |
| 26 | Emergent | 0.00 | 0.02 | 0.02 | 0.00 | 0.00 | 0.02 |
| W1 | Forested/Emergent | 0.00 | 0.10 | 0.10 | 0.00 | 0.00 | 0.10 |
| W2 | Forested/Emergent | 0.00 | 0.22 | 0.22 | 0.04 | 0.00 | 0.18 |
| West Acquisition Area | | | | | | | |
| 35a-d | Forested/Emergent | 0.04 | 0.63 | 0.67 | 0.27 | 0.00 | 0.40 |
| 37a-f | Forested/Emergent | 0.36 | 3.75 | 4.11 | 2.86 | 0.00 | 1.25 |
| 40 | Forested | 0.00 | 0.03 | 0.03 | 0.00 | 0.03 | 0.00 |
| 41a and b[3] | Emergent | 0.00 | 0.44 | 0.44 | 0.00 | 0.00 | 0.44 |
| 44a and b | Forested | 0.00 | 0.26 | 0.26 | 0.18 | 0.08 | 0.00 |
| A5 | Emergent | 0.02 | 0.01 | 0.03 | 0.00 | 0.00 | 0.03 |
| A6 | Forested | 0.09 | 0.07 | 0.16 | 0.16 | 0.00 | 0.00 |
| A7 | Forested | 0.00 | 0.30 | 0.30 | 0.30 | 0.00 | 0.00 |
| A8 | Forested/Shrub | 0.00 | 0.38 | 0.38 | 0.07 | 0.31 | 0.00 |
| A12 | Shrub | 0.06 | 0.02 | 0.08 | 0.00 | 0.08 | 0.00 |
| A 18 | Shrub | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.00 |

**Table 3.1-1. Summary of wetland impacts for Seattle-Tacoma International Airport Master Plan Update improvements by construction project (all values are in acres) (continued).**

| Wetland Number | Vegetation Type [1] | Indirect Impact (acres) | Direct Impact (acres) | Total Impact (acres)[2] | Vegetation Types Impacted (acres) | | |
|---|---|---|---|---|---|---|---|
| | | | | | Forested | Shrub | Emergent |
| Vacca Farm Site | | | | | | | |
| A1 | Forested/Shrub/ Emergent | 0.00 | 0.59 | 0.59 | 0.09 | 0.09 | 0.41 |
| FW 5 | Farmed Wetland | 0.00 | 0.08 | 0.08 | 0.00 | 0.00 | 0.08 |
| FW 6 | Farmed Wetland | 0.00 | 0.07 | 0.07 | 0.00 | 0.00 | 0.07 |
| Riparian Wetland | | | | | | | |
| R1 | Emergent | 0.00 | 0.13 | 0.13 | 0.00 | 0.00 | 0.13 |
| | **Subtotal** | **1.29** | **12.94** | **14.23** | **6.73** | **1.87** | **5.63** |
| **South Aviation Support Area (SASA)/Tyee Valley Golf Course** | | | | | | | |
| 52 | Forested/Shrub/Em ergent | 0.54 | 0.00 | 0.54 | 0.54 | 0.00 | 0.00 |
| 53 | Forested | 0.00 | 0.60 | 0.60 | 0.60 | 0.00 | 0.00 |
| E2 | Forested | 0.00 | 0.04 | 0.04 | 0.04 | 0.00 | 0.00 |
| E3 | Forested | 0.00 | 0.06 | 0.06 | 0.06 | 0.00 | 0.00 |
| G1 | Shrub (Slope) | 0.00 | 0.05 | 0.05 | 0.00 | 0.05 | 0.00 |
| G2 | Emergent | 0.00 | 0.02 | 0.02 | 0.00 | 0.00 | 0.02 |
| G3 | Emergent | 0.02 | 0.04 | 0.06 | 0.00 | 0.00 | 0.06 |
| G4 | Emergent | 0.04 | 0.00 | 0.04 | 0.00 | 0.00 | 0.04 |
| G5 | Emergent | 0.47 | 0.40 | 0.87 | 0.00 | 0.00 | 0.87 |
| G7 | Forested/Shrub | 0.00 | 050 | 0.50 | 0.13 | 0.37 | 0.00 |
| | **Subtotal** | **1.07** | **1.71** | **2.78** | **1.37** | **0.42** | **0.99** |
| **Borrow Area and Haul Road** | | | | | | | |
| 28 | Emergent | 0.00 | 0.07 | 0.07 | 0.00 | 0.00 | 0.07 |
| B11 | Emergent | 0.00 | 0.18 | 0.18 | 0.00 | 0.00 | 0.18 |
| B12 | Forested | 0.04 | 0.03 | 0.07 | 0.00 | 0.07 | 0.00 |
| B14 | Shrub | 0.00 | 0.78 | 0.78 | 0.00 | 0.55 | 0.23 |
| | **Subtotal** | **0.04** | **1.06** | **1.10** | **0.00** | **0.62** | **0.48** |
| **Mitigation[4]** | | | | | | | |
| Auburn area 7 | Emergent | 0.00 | 0.02 | 0.02 | 0.00 | 0.00 | 0.02 |
| Auburn area 9 | Emergent | 0.00 | 0.03 | 0.03 | 0.00 | 0.00 | 0.03 |
| Auburn area 10 | Emergent | 0.00 | 0.07 | 0.07 | 0.00 | 0.00 | 0.07 |
| | **Subtotal** | **0.00** | **0.12** | **0.12** | **0.00** | **0.00** | **0.12** |
| **TOTAL** | | **2.40** | **15.97** | **18.37** | **8.17** | **2.98** | **7.22** |

1. All wetlands are palustrine, based on USFWS wetland classification system (Cowardin et al. 1979).
2. Values are rounded to two significant figures. Wetland impact may be subject to minor changes.
3. Includes 0.18 acre of open water habitat.
4. Impacts result from access roads.

**AR 009698**




Note: Updated GIS coverage 11/30/00

Port of Seattle/Natural Resource Mitigation Plan/556-2912-001/01(03) 12/00 (K)

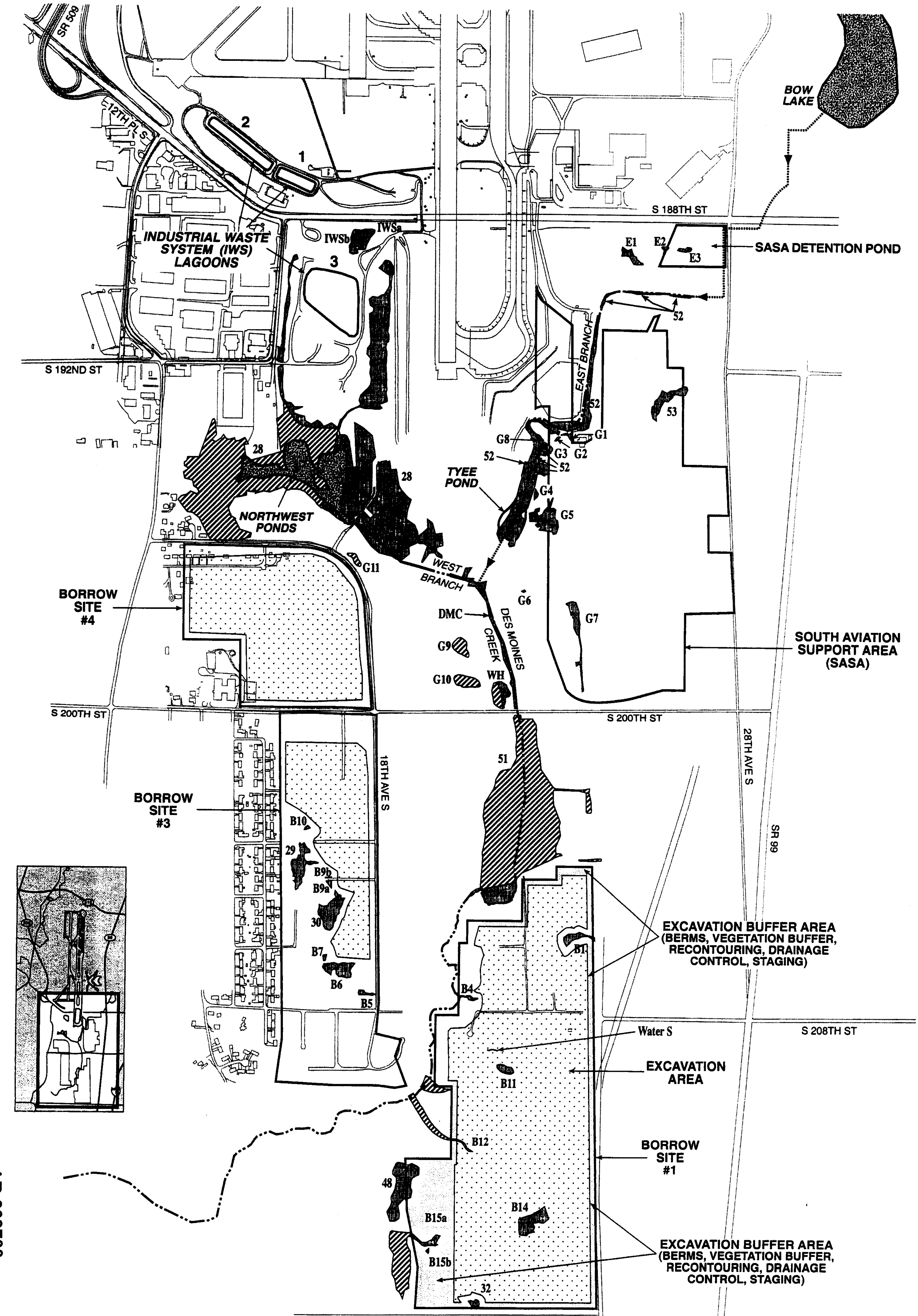
| | | | |
|---|---|---|---|
| (hatched) | Wetlands not Verified by ACOE | (stippled dark) | Water Features |
| (solid dark) | Delineated Wetlands Verified by ACOE | (dotted) | Embankment Area (Fill and Grading Third Runway, Runway Safety Area and S 154th Street) |
| —··— | Stream | *41a* | Wetland Number |

SCALE IN FEET
0 400 800

N

**Figure 3.1-1**
**Wetland Impacts in the Miller Creek Basin Near STIA**

AR 009699




AR 009700

Note: Updated GIS coverage 11/30/00

Port of Seattle/Natural Resource Mitigation Plan/556-2912-001/01(03) 12/00 (K)

Water Features

Delineated Wetlands Verified by the ACOE

Stream

B12 Wetland Number

Excavation Area

Wetlands not Verified by the ACOE

Piped Stream

SCALE IN FEET

0 400 800

N

**Figure 3.1-2**
**Wetland Impacts in the Des Moines Creek Basin Near STIA**

**Table 3.1-2. Summary of permanent wetland impacts by project and wetland category[1] (in acres).**

| Project | Category II | Category III | Category IV | Total |
|---|---|---|---|---|
| RSA | 0.00 | 0.14 | 0.00 | **0.14** |
| Third Runway | 8.37 | 4.89 | 0.97 | **14.23** |
| Borrow Area 1 and Haul Rd | 0.14 | 0.96 | 0.00 | **1.10** |
| SASA | 0.54 | 1.20 | 1.04 | **2.78** |
| Off-site Mitigation[2] | 0.00 | 0.12 | 0.00 | **0.12** |
| **TOTAL** | **9.05** | **7.31** | **2.01** | **18.37** |

[1] Ecology (1993)
[b] Impacts result from a permanent access road in an emergent wetland at the Auburn mitigation project.

During Master Plan Update improvement project construction, about 2.05 acres of wetland could temporarily be disturbed by construction activities, stormwater management, and temporary erosion and sediment control facilities (Table 3.1-3 and Figure 3.1-3) (Parametrix 2000b). Upon completion of construction, temporarily impacted areas will be restored. Restoration activities will include removing invasive plant species, planting native species, and regrading of temporarily impacted emergent wetlands to create higher quality forest, shrubs, and open water wetlands.

Additional impacts to wetlands that result from implementing the mitigation projects include constructing temporary and permanent access roads in wetlands and use of wetlands for temporary construction staging. Areas subject to temporary construction impacts will be regraded and replanted following construction.

**Table 3.1-3. Summary of temporary construction impacts to wetlands in the proposed Seattle-Tacoma International Airport Master Plan Update improvement area.**

| Wetland | Classification [1] | Total Temporary Impact Area (acres) | Vegetation Type Impacted (acres) | | |
|---|---|---|---|---|---|
| | | | Forest | Shrub | Emergent |
| **Runway Safety Area Extension** | | | | | |
| 4 | Forested [2] | 0.20 | 0.20 | 0.00 | 0.00 |
| 5 | Forested /Shrub [2] | 0.20 | 0.10 | 0.10 | 0.00 |
| **Third Runway** | | | | | |
| 9 | Forested/Emergent | 0.16 | 0.11 | 0.00 | 0.05 |
| 18 | Forested/Shrub/Emergent | 0.22 | 0.04 | 0.07 | 0.11 |
| 37 | Forested/Shrub/Emergent | 0.71 | 0.50 | 0.10 | 0.11 |
| 44a | Forested/Shrub | 0.28 | 0.18 | 0.10 | 0.00 |
| A1 | Forested/Shrub/Emergent [2] | 0.05 | 0.01 | 0.01 | 0.03 |
| A12 | Shrub | 0.03 | 0.00 | 0.03 | 0.00 |
| A13 | Forested | 0.01 | 0.01 | 0.00 | 0.00 |
| R2 | Emergent | 0.02 | 0.00 | 0.00 | 0.02 |
| **South Aviation Support Area** | | | | | |
| 52 | Forested/Shrub/Emergent [2] | 0.17 | 0.00 | 0.05 | 0.12 |
| **TOTAL** | | **2.05** | **1.15** | **0.46** | **0.44** |

[1] All wetlands are palustrine, based on USFWS wetland classification system (Cowardin et al. 1979).
[2] Temporary impacts will be limited to installation of sediment fencing and standard BMPs.

Approximately 40.49 acres of wetland will be disturbed during mitigation activities (Table 3.1-4) (Parametrix 2000b).

**Table 3.1-4. Summary of wetlands disturbed during mitigation activities.**

| Wetland | Vegetation Types | Total Area (acres) | Vegetation Type Disturbed (acres) | | |
|---|---|---|---|---|---|
| | | | Forest | Shrub | Emergent |
| **Temporary impacts to wetlands associated with implementing mitigation that includes excavation or installation of temporary roads** | | | | | |
| FW 1, 2, 3, 8, 9, 10, and FW 11 [1] | Farmed Wetlands | 0.88 | 0.00 | 0.00 | 0.88 |
| A1 [1] | Forest/Shrub/Emergent | 3.74 | 0.56 | 0.56 | 2.62 |
| A2 [1] | Shrub | 0.05 | 0.00 | 0.05 | 0.00 |
| A3 [1] | Shrub | 0.01 | 0.00 | 0.01 | 0.00 |
| A4 [1] | Shrub | 0.03 | 0.00 | 0.03 | 0.00 |
| Auburn Area 1 [2] | Emergent | 1.55 | 0.00 | 0.00 | 1.55 |
| Auburn Area 2 [3] | Emergent | 0.06 | 0.00 | 0.00 | 0.06 |
| Auburn Area 3 [3] | Emergent | 5.11 | 0.00 | 0.00 | 5.11 |
| Auburn Area 4 [3] | Emergent | 0.99 | 0.00 | 0.00 | 0.99 |
| Auburn Area 5 [3] | Emergent | 3.27 | 0.00 | 0.00 | 3.27 |
| Auburn Area 6 [3] | Emergent | 0.35 | 0.00 | 0.00 | 0.35 |
| Auburn Area 8 [3] | Emergent | 0.60 | 0.00 | 0.00 | 0.60 |
| Auburn Area 11 [3] | Emergent | 0.01 | 0.00 | 0.00 | 0.01 |
| Auburn [4] | Emergent | 2.20 | 0.00 | 0.00 | 2.20 |
| | **Subtotal** | **18.85** | **0.56** | **0.65** | **17.64** |
| **Temporary impacts in wetlands associated with enhancement planting** | | | | | |
| 18 [5] | Forest/Shrub/Emergent | 1.27 | 1.27 | 0.00 | 0.00 |
| 28 [6] | Forest/Shrub/Emergent | 4.50 | 0.00 | 0.00 | 4.50 |
| 37a [5,9] | Forest/Emergent | 1.96 | 1.50 | 0.00 | 0.46 |
| A1 [5,9] | Forest/Shrub/Emergent | 0.34 | 0.34 | 0.00 | 0.00 |
| A9 [5,9] | Shrub | 0.04 | 0.00 | 0.04 | 0.00 |
| A10 [5,9] | Shrub | 0.01 | 0.00 | 0.01 | 0.00 |
| A11 [5,9] | Shrub | 0.02 | 0.00 | 0.02 | 0.00 |
| A13 [5,9] | Forest | 0.12 | 0.12 | 0.00 | 0.00 |
| A16 [5,9] | Shrub/Emergent | 0.05 | 0.00 | 0.00 | 0.05 |
| R1 [5] | Emergent | 0.04 | 0.00 | 0.00 | 0.04 |
| R2 [5,9] | Shrub/Emergent | 0.12 | 0.00 | 0.06 | 0.06 |
| R3 [5,9] | Shrub | 0.02 | 0.00 | 0.02 | 0.00 |
| R4 [5,9] | Emergent | 0.11 | 0.00 | 0.00 | 0.11 |
| R4 [2,5,9] | Forest/Emergent | 0.11 | 0.03 | 0.00 | 0.08 |
| R5 [5,9] | Emergent | 0.05 | 0.00 | 0.00 | 0.05 |
| R5 [2,5,9] | Forest/Emergent | 0.07 | 0.02 | 0.00 | 0.05 |
| R6 [5,9] | Forest/Emergent | 0.21 | 0.05 | 0.00 | 0.16 |
| R6 [2,5,9] | Emergent | 0.09 | 0.00 | 0.00 | 0.09 |
| R7 [5,9] | Forest/Emergent | 0.04 | 0.04 | 0.00 | 0.00 |
| R7 [1,5,9] | Emergent | 0.04 | 0.04 | 0.00 | 0.00 |
| R8 [5,9] | Shrub/Emergent | 0.40 | 0.00 | 0.20 | 0.20 |
| R9 [5,9] | Forest | 0.38 | 0.38 | 0.00 | 0.00 |

Table 3.1-4. **Summary of wetlands disturbed during mitigation activities (continued).**

| Wetland | Vegetation Types | Total Area (acres) | Vegetation Type Disturbed (acres) | | |
|---|---|---|---|---|---|
| | | | Forest | Shrub | Emergent |
| R9 [1,5,9] | Forest/Shrub/Emergent | 0.30 | 0.30 | 0.00 | 0.00 |
| R10 [5,9] | Shrub | 0.04 | 0.04 | 0.00 | 0.00 |
| R11 [5,9] | Emergent | 0.42 | 0.00 | 0.00 | 0.42 |
| R12 [5,9] | Forest | 0.03 | 0.03 | 0.00 | 0.00 |
| R13 [5,9] | Emergent | 0.12 | 0.00 | 0.00 | 0.12 |
| R14 [1,5,9] | Shrub/Emergent | 0.13 | 0.13 | 0.00 | 0.00 |
| R14 [2,5,9] | Emergent | 0.08 | 0.00 | 0.00 | 0.08 |
| R15 [1,5,9] | Forest/Shrub/Emergent | 0.79 | 0.25 | 0.40 | 0.14 |
| R15 [2,5,9] | Forest/Emergent | 0.25 | 0.06 | 0.00 | 0.19 |
| R17 [5,9] | Forest | 0.31 | 0.31 | 0.00 | 0.00 |
| Waters B, V1 [7], V2 [7] | Open Water | 0.05 | 0.00 | 0.00 | 0.05 |
| Auburn [8] | Emergent | 9.13 | 0.00 | 0.00 | 9.13 |
| | **Subtotal** | **21.64** | **4.91** | **0.75** | **15.98** |
| **TOTAL** | | **40.49** | **5.47** | **1.40** | **33.62** |

1 Temporary impacts associated with restoration activities at the Vacca Farm site.
2 Temporary impacts result from constructing temporary roads to provide access to the mitigation site.
3 Excavation in wetlands at off-site mitigation site to increase habitat diversity/complexity, construction of temporary roads to access the interior portion of the site to conduct monitoring and maintenance activities, and approximately 3 acres of temporary staging area.
4 Maximum of 2.20 acres of existing off-site ditches and farmed wetland will be converted to a wetland drainage channel that connects the mitigation site to the 100-year floodplain of the Green River.
5 Enhancements in these wetlands may include excavation for temporary irrigation systems.
6 Planting and removal of culverts in wetland located at the Tyee Valley Golf Course.
7 Existing drain tiles will be removed and natural wetland topography restored.
8 Mowing, discing, and planting in an existing low quality emergent wetland.
9 Wetlands in the Miller Creek and Riparian buffer.

Where fill impacts to wetlands result in small fragments of remaining wetlands, the remaining wetland area has been considered permanently impacted, and tabulated in Table 3.1-1. For example, the small areas of Wetland A6 and A8 located between the runway embankment and proposed stormwater detention facilities may not persist as functioning wetland following completion of the project.

The calculated permanent impacts to wetlands (18.37 acres) also include about 2.4 acres of indirect wetland impacts (see Table 3.1-1) that could occur in certain locations where there are changes to wetland hydrology, shading, or fragmentation resulting in loss of wetland functions (Parametrix 2000b). While these indirect impacts could result in the loss of some wetland functions from an area, they may not necessarily remove all functions. For example, where the SASA bridge crosses Wetland 52, shading will eliminate wetland vegetation and wildlife habitat, however, the corridor and hydrologic functions provided by this area will remain. In other areas, if wetland hydrology is reduced or eliminated, existing vegetation will remain and wildlife habitat will continue to be provided. However, these indirect impacts are mitigated at ratios of 3:1.

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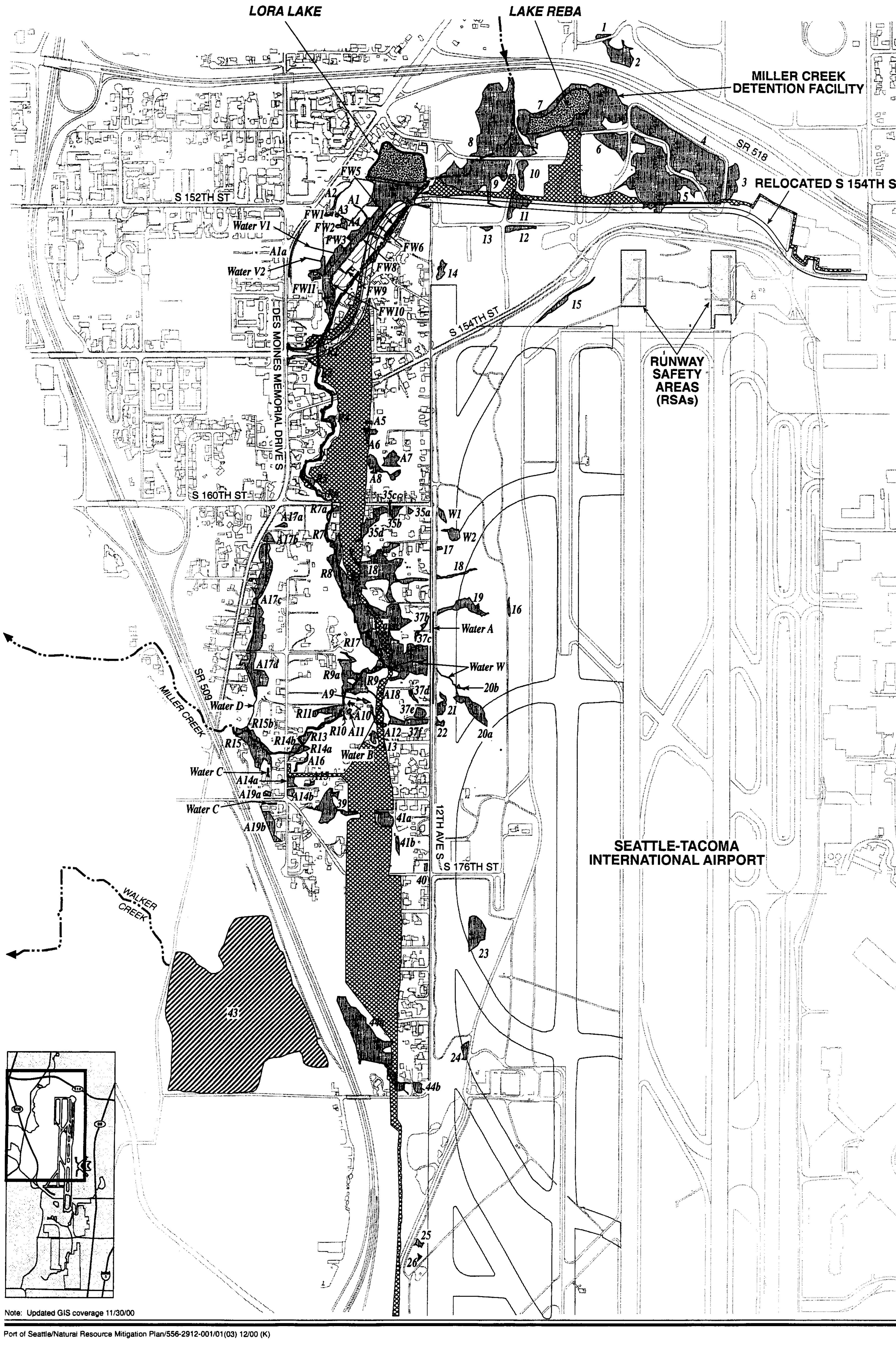


Note: Updated GIS coverage 11/30/00

Port of Seattle/Natural Resource Mitigation Plan/556-2912-001/01(03) 12/00 (K)

Wetlands Not Verified by ACOE

Delineated Wetlands Verified by ACOE

Stream

Water Features

Location of Temporary Construction Impacts

*41a* Wetland Number

SCALE IN FEET

0 400 800

N

**Figure 3.1-3**
**Location of Temporary Wetland Impacts in the Miller Creek Basin Near STIA**

AR 009704

Other indirect impacts to wetlands that could affect their function include noise and human disturbance, changes in water quality impacts, and changes in surface hydrology. These impacts could alter or reduce the level of some functions, but would not eliminate the wetlands themselves or their functions. These impacts are also mitigated by this plan because, in most cases, land use conditions that have degraded these wetlands are removed, and restoration actions are implemented to enhance wetland function (Parametrix 2000b).

## 3.2 STREAMS

Impacts to streams resulting from Master Plan Update improvements include filling approximately 980 ft of Miller Creek (Figure 3.2-1). Filling a portion of Miller Creek to accommodate the runway embankment and road relocations would result in loss of surface water conveyance that must be replaced through mitigation (see Section 5.2). The section of Miller Creek to be relocated, adjacent to the Vacca Farm site, is an artificial (ditched) stream channel. The natural stream was moved to its present location and constructed as a straight channel to improve the area for farming.

## 3.3 FLOODPLAINS

Fill for the proposed Master Plan Update improvements would result in the loss of approximately 5.24 acre-ft of floodplain storage where the segment of Miller Creek will be relocated (see Figures 1.3-2 and 3.2-1). Without mitigation, encroachment on the floodplain would result in loss of flood storage capacity and potential increases in flooding in downstream areas.

Flooding impacts in the Miller Creek basin as a result of the project are unlikely because required mitigation will include adherence to floodplain development standards and floodway management requirements of FEMA, FAA, Ecology, King County, and the City of SeaTac. Floodplain development standards prohibit any reduction in the 100-yr floodplain or base flood storage volume. Compensatory mitigation is required for any proposed filling of the 100-yr floodplain so as to achieve no net loss in flood storage capacity.

Temporary floodplain impacts during construction could include temporary fill for construction access roads and construction in the floodplain as floodplain and wetland mitigation plans are implemented. Since construction would occur during the dry season when the probability of a significant flood is very low, this potential impact is not significant.

## 3.4 DRAINAGE CHANNELS

Construction of the runway embankment will fill approximately 1,290 ft of three drainage channels near 12th Avenue (Figure 3.4-1) and portions of an agricultural drainage channel at the Vacca Farm site. Portions of Channels A, W, and B will be filled to accommodate the embankment for the third runway (see Figure 3.4-1). These channels do not contain fish habitat. Their primary function is to convey roadside runoff and seepage flow from the hill slopes to the riparian wetlands adjacent to Miller Creek. Without mitigation, filling these channels could result in reduced base flows reaching Miller Creek; however, mitigation actions to reroute seepage and stormwater flow to the riparian wetlands will continue to provide comparable base flow to the stream. Because appropriate mitigation actions will be implemented (see Section 5.2.3), no impacts to Miller Creek will occur from filling these drainage channels.

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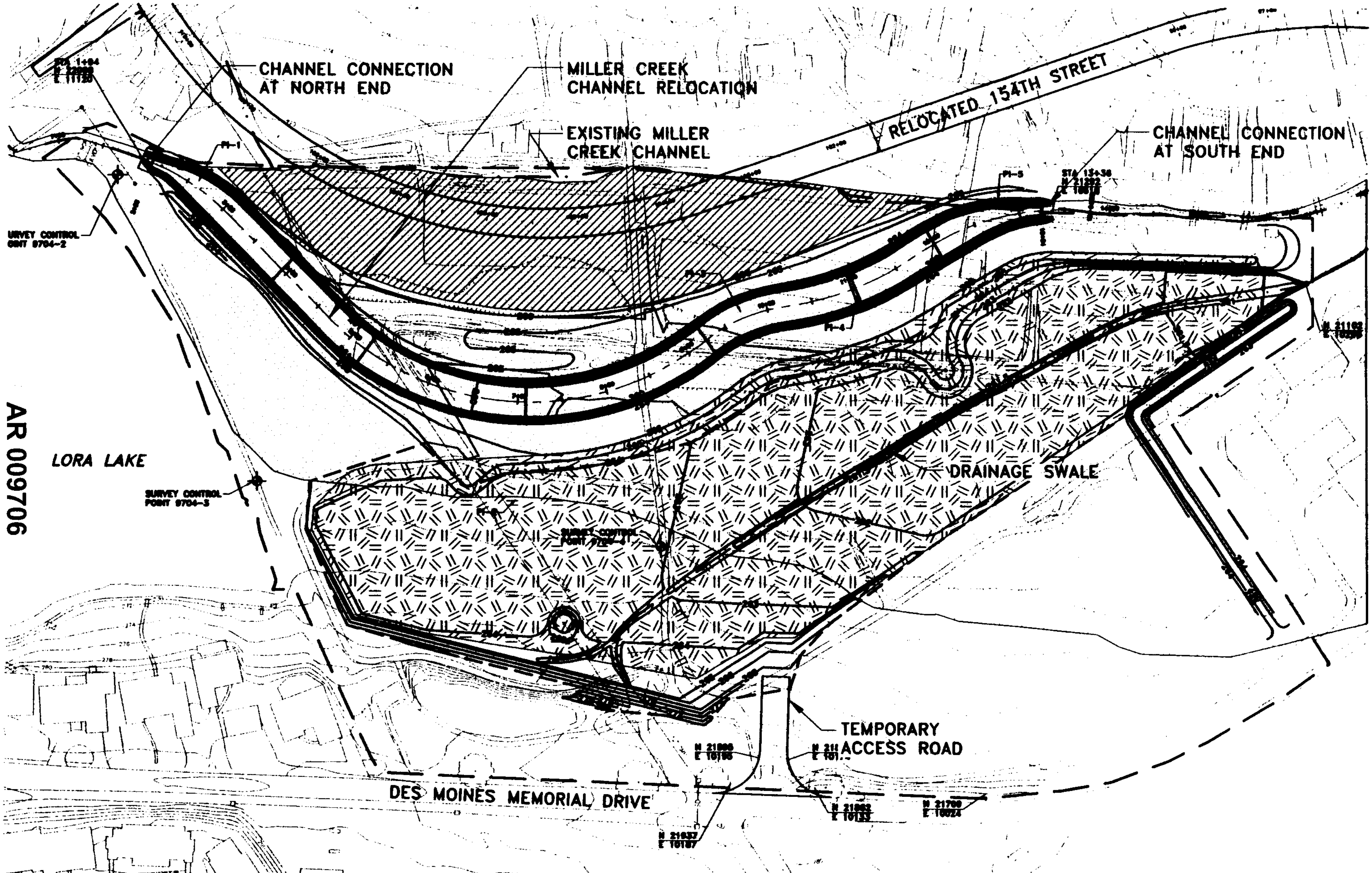




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0 75 150
Scale in Feet

N

| | | |
|---|---|---|
| | Existing Floodplain | (Elevation ±264.5) |
| | Impacted Floodplain | 8,455 c.y. (5.24 ac-ft.) |
| | Floodplain Excavation | 9,589 c.y. (5.94 ac-ft.) |
| — — — | Vacca Farm Site | |
| —264— | Proposed Grade | |

**Figure 3.2-1**
**Miller Creek**
**Relocation and Floodplain**
**Grading at the Vacca Farm Site**

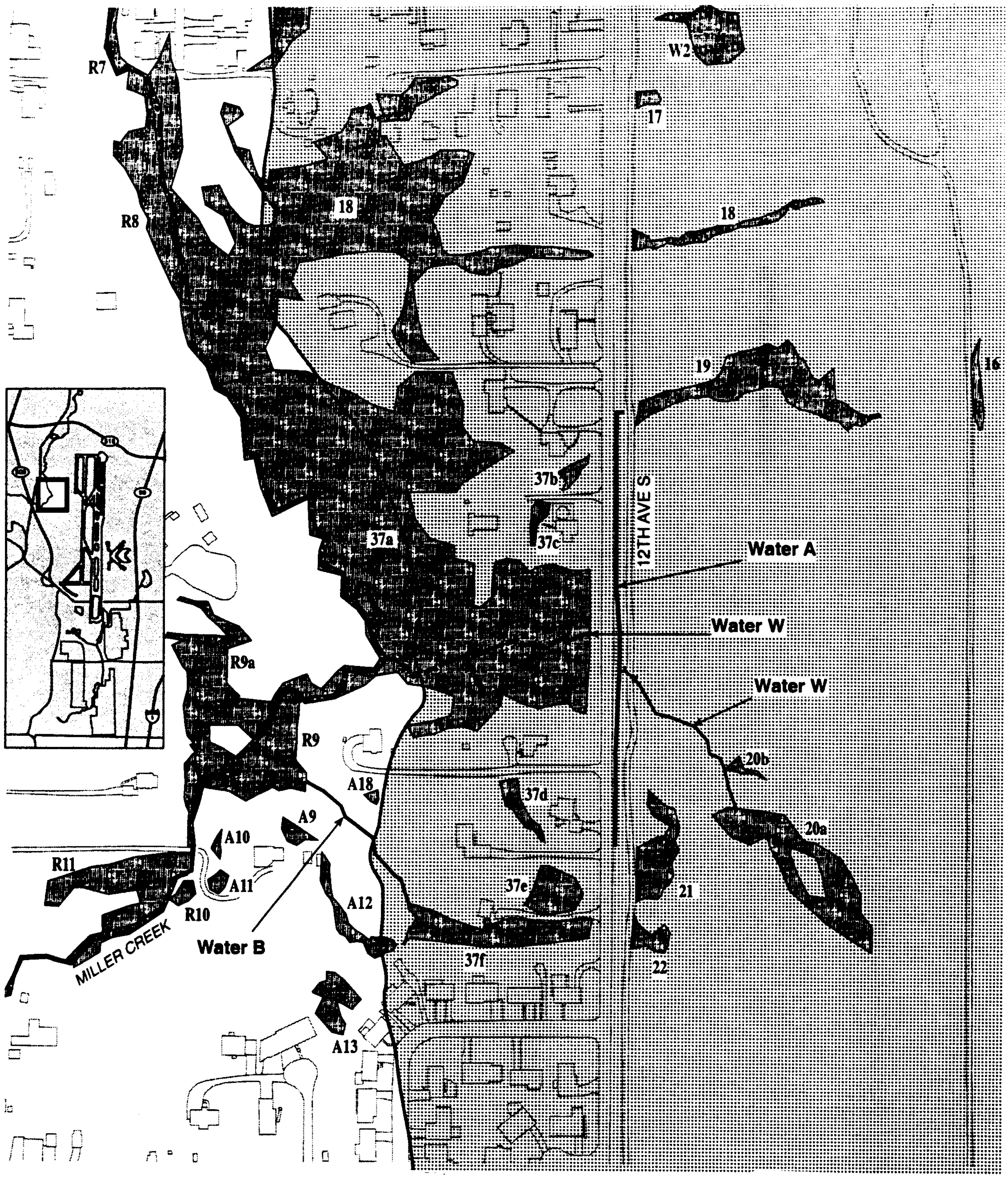


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**Figure 3.4-1 Location of Drainage Channel Impacts in the Miller Creek Basin**

A drainage ditch located in the Vacca Farm site (see Figure 2.1-4) parallels Miller Creek for approximately 800 ft. The ditch, which is part of Wetland A1, provides positive drainage for the adjacent farmland, connecting to Miller Creek near South 156$^{th}$ Way. A portion of the channel (approximately 400 ft) would be restored to natural wetland grades and vegetation.

## 3.5 WATER QUANTITY AND WATER QUALITY

The permanent activities associated with implementation of the Master Plan Update improvements will include grading, filling, paving new streets and runways, and constructing new buildings. These improvements would increase impervious surface areas in the Miller Creek and Des Moines Creek watersheds. Details describing stormwater quality and quantity can be found in Section 6.

Additional impervious surfaces could further increase stormwater runoff rates and volumes, and pollutant loads to the receiving streams. Unless mitigated, changes in runoff would be expected to increase flooding and erosion, and would degrade instream habitat and water quality in Miller Creek downstream of stormwater inputs from the improved areas. The impervious surface areas could reduce the groundwater recharge occurring in the development footprints, resulting in less groundwater seepage during low-flow periods.

Operational impacts to water quality from fuel spills that could occur where fuel is routinely handled are routed to the IWS by an established drainage system. Such spills do not enter the stormwater system and thus do not discharge to wetlands, streams, or other surface waters. Emergency fuel spills that occur outside the fuel handling areas could enter the stormwater drainage system, where they can be controlled and treated through emergency actions.

In the Miller Creek Basin, Master Plan Update improvement projects will result in a net increase of 105.6 acres[4] of impervious surface area, increasing the overall impervious area in the basin by about 1 percent above the existing baseline condition (about 23 percent of impervious surface [Parametrix 1999]). In the Walker Creek Basin, Master Plan Update improvements will result in an increase of 6.2 acres. In the Des Moines Creek Basin, Master Plan Update improvements will result in an increase of 128.2 acres of impervious surface, increasing the overall impervious area in the basin by about 4 percent above the existing base condition (approximately 32 percent impervious [Parametrix 1999]). A total of 417 acres will drain to the IWS under future conditions.

The new impervious surfaces could increase stormwater runoff rates (FAA 1996) and volumes. Unless mitigated, changes in runoff would be expected to increase flooding and erosion and would degrade instream habitat and water quality in Des Moines and Miller Creeks downstream of stormwater inputs from the improved areas. Chinook salmon critical habitat in the estuaries of Miller and Des Moines Creeks will not be directly altered by runoff from new impervious surfaces in the Master Plan Update. In addition, existing hydrologic impacts from existing impervious surfaces will be mitigated.

[4] The net change in impervious area includes a reduction of approximately 50 acres of impervious surfaces (streets, driveways, and rooftops) that will result when existing houses and streets are removed in the acquisition area. Demolition in these areas is ongoing and is expected to be completed by 2002.

The impacts of these actions are further discussed in the project EIS, and in the *Comprehensive Stormwater Management Plan* (Parametrix 2000a). Without the proposed mitigation identified in Section 6.1 of this report, this new impervious surface could cause increased flooding, erosion, and habitat and water quality degradation in the Miller and Des Moines Creek watersheds. The *Preliminary Comprehensive Stormwater Management Plan* summarizes the 1994 base watershed drainage area conditions and future conditions for Miller Creek and Des Moines Creek (Parametrix 1999).

Mitigation and
Monitoring Summary

# 4. MITIGATION, MONITORING, MAINTENANCE, AND CONTINCENCY OVERVIEW

This chapter provides an overview of the mitigation, performance monitoring, maintenance, and contingencies actions incorporated into the Master Plan Update to mitigate adverse project impacts to wetlands, streams, floodplains, and drainage channels. In addition, the Port has made extensive efforts throughout the Master Plan Update planning process to avoid, minimize, and rectify, as well as compensate for, adverse impacts. Table 4.1-1 summarizes the comprehensive approach that the Port has taken to avoid, minimize, rectify, and compensate for impacts to wetlands and aquatic resources (Figures 4.1-1 and 4.1-2). Compensatory mitigation projects are summarized in Table 4.1-2, and are the focus of this plan.

The mitigation plan focuses on those compensatory mitigation actions proposed to replace wetland and stream functions impacted by the project (Parametrix 2000b). Thus, key elements of the compensatory mitigation plan are targeted at restoring functions in-basin and include sediment and nutrient retention (water quality), organic carbon production and export, surface water storage (flood water detention and storage), and aquatic habitat functions (e.g., instream aquatic habitat and riparian habitat).

On-site (i.e., in-basin) mitigation actions are summarized in this chapter (Section 4.1.1), and described in detail in Chapter 5 (for aquatic habitat, floodplain, stream, and wetland restoration) and Chapter 6 (for water quality and water quantity). The off-site wetland mitigation is summarized in this chapter (Section 4.1.2), and described in detail in Chapter 7. A description of the overall functional replacement resulting from the mitigation projects is provided in Section 4.1.3.

The Port's mitigation plans include enforceable performance standards and a long-term monitoring plan, which are described in Section 4.2. Monitoring and evaluation of the projects against these performance standards will allow the success of the mitigation projects to be evaluated by the Port and regulatory agencies and provide assurance that the ecological benefits of the mitigation are ultimately achieved. The monitoring section discusses the adaptive management approach that the Port will use to evaluate performance of the mitigation site and implement contingency measures if performance standards are not met. In addition, Section 4.2 summarizes the monitoring methods to evaluate hydrology, vegetation and wildlife habitat on the mitigation sites, the monitoring and control of hazard wildlife (Port of Seattle 2000), and an integrated weed management strategy for managing invasive non-native plant species.

## 4.1 MITIGATION

The recommended preference for selecting wetland mitigation sites in Washington is as follows: (1) on-site and in-kind; (2) off-site, within the watershed, and in-kind; (3) off-site, out of the watershed, and in-kind; and (4) off-site, out of the watershed, and out-of-kind (Ecology 1990). The Port's proposed mitigation for wetland impacts has followed these recommendations where possible. Therefore, most mitigation for impacts to wetland function is on-site and in-kind in the Miller and Des Moines Creek basins.

**Table 4.1-1. Summary of mitigation actions and their relation to National Environmental Policy Act, State Environmental Policy Act, and Clean Water Act mitigation sequencing requirements.**

| Mitigation Requirement | Proposed Mitigation Action |
|---|---|
| **New Third Runway** | |
| Avoid the impact by not taking a certain action or parts of an action. | Avoid fill in wetlands and Miller Creek by designing the runway to meet the minimum operational, engineering, safety, and maintenance standards.<br>Locate, where feasible, permanent stormwater detention ponds in uplands. Avoid excavation within 50 ft of Category II and III wetlands in Borrow Area 3.<br>Avoid wetlands in Borrow Area 1 where practical. |
| Minimize the impact by limiting the degree or magnitude of the action. | Construct retaining walls at the northwest end of the runway to reduce impacts to Miller Creek and Category II wetlands (Wetlands 8, 9, and A1) located at the north end of the project.<br>Install a retaining wall near the west-central portion of the embankment to reduce impacts to Category II Wetlands 18 and 37 and avoid relocating a second segment of Miller Creek.<br>Place a retaining wall near the southwest end of the runway to reduce impact to a Category II wetland (Wetland 44).<br>Design Borrow Areas 1 and 3 with a 150- to 200-ft setback from Des Moines Creek to minimize potential impact to the stream and its buffers.<br>Implement stormwater pollution prevention plans (SWPPPs) prior to any construction project. |
| Rectify the impact by restoring the affected environment. | Remove temporary stormwater management facilities located in wetlands following construction. These disturbed areas will be restored to pre-construction conditions |
| Reduce the impact over time by preservation and maintenance actions during the life of the action. | Establish and enhance a 100-ft average (minimum 50-ft) forested buffer on both banks of Miller Creek to reduce potential construction and operational impacts to riparian wetlands and aquatic resources.<br>Maintain hydrology to wetlands by directing seepage water from the embankment to wetlands downslope of the embankment.<br>Provide water quantity and water quality mitigation to protect aquatic habitat in Miller Creek from stormwater impacts during operation. |
| Compensate for the impact by replacing, enhancing, or providing substitute resources. | Restore the Vacca Farm wetland/floodplain area, including creating new floodplain, restoring wetland hydrology and vegetation, and providing protective buffers.<br>Restore and enhance Miller Creek instream habitat in the Vacca Farm area.<br>Restore natural channel morphology to a ditched and channelized reach of the stream.<br>Enhance instream habitat and place large woody debris in Miller Creek and enhance adjacent riparian buffers between Vacca Farm and Des Moines Memorial Drive.<br>Enhance wetlands along Miller Creek within the 100-ft buffer by restoring native vegetation and removing invasive non-native species.<br>Construct replacement drainage channels west of the embankment to replace filled drainage channels. |

**Table 4.1-1. Summary of mitigation actions and their relation to National Environmental Policy Act, State Environmental Policy Act, and Clean Water Act mitigation sequencing requirements (continued).**

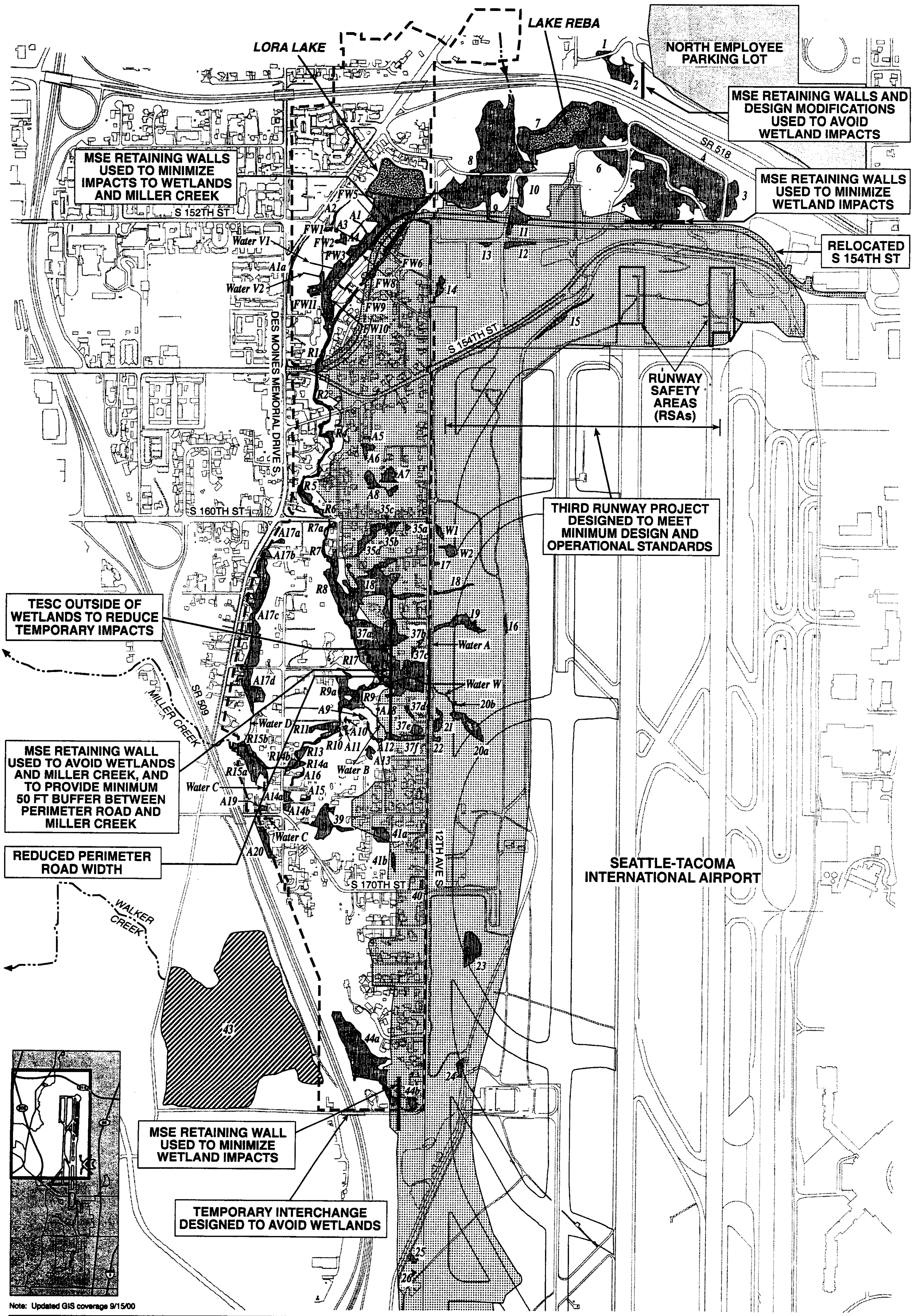
| Mitigation Requirement | Proposed Mitigation Action |
|---|---|
| Compensate for the impact by replacing, enhancing, or providing substitute resources (con't). | Restore wetlands on the Tyee Valley Golf Course including restoring wetland vegetation to reduce wildlife hazards and improve water quality.<br>Enhance aquatic habitat in Des Moines Creek by restoring a 100-ft wide forest/shrub buffer along the stream between the Northwest Ponds and the proposed SR 509 right-of-way (ROW).<br>Provide a $300,000 trust fund to enhance fisheries habitat in Miller Creek and Des Moines Creek.<br>Create replacement wetlands at an off-site location for the loss of wildlife habitat within 10,000 ft of the airport runways. |
| | Monitor mitigation projects for compliance with performance standards and other permit conditions.<br>Monitor stormwater runoff for compliance with National Pollutant Discharge Elimination System (NPDES) requirements.<br>Monitor remaining wetlands downslope of the new embankment (i.e., between the embankment and Miller Creek) for indirect impacts to wetland hydrology. |
| **Runway Safety Areas** | |
| Avoid the impact by not taking a certain action or parts of an action. | Construct retaining walls to support a relocated South 154th Street and avoid permanent fill in Wetlands 3 and 4. |
| Minimize the impact by limiting the degree or magnitude of the action. | Construct retaining walls to support a relocated South 154th Street and reduce permanent fill and minimize temporary impacts in Wetland 5.<br>Implement SWPPPs prior to any construction project. |
| Rectify the impact by restoring the affected environment. | Restore wetland areas temporarily impacted by required temporary erosion and sediment control facilities. |
| Reduce the impact over time by preservation and maintenance actions during the life of the action. | Provide water quantity and water quality mitigation to protect wetlands and other receiving waters from stormwater impacts during operation. |
| Compensate for the impact by replacing, enhancing, or providing substitute resources. | Restore the Vacca Farm wetland/floodplain area to provide hydrologic and water quality functions.<br>Create replacement wetlands for wildlife habitat (greater than 10,000 ft from the airport runways at the Auburn site). |
| Monitor the impact and take appropriate corrective actions. | Monitor remaining wetlands for indirect impacts to hydrology.<br>Monitor mitigation projects for compliance with performance standards and other permit conditions.<br>Monitor stormwater runoff for compliance with NPDES requirements. |
| **South Aviation Support Area** | |
| Avoid the impact by not taking a certain action or parts of an action. | Design the SASA footprint to avoid relocation of Des Moines Creek.<br>Temporary impacts to Des Moines Creek and Wetland 52 are not anticipated. |

**Table 4.1-1. Summary of mitigation actions and their relation to National Environmental Policy Act, State Environmental Policy Act, and Clean Water Act mitigation sequencing requirements (continued).**

| Mitigation Requirement | Proposed Mitigation Action |
|---|---|
| Minimize the impact by limiting the degree or magnitude of the action. | Design the SASA to avoid direct impacts to forested wetland (Wetland 52) that provides groundwater discharge functions. |
| Reduce the impact over time by preservation and maintenance actions during the life of the action. | Design water quantity and water quality mitigation to protect wetlands from stormwater impacts. |
| Rectify the impact by restoring the affected environment. | Restore potential temporary impacts to Des Moines Creek and Wetland 52. |
| Compensate for the impact by replacing, enhancing, or providing substitute resources. | Restore wetlands on the Tyee Valley Golf Course to provide water quality and hydrologic benefits to replace lost wetland functions. |
| | Construct replacement wetlands for wildlife habitat (greater than 10,000 ft from the airport runways at the Auburn site). |
| | Enhance and restore a 100-ft-wide forest/shrub buffer along Des Moines Creek to enhance aquatic habitat. |
| | Provide a trust fund for enhancement of fisheries habitat of Des Moines Creek. |
| Monitor the impact and take appropriate corrective actions. | Monitor Wetland 52 for indirect impacts to wetland hydrology. |
| | Monitor mitigation projects for compliance with performance standards and other permit conditions. |
| | Monitor stormwater runoff for compliance with NPDES requirements. |
| **On-site Borrow Source Areas** | |
| Avoid the impact by not taking a certain action or parts of an action. | Redesign development areas within Borrow Areas 1 and 3 to avoid excavation of twelve wetlands (Wetlands B1, B4, B5, B6, B7, B9, B10, B15a, B15b, 29, 30, and 48). |
| Minimize the impact by limiting the degree or magnitude of the action. | Establish a 150- to 200-ft buffer between Borrow Area 1 and Des Moines Creek to avoid impacts to stream hydrology and riparian buffers. |
| | Follow a Temporary Erosion and Sediment Control Plan (TESCP) to eliminate siltation reaching wetlands or Des Moines Creek from excavation activities. |
| | Establish final surface grades in Borrow Area 1, and construct interceptor swale system in Borrow Area 3, to direct surface water runoff and groundwater seepage to wetlands near borrow areas, and minimize and avoid indirect hydrology impacts. |
| Reduce the impact over time by preservation and maintenance actions during the life of the action. | Maintain Best Management Practices (BMPs) throughout the operating period to ensure adjacent wetlands will be protected from adverse construction-related activities. |
| Compensate for the impact by replacing, enhancing, or providing substitute resources. | Restore wetlands on the Tyee Valley Golf Course to compensate for water quality and hydrologic support functions impacted in the Des Moines Creek basin. |
| | Enhance a 100-ft-wide forest/shrub buffer along Des Moines Creek to enhance aquatic habitat. |
| | Provide a trust fund for enhancement of fisheries habitat of Des Moines Creek. |
| Monitor the impact and take appropriate corrective actions. | Monitor Wetlands B1, B4, B5, B6, B7, B9, B10, B15a, B15b 29, and 30 and 48 for potential indirect impacts to wetland hydrology from excavation activities. |
| | Monitor stormwater runoff and TESC for compliance with NPDES requirements. |

NEPA = National Environmental Policy Act

SEPA = State Environmental Policy Act








Wetlands not Verified by ACOE

Delineated Wetlands Verified by ACOE

Stream

Acquisition Area Boundary

Water Features

Embankment Area (Fill and Grading Third Runway, Runway Safety Area and S 154th Street)

*41a* Wetland Number

SCALE IN FEET

0 400 800

N

**Figure 4.1-1**
**Avoidance of Wetland and Stream Impacts in the Miller Creek Basin**

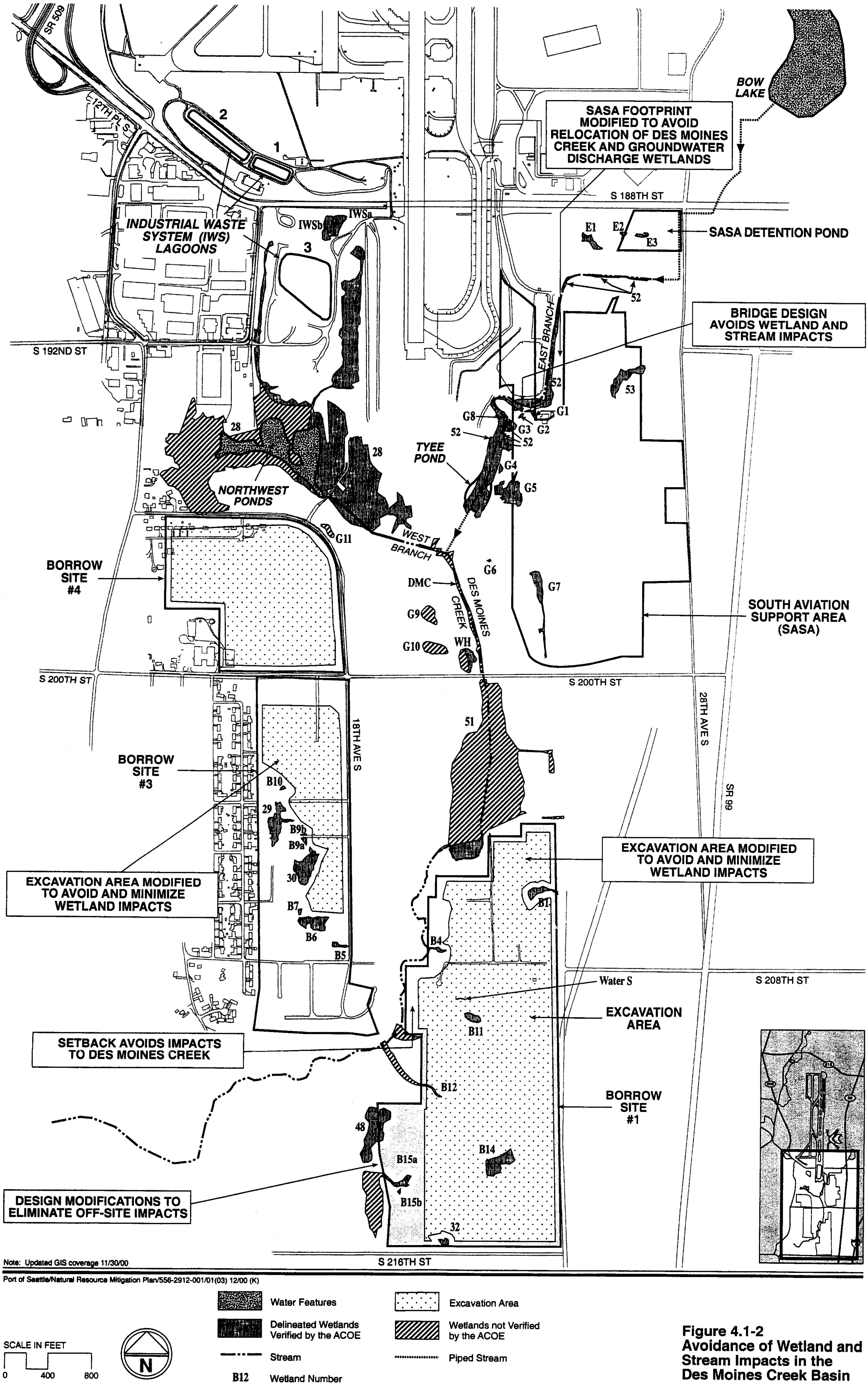



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**Figure 4.1-2**
**Avoidance of Wetland and Stream Impacts in the Des Moines Creek Basin**

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**Table 4.1-2. Summary of compensatory mitigation (on- and off-site) for watershed, wetland, and stream impacts at Seattle-Tacoma International Airport.**

| Description of Impact | Mitigation Action | Explanation/Comment |
|---|---|---|
| **On-Site Mitigation**[1] | | |
| Permanent Impacts | | |
| Fill approximately 980 linear ft of Miller Creek channel to accommodate third runway embankment. | Relocate approximately 1,080 ft of Miller Creek channel. | Channel relocation will enhance aquatic habitat by providing stream buffers, and instream habitat features, and increase channel length by approximately 100 ft. |
| | | Establish a buffer around the channel relocation project with native trees and shrubs. (This buffer extends into the floodplain area.) |
| Fill drainage channels to accommodate third runway embankment. | Create new permanent drainage channels and establish protective buffers. | Create approximately 1,290 ft of new permanent drainage channel(s) with associated buffer habitat. |
| Fill approximately 8,500 cy of Miller Creek floodplain to accommodate third runway embankment and South 154$^{th}$ Street relocation. | Replace lost floodplain. | Excavate approximately 9,600 cy to achieve storage of 5.94 acre-ft from the Vacca Farm site, providing an excess of 0.7 acre-ft of floodwater storage. |
| Impact approximately 18.37 acres of wetland during construction of the third runway embankment and other construction-related projects. | Restore Vacca Farm to historic floodplain shrub wetland. | Approximately 9.0 acres of prior converted cropland, farmed wetland, and existing low quality wetlands will be graded and planted with native trees, shrubs, and emergent species (Refer to Table 5.1-1 in Chapter 5). Restoration of the area will stabilize soils, improve water quality, and enhance Miller Creek habitat. It will reduce wildlife habitat attractants and conform to FAA mandates regarding wildlife attractants for airport safety. |
| | | Remove bulkheads and restore 25-ft buffer around Lora Lake. |
| | | Restoration of entire Vacca Farm site will provide approximately 17 acres of enhanced stream habitat, floodplain wetlands, aquatic habitat in Lora Lake, and buffers (Refer to Table 5.1-1 in Chapter 5). |
| | Establish a buffer between the floodplain enhancement area and Des Moines Memorial Drive. | The buffer will be established and enhanced by planting native upland trees and shrubs to provide approximately 1.5 acres of upland buffer. |
| | | Enhance approximately 7.4 acres of wetlands along Miller Creek by removing structures and restoring native wetland vegetation (Table 4.1-3). |

**Table 4.1-2. Summary of compensatory mitigation (on- and off-site) for watershed, wetland, and stream impacts at Seattle-Tacoma International Airport (continued).**

| Description of Impact | Mitigation Action | Explanation/Comment |
|---|---|---|
| | Restore wetlands on the Tyee Valley Golf Course. | Plant approximately 4.5 acres of historic peat wetlands in the Tyee Valley Golf Course Mitigation Area and 1.0 acre of wetland in the west branch Des Moines Creek buffer with native shrub communities (see Table 4.1-3). Plant native shrubs in approximately 1.6 acres of buffer in the Tyee Valley Golf Course mitigation area and approximately 3.4 acres in the west branch Des Moines Creek buffer. These enhancement will be coordinated with Des Moines Creek Basin Committee planned RDF.<br>The enhancement and RDF will improve hydrologic functions of the watershed, reduce wildlife attractants near the airfield, and restore a peat wetland. |
| **Temporary Impacts [1]** | | |
| Construct temporary stormwater management ponds and other construction impacts, which may impact up to 2.05 acres of wetland. | Restore wetland areas after construction is complete. | Wetlands that will be temporarily filled or disturbed will be restored. Restoration will include establishing pre-disturbance topography and planting with native shrub vegetation. |
| **Indirect and Cumulative Impacts[1]** | | |
| Filled wetlands near Miller Creek reduce aquatic habitat value of the stream. | Establish and enhance buffers along Miller Creek corridor between South 156th Street and Des Moines Memorial Drive. | Establish a 100-ft buffer (on average) on both sides of Miller Creek; minimum buffer width on the east side of the stream will be 50 ft. These buffers and the enhanced Miller Creek Wetlands will provide approximately 40 acres of riparian buffer habitat (see Table 4.1-3). |
| | Establish a 25-ft buffer around Lora Lake. | Approximately 0.60 acre of buffer around Lora Lake will be converted from lawn to native wetland and upland shrub vegetation (refer to Table 5.1-1 in Chapter 5).. |
| Additional development in the watersheds could result in additional cumulative impacts. | Participate in developing and implementing Miller Creek and Des Moines Creek basin plans. | These planning processes will identify effective, long-term solutions to restore additional fish habitat to Miller and Des Moines Creeks. The Port will contribute both staffing resources and funds, and work with other cooperating jurisdictions to plan and implement appropriate watershed restoration projects. |

Table 4.1-2. **Summary of compensatory mitigation (on- and off-site) for watershed, wetland, and stream impacts at Seattle-Tacoma International Airport (continued).**

| Description of Impact | Mitigation Action | Explanation/Comment |
|---|---|---|
| The runway fill or borrow area excavation may eliminate water sources that contribute to remaining wetlands down slope of the runway. | Design internal drainage and conveyance channels. | Subsurface and surface replacement channels will continue to collect and distribute groundwater currently surfacing near 12th Avenue South to Miller Creek and associated wetlands. |
| | Monitor wetlands adjacent to the third runway embankment and borrow areas. | Surface drainage patterns and conveyance swales will be designed to collect and distribute groundwater seepage and surface runoff to wetlands downslope of the borrow areas. |
| | | Wetlands subject to potential indirect impacts will be monitored to determine if unmitigated indirect impacts have occurred. If significant new wetland impacts are verified, corrective actions will be implemented. |
| Off-Site Mitigation | | |
| **Permanent Impacts** | | |
| Loss of approximately 18.37 acres of wetland wildlife (avian) habitat. | Replace high quality wetland and avian habitat functions off-site at an overall ratio of 2:1. | Due to conflicts with avian habitat and aviation safety concerns, new wetlands habitat will be created at a 67-acre site in Auburn, Washington. This wetland creation will increase overall avian and other wildlife use and diversity in an area that will not compromise aviation safety. |

[1] All mitigation areas (including, but not limited to, streams, wetlands, buffers, and floodplains) located within 10,000 ft of a runway shall be subject to the provisions of the Port's *Wildlife Hazard Management Plan* (USDA 2000) for the management of wildlife and wildlife attractant areas.

**Table 4.1-3. Summary of wetland mitigation credit for Seattle-Tacoma International Airport Master Plan Update improvements**

| Mitigation | Mitigation Area (acres) | Mitigation Credit |
|---|---|---|
| **In-Basin** | | |
| Wetland Restoration – Credit ratio 1:1 | | |
| Vacca Farm (prior converted cropland and other upland) | 6.60 | 6.60 |
| Wetland Enhancement – Credit ratio 1:2 | | |
| Vacca Farm (Farmed Wetland, Other Wetlands, Lora Lake) | 5.70 | 2.85 |
| Wetlands in Miller Creek Wetland and Riparian Buffer | 7.40 | 3.70 |
| Tyee Valley Golf Course | 4.50 | 2.25 |
| Wetland in Des Moines Creek Buffer | 1.01 | 0.51 |
| Subtotal | 25.21 | 12.61 |
| Buffer Enhancement- Credit ratio 1:5 | | |
| Miller Creek Buffer, South of Vacca Farm | 32.00 | 6.40 |
| Vacca Farm | 4.58 | 0.92 |
| Lora Lake | 0.27 | 0.05 |
| Tyee Valley Golf Course Mitigation Area Buffer | 1.57 | 0.31 |
| West Branch Des Moines Creek Buffer | 3.38 | 0.68 |
| Subtotal | 41.80 | 8.36 |
| **Total In-Basin Mitigation[1, 2]** | **67.01** | **20.97** |
| **Out-of-Basin** | | |
| Wetland Creation[3] - Credit ratio 1:1 | | |
| Forested (17.20 ac), shrub (6.0 ac), emergent (6.20 ac), and open water (0.60ac) | 29.98 | 29.98 |
| Wetland Enhancement - Credit ratio 1:2 | 19.50 | 9.75 |
| Buffer Enhancement - Credit ratio 1:5 | 15.90 | 3.18 |
| **Total Out-of-Basin Mitigation** | **65.38** | **42.93** |
| **Total Mitigation[4]** | **134.39** | **63.90** |

1 Mitigation credit has not been assigned for relocating a portion of Miller Creek channel, instream enhancement projects, drainage channel replacement, Des Moines Creek buffer enhancement, or $300,000 trust fund for watershed restoration.

2 Mitigation areas in the Des Moines and Miller Creek watersheds are 10.46 acres and 56.55 acres respectively; in- basin mitigation area divided by wetland impact (18.37 acres) provides 3:1 aerial replacement ratio.

3 Based on maps of hydric soils, mitigation can be also characterized as restoration.

4 Total mitigation area divided by wetland impact (18.37 acres) provides a 7.3:1 aerial replacement ratio; total mitigation credit divided by wetland impact (18.37) provides a 3.5:1 replacement ratio.

However, all mitigation areas (including but not limited to wetlands, streams, buffers, and floodplains) and other lands located within 10,000 ft of a runway are subject to the provisions of the Port's WHMP (USDA 2000) for management of wildlife and wildlife attractants (FAA Advisory Circular 150/5200-33). No open-water habitat can be created within 10,000 ft of the airfield as part of this mitigation plan. On-site mitigation is planned to reduce certain existing wildlife hazards to comply with FAA mandates regarding wildlife attractants near airports. Mitigation for wildlife habitat (bird and small mammals), is provided off-site. The off-site mitigation is designed to provide a large, high-quality, diverse wetland system and is located in the City of Auburn. At this site, habitat mitigation can be provided that is consistent with the FAA Record of Decision (1997) and Advisory Circular 150/5200-33 regarding wildlife attractants near airports.

### 4.1.1 On-Site In-Basin Mitigation

Following the recommended preference for on-site, in-basin mitigation, a number of on-site mitigation elements are proposed to compensate for Master Plan Update improvements affecting wetlands, hydrology, water quality, and aquatic habitat in the Miller and Des Moines Creek basins. Mitigation projects in Miller and Des Moines Creek basins are designed to replace all lost wetland functions with the exception of avian habitat. In-basin mitigation is also directed toward removing certain existing land use conditions that, over time, have contributed to degraded wetland and aquatic habitats in these basins. The mitigation projects designed for the Master Plan Update improvements (Figure 4.1-3 and see Table 4.1-2) have been developed in direct response to agency guidelines for in-basin functional mitigation.

#### 4.1.1.1 Miller Creek Basin

The focus of mitigation in the Miller Creek basin is to restore and enhance ecosystem functions to the aquatic/wetland systems along a significant portion of Miller Creek. Mitigation actions in the Miller Creek basin will restore wetland, stream and riparian functions to a 1.4 mile reach, or approximately one third of the entire length of Miller Creek.

The Miller Creek watershed has been modified and habitats degraded by historical and on-going agricultural, residential, commercial, and industrial development. Approximately 80 percent of the watershed has been converted from its original forested condition to residential or commercial land uses (Parametrix 2000a). Increased impervious surfaces have resulted in increased runoff rates and volumes which have contributed to erosion and downcutting in high energy reaches, and increased sedimentation and habitat degradation in low gradient reaches (FAA 1996; KCSWM 1994). Runoff from residential, commercial, and agricultural areas have increased inputs of sediment, nutrients, and pollutants to the steam. Upland and wetland riparian areas adjacent to the stream have been altered from the original forest and/or shrub cover to impervious surfaces, agricultural fields, residential lawns, or ornamental landscaping. Native plant and animal habitats have been reduced in size and fragmented, resulting in a loss of species diversity.

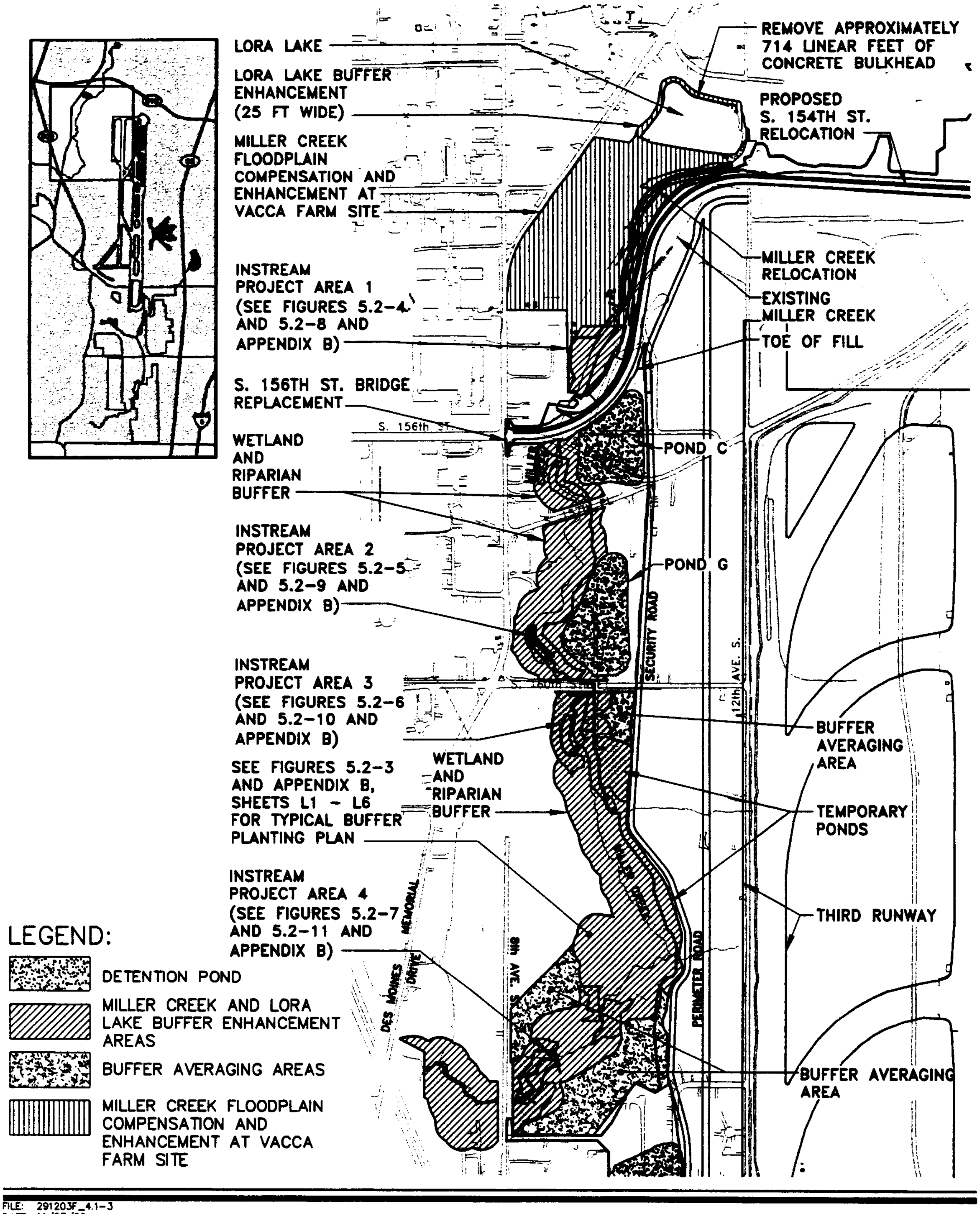


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**Figure 4.1-3**
**Locations of Mitigation Projects in the Miller Creek Basin**

The natural channel morphology of Miller Creek has been altered, particularly in reaches above South 160th Street. Extensive areas of the channel have been armored with riprap or retaining walls, and dredged or straightened to protect property adjacent to the stream or to drain land for agricultural uses. For much of its length, Miller Creek lacks connections to adjacent floodplains, floodplain wetlands, or riparian areas due to filling of adjacent wetlands, as well as dredging and straightening the channel to increase conveyance. These changes have resulted in a lack of habitat complexity, a lack of woody debris in the channel, a lack of shading from riparian vegetation, the loss of surface water storage, and degraded water quality and biotic integrity in much of the basin.

To replace functions impacted by the Master Plan Update improvements and to restore and enhance aquatic and wetland functions in the Miller Creek basin, the Port proposes the following specific mitigation:

- Restore *natural channel morphology, habitat complexity, and instream habitat* along an approximately 1.4-mile reach of Miller Creek extending from south of Lora Lake to Des Moines Memorial Drive.
- Restore *floodplain, floodplain wetlands, and riparian areas* along the upper reaches of Miller Creek, and re-integrate floodplains and adjacent wetlands with the stream.
- Restore, replace, and enhance *wetland and aquatic habitat functions* to the currently degraded, lacustrine, stream, floodplain, and riparian wetland system along the upper reaches of Miller Creek.
- *Maintain wetland hydrology and baseflow* function in wetlands adjacent to the embankment fill by providing surface water drainage features to convey groundwater and surface water runoff from the new embankment to downslope wetlands.
- *Restore and enhance wetland and aquatic functions*, and *protect the long-term viability* of these systems, by establishing native forested buffers around wetlands and aquatic systems from Lora Lake to Des Moines Memorial Drive.
- *Restore habitat connectivity* in the upper reaches of the Miller Creek basin by providing a continuous forested wetland and riparian corridor connecting currently fragmented wetland, aquatic, and riparian habitats between Lora Lake and Des Moines Memorial Drive.

To accomplish these objectives, mitigation projects will be concentrated in two areas along the upper reaches of Miller Creek: (1) Lora Lake and the Vacca Farm and (2) Miller Creek and its riparian zone between Lora Lake and Des Moines Memorial Drive.

In addition to these projects, the Port will establish watershed trust funds to fund local stream restoration projects in the Miller Creek basin.

#### 4.1.1.2 Des Moines Creek Basin

Mitigation projects for the Des Moines Creek basin are designed to mitigate for unavoidable project impacts to wetlands and aquatic resources by restoring wetland and stream functions, and by providing mitigation for potential indirect effects to wetland hydrology. Mitigation actions in the Des Moines Creek basin will increase infiltration adjacent to the stream, reduce pollutant runoff, increase sediment retention, and improve nutrient cycling functions in the wetland adjacent to Des Moines Creek. To replace functions impacted by Master Plan Update improvements and to restore and enhance aquatic and wetland habitat in the Des Moines basin, the Port proposes the following specific mitigation:

- *Restore and enhance wetland* and *aquatic* habitat by replacing the existing turfgrass wetland with a native shrub wetland at the Tyee Valley Golf Course adjacent to Des Moines Creek
- *Enhance water quality, fish habitat and restore stream conditions* in Des Moines Creek by establishing a forested buffer along a 870 ft reach of west branch Des Moines Creek
- *Avoid, minimize, and mitigate* potential indirect hydrology impacts to wetlands adjacent to the Borrow Areas by directing groundwater seepage and/or surface water runoff to wetlands near the Borrow Areas

In addition to these projects, the Port will establish watershed trust funds to fund local stream restoration projects in the Des Moines Creek basin.

#### 4.1.1.3 In-basin Stormwater Mitigation

The Port will construct the necessary stormwater conveyance, detention, and treatment facilities to manage runoff from both newly developed project areas and existing airport areas. These facilities will not only mitigate new construction impacts, as required by current stormwater regulations and mitigation goals identified during the environmental review process, but they will also help to reduce flood peaks in these basins to further mitigate the impacts of airport stormwater discharges.

In-basin stormwater facilities will be constructed in Miller, Walker, and Des Moines Creek basins, at 14 separate locations and provide approximately 326 acre-ft of new storage. The following sections describe specific mitigation to reduce stormwater impacts from Master Plan Update improvements. Detailed information on mitigation for stormwater quantity and quality is included in the *Stormwater Management Plan* (Parametrix 2000a).

**Stormwater Detention Based on Higher Stormwater Standards**

Detention storage provided for Master Plan Update improvement projects will exceed that normally required by local regulations, and result in additional mitigation of stormwater impacts from Master Plan Update improvement project areas, including reduced peak stormwater runoff impacts on Miller, Walker, and Des Moines Creeks.

**Reduce Runoff from Existing Airport Areas With Stormwater Detention**

To control runoff from areas of the airport developed prior to 1994, stormwater detention will be provided to mitigate existing runoff impacts. Proposed detention facilities on Miller, Walker, and Des Moines Creeks include stormwater detention to mitigate impacts of pre-1994 development. In the retrofit analysis, the pre-development flow rates assumed that existing land cover is 10 percent impervious area, 75 percent forest, and 15 percent grass (also known as the pre-development "target flow regime"). Stormwater detention designs for retrofitting in Miller, Walker, and Des Moines Creeks are based on the Level 2 flow control.



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**Provide Infiltration at Stormwater Detention Facilities**

Further improvements to low stream flows will be achieved by infiltrating stormwater at the detention facilities. Because site conditions must be favorable for infiltration to be feasible, the Port has evaluated infiltration for stormwater detention facility design. Ponds in the Miller Creek Basin will use infiltration.

**Water Quality Mitigation**

The STIA Master Plan Update improvement projects are not expected to impact existing water quality because (1) the quality of STIA runway stormwater has been shown to be comparable to or better than regional urban stormwater, and (2) in contrast to existing land uses, all Master Plan improvements will be served by BMPs in compliance with the Stormwater Management Manual for Puget Sound (Ecology 1992) (e.g., bioswales, filter strips, wet vaults, infiltration).

Since Miller, Walker, and Des Moines Creeks drain urban watersheds, they have been subject to cumulative impacts of heavy metals, oils, and grease from nearby urban highways; fecal coliform from failing residential septic systems and adjacent farms; suspended solids and litter carried in urban runoff; and increased levels of phosphorus and nitrogen from fertilization of cultivated areas. These impacts are typical of an urban environment supporting an assortment of residential, commercial, and industrial activities. Sources of many of these pollutants will be removed as part of the Master Plan Update improvements within the approximately 258-acre acquisition area. Because actions to mitigate impacts to water quality will be in place, the quality of stormwater runoff in the future will be equal to or better than current stormwater quality. A detailed discussion of water quality benefits and mitigation is included in the *Comprehensive Stormwater Management Plan* (Parametrix 2000a).

### 4.1.2 Off-Site Mitigation

Off-site mitigation is proposed because FAA regulations prohibit the siting of potential wildlife attractants (including wetland mitigation) within 10,000 ft of active runways. The Port searched for wetland mitigation sites in the Des Moines and Miller Creek watersheds that could be used to provide replacement wildlife habitat; however, these watersheds are almost totally within the 10,000-ft exclusion area for wildlife habitat mitigation. Areas within these two watersheds that are more than 10,000 ft from existing runways were found not to be suitable for mitigation due to their small size, developed nature, forested condition, or the lack of hydrologic conditions necessary to support wetlands.

To mitigate for the loss of wildlife habitat due to the Master Plan Update improvements, the Port will construct wetland mitigation off-site on a 67-acre parcel in the City of Auburn. This wetland mitigation area will replace lost wetland functions at a minimum 2:1 replacement ratio. This mitigation provides the opportunity to create, restore, and enhance high quality, diverse forested, shrub, emergent, and open water wetland habitats and functions to a site where these functions are currently absent or degraded. Approximately 17.2 acres of forest, 6.0 acres of shrub, 6.2 acres of emergent, 0.60 acre of open water, and 19.50 acres of enhanced emergent wetland habitat will be created or restored. Overall habitat functions will be enhanced by providing approximately 11.9 acres of forested buffers around the perimeter of the site and approximately 4.0 acres of upland habitat within the interior portion of the site. Wetland functions in existing wetlands will be enhanced by replacing non-native pasture grasses with native forested, shrub and emergent wetland plant communities.

### 4.1.3 Replacement of Functions by the Mitigation Plan

Mitigation for unavoidable impacts to wetlands proposed in this plan meets or exceeds requirements to mitigate for lost wetland area and functions (See Table 4.1-3). In Miller and Des Moines Creek basins, the Port proposes to restore and enhance non-avian habitat wetland functions in 25.21 acres of wetlands and aquatic habitat, providing mitigation for impacts to 18.37 acres. Buffers associated with restored streams and wetlands in the basin will total approximately 42 acres. Out-of-basin mitigation at the Auburn mitigation site will consist of creating approximately 30 acres of new wetlands, enhancing 19.5 acres of existing emergent wetlands, and enhancing approximately 15.9 acres of forest habitat.

Additional mitigation to replace functions will be provided in the form of funding for stream enhancement and provision of extensive buffers and in-basin water quality and water quantity controls on stormwater runoff. These mitigation actions provide further assurance that all wetland functions potentially impacted are replaced, and there is significant ecological restoration of the impacted watersheds.

## 4.2 MONITORING PLAN AND CONTINGENCY MEASURES

Effective monitoring, adaptive maintenance, and contingency actions are planned to evaluate if performance standards are met, and to correct deficiencies if needed. Monitoring and reporting of monitoring results for agency review and concurrence will assure that appropriate contingency actions are taken, and ecological benefits are ultimately achieved. This section describes the monitoring of mitigation sites that will occur over a 10-year period to verify that each project is meeting established performance standards and permit conditions. The monitoring approach for all mitigation projects is described here. Specific monitoring requirements for individual projects are included in Chapter 5 (on-site) and Chapter 7 (off-site). If monitoring demonstrates that performance standards are not met, then contingency actions will be evaluated and implemented to assure that the desired wetland functions are ultimately provided by the mitigation projects.

### 4.2.1 Monitoring Approach

The monitoring plan describes steps that the Port will take to ensure that the mitigation projects meet design goals, objectives, performance standards, and permit conditions. Monitoring will be used to evaluate conditions at each mitigation site relevant to mitigation success, including overall site conditions, site hydrology, vegetation, wildlife, invasive species, and when applicable for specific projects, channel morphology and instream habitat features. Measures of factors indicating ecological function (such as percent cover of native vegetation, percent survival of planted stock, channel bed material size distribution, channel profiles, density of large woody debris in streams, and frequency and size of pools in streams) will be used to quantify site conditions and allow comparisons with performance standards.

Performance standards are measured using standard field techniques, and are thus enforceable by permitting agencies. Performance standards developed for the Port's mitigation plan reflect reviews by ACOE and Ecology.

Monitoring results will be used to evaluate appropriate contingency measures in cases where performance standards are not met. Contingency measures will be implemented following an adaptive management approach, described in Section 4.2.2. The adaptive management approach depends on monitoring data to:

- Evaluate the locations and need for contingency measures
- Develop appropriate contingency measures
- Adapt contingency measures as necessary to meet performance standards
- Evaluate the success of contingency measures following implementation

#### 4.2.1.1 Monitoring Period

Monitoring of the mitigation sites includes monitoring before, during, and after mitigation construction. The Port has conducted regular monitoring of the acquisition area during the acquisition and mitigation design phases to ensure that no wetlands or aquatic resources are impacted by nearby construction or survey activities. Pre-construction monitoring includes steps such as ensuring that wetlands and/or stream boundaries are clearly marked or fenced, inspecting sediment and erosion control measures, and regular site inspections to ensure that construction or survey operations are avoiding wetlands and streams. In addition, groundwater hydrology monitoring will be initiated in wetlands near the new embankment and borrow areas prior to project construction to allow the Port to evaluate any potential indirect impacts. This monitoring will allow the Port to detect potential indirect hydrology impacts, and implement appropriate contingency measures to maintain hydrology in these wetlands.

The Port will also monitor all mitigation sites during construction. Construction monitoring is essential to ensure that mitigation designs are implemented according to plans and specifications in this mitigation plan, and in the final construction documents. Construction monitoring will also ensure that construction activities are consistent with federal, state, and local permit conditions. Construction monitoring will include regular and periodic inspections of the project site, regular meetings with contractors, and site visits during implementation of critical design elements (e.g., diverting flows to the new Miller Creek channel). Inspection activities during regular visits will include, for example, verifying that appropriate sediment and erosion control measures are in place, plants are being installed correctly and consistent with the plans, and that habitat features are installed consistent with the plans. If changes to the planting design or plant schedule are required (as a result of new information about site conditions), they will be reviewed and approved by the wetland scientist or landscape architect appointed by the Port prior to implementation. Any modifications that affect the ability of the project to meet performance standards will be presented to ACOE for approval prior to implementation.

Construction monitoring will also ensure that elements of mitigation construction are coordinated with other site activities. Because mitigation construction will often be coordinated with Master

Plan Update improvement construction activities, construction monitoring will also ensure that Master Plan Update construction-related activities do not result in impacts to mitigation sites. For example, mitigation planting zones that are adjacent to Master Plan Update construction sites (e.g., Miller Creek relocation and South 154th Street relocation) will be protected and monitored to ensure that plants installed on the mitigation sites are not damaged or disturbed by Master Plan Update construction.

All mitigation projects will be monitored for at least a 10-year period following completion of mitigation construction and approval of record drawings by the agencies. Monitoring is currently scheduled to take place at a minimum during years 0 (baseline), 1, 2, 3, 5, 7, 9, and 10, and monitoring reports will be submitted to the agencies (i.e., ACOE, Ecology) each year monitoring is conducted.

Baseline monitoring data will be collected following completion of mitigation construction. The baseline monitoring report will include a summary of site conditions immediately following mitigation construction, as well as the documentation of the protocol to be used to monitor the mitigation sites (e.g., sampling methodology, locations of all monitoring wells, photo points, vegetation sampling plots). Post-construction monitoring methods, parameters to be measured, and specific monitoring schedules for each of the mitigation projects are included in this document in the individual sections describing each mitigation project (Chapters 5 and 7).

#### 4.2.1.2 Monitoring Reports

**Baseline Monitoring Report**

On completion of construction for each mitigation project, record drawings will be submitted to EPA, USFWS, Ecology, and ACOE. Record drawings will document the final design of the mitigation sites, and any minor changes to mitigation plans that may have occurred during construction. For example, record drawings will include the following:

- Final site topography
- Site boundaries and location of perimeter fencing and signs
- Planting plans showing species composition, spacing and sizes, and location of planting zone boundaries
- Photographs taken of the mitigation site from permanent reference points
- Locations of all monitoring sample points and/or transects (e.g., vegetation transects and plots, permanent photo points, groundwater monitoring well locations, staff gauge locations, etc.)

A baseline monitoring report will also be prepared to document initial post-mitigation site conditions for hydrology, wildlife, vegetation, invasive species, channel morphology, and instream habitat features for each mitigation project as they apply. These baseline conditions will allow the Port and agencies to evaluate changes on the mitigation site over time, and progress toward meeting mitigation objectives and final performance standards.

A report including the record drawings of the mitigation site and locations of monitoring sampling locations will be submitted within 60 days of the completion of the final planting for a given mitigation site. The baseline monitoring report will be submitted within 120 days of the completion of the final planting for a given mitigation site.

**Post-construction Monitoring Reports and Reporting Schedule**

Monitoring of all mitigation sites (including temporary impacts that involve fill or clearing of vegetation in wetlands) will be conducted for a period of not less than 10 years, consistent with the monitoring plans, methods, and schedules described in this document. Regular monitoring periods for post-construction monitoring will be in years 0 (baseline), 1, 2, 3, 5, 7, 9, and 10. Monitoring reports will summarize the monitoring information collected during each monitoring period. Reports will also compare results from each monitoring period to baseline conditions, previous monitoring year results, and performance standards, and discuss any recommended contingency actions. Monitoring reports will be submitted by the end of the year (i.e., December 31st) of each monitoring period, or at a time mutually agreed upon by the Port and agencies. Monitoring schedules specific to each mitigation project are included in the individual project descriptions in Chapter 5 and Chapter 7 of this document.

**Reporting of Hazard Wildlife Monitoring Results**

In addition to performance monitoring that will be conducted specifically for the mitigation sites, the Port of Seattle conducts regular monitoring as part of the WHMP. Monitoring activities and results regarding hazard wildlife in the area of the mitigation projects will be included as an attachment to the mitigation monitoring reports. The purpose of this attachment will be to document the status of the mitigation projects near the airport with regard to hazard wildlife.

#### 4.2.1.3 Monitoring Methods

**Hydrology**

Groundwater and/or surface water hydrology will be monitored at mitigation sites for a 10-year period following completion of all mitigation construction. The hydrology in wetlands located adjacent to the runway embankment, SASA, Borrow Area 1, and Borrow Area 3 will also be monitored. The primary purpose of monitoring groundwater levels in mitigation areas is to verify that groundwater, which maintains wetland conditions on most of the mitigation sites, is present and continues to support wetland conditions. The evaluation will include determining that groundwater levels and periods of saturation are sufficient to support the wetland plant communities present on each site. Monitoring wetland hydrology in wetlands adjacent to the Master Plan Update improvements will be completed to verify that indirect impacts to wetland hydrology do not occur, and to implement contingency actions if they are found.

Permanent groundwater monitoring wells will be installed to monitor seasonal groundwater levels at each site. The number and location of monitoring wells will be established following an assessment of post-grading site conditions at each mitigation site. However, well numbers and locations will be sufficient to ensure that groundwater hydrology can be measured in each planting zone, and in all wetlands at each mitigation site. Well locations will be surveyed and included on site base maps.

Final well numbers and locations will be included in the record drawings. All monitoring wells will be installed by a licensed well driller and recorded with Ecology.

Depths to groundwater will be measured monthly during the first 3 years following completion of grading and then seasonally (i.e. four times a year) thereafter. These data will be used to evaluate the depth, frequency, and duration of inundation, and/or soil saturation on the mitigation sites, and determine whether wetland hydrology performance standards are met. These data will also be used to determine appropriate contingency measures if performance standards are not met, and to evaluate adaptive management or maintenance needs.

Groundwater monitoring will also be used to evaluate any potential indirect impacts to wetland hydrology in wetlands between the new third runway embankment and Miller Creek, and wetlands downslope of the borrow areas. Master Plan Update improvements have been designed to avoid and minimize any indirect impacts to wetland hydrology, and hydrology in these wetlands will be monitored to verify that indirect impacts have not occurred.

Surface water levels and/or flows will be monitored at selected mitigation sites where flow rates or the extent, frequency, or duration of inundation are important components of the mitigation (e.g., Miller Creek channel relocation, replacement drainage channels, Auburn open water habitat, Wetland 30 near Borrow Area 3). Surface water levels will be evaluated using staff gages. Surface water depths and/or flow rates will be measured during regular monitoring visits. Flow rates will be measured using depth and velocity methods.

**Wetland Indicators**

Wetlands at each mitigation site will be evaluated to verify that these areas continue to meet jurisdictional wetland criteria following mitigation. Methods consistent with the ACOE 1987 Manual (Environmental Laboratory 1987) for delineating wetlands will be used to verify that hydric soils, hydrology indicators, and hydrophytic vegetation are present in the wetland areas.

**Vegetation**

Vegetation monitoring will be used to determine if native plant communities are established in accordance with the specific performance standards for each site, and to provide guidance for the implementation of contingency measures when necessary. A range of variables will be evaluated, including percent survival, canopy cover by strata, height by strata, number of vegetation strata, species composition and richness, evidence of herbivore damage or disease, recruitment (i.e., the number of newly establishing individuals), and canopy cover and number of invasive, non-native species.

Immediately after completion of plant installation, the landscape architect or wetland scientist will inspect the site to evaluate the planted stock for overall health. If necessary, re-planting will be recommended to ensure that the site has been planted according to the plans and specifications. Following this inspection, record drawings will be completed to show the location of the installed plant material, the species composition, density and spacing of plants in each planting zone, and average height of each strata in each zone. Permanent vegetation photo points, sampling plots, and/or transects will be established in the field and shown on the record drawings. Vegetation data will be collected to establish baseline conditions on the monitoring site. Record drawings and baseline conditions establish a benchmark against which future changes in the vegetation can be compared. The photo points will provide a visual representation of plant cover, species composition, and general health.

The timing of the baseline monitoring will depend on construction schedules, and subsequent monitoring visits will be scheduled such that at least one full growing season occurs between monitoring dates. Vegetation sampling should occur in the late spring or early summer (June through early July). A combination of plot and plotless vegetation sampling techniques will be used following standard vegetation sampling protocols (Kent and Coker 1994). Vegetation sampling plots and/or transects will be located to ensure a representative sample of the entire mitigation site (i.e., in each planting zone, in representative locations throughout the site).

Plant survival is a key indicator of the success of native vegetation establishment and of the maintenance of target densities on the mitigation sites. A minimum survival rate of 80 percent for planted stock (calculated as percent of original individuals planted) will be required for the first 3 years of the monitoring period.

Due to the difficulty in locating and tracking individual plants over time, plant cover rather than survival or density will be evaluated following year 3. After year 3, cover of native species will more accurately reflect the ultimate habitat conditions desired on the mitigation sites. After year 3, performance standards will target a density and/or cover measure so that plant abundance can be evaluated even if plant numbers cannot be accurately estimated.

Natural colonization on the mitigation site is an important measure of the success of the mitigation. Plants that colonize the site (i.e., recruitment) following mitigation construction will be included in several of the variables used in the vegetation monitoring (e.g., density, species composition and richness measures, and percent cover).

**Wildlife**

Port wildlife managers will monitor the mitigation sites near STIA to determine hazard wildlife use (USDA 2000). Mitigation areas will be monitored according to the Port's WHMP. Information obtained from the hazard wildlife studies will be used to determine hazard wildlife use of the mitigation area, and any conflicts with FAA requirements regarding wildlife attractants near airports. Monitoring activities may include seasonal bird counts to determine levels of use and presence/absence of specific avian species. If results of the monitoring activities suggest that hazard birds are using the mitigation site, corrective actions regarding planting schemes and/or hydrologic regimes may be implemented following procedures identified in the wildlife monitoring plan. Any measures to control hazard wildlife that are recommended as a result of this monitoring will be reported to the agencies in the regular post-construction monitoring reports to ACOE and Ecology.

Mitigation sites will also be monitored for non-hazard wildlife (e.g., amphibians) during annual monitoring visits. Wildlife will be evaluated by assessing wildlife habitat components (i.e., vegetation structure, diversity and cover, or habitat elements such as coarse woody debris), and to determine if performance standards are met. There are no performance standards that require monitoring of wildlife use or populations. However, during monitoring visits, observations of wildlife will be made and reported rather than directly sampling wildlife populations.

**Channel Morphology and Instream Habitat**

Channel morphology and instream habitat will be evaluated using standard methods in stream ecology (Hauer and Lamberti 1996). These methods will be used to measure variables such as channel profiles, cross sections, substrate size, type and amount of large woody debris, canopy cover from riparian vegetation, and type and number of habitat features (e.g., undercut banks, side channels, pools). Channel morphology and instream habitat features will be evaluated during regular monitoring visits, as well as following storm events. In addition, biological monitoring will be conducted in Miller Creek to evaluate changes in the Benthic Index of Biotic Integrity (BIBI) over the 10-year monitoring period (Karr and Chu 1999). Visual inspections and photo documentation will also be used to evaluate channel morphology, the stability of habitat features, and evidence of erosion or scouring.

**Sample Data Sheets**

Sample data sheets in Appendix H show the general format and type of information to be recorded during regular monitoring visits. These data sheets reflect typical measurements of hydrology, wildlife, photographic documentation, plant cover, and plant growth that will be measured during monitoring visits.

### 4.2.2 Adaptive Management Approach

Implementation of contingency actions and other management activities on the mitigation sites will be based on an adaptive management strategy using performance standards to trigger contingency and management actions. "Adaptive Management" recognizes that since the best contingency and management actions cannot always be predicted in advance and for all potential site deficiencies, they are determined on a case-by-case basis. Monitoring results will be used to identify any areas in which mitigation sites are not meeting performance standards, evaluate the reason(s) performance standards are not being met, and design and implement appropriate contingency actions.

If necessary, the first step following monitoring will be to determine why performance standards are not being met, and to identify key contributing factors (e.g., unusual drought, inadequate hydrology, invasive species, small mammal damage). Once contributing factors are identified, appropriate contingency measures to remove or ameliorate the contributing factors will be designed and implemented. Effects of contingency measures will be monitored to ensure that they have the desired result. The results of monitoring the efficacy of contingency measures will be used to fine-tune or adjust contingency measures to increase their effectiveness. Any planned contingency actions, as well as the results of implementing specific contingencies will be fully documented and reported in the regular post-construction monitoring reports. Additional information is provided in the following sections on the weed management strategy for all mitigation sites and the relationship of the WHMP (USDA 2000) to the mitigation sites in the Miller and Des Moines Creek basins.

#### 4.2.2.1 Maintenance and Contingency

The mitigation projects are designed to be self-sustaining over the long term and are not anticipated to require significant routine maintenance following the 10-year monitoring period. However, during the monitoring period, some maintenance actions will be required on the mitigation sites.

Both routine maintenance tasks (e.g., maintaining irrigation systems) and adaptive management/contingency measures (e.g., weed management, replacing plants) will be required during the monitoring period to ensure that overall objectives and goals are met.

**Routine Maintenance**

Routine maintenance will include maintaining temporary irrigation systems, repairing or maintaining TESC measures, removing trash, repairing fences and signs, replacing dead plant material, maintaining herbivore deterrents (e.g., geese exclusion devices, herbivore collars), and methods for control of invasive plant species. For the first year following planting, the landscape contractor will be responsible for ensuring the health of planted material and for replacing dead or severely stressed plant material. After the first year, the Port will be responsible for maintaining plants and will replace plants as needed based on performance standards and consistent with specified contingency measures. Additionally, if any of the trees planted in mitigation projects within 10,000 ft of STIA runways create prime roosting habitat for starlings, blackbirds, crows, or raptors, the Port may remove these trees to conform with FAA mandates regarding aircraft safety and bird hazards. In this eventuality, the Port will replace these plants with small trees or shrubs, consistent with the WHMP.

Routine invasive plant species control includes actions such as maintaining areas of mulching or weed fabric around planted stock, application of herbicide and/or mowing areas in between planted stock. Routine weed control does not include contingency measures that are needed to meet the invasive species performance standard for re-vegetated areas of no more than 10 percent cover at monitoring year 10. Additional weed control methods are discussed below under contingencies.

The need for maintenance is anticipated to decline during the monitoring period, as the mitigation has been designed to be self-sustaining in the long term. Maintenance will continue as needed for as long as the compliance monitoring period (i.e., at least 10 years).

#### 4.2.2.2 Contingency Measures

Specific contingency measures have been developed for each performance standard at each mitigation site. Contingency measures will be implemented following the adaptive management approach in cases where performance standards are not being met. Proposed contingency actions will be fully discussed in monitoring reports submitted to the agencies, and all contingency measures will be monitored and evaluated to verify that they are achieving the desired result. Project-specific contingency measures are included with the individual project descriptions in Chapter 5 and Chapter 7 of this document. The Port will consult with ACOE and Ecology prior to implementing any additional contingency measures that may be required, but that are not included in this document.

Control of invasive non-native plant species will likely require contingency measures on most of the mitigation sites during the first several years following construction. Specific control measures will depend on the invasive species of concern and site conditions. The Port will use an integrated, adaptive weed management strategy to control invasive non-native species on the mitigation sites. This strategy is explained in Section 4.2.2.4.

#### 4.2.2.3 Wildlife Hazard Management

Monitoring and maintenance/contingency actions for the in-basin mitigation areas adjacent to STIA will be coordinated with the Port's WHMP. Regular reports on the results of monitoring for hazard wildlife at the mitigation sites will be included in the mitigation monitoring reports submitted to regulatory agencies.

The mitigation and implementation plans have been designed to be consistent with the FAA-approved WHMP, while providing for the restoration of wetland and stream functions potentially impacted by the project. Because the specific requirements of the WHMP (e.g., choice of plant species) were incorporated into the mitigation designs to avoid wildlife hazards at the mitigation sites, it is not anticipated that alterations to the mitigation sites will be necessary to comply with the requirements of the WHMP. The Port will monitor the mitigation sites regularly as part of its routine hazard wildlife monitoring program. Activities on the mitigation site for the purposes of wildlife hazard management would be consistent with permit conditions. The mitigation monitoring reports will identify hazard wildlife management activities (if any) on the mitigation sites.

In the event that the FAA determines that the mitigation measures have created a wildlife hazard to aircraft based on information obtained from the wildlife monitoring program, the wildlife hazard will be addressed according to the WHMP. The process will be as follows:

- The FAA will consult with the United States Department of Agriculture – Wildlife Science Division (WSD).
- The WSD will recommend a list of strategies that can be used to eliminate the problem.
- The Port and WSD will implement the strategies to eliminate the hazard.
- Implementation will be consistent with the wildlife hazard, and depending on the nature of the action, agencies will be properly notified.

#### 4.2.2.4 Integrated Weed Management

An integrated weed management strategy will be used at all mitigation sites that will allow the successful establishment of native vegetation and prevent long-term dominance of the site by invasive and non-native plants.[5] The goal of the weed management plan can be accomplished by a combination of the following steps:

- Reducing existing on-site sources of invasive non-natives by measures such as stripping the soil surface to remove above and below-ground plant parts, mowing and/or applying herbicide
- Planting rapidly growing native species that will quickly establish cover and shade on the mitigation site to reduce weed invasion in the short-term

[5] The plan assumes that complete eradication of non-native plants, especially invasive non-native plants, is not possible because the mitigation sites are surrounded by large sources of non-native seeds. A variety of bird species are also expected to import native and non-native plant species to the sites. The presence of some non-native species will likely be a permanent feature of the mitigation sites.

- Using hydroseed/mulch to establish an initial "weed barrier" to provide initial plant cover on the site, and reduce colonization by invasive species
- Using sterile mulch around new plantings as a weed barrier
- Monitoring the site for new weed invasions and controlling or removing invasive species before they are allowed to dominate the site

Control of invasive plants will be most important during the initial years (i.e., 1 through 7) of the monitoring period while the native vegetation is becoming established. Control methods include, but are not limited to, using manual/mechanical methods to mow, cut, grub, or girdle plants, and selective use of EPA-approved herbicides. Use of herbicides will be minimized. However, limited herbicide use in combination with other control methods may be necessary to control some of the aggressive invasive species likely to occur on the site (e.g., Himalayan blackberry [*Rubus discolor*], reed canarygrass [*Phalaris arundinacea*]).

Miller Creek Relocation/
Vacca Farm Restoration

# 5. IN-BASIN MITIGATION PROJECTS

This chapter describes in-basin mitigation projects that are designed to restore and enhance physical and biological functions in Miller and Des Moines Creeks and nearby wetlands. The Port will provide on-site (i.e., in-basin) mitigation in both the Miller Creek and Des Moines Creek basins to compensate for unavoidable project impacts to wetland, stream, and hydrologic functions. In developing this plan, the Port utilized agency guidance to identify in-basin mitigation activities that will compensate for project impacts to wetland and stream functions. Elements of the mitigation plan are specifically targeted at restoring in-basin functions that will be impacted by the project, such as sediment and nutrient retention (water quality), organic carbon production and export, surface water storage (flood water detention and storage), and aquatic habitat functions (e.g., instream aquatic habitat and riparian habitat).

The mitigation plan will result in increased functional performance of the wetlands, streams, and stream buffers in the mitigation sites relative to their degraded existing conditions. For example, wetlands currently dominated by non-native ornamental vegetation and turf grasses will be restored to forested systems containing a greater diversity of native species and habitats. Along Miller and Des Moines Creeks, water storage, nutrient and sediment retention, instream habitat, and non-avian wildlife habitat functions will all be improved relative to existing conditions.

The in-basin mitigation projects described below include the following projects.

*Miller Creek Basin*

Vacca Farm Mitigation: Miller Creek Relocation (Section 5.1.1), Vacca Farm Wetlands and Floodplain Restoration (Section 5.1.2), and Lora Lake Buffer Shoreline Enhancement (Section 5.1.3)

Miller Creek Wetland and Riparian Buffer Enhancement (Section 5.2.1)

Miller Creek Instream Habitat Enhancements (Section 5.2.2)

Drainage Channel Replacement (Section 5.2.3)

Restoration of Temporary Construction Impacts (Section 5.2.4)

*Des Moines Creek Basin*

Tyee Valley Golf Course Wetland Enhancement (Section 5.3.1)

Des Moines Creek Buffer Enhancement (Section 5.3.2)

The sections in this chapter provide descriptions and plans for each of the in-basin mitigation projects. Section 5.1 describes relocation and restoration of a portion of the Miller Creek channel; restoration and enhancement of the Lora Lake shoreline; and restoration of wetlands, floodplain, and buffers on the Vacca Farm site. Section 5.2 describes mitigation projects to restore and enhance wetlands and riparian buffers along a 6,500-ft reach of Miller Creek, and to enhance instream habitat along this reach. In addition, mitigation actions to restore wetlands temporarily impacted by construction the design and replacement drainage channels (Section 5.2) that mitigate for filling of existing ditches and drainage channels are described.

The describes restoration projects in the Des Moines Creek (Section 5.3) basin are designed to enhance existing wetlands on the Tyee Valley Golf Course and to enhance the riparian buffer along sections of Des Moines Creek. Plans to minimize and mitigate potential indirect hydrology impacts to wetlands near the borrow areas are also provided.

For each mitigation project described in this chapter, the mitigation plans are organized following Ecology guidance (Ecology 1994). The mitigation plan, goals, and objectives are introduced first, followed by a description of the project site, existing ecological conditions, the rationale for selecting the project, and any constraints on the proposed mitigation. Next the mitigation design is described in detail, with reference to figures and the plan sheets in Appendices A through E. Performance standards, monitoring schedules, and maintenance and contingency measures necessary to ensure mitigation success, are described next. The final section for each project describes the specific construction steps, methods, and sequencing required to implement the mitigation design.

## 5.1 VACCA FARM MITIGATION

Mitigation actions at the Vacca Farm site are designed to enhance approximately 17 acres of aquatic and riparian habitats by restoring natural channel morphology to Miller Creek, integrating the channel with its floodplain, removing bulkheads along the Lora Lake shoreline, and restoring functions to wetlands, farmed wetlands, prior converted croplands, and riparian and upland buffers on the site (Table 5.1-1; Appendix A). These actions will enhance fish habitat in Miller Creek, improve water quality (provide shade, ameliorate elevated water temperatures, increase dissolved oxygen, provide inputs of organic matter, improve sediment retention, and remove potential sources of fertilizer or pesticide inputs), provide no net loss of floodplain storage, and enhance the diversity and complexity of wetland habitats. Mitigation projects in the Vacca Farm area have also been designed to reduce the potential wildlife hazards that currently exist on the site, consistent with FAA Advisory Circular 150/5200-33. The major mitigation elements for the Vacca Farm site include the following:

- Relocation of a channelized portion of Miller Creek
- Restoration of natural channel morphology and instream habitat to the relocated reach
- Restoration and enhancement of riparian buffers along Miller Creek
- Restoration and enhancement of floodplain wetlands on the Vacca Farm site
- Restoration and enhancement of upland buffers around the Vacca Farm site
- Restoration and enhancement of wetland and upland buffers along the Lora Lake shoreline
- Removal of bulkheads from the Lora Lake shoreline, and restoration of a more natural shoreline along the lake

**Table 5.1-1. Summary of wetland mitigation areas at Vacca Farm.**

| Mitigation Area at Vacca Farm | Wetland Area (acres) |
|---|---|
| Wetland Restoration | **6.60** |
| Wetland Enhancement | |
| Wetlands (A1, A1a, A2, A3, A4) | 1.59 |
| Farmed Wetlands (1, 2, 3, 9, 10, 11) | 0.73 |
| Lora Lake shoreline | 0.32 |
| Lora Lake aquatic habitat | 3.06 |
| **Subtotal** | **5.70** |
| Buffer Enhancement | |
| Des Moines Memorial Drive Buffer | 1.54 |
| Stream Buffer | 3.04 |
| Lora Lake Buffer | 0.27 |
| **Subtotal** | **4.85** |
| **Total Restoration Area** | **17.15** |

### 5.1.1 Miller Creek Relocation and Channel Restoration Plan

To accommodate the embankment for the third runway, the RSAs, and the relocation of South 154th Street, approximately 980 ft of Miller Creek will be realigned and relocated. The new stream channel will be constructed approximately 200 ft west of the existing channel, through the Vacca Farm site. The channel reach to be relocated has been dredged and straightened, lacks complexity (e.g., straight uniform channel bed, no undercut banks, no side channels, no pool/riffle morphology, uniform silty substrate), there are few instream habitat features (e.g., no large woody debris, no pools or backwater areas), and the riparian vegetation provides little shade or organic matter to the channel.

Relocating the stream will increase the channel length to approximately 1,080 ft. A low-flow channel will meander within a larger high-flow channel, and the new channel will include instream habitat features (e.g., large woody debris). The channel will be designed to be connected to the floodplain by overbank flooding with approximately a 1-year return interval. Channel banks will be planted with native shrub plant communities and the new channel will have a native forested riparian zone to ameliorate water quality, and provide shade and large woody debris.

#### 5.1.1.1 Goals, Objectives, and Design Criteria

The overall goals of this plan are to provide a new, longer stream channel with enhanced habitat features and a more natural channel morphology compared to the existing channel that will be filled. The channel design is constrained by the existing high and low flow conditions in Miller Creek and the very gradual slope of the channel through this reach. The goals of the design are focused on the need for the relocated channel to continue to convey base flows, to maintain sufficient depths during summer low-flow periods for fish passage, to prevent deposition of fines and scouring to maintain fish habitat, and to allow flood flows greater than annual peak flows to overtop the channel banks and flow onto the floodplain. Specific goals for the design of the relocated channel are:

- The stream continues to provide base flow conveyance.
- Minimum flow velocity remains high enough to minimize fine sediment deposition.
- The new channel accommodates peak flows up to the 100-year flow with no net reduction of 100-year floodplain storage or floodway conveyance.
- The new channel provides improved fish habitat.
- The new channel replaces or enhances riparian habitat function.
- The channel does not attract wildlife (such as waterfowl or flocking birds).

The goals are prioritized from the most critical hydrologic functions that the existing channel provides to enhancements that will improve channel and riparian habitat.

To implement the general goals identified above, specific objectives and design criteria were developed (Table 5.1-2). Specific performance standards, monitoring approach, and contingency measures for the channel relocation are discussed in more detail in Section 5.1.1.10.

**Table 5.1-2. Mitigation goals, design objectives, and design criteria for the Miller Creek relocation project.**

| Goals and Design Objectives | Design Criteria |
|---|---|
| **Goal 1: The stream will continue to provide base flow conveyance** | |
| Provide flow depths to allow fish passage, prevent fish stranding, and provide habitat. | Construct low flow channel 8 feet wide with 1:1 slopes and 0.5 ft deep to convey summer base flows.<br>Construct high flow channel 32 feet, side slopes of 2:1 (typical) from depths of 0.5 to 1.0 ft to provide capacity for wet season base flow. |
| **Goal 2: Low flow velocity should minimize fine sediment deposition** | |
| Minimize sedimentation with minimum flow velocity. | The channel cross section will provide an average dry season base flow velocity that is greater than the silt transport velocity (0.7 ft/sec).<br>Design a natural channel with stable gravel bottom. |
| Minimize channel scouring at the maximum design flow velocity. | Channel flow velocity cannot exceed the gravel movement velocity (4 ft/sec) for the 100-year flow. |
| **Goal 3: The channel will accommodate peak flows, including the 100-year flow** | |
| Accommodate the 100-yr-peak flow. | Flows greater than the annual peak flow will overtop the channel and inundate the adjacent floodplain restoration. |
| **Goal 4: The new channel will provide enhanced fish habitat** | |
| Provide enhanced fish habitat without fish passage barriers. | Provide a natural channel configuration. Increase channel length by about 10 percent and a meandering low flow channel.<br>Provide habitat features, including instream features such as deflectors and overhanging logs as needed to maximize available habitat. |

Table 5.1-2. **Mitigation goals, design objectives, and design criteria for the Miller Creek relocation project (continued).**

| Goals and Design Objectives | Design Criteria |
|---|---|
| **Goal 5: The channel will replace and enhance riparian habitat function** | |
| Provide riparian habitat. | Provide a minimum 50ft vegetated buffer on the east side of the channel. |
| | Establish native vegetation along channel banks and the riparian zone of the new channel. |
| **Goal 6: The channel will not attract wildlife** | |
| | Densely plant woody vegetation along the new channel to cover open water and reduce use of the area by waterfowl. |

### 5.1.1.2 Ecological Assessment of Miller Creek at Vacca Farm

Overall conditions in the Miller Creek basin are described in Chapter 2. In this section, existing conditions at the Vacca Farm site relevant to the mitigation design are described in more detail. Miller Creek originates north of SR 518, flows south through the Miller Creek detention facility along the southeast side of Lora Lake, and then south along the eastern edge of the Vacca Farm site. The Miller Creek detention facility detains and stores flood waters from the upper reaches of the Miller Creek basin during periods of high flow. Vacca Farm sits in a broad, flat valley of alluvial sands, silts, and peat soils located south of Lora Lake. Through the Vacca Farm site, portions of Miller Creek have been channelized and straightened to improve drainage on the site. From the Vacca Farm site, Miller Creek continues south and west through residential areas and ultimately empties into Puget Sound (see Figure 2.1-2 and 2.2-1).

The Miller Creek channel between the Miller Creek detention facility outlet to South 156th Way has been dredged and straightened to drain wetlands for farmland reclamation. Topographic conditions, peat soils, and seasonally high water tables along this reach indicate that this area was historically a wetland. The channel currently overflows its banks with at least a 2-year frequency with full flow velocity of 1.7 ft per second (see Figure 2.2-2)(FAA 1996). Frequent flooding is primarily the result of limited channel capacity, in part due to channel slope.

Miller Creek is approximately 4 to 10 ft wide and 2 ft deep below the outfall of the Miller Creek detention facility. The bank is lined with large rocks in the upper segments near Lora Lake, and the channel has a very silty substrate. The section of the stream within the Vacca Farm site that will be relocated is a ditched reach with a silty bottom substrate. Downstream of South 156th Street, the channel contains natural meanders that vary from approximately 5 to 10 ft in width and the substrate consists of areas of sand and gravel with some silt.

A side channel (ditch) in the Vacca Farm site runs parallel to and west of the main channel. The side channel does not drain runoff from a distinct subbasin area nor does it provide additional channel capacity to the main channel. Rather, it provides positive drainage for a portion of the relatively flat farmland located west of Miller Creek.

## Hydrology

Urbanization and development of the watershed have led to increased runoff rates and volumes that have contributed to erosion and downcutting. Increased erosion and downcutting have also resulted in sedimentation and habitat degradation in the low-gradient areas (FAA 1996). In 1990, King County constructed the Miller Creek detention facility to alleviate some of these impacts (see Figure 1.3-1).

Since 1982, King County Surface Water Management (KCSWM) has monitored flow rates at the outlet of the Miller Creek detention facility (KCSWM 1994). The available flow data provide a good record of base flows, normal wet and dry season flows, and annual peak flows. Stream flow rates are typically highest between October and April and lowest between May and September (FAA 1996). Montgomery Water Group (1995) modeled hydrologic characteristics in the basin and found that in some years no flow occurs in the upper watershed areas during portions of the summer (i.e., 1-in-10 year low flow). They also reported that summer flows are 0.5 cubic feet per second (cfs) less than about 10 percent of the time. Flows during the dry season and wet season are shown in Table 5.1-3. Table 5.1-4 summarizes data for flood frequency estimates in Miller Creek at the Miller Creek detention facility.

**Table 5.1-3. Estimated base flow rates at the Miller Creek detention facility outlet structure.**

| Season | Flow Rate (cfs) |
|---|---|
| Dry (May – September) | 0.5 |
| Wet (October – April) | 5.0 |
| Approximate Annual Peak | 40.0 |

Source: KCSWM (1994)

**Table 5.1-4. Flood frequency estimates for Miller Creek at the Miller Creek detention facility control structure.**

| Return Period (years) | Peak Flow Rate (cfs) |
|---|---|
| 1.01 | 21 |
| 1.11 | 40 |
| 2 | 75 |
| 10 | 125 |
| 20 | 141 |
| 50 | 161 |
| 100 | 175 |

Source: Montgomery Water Group (1995)

## Existing Fish Habitat

Historically, Miller Creek supported anadromous fish runs of coho salmon (*Oncorhynchus kisutch*), chum salmon (*O. keta*), and sea-run cutthroat trout (*O. clarki clarki*), as well as resident populations of pumpkinseed sunfish (*Leponis gibbosus*), sculpin, and cutthroat trout (FAA 1996). A qualitative electrofishing survey conducted in August 1996 identified cutthroat trout, pumpkinseed sunfish, and three-spine stickleback (*Gasterosteus oculeatus*) in reaches between South 160th Street and the outlet of Lake Reba (Aquatic Resource Consultants 1996). One coho smolt was captured downstream of the culvert under South 160th Street during a 1996 electrofishing survey. In addition, three cutthroat trout were found north of a natural waterfall above South 160th Street during another electroshocking study on November 10, 1998 by Parametrix, Inc.

The stream currently supports a small coho salmon run maintained by annual releases of hatchery-reared fingerlings raised by the Des Moines Chapter of Trout Unlimited (FAA 1996; Hillman et al. 1999). No spawning activity was observed during surveys conducted in 1996 by WDFW. However, the Des Moines Chapter of Trout Unlimited reported 91 coho spawners in a recent survey. The Port has prepared a Biological Assessment which evaluates the affect of the MPU improvement projects on fish species recently listed under the Endangered Species Act (ESA) (Parametrix 2000d).

Residential development in the watershed has resulted in a general deterioration of fish habitat due to removal of native riparian vegetation, stream channelization and bank armoring, filling of riparian wetlands, reduction of the availability of large woody debris, and increased runoff rates and non-point source pollution loading. The expansion of impervious surface area in the basin has caused increased volumes and velocities of stormwater runoff resulting in increased bank erosion, and downcutting. These factors have contributed to a general lack of (1) instream cover, (2) available low- and high-flow habitat or refuge, (3) available spawning habitat in the basin, (4) habitat complexity, and (5) high-quality water (KCSWM 1987; and FAA 1996).

Natural, unaltered stream reaches in the Miller Creek basin are essentially nonexistent, while major portions of the main stem and associated drainage ditches are channelized or otherwise modified (KCSWM 1987). The portion of the stream crossing the Vacca Farm site, which has been channelized, lacks woody debris, and provides limited habitat complexity. This reach is dominated by low-velocity flows, and excessive sedimentation, which appears to be partially caused by agricultural runoff. FAA (1996) estimated that 10 tons of sediment are transported to the stream annually from approximately 11 acres of adjacent agricultural land. These factors contribute to the lack of pools, and therefore a lack of refugia for fish during high-flow events.

Several natural and man-made barriers appear to limit fish access to the upper basin; however, they are not barriers under all flow conditions. The most prominent barrier on Miller Creek is a natural 8-ft-high waterfall about 0.2 mile upstream of South 160th Street that restricts upstream fish passage. Several corrugated metal and concrete box culverts, such as a culvert located at South 160th Street, appear to be barriers under certain flow conditions.

These barriers, combined with habitat availability, likely contribute to the current fish distributions in Miller Creek; salmonids occupy primarily downstream reaches while other species occur upstream. Recent studies (FAA 1996; Hillman et al. 1999) have found that suitable coho salmon spawning habitat and evidence of coho salmon spawning is limited to the area downstream of First Avenue South, while suitable cutthroat trout spawning habitat was scattered in small patches between South 156th Way and First Avenue South. Areas upstream of First Avenue South consisted predominantly of a fine silt and sand substrate, which is more suitable habitat for the non-salmonid fish species that occur there.

**Existing Riparian Vegetation**

Downstream of the Miller Creek detention facility, about 200 linear ft of the stream are bordered by small tree and shrub riparian vegetation. Riparian vegetation consists of stands of red alder saplings (*Alnus rubra*) with an understory of hardhack (*Spiraea douglasii*), Himalayan blackberry (*Rubus discolor*), and field horsetail (*Equisetum arvense*).

Throughout most of the Vacca Farm site, riparian vegetation associated with Miller Creek is typically a narrow band less than 50 ft wide. Riparian vegetation is dominated by reed canarygrass (*Phalaris arundinacea*), climbing nightshade (*Solanum dulcamara*), and introduced grass species. Scattered throughout this area are black cottonwood (*Populus trichocarpa*), and willow (*Salix* spp.) trees and saplings. This narrow band of low-quality riparian vegetation separates the stream from the adjacent cultivated farmland.

### 5.1.1.3 Ownership

Property at the Vacca Farm site and along Lora Lake needed for the stream relocation has been purchased by the Port as part of the larger property acquisition program for the proposed Master Plan Update improvements.

### 5.1.1.4 Rationale for Selection

The Miller Creek relocation mitigation provides the opportunity to restore both high quality stream habitat and floodplain wetland habitat that will result in on-site, in-kind replacement for stream and wetland functions impacted by the MPU projects. The existing portion of Miller Creek that will be relocated was moved from its original location within the floodplain at the Vacca Farm site to increase the amount of floodplain suitable for farming. The original channel was moved to the east, straightened, and dredged to facilitate drainage and increase agricultural land on the site. As a result, although the channel still floods, it lacks the connection with its floodplain and floodplain wetlands that it historically had. The channel does not meander across the floodplain and there are no side channels, sloughs, or backwater areas. The existing channel lacks complexity (e.g., straight uniform channel bed, no undercut banks, no side channels, no pool/riffle morphology, uniform silty substrate), there are few instream habitat features (e.g., no large woody debris, no pools or backwater areas), and the riparian vegetation provides little shade or organic matter to the channel.

Relocation and restoration of channel morphology therefore provides the opportunity to restore both aquatic habitat and floodplain wetland functions on the site. The mitigation plan for the channel relocation will restore channel morphology and instream habitat. In addition, the connection between channel and floodplain wetlands will be restored to the extent possible, while avoiding the creation of new hazard wildlife attractants near the airport. Integration of channel and floodplain will be designed to allow the channel to flood periodically, but to avoid standing water in floodplain wetlands.

#### 5.1.1.5 Constraints

Relocation of Miller Creek must occur on-site in proximity to the existing channel. The Vacca Farm site is nearly level, with only a few feet of grade change from north to south. The alignment for the new channel has been designed to facilitate meeting design criteria for flow and velocity given the existing site topography. Meeting these criteria requires that the stream relocation reach be as short as possible to ensure that the maximum channel slope is maintained. The length of the relocated stream reach cannot be increased and still meet the minimum gradient for required flow velocities and depth. As a consequence of constraints on channel length, the new channel will remain fairly close to the re-aligned roadway and the embankment. The buffer width between the relocated stream and South 154th Street is constrained by the maximum length of the new stream channel (Figure 5.1-1). Constraints on the channel design are described in detail in Section 5.1.1.6, Channel Relocation Mitigation Design.

No other apparent constraints outside of the Port's control could affect the success of the stream relocation. No plans exist to change the Miller Creek detention facility's operation procedure. Stormwater management is now planned to occur in new facilities (i.e., vaults and/or ponds located in upland areas) that are independent of the Miller Creek detention facility (for details, refer to the *Stormwater Management Plan,* Parametrix 2000a). However, even if the existing detention facility were enlarged to provide more flood storage, this would not be expected to change flow rates in Miller Creek. The detention facility could be enlarged to provide greater stormwater storage without increasing the maximum elevation of water storage or peak discharge rates. This could be accomplished by excavating uplands that are located south of the facility to an elevation within the operating range of the facility to provide new storage. This will not affect the mitigation design because stream hydrology, specifically base flow and normal seasonal flow, will not be significantly modified, and it is unlikely that peak stormflows will be increased.

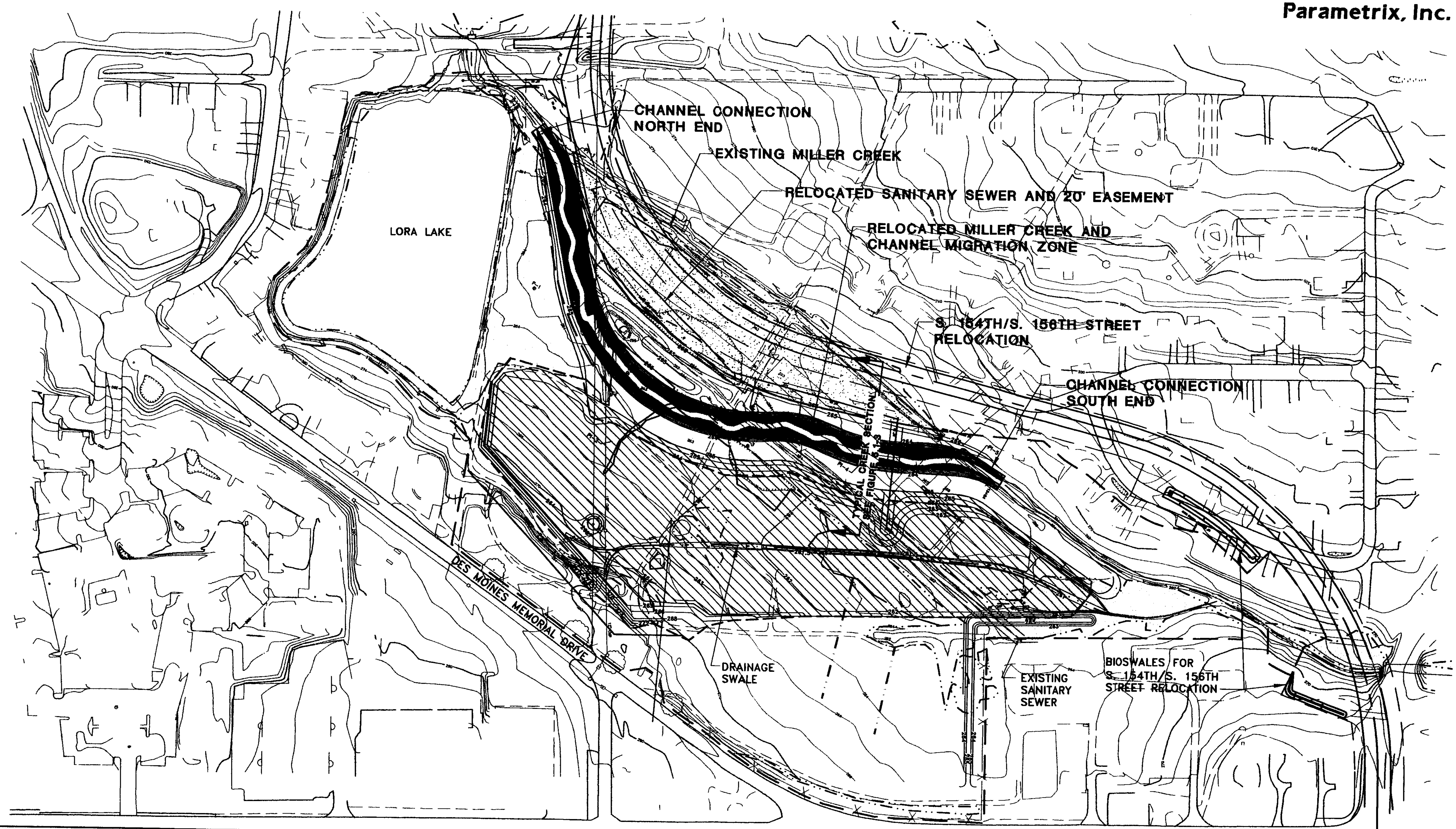
#### 5.1.1.6 Channel Relocation Mitigation Design

The goals of the design are focused on the need for the relocated channel to continue to convey base flows, to maintain sufficient depths during summer low-flow periods for fish passage, to prevent deposition of fines and scouring to maintain fish habitat, and to allow flood flows greater than annual peak flows to overtop the channel banks and flow onto the floodplain.

**Channel Design**

The channel design process evaluated and adjusted design variables and constraints (e.g., channel depth, width, flow velocity, channel slope, etc.) to meet the design goals and criteria. The critical variables in new channel design are channel slope, flow velocities (i.e., dry and wet season base flows, annual peak flows, and flood flows above annual peak flows), maximum design flow, channel depth and bottom width, channel roughness, and channel length. Initial channel slope was determined using the available drop in elevation along the new reach. The corresponding channel bottom width was determined and adjusted until the minimum flow depth (0.25 ft) was achieved. The slope was then adjusted until the base flow velocity was high enough to move sediment particles smaller than sand to reduce siltation and fining of the bed. Using the adjusted slope, the channel was then designed to convey peak flows (in connection with maximum depths and channel configurations described in the following sections). Channel widths and flow depth were then adjusted to assure that peak flow velocities were less than the transport velocity for gravel.

Parametrix, Inc.

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| — — | EXISTING SANITARY SEWER |
| — · · — | WETLAND BOUNDARY |
| —263— | EXISTING CONTOUR |
| —263— | PROPOSED CONTOUR |
| — — | LIMIT OF CONSTRUCTION |
| (stippled) | FILLED FLOODPLAIN 8,455 CY (5.24 AC.-FT.) |
| (blank box) | WETLAND (VERIFIED) |
| (hatched) | PROPOSED FLOODPLAIN EXCAVATION 9,589 CY (5.94 AC.-FT.) |

**Figure 5.1-1**
**Vacca Farm Wetland Restoration Grading Plan**

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## Hydrology

The hydrologic design criteria for the Miller Creek relocated channel design are listed in Table 5.1-2. Design criteria for determining base flow, annual peak flow, and 100 year flow conditions were established from data gathered by KCSWM. These flow rates were determined from data gathered at the outlet of the Miller Creek detention facility (which includes Lake Reba), which is several hundred feet upstream of the mitigation site. Data have been gathered at this location since 1988 (KCSWM 1994). These flow data provide a good record of normal base flows, seasonal peak flows, average flows by season, and extreme flows during near-record events. Design criteria for base flow and annual peak flow conditions were established from these data (Table 5.1-5). Statistical analysis of the flow monitoring data was not conducted.

**Table 5.1-5. Estimated flow rates for Miller Creek channel design.**

| Flow Regime | Flow Rate (cfs) |
|---|---|
| Dry season base flow | 0.5 |
| Wet season base flow | 5 |
| Stormflow | 10 |
| Annual peak flow | 40 |
| 2-year peak flow | 75 |
| 10-year peak flow | 125 |
| 100-year peak flow | 175 |

Source: Montgomery Water Group (1995); with additional data compiled by Parametrix.

In addition to monitored flow rate data, a detailed hydrologic modeling study was prepared (Montgomery Water Group 1995) that calculated peak flow rates for flood frequencies up to the 100-year flood (Table 5.1-6). The flood return frequencies were calculated assuming that the Miller Creek detention facility detention system and control structure is in place. The calculated flow rates appear to be consistent with the flow monitoring data. The peak monitored flow rate (225 cfs) on November 24, 1990 was in excess of the current predicted 100-year flood flow. The control structure was constructed after the 1990 storm; it is likely that the peak flow rate of November 1990 would have been reduced by the detention system. Because stormwater runoff would be mitigated in separate stormwater management facilities, this plan does not increase channel capacity for increased flows.

**Table 5.1-6. Flood frequency estimates for Miller Creek at the Miller Creek detention facility control structure.**

| Return Period (years) | Peak Flow Rate (cfs) |
|---|---|
| 1.01 | 21 |
| 1.11 | 40 |
| 2 | 75 |
| 10 | 125 |
| 20 | 141 |
| 50 | 161 |
| 100 | 175 |

Source: Montgomery Water Group (1995).

## Stream Hydraulics

Stream hydraulics are the existing or proposed physical conditions that influence the direction, depth, and flow velocity in the proposed relocated stream. Several factors influence hydraulics, including flow rates, channel slope, channel cross section, channel roughness, and flow depth. While several of these features will be designed, factors such as flow rate or average channel slope cannot be modified. The following sections discuss the design parameters that apply to all channel segments, and the proposed channel configuration for each segment.

### Flow Velocity

Channel flow velocity is the primary variable influencing channel design and fish habitat. The low flow goal is to minimize fine-grained (sands and finer) material sedimentation in the proposed channel during normal dry season base flows. Conversely, the flow velocity at peak flows must not exceed rates that would erode the channel banks or scour loose substrate larger than small gravel.

The relationship between flow velocity and sediment transport velocity is shown in Figure 5.1-2. If the flow velocity equals or exceeds that shown for each grain size, the sediment can be expected to move until the velocity decreases. If the maximum velocity of a specific section of a stream channel is known, an estimate of the size of the bed material that would be relatively stable can be determined. These relationships are used to determine the size of stream substrate materials and their long-term stability. The Miller Creek channel design thus balances a minimum base flow velocity designed to prevent sedimentation, with a maximum peak flow velocity designed to prevent scouring. Using Figure 5.1-2, the channel parameters were adjusted to maintain base flow velocity greater than the silt movement velocity, but less than the gravel movement velocity for peak flow. Preventing gravel movement in the new reach will prevent scouring of the substrate.

### Channel Slope

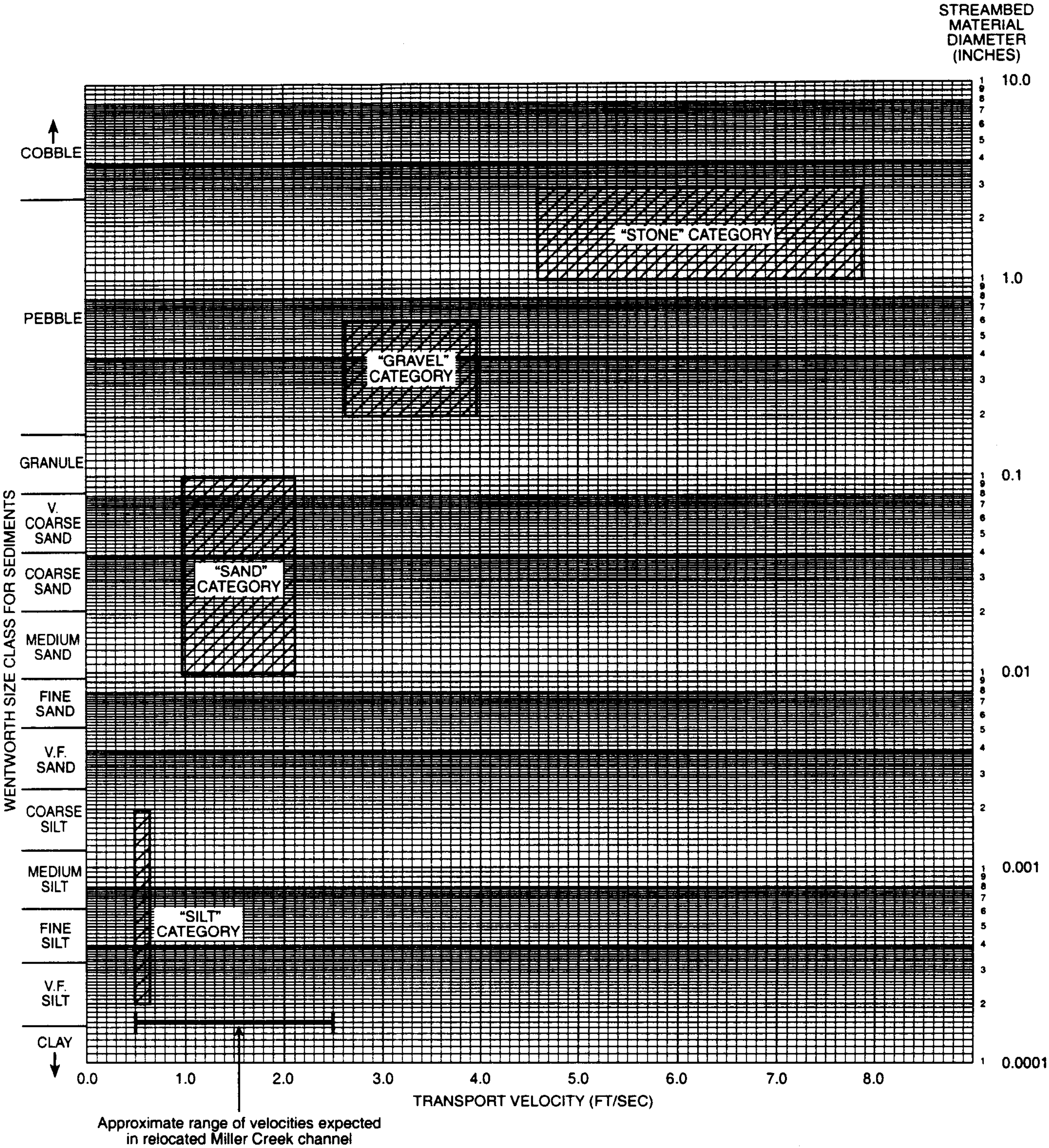
The average channel slope in the relocated reach is determined by physical constraints (i.e., topography) of the Vacca Farm site. The proposed channel drops 2.5 ft in approximately 1,118 ft for an average channel slope of 0.22 percent. The approximate elevation at the point where the relocated stream rejoins the existing channel is 260.0 ft. However, the natural land slope along the proposed stream channel does not drop continuously. Due to the small vertical drop over the relocated segment, a relatively uniform grade is proposed for Miller Creek.

### Channel Flow Depth

Given the goals for fish habitat, desired substrate characteristics, and stream hydrology, flow depth standards have been determined. These flow standards are: (1) a dry season water depth of at least 0.25 ft; (2) a wet season water depth of 1 ft; (3) a maximum depth of 2 ft at the mean annual flow rate, and (4) flows greater than the annual maximum flow rate (40 cfs) will overflow the streambanks, flooding the Vacca Farm site.

### Maximum Design Channel Flow

The topography and available channel slope in the project area limit constructing a large channel that can convey the 100-year storm while maintaining a minimum flow depth for dry season base flows. Therefore, the channel will overflow onto the floodplain at flows greater than approximately 40 cfs. The floodplain and floodway are designed to convey the 100-year flows of 175 cfs.




Source: Fisheries and Oceans (1980)



**Figure 5.1-2**
**Sediment Transport Velocity vs. Sediment Diameter**

## Channel Bottom Width

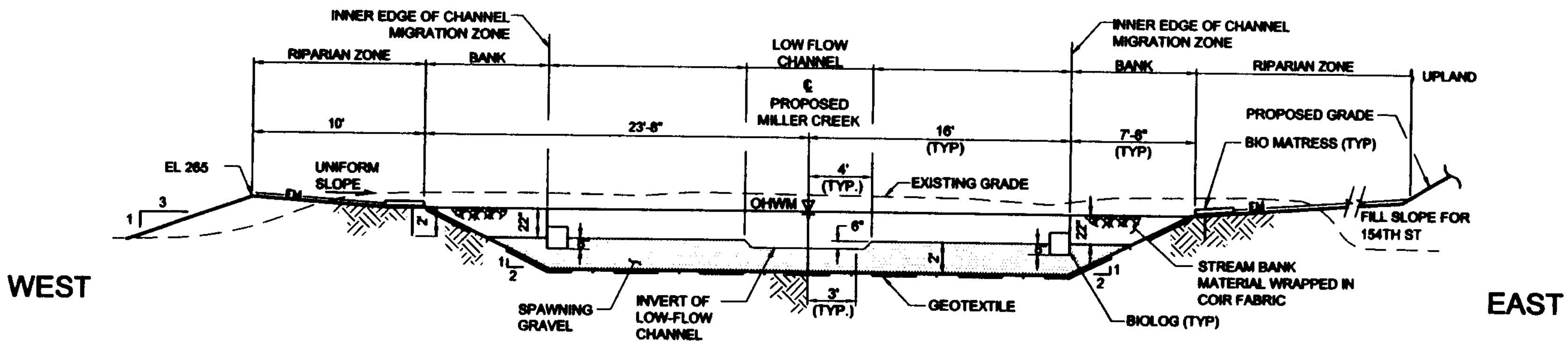
The channel bottom width for the relocated channel is largely controlled by the minimum low-flow depth of 0.25 ft. During the dry season, the water depth must average at least 0.25 ft to provide minimum depth for fish movement. To determine the channel bottom width, the base flow rate, slope, roughness, and side slopes were fixed, and the bottom width was adjusted until the flow depth was at least 0.25 ft. The results were checked to ensure that no other design criteria were changed to exceed design parameters. Results indicate that a channel bottom width ranging from 4 to 10 ft meets the design criteria for minimum flow depth. Thus, a low-flow channel between 4 and 10 ft wide will maintain a minimum flow depth of 0.25 ft during summer low flows to allow fish passage while conveying wet season base flows (Figure 5.1-3).

## Channel Roughness and Side Slopes

Channel roughness, described by using Manning's roughness factor (n), is a key factor in determining channel capacity. The Manning's channel roughness factor for a natural stream channel with a gravel or stony bottom and limited instream vegetation is 0.0035. This factor was used for calculating channel capacity for the relocated reach. The Miller Creek relocated channel will consist of a high-flow or bench area and a low-flow channel. The low-flow channel will have an 18- to 24-inch-deep gravel streambed, and will be generally 4 to 10 ft wide by 6 inches deep. It will meander within the 32-ft-wide high-flow channel, forming a channel migration zone (see Figure 5.1-3). The low-flow channel is designed to convey base flows and to overtop its banks approximately once a year during annual peak flows (i.e., between approximately 20 and 40 cfs). The annual peak flows will be accommodated within the 32-ft high-flow channel. Flood flows greater than the annual peak flows (i.e., greater than 40 cfs) will overflow the streambanks onto the floodplain.

The new channel is located in an area with peat soils; however, the channel will not be constructed directly in peat soils without bank stabilization (see Figure 5.1-3). The streambanks will be constructed using blended soils and gravels wrapped in an erosion control fabric. The toe of the channel banks will be protected by installation of prefabricated logs made of dense coconut fibers wrapped in erosion control fabric. This construction method provides immediate erosion protection while also providing a rooting substrate that will facilitate revegetation of the banks. The area adjacent to the channel banks will be sloped toward the channel at 2 to 10 percent grade for positive drainage.

The side slopes of the low flow channel will be 1:1, which is required to maintain minimum flow depths of 0.25 ft for fish passage. This design will also allow some minor undercutting of channel banks over time to increase shelter for fish. Low flow channels of natural streams in the Puget Sound region typically have vertical side slopes (Rosgen 1994; Montgomery and Buffington 1993), and the design thus mimics natural stream channels. The side slopes of the new channel will be stabilized with bioengineering and the planting of native vegetation (i.e., primarily willow stakes). The low channel gradient and design of the low-flow channel to overflow into the larger channel during storms greatly decrease the likelihood of erosive flows.

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SCALE: HORIZONTAL 1"=10'
VERTICAL 1"=10'

**Figure 5.1-3**
**Channel Cross Section**
**Miller Creek Location**

## Channel Alignment

The channel will be constructed to meander within the limits of the stream corridor as shown in plan and cross section in Figures 5.1-1 and 5.1-3. The extent of meandering is limited by the need to maintain a minimum channel slope to meet flow velocity goals.

## Sewer Line Relocation

Relocation of Miller Creek (design and construction) will be coordinated with the realignment of the sewer line required by the relocation of South 154th Street. The sewer line will parallel the new road alignment (outside of the mitigation site boundary) and will cross under the new channel (see Figure 5.1-1). The sewer line will be approximately 4 ft below the invert of the new channel. The trench in which the sewer line lies will be backfilled with compacted fill material that will provide a stable surface over the sewer line. The Port has analyzed the need for additional stabilization below the new channel to protect the sewer line and the channel. This analysis indicates that because of the depth of the sewer line, the flat topography of the site, and the small size of the channel, no extra measures will be required to stabilize the channel over the sewer line. The new channel will be located in a portion of the Miller Creek floodplain that is more or less flat; stream velocities are low in this portion of the stream, and there is no potential for significant downcutting within the new channel reach. During periods of high flows, the channel is designed to overtop its banks and flow onto the floodplain, which further reduces any potential for downcutting.

The 20-ft easement for the relocated sewer will be located outside of the mitigation site boundaries, except where the line crosses under the stream. A maintenance access road will be located within the easement along the east side of the mitigation site; however, the access road will not go through the mitigation site (Appendix A, Sheet C2).

## Wildlife Considerations

Design and implementation of mitigation for STIA must meet flight safety issues and FAA requirements. Collisions between birds and aircraft are a serious safety issue. Open-water areas, wetlands, and tall trees can create an aviation hazard by attracting waterfowl, small flocking birds (such as European starlings), and raptors. Fish can also attract birds, such as raptors or herons, that pose hazards to aviation. When these habitat features are within 10,000 ft of airport runways, the potential for collisions with aircraft can be serious. For these reasons, mitigation projects within 10,000 ft of STIA runways are designed, where feasible, to reduce existing wildlife hazards and avoid creating new hazards.

Fish habitat design standards for Miller Creek were developed based on the habitat requirements of cutthroat trout.[6] The planned features include:

- Shading to minimize temperature increases during the summer
- Higher velocity riffles to maintain oxygen levels and reduce sedimentation

[6] While coho salmon may find suitable rearing habitat in this area, flow conditions are not anticipated to be suitable for spawning coho.

- Placement of logs, rocks, or other structures to provide refuge
- Shading of the channel with native vegetation

Channel shading will enhance the stream habitat and also decrease the stream's visibility to birds of prey (e.g., herons, raptors) that would use the stream to collect food. Riparian vegetation will thus help reduce potential wildlife hazards along the channel. The following sections describe how the stream design will meet cutthroat trout habitat criteria and FAA requirements for aviation safety.

**Instream Habitat**

The instream habitat criteria used in the relocated channel design are based on general habitat requirements of the resident salmonid cutthroat trout and coho salmon, which could potentially use the site. Although anadromous salmonids have not been observed in the proposed impact areas, resident cutthroat trout are present. These criteria are used to provide the highest quality fish habitat possible. Designing the relocated stream to meet habitat requirements of salmonids helps ensure that the best possible fish habitat is created.

In general, salmonids require cool, well-oxygenated water; spawning gravel that is free of accumulated silt; and abundant instream cover for habitat. In addition, because habitat requirements vary as life stages change, habitat complexity within the stream is also necessary. General physical habitat requirements include access to critical habitat features, stable flows, appropriate stream substrate, and riparian and instream cover.

Salmonids require cover provided by such features as undercut banks, logs, boulders, deep pools, and overhanging riparian vegetation for feeding, hiding, and resting. In addition, these features help stabilize streambanks and substrate during high-flow periods. The relocated channel, which is designed with vertical banks in the low-flow depth range, will encourage minor undercutting to provide cover during low-flow periods. Large woody debris (e.g., deflector logs, angle logs, and root wads), and boulders will be used to stabilize the substrate, protect the upper banks from excessive erosion, and provide hiding and holding habitat for fish during higher flow periods (Figure 5.1-4).

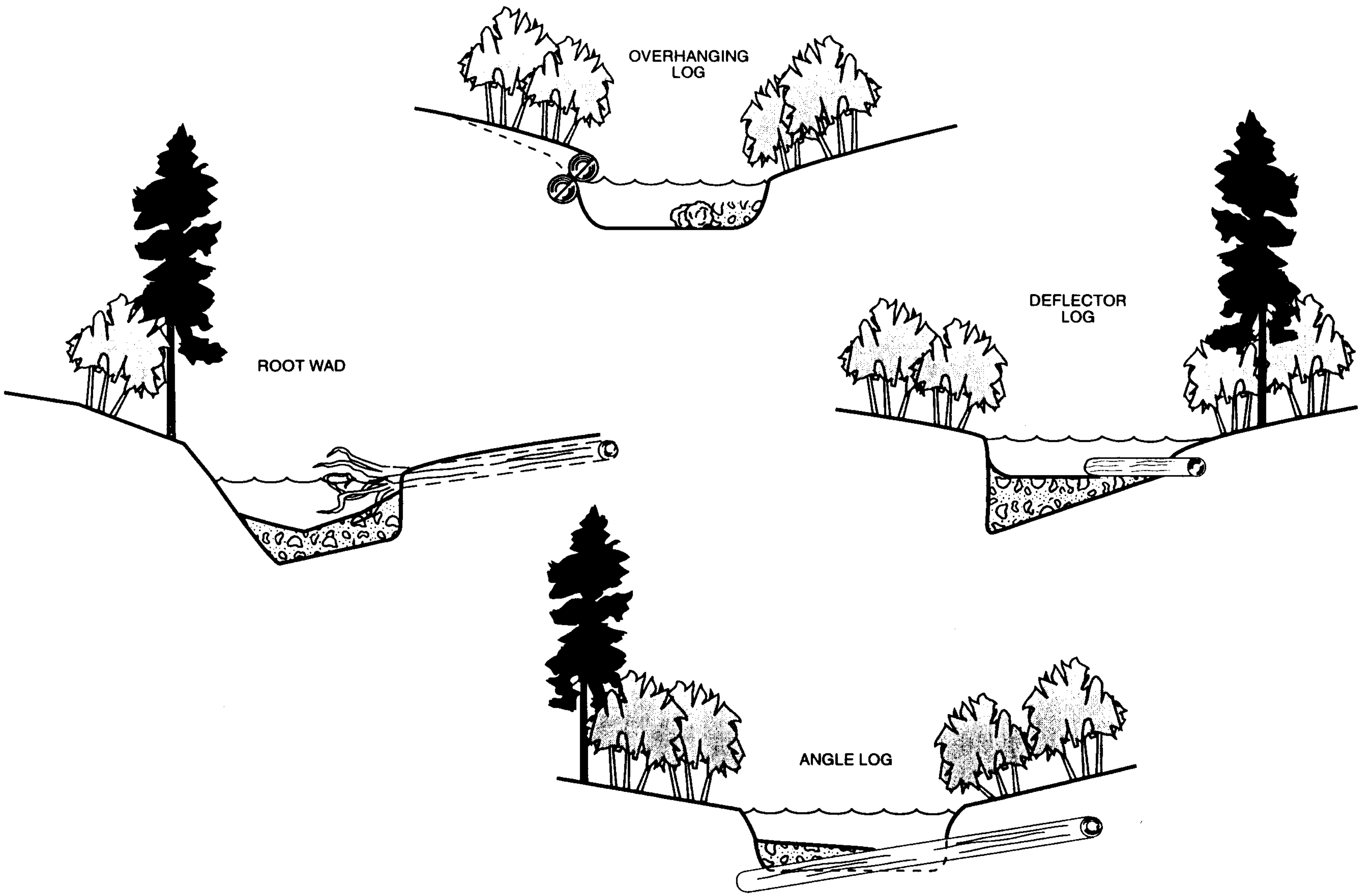
**Fish Access**

Adequate fish access throughout the entire relocated stream section will be provided by the minimum design depth requirements (i.e., 0.25 ft during dry season base flows). Accessible habitat includes protected areas (i.e., low-velocity pockets) during high flows. The channel is also designed to avoid habitat features that could cause stranding problems during low-flow conditions.

This minimum depth requirement should allow fish access to habitat throughout the length of the channel, thus limiting stranding problems during low-flow periods.

**Stable Flow**

Stable flows ensure habitat access and protect the habitat against erosion or scouring; they also minimize fish displacement to less preferred habitats. The channel width and bank slope criteria incorporated in the design will help maintain relatively stable flow velocities throughout the range of flows expected in the new channel.




Data Compiled by Parametrix

Port of Seattle/Natural Resource Mitigation Plan/556-2912-001/01(03) 12/00 (K)

**Figure 5.1-4**
**Representative Fish Habitat Enhancement Features**

**Stream Substrate**

Cutthroat trout require stable gravel and sand substrates largely free of accumulated silt for spawning and during early rearing life stages. This substrate also contributes to the optimum production of desired prey. Substrate in the relocated channel will consist of gravel, coarse sands, and cobble material to provide stable spawning and rearing habitat. However, portions of the channel will naturally accumulate sand over time. The flow velocity criteria for the channel were set to maintain suitable substrate for fish by minimizing the accumulation of fine-grained material in the channel during low-flow periods and preventing excessive scouring of the substrate during high flows. Since flow velocities are not constant along the entire channel, sedimentation is expected to occur on the inside of bends and in deeper pools during low-flow periods. However, these sediments will flush out again during higher flows.

**Floodplain Conveyance**

The 100-year floodplain elevation and floodway delineation in the proposed project area were determined by FEMA when the Flood Insurance Rate Maps (FIRM) were prepared. The proposed channel capacity was checked for the 100-year flow rate peak capacity. No impacts are expected to flood conveyance since the floodplain storage does not decrease (see Section 5.1.2) and the floodplain has adequate capacity to convey the 100-year flood.

**Channel Planting and Riparian Buffer**

The new channel banks will be stabilized and cover will be provided to the stream by planting the banks with native willows. A forested buffer will also be planted along the stream riparian zone to maximize stream shade and provide overhanging cover as habitat. These planting plans are described in Section 5.1.2.8. Upland trees and shrubs will also be planted on the roadway slope east of the new channel. These plantings will buffer the stream from the road but no mitigation credit will be sought for this area (Appendix A, Sheet C1.1).

#### 5.1.1.7 Implementation

Construction of the third runway, which requires the relocation of Miller Creek, is currently scheduled as part of the first phase of the proposed Master Plan Update implementation. Channel relocation construction is currently anticipated to begin the first construction season (i.e., summer) following granting of the permits for the project. After the new channel is complete, Miller Creek will be diverted and monitoring will begin. Instream work associated with new channel construction must occur during low flow periods and be consistent with Hydraulic Project Approval (HPA) permit conditions as specified by WDFW. Construction of the channel relocation will be coordinated with construction of the third runway, South 154th Street/South 156th Street relocation, the sewer line relocation, and construction of Vacca Farm floodplain projects. A detailed description of implementation, construction methods, and construction steps for the Vacca Farm projects, including the stream relocation, is included in Section 5.1.4.

#### 5.1.1.8 Monitoring and Performance Standards

The Miller Creek relocation project will be monitored consistent with the approach and schedule outlined in Chapter 4 of this document. Detailed performance standards and contingency measures for the Miller Creek channel are included in Table 5.1-7, which summarizes performance standards and monitoring methods and parameters for all of the Vacca Farm mitigation projects. The general monitoring schedule for the Vacca Farm projects is provided in Table 5.1-8. Monitoring of the new channel includes routine inspections and emergency inspections following major floods.

**Hydrology and Hydraulics**

The effectiveness of the relocated stream will be evaluated in several ways. Because erosion and sedimentation are the primary indicators of stream hydraulic conditions, they are the critical criteria to be included in the proposed monitoring plan. The following activities will be included in the stream monitoring plan to determine whether specific performance standards are being met (see Tables 5.1-7 and 5.1-8):

- Inspect the constructed habitat features (log weirs, root wads, etc.) to ensure that they have not been damaged or displaced (to the extent that they are not providing habitat).
- Inspect the substrate to ensure that sedimentation and erosion prevention goals are met.
- Inspect for erosion or scouring.
- Evaluate substrate material to determine if particle sizes remain stable, and there is no evidence of excessive siltation or scouring.
- Inspect stream structures and channel after major storms, as monitored by the KCSWM gage.
- Inspect for adverse flooding impacts and ponding water.

The site perimeter of all mitigation sites will be protected by fencing approved by the ACOE. Site perimeters will also be marked by permanent signs that clearly designate the area as a protected wetland mitigation site. Signs will be inspected regularly and maintained in good condition by the Port.

**Channel Bank and Riparian Buffer**

Vegetation along the new channel will be monitored to ensure that channel and riparian plantings meet design goals and become successfully established along the relocated stream. Performance standards, variables to be evaluated (e.g., survival, cover), and specific contingency measures for riparian vegetation are included in Table 5.1-7.

**Instream Habitat**

Instream habitat conditions in the relocated channel section will be described based on a variety of monitoring data collected using standard methods for ecological evaluations of streams. Hydrologic conditions important to habitat that will be described include water depths, velocities, profile and area of wetted channel. Substrate conditions (size and type) will be evaluated and described by site observations and pebble counts. The amounts and types of large woody debris in the stream channel will be described, including the special habitat conditions (undercut banks, side channels, and pools) this large woody debris creates. The influence of riparian vegetation on instream habitat will be described based on surveys of plant cover overhanging the high and low flow channels. Methods for collecting and evaluating this information are provided in Table 5.1-8.

**Table 5.1-7. Final performance standards, evaluation approaches, and contingency measures for mitigation projects at Vacca Farm.**

| Design Criteria | Performance Standard | Evaluation Approach | Contingency Measures[1] |
|---|---|---|---|
| **Relocation of Miller Creek** | | | |
| Construct low flow channel 8 feet wide with 1:1 slopes and 0.5 ft deep to convey summer base flows. | Maintain at least a minimum dry season water depth of 0.25 ft (at about 0.5 cfs). | Dry and wet season measurements of water depths and velocities. | Evaluate factors responsible for not meeting performance standards. |
| Construct high flow channel 32 feet, side slopes of 2:1 (typical) from depths of 0.5 to 1.0 ft to provide capacity for wet season base flow. | Wet season (October to April) average base flow depth is approximately 1 ft (at 5 cfs). | Survey of constructed channel cross sections and flow measurements. | Adjust channel low flow depth or channel bottom width using habitat features such as logs, boulders, root wads, etc. or regrading channel if necessary. |
| The channel cross section will provide an average dry season base flow velocity that is greater than the silt transport velocity (0.7 ft/sec). | Flows during most low flow periods will exceed 0.7cfs. | Dry and wet season velocity measurements. | Reduce width of low-flow channel using woody debris or boulders.<br>Re-grade if constructed channel does not meet performance standard. |
| Design a natural channel with stable gravel bottom. | Riffle substrate will be composed of substrate suitable for spawning of cutthroat trout with no greater than 20% fine sediments (i.e., sand or smaller). | Volumetric assessment of substrate (eg. McNeil core or bulk sample) to document substrate conditions. | If fine sediments are present, evaluate sources and potential stabilization methods to control or eliminate.<br>Adjust stream bottom width to increase velocity (using woody debris or boulders). |
| Channel flow velocity cannot exceed the gravel movement velocity (4 ft/sec) for the 100-year flow. | Bed material shall be spawning size gravels appropriate for cutthroat trout; bed material size will not increase significantly compared to as-built conditions. Scoured channel bottom sections, if present, shall not exceed 10 linear feet. | Volumetric assessment of substrate (eg. McNeil core or bulk sample) to document substrate conditions.<br>Velocity measurements.<br>Channel survey to evaluate evidence of scouring or erosion. | Adjust width of channel, replace spawning gravels, and repair any eroded channel banks with bioengineering or additional streambank planting |
| Flows greater than the annual peak flow will overtop the channel and inundate the adjacent floodplain restoration. | Flows greater than the annual peak flow of about 40 cfs will overflow the streambanks. | Measure water elevations in floodplain and relate to gauged stream data. | Adjust bank height, channel morphology, or roughness to alter amounts of overbank flow.<br>Regrade if necessary. |
| Provide a natural channel configuration. Increase channel length by about 10 percent and a meandering low flow channel. | Channel has pool/riffle morphology for about 1,080 feet in length. Baseflow channel is non-linear. | Review record drawings for as-built condition. Monitor channel condition. | Reconstruct to conform to required design. |

Table 5.1-7. **Final performance standards, evaluation approaches, and contingency measures for mitigation projects at Vacca Farm (continued).**

| Design Criteria | Performance Standard | Evaluation Approach | Contingency Measures[1] |
|---|---|---|---|
| Provide habitat features, including instream features such as deflectors and overhanging logs as needed to maximize available habitat. | Meers design criteria for channel habitat features (e.g., LWD, overhanging logs, deflector logs, undercut banks).<br><br>Density or abundance of habitat features should remain stable or increase compared to as-built conditions. | Measure abundance, sizes, and location of LWD in the new channel. | If losses of LWD occur, evaluate factors contributing to reduction in LWD (e.g., high flows) and address.<br><br>Add LWD to channel as necessary. |
| Provide approximately 3.0 acres of vegetated buffer on the east side of the channel. Establish native vegetation along channel banks and the riparian zone of the new channel. | Establish 3.0 acres of native shrub/forested riparian zone and upland buffers with an average tree density of at least 280 stems/acre and shrub density of at least 2,100 individuals per acre in the first 3 monitoring years.<br><br>Average survival of planted trees and shrubs in the first 3 monitoring years shall be at least 80%; cover of native species will be 80% by year 10.<br><br>Cover of non-native invasive species will be no greater than 10% by monitoring year 10. | Vegetation sampling (plots, transects, or plotless techniques) to measure stem density plant cover, count live and dead plants and measure cover of exotic species. | Install additional plants if necessary. Identify substitute native species that are adapted to site conditions.<br><br>Eliminate or reduce the abundance of non-native invasive species.<br><br>Install protective collars to reduce herbivore damage. |
| Densely plant woody vegetation along the new channel to cover open water and reduce use of the area by waterfowl. | Canopy coverage over the stream channel will be 80 percent by the end of the 10-year monitoring period. | Vegetation sampling to determine tree and shrub cover. | Add additional plants if areas of exposed stream channel are present. |
| **Wetland Enhancement and Restoration** | | | |
| Excavate approximately 9,600 cy of soil between elevation 262 ft and 266 ft. Excavate drainage swales to provide positive drainage from the floodplain and prevent standing water during non-flood periods. | Provide for approximately 5.94 acre-ft of flood storage on Vacca Farm to compensate for approximately 5.24 acre-ft filled for the embankment.<br><br>Floodplain grades will slope towards drainage swales which connect to Miller Creek. | Record drawings and hydrologic monitoring. | Regrade area if not excavated to specifications.<br><br>Modify design of swales to improve drainage conditions if necessary. |

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**Table 5.1-7. Final performance standards, evaluation approaches, and contingency measures for mitigation projects at Vacca Farm (continued).**

| Design Criteria | Performance Standard | Evaluation Approach | Contingency Measures[1] |
|---|---|---|---|
| Use excavated material from grading the secondary swales to create topographic variation in the floodplain. | Topographic features (mounds, ridges) will be constructed at a density of approximately 4 per acre. | Determine density from record survey. | Construct additional features if project has not been built to specifications. |
| Eliminate farming activities and remove existing structures from restoration site. | Farming leases and activities will be terminated. All structures will be removed from the site. | Record reviews to verify restrictive covenants prohibit farming. | |
| Remove ditches and drains. Grade floodplain to elevations that restore wetland hydrology. | Groundwater/soil saturation levels in the floodplain wetlands will demonstrate saturation near the surface during March through May during years of normal precipitation. | Hydrologic monitoring using shallow wells Compare changes in hydrology to rainfall trends. | Modify grading, drainage swales, or channel configuration to decrease or promote soil saturation. |
| Restore and enhance approximately 9.24 acres of farmed wetlands, wetland, and prior converted cropland in the floodplain and wetlands around Lora Lake with native vegetation. Enhance approximately 1.8 acres of floodplain and Lora Lake shoreline buffer with native vegetation (see Table 5.1.1). Plant native shrub species at densities of approximately. Intersperse native trees in this area. Shrubs will be planted at a density greater than 2,100 per acre. | The restoration area will be a minimum of 11 acres. | Determine area from record survey. | Modify construction if not built as specified. |
| | Shrub and tree survival will average at least 80% in the first 3 monitoring years. At that time, at least 2,100 shrubs/acres will remain. | Vegetation sampling (plots, transects, or plotless techniques) to estimate mortality. | If standards are not met:<br>• Select species that are better adapted to existing hydrologic conditions.<br>• Install additional plant material.<br>Install protective collars to reduce herbivore damage. |
| | Percent canopy cover of native species will be at least 80% by year 10. | Vegetation sampling (plots, transects, or plotless techniques) measure cover. | See above. |
| | Non-native invasive species cover will be no more than 10% by year 10 in newly planted areas. | Vegetation sampling (plots, transects, or plotless techniques) to estimate canopy cover | Install additional plant material.<br>Install protective collars.<br>Control/reduce non-native invasive species. |
| | By the end of year 3, plant diversity in each stratum will not decrease by more than 10% from the number and type of plants installed at baseline. | | |
| Plant the floodplain with native trees, shrubs, and tall grasses (see Table 5.1-11 and 5.1-12) to deter waterfowl. | Percent canopy cover of native species will be at least 80% by year 10. | Vegetation sampling (plots, transects, or plotless techniques) to estimate canopy cover | See above. |

Table 5.1-7. **Final performance standards, evaluation approaches, and contingency measures for mitigation projects at Vacca Farm (continued).**

| Design Criteria | Performance Standard | Evaluation Approach | Contingency Measures[1] |
|---|---|---|---|
| Enhance existing forested wetland south of Lora Lake with native trees and shrubs. Total density of planted material will be greater than 250 stems/acres (trees) and 1,700 individuals per acre (shrubs). | Percent canopy cover of native species will be at least 80% by year 10. | Vegetation sampling (plots, transects, or plotless techniques) to estimate canopy cover | See above. |
| **Lora Lake Buffer Enhancement** | | | |
| Plant a 25-ft buffer (0.60 acre) around Lora Lake with native trees and shrubs. | Lora Lake will have a 25-ft wide (0.60 acres) protected by restrictive covenants. | Verify records to assure covenant is in place. | |
| All structures within the 25-ft buffer will be demolished and failing septic systems (if present) will be removed shrubs. | Record drawings and photo documentation verify that no structures remain within the buffer area around Lora Lake. | Record drawings and site inspections. | Remove remaining structures if not completed per design. |
| Plant native tree species at densities of greater than 280 per acre. Plant native shrub species at densities of greater than 2,100 per acre. | Average survival of planted stock will be at least 80% in the first 3 monitoring years. At the time at least 280 trees per acre and 2,100 shrubs per acre will remain. | Vegetation sampling (plots, transects, or plotless techniques), as described above. | Contingency measures for vegetation performance standards are described above. |
| | Percent canopy cover of native species will be at least 80% by year 10. | | |
| | By the end of year 3, plant diversity in each stratum will not decrease by more than 10% from the number and type of plants installed at baseline. | | |
| | Non-native invasive species cover will be no more than 10% by year 10 in newly planted areas. | | |
| Concrete bulkhead will be removed and shoreline graded to a stable slope configuration. | Record drawings and photo documentation verify that the concrete bulkhead has been removed. | Record drawings to verify removal and bulkheads and slope of shoreline. | Remove all structures and bulkhead areas to be consistent with design. |
| | New shoreline of Lora Lake will have a slope of 3:1 or less. | | Re-grade as necessary to be consistent with design. |

[1] For all performance standards, monitoring periods may be extended if performance standards are not met.

**Table 5.1-8. Miller Creek relocation mitigation monitoring methods and schedule.**

| | | | Years Following Construction | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Feature** | **Activity** | **Duration** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Habitat Structures | Visual inspection, photodocumentation | Annually (May), or after flows in excess of the 2-year peak flow (during the first 3 years) | X | X | X | X | | X | | X | | X | X |
| Channel Morphology | Measured cross sections, longitudinal profiles, photodocumentation | Annually (May), or after flows in excess of the 2-year peak flow (during the first 3 years) | X | X | X | X | | X | | X | | X | X |
| Substrate | Pebble counts | Semi-annually (February/August) | X | X | X | X | | X | | X | | X | X |
| Erosion or Scouring | Evaluate materials and scouring | Annually (May), or after flows in excess of the 2-year peak flow (during the first 3 years) | X | X | X | X | | X | | X | | X | X |
| Adverse Flooding | Inspect floodplain for ponded water | Twice yearly (February/ November) | X | X | X | X | | X | | X | | X | X |
| Channel Plantings | Vegetation sampling | Semi-annually (May/June & September/October) | X | X | X | X | | X | | X | | X | X |

### 5.1.1.9 Site Protection

The Port will execute and file restrictive covenants on the mitigation projects at Vacca Farm site. Copies of restrictive covenants that have been approved by the ACOE, Ecology, FAA, and U.S. Department of Agriculture – Wildlife Services Division (USDA-WSD) are included in Appendix F.

### 5.1.1.10 Maintenance and Contingency Plans

A key design objective for the stream channel is that it shall function as a natural channel, requiring little or no maintenance. To ensure that this goal is achieved, the monitoring plan and contingencies have been designed to allow the channel to perform within a range of conditions. If the performance standards indicate that the channel is not within this acceptable range, periodic maintenance may be required to change or remove the factors responsible. Specific contingency measures for the channel relocation are included in Table 5.1-7.

The proposed channel configuration has two basic conveyance criteria that need to be maintained to meet performance standards: (1) maintain minimum flow depths and velocity for fish passage, water quality, and sedimentation; and (2) provide flow capacity for peak flows. If there were to be future changes in flow rates in Miller Creek compared to design flows, contingency measures may be required for the project to continue to meet goals and objectives. The Port does not anticipate that contingency measures will be needed due to future changes in flow rates for the following reasons. Flow rates are unlikely to differ from the design flows used to develop this plan because the design flows were derived from detailed data (including a calibrated HSPF model), and because of the extensive stormwater management plans developed for the project (see Chapter 6 and Parametrix 2000a). Possible contingency measures that would be implemented in the case of altered flow rates could include:

- Widening the base flow channel to reduce velocities and improve capacity
- Narrowing the base flow channel with logs or boulders to increase base flow depth and velocity
- Widening the flood flow portion of the channel (above 0.5 ft) to improve capacity and reduce velocity
- Adding log weir steps to flatten stream slope, reducing velocity and increasing base flow depth
- Adding a bypass flow channel to convey peak flows past the main channel.

### 5.1.2 Vacca Farm Floodplain and Wetland Restoration Plan

To mitigate for wetland impacts and the loss of floodplain storage (approximately 5.24 acre-ft) and wetland impacts in the Miller Creek basin, the floodplain and wetlands in the Vacca Farm area will be restored (see Table 5.1-1). Restoration of the historic floodplain and wetlands will include providing approximately 5.94 acre-ft of flood storage, restoring wetland hydrology, and re-establishing native vegetation in approximately 12 acres of existing cultivated farmland and aquatic habitat of Lora Lake. Existing degraded wetlands on the Vacca Farm site will be enhanced by replacing non-native vegetation with native plant communities. Functions in the restored wetlands will be further enhanced by planting forested upland buffers around the perimeter of the Vacca Farm site (Figure 5.1-5). Approximately 5 acres of upland buffers will enhance and protect the floodplain wetlands by increasing infiltration and supporting wetland hydrology and stream base flows, removing sediments and nutrients, and providing physical protection and visual screening from adjacent properties. The Vacca Farm mitigation allows significant wetland functional restoration to occur in proximity to, and in the same basin as, project impacts.

Vacca Farm contains areas which historically were wetland but have altered hydrology due to prior agricultural activities. The floodplain and wetland restoration would restore wetland hydrology to the site by removing existing drainage features and excavating part of the floodplain to bring seasonal groundwater levels closer to the surface. Native wetland plant communities will be restored to the floodplain wetlands and existing degraded emergent wetlands will be enhanced to forested or shrub wetlands (see Figure 5.1-5). These actions will enhance hydrologic (i.e., surface water storage) and water quality functions at the Vacca Farm site, as well as reduce the volume of eroded soil, pesticide and fertilizer runoff reaching Miller Creek.

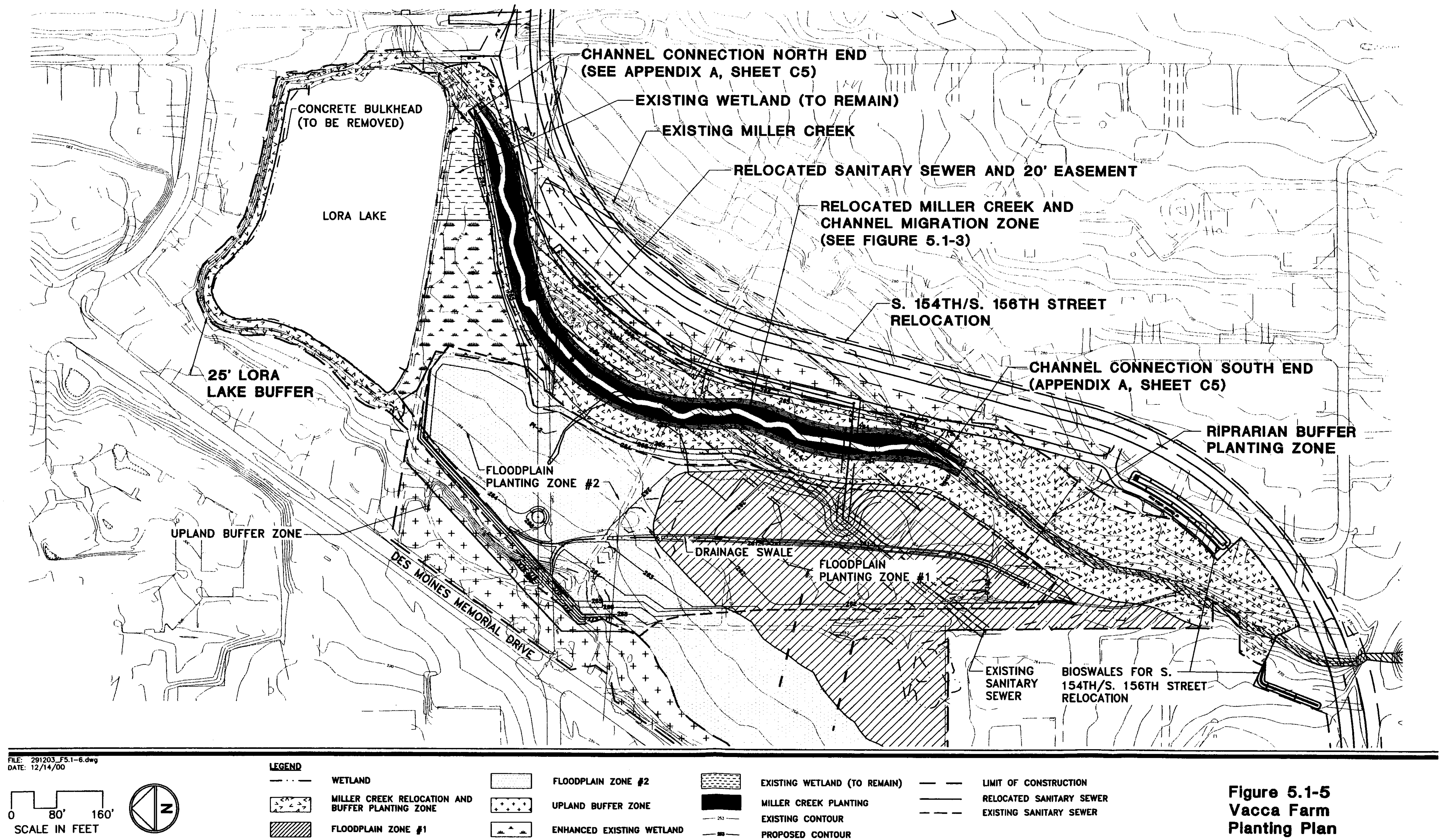



**Figure 5.1-5**
**Vacca Farm**
**Planting Plan**

To protect aquatic habitat in Miller Creek and to protect and enhance functions of floodplain wetlands, forested buffers will be established and enhanced. An upland buffer area will be established along the east side of the relocated Miller Creek between the riparian zone of the stream and the relocated roadway for South 154th Street (Figure 5.1-6; and see Figure 5.1-5). The buffer will reduce human intrusion into the riparian zone, screen riparian habitats from human activity, and protect water quality and aquatic habitat. A second upland buffer will be established between the floodplain enhancement area and Des Moines Memorial Drive on the west side of the Vacca Farm site (see Figure 5.1-5). The forested buffer in this area will provide a physical buffer between the road and the enhanced shrub floodplain wetlands and restored stream.

#### 5.1.2.1 Goals, Objectives, and Design Criteria

Three specific goals have been identified for the Vacca Farm floodplain and wetlands mitigation:

Goal 1: Compensate for loss of floodplain habitat, flood storage, and wetlands in the Miller Creek basin.

Goal 2: Restore and enhance floodplain and wetland functions adjacent to Miller Creek in the Vacca Farm site by restoring historic floodplain and wetland hydrology and vegetation. Enhance floodplain, wetland, and stream functions by providing forested riparian and upland buffers.

Goal 3: Grade the floodplain and create a planting plan for the wetland community in the floodplain area that does not attract waterfowl and flocking birds, and reduces existing wildlife hazards.

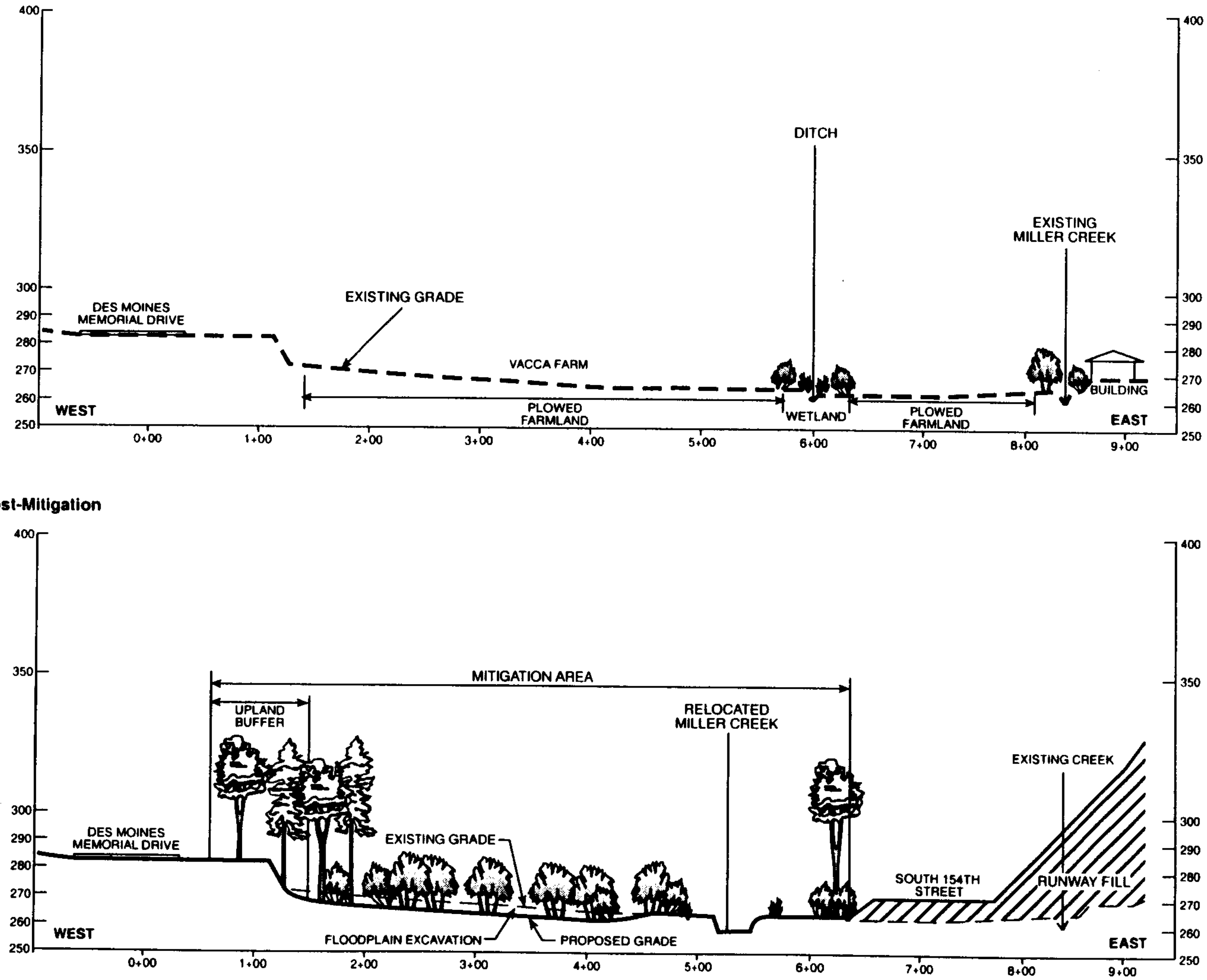
Specific objectives and design criteria that have been developed to achieve these wetland mitigation goals are listed in Table 5.1-9.

#### 5.1.2.2 Mitigation Site Description

The Miller Creek Floodplain and Wetland Restoration project will be located at the Vacca Farm site, northwest of the existing airfield. The Vacca Farm site includes Lora Lake and the area to the south of Lora Lake between the existing Miller Creek channel and Des Moines Memorial Drive (see Figures 2.1-2 and 2.1-4). Vacca Farm contains upland areas around the perimeter of the site, agricultural fields, some scattered farm structures, a system of drainage ditches and tile drains, farmed wetlands, and forested, shrub and emergent wetlands (Parametrix 2000c). A large ditch runs through the middle of the Vacca Farm site, parallel to the existing Miller Creek channel, flowing into Miller Creek at the south end of the site (see Figure 2.1-4).

Existing Conditions

Post-Mitigation




Port of Seattle/Natural Resource Mitigation Plan/556-2912-001/01(03) 12/00 (K)

VERTICAL SCALE 1" = 60'
HORIZONTAL SCALE 1" = 150'

**Figure 5.1-6**
**Typical Cross Section of Miller Creek Floodplain Enhancement**

AR 009765

**Table 5.1-9. Mitigation goals, design objectives, and design criteria for the Vacca Farm wetland restoration project.**

| Goals and Design Objectives | Design Criteria |
|---|---|
| **Goal 1: Compensate for loss of floodplain and flood water storage** | |
| Provide additional floodplain area by excavating approximately 9,600 cy on the Vacca Farm site. | Excavate approximately 9,600 cy of soil between elevation 262 ft and 266 ft. |
| | Drainage swales to provide positive drainage from the floodplain and prevent standing water during non-flood periods. |
| | Use excavated material from grading the secondary swales to create topographic variation in the floodplain. |
| **Goal 2: Increase functional linkages between historic wetlands and Miller Creek** | |
| Remove existing agricultural uses from the floodplain area on the Vacca Farm site. | Eliminate farming activities and remove existing structures from restoration site. |
| Restore wetland hydrology to farmed wetlands and prior converted croplands. | Remove ditches and drains. Grade floodplain to elevations that restore wetland hydrology. |
| Plant floodplain with native trees and shrubs. | Restore 11 acres of floodplain (see Table 5.1-1) with native vegetation. |
| | Plant native shrub species at densities of approximately. Intersperse native trees in this area. Shrubs will be planted at a density greater than 2,100 per acre. |
| **Goal 3: Create a planting plan for the wetland community in the floodplain area that does not attract waterfowl and flocking birds** | |
| Deter flocking waterfowl, from using the site. | Plant the floodplain with native trees, shrubs, and tall grasses (see Table 5.1-11 and 5.1-12) to deter waterfowl. |

### 5.1.2.3 Ownership

The Port owns all of the property on the Vacca Farm site.

### 5.1.2.4 Rationale for Selection

The Vacca Farm site allows significant wetland functional restoration to occur in proximity to, and in the same basin as, project impacts. Mitigation at this site provides the opportunity to restore wetland hydrology and wetland habitat to areas that historically were wetlands, but have altered hydrology due to prior agricultural activities. In addition, because the site has been farmed, the site is dominated by non-native plants, and there are no extensive areas of existing forest or invasive species, and the site is relatively flat. Therefore, minimal grading would be required, and natural vegetation communities would not be disturbed by mitigation activities. The floodplain and wetland restoration will also reduce wildlife hazards near the airport by replacing emergent wetlands with forested and shrub wetlands. These actions will enhance hydrologic (surface water storage) and water quality functions at the Vacca Farm site, as well as reducing the volume of eroded soil, pesticide, and fertilizer runoff reaching Miller Creek.

### 5.1.2.5 Constraints

No constraints have been identified that would preclude implementing this plan.

### 5.1.2.6 Ecological Assessment of the Vacca Farm Mitigation Site

Ecological conditions important to the mitigation design and implementation are summarized below. Historically the Vacca Farm site likely was a mosaic of forested and shrub wetlands. These wetlands developed on peat soils that formed in a wide floodplain along a low-gradient, frequently flooded reach of Miller Creek. The site currently consists of uplands, agricultural fields, farmed wetlands, and forested, shrub and emergent wetlands.

Miller Creek Floodplain

The 100-year floodplain in the vicinity of the Vacca Farm is quite extensive (see Figure 2.2-2). The wetland area and poor drainage that existed prior to agricultural drainage activities are evident from the 100-year floodplain estimated by FEMA. The approximate 100-year flood elevations, determined by FEMA as part of its study, vary from 266 ft at the Miller Creek detention facility outlet to approximately 265 ft at the downstream end of the Vacca Farm site. A floodway has also be delineated and mapped in a portion of the floodplain on the Vacca Farm site.

Hydrology

Wetland hydrology on the Vacca Farm site is supported primarily by high local groundwater levels, and secondarily by precipitation and overbank flooding in Miller Creek. Four groundwater-monitoring wells were installed at the Vacca Farm site on May 14, 1997 to evaluate site hydrology. Groundwater levels were then measured during 16 separate site visits between May 30, 1997 and November 12, 1997 (Table 5.1-10). During this period, groundwater levels averaged approximately 1.5 to 2 ft below the ground surface. The largest fluctuation occurred at monitoring well P-1, located in the existing forested and shrub wetland. At this well, the groundwater table was lowest during the dry summer months, and as expected, higher groundwater levels occurred in the spring and fall. For the past several years (1996 to 2000) during the winter and early spring months, the Vacca Farm site was temporarily flooded, and soils were saturated to the surface. These data were used to estimate hydrologic conditions expected to occur in the floodplain restoration site once drainage ditches are removed and excavation in the floodplain area is complete.

Soils

*The Soil Survey for King County Area Washington* (Snyder et al. 1973) has not mapped soils within the project area. However, Parametrix, Inc. and HWA GeoSciences, Inc. (1998) have evaluated existing soil conditions on the Vacca Farm site. Results of the soil investigations revealed that most of the soils on the site are underlain by soft, saturated peat that overlies layers of alluvial sands, silts, and dense, glacially deposited material. These conditions indicate that the area was largely a historic wetland that has now been partially drained and highly modified. Typical soil profiles in peat dominated areas on Vacca Farm are shown in Appendix A, Sheet C6.1. Soils in the upland areas on the Vacca Farm are predominantly silty loams with scattered inclusions of sandy loams.

**Table 5.1-10. Groundwater monitoring well data[1] on the Vacca Farm site.**

| | Well Numbers and Surveyed Elevation (ft)[2] | | | |
|---|---|---|---|---|
| **Sampling Date** | **P-1 (263.7)** | **P-2 (265.1)** | **P-3 (262.9)** | **P-4 (273.1)** |
| 5/30/1997 | -0.9 | -2.0 | -1.3 | -2.5 |
| 6/05/1997 | -0.5 | -1.5 | -0.4 | -2.3 |
| 6/11/1997 | -0.8 | -1.8 | -0.6 | -2.3 |
| 6/19/1997 | -1.0 | -1.9 | -0.7 | -2.4 |
| 7/03/1997 | - | -2.0 | -0.6 | -2.4 |
| 7/10/1997 | -0.5 | -1.6 | -0.4 | -2.3 |
| 7/25/1997 | -2.0 | -2.2 | -1.3 | -2.5 |
| 7/31/1997 | - | -2.3 | -1.6 | -2.5 |
| 8/07/1997 | -2.6 | -2.4 | -1.8 | -2.5 |
| 8/14/1997 | -2.7 | -2.6 | -2.1 | -2.5 |
| 9/04/1997 | - | -2.4 | -1.8 | -2.5 |
| 9/18/1997 | -0.1 | -1.1 | -0.5 | -2.2 |
| 9/26/1997 | -1.0 | -1.7 | -0.5 | -2.3 |
| 10/03/1997 | -0.6 | -1.2 | -0.3 | 2.2 |
| 10/16/1997 | -0.8 | -1.6 | -0.3 | -2.2 |
| 11/12/1997 | -0.5 | -1.4 | -0.2 | -2.2 |

1 Data are represented as depth to groundwater in ft.
2 Elevations are represented as ft above mean sea level.

## Upland Vegetation

Upland areas on the Vacca Farm site primarily consist of recently cultivated cropland; no native plant communities are present. Limited areas on the edge of the cultivated fields on the south and west side of the site are dominated by Scots broom (*Cytisus scoparius*), Himalayan blackberry, Canada thistle (*Cirsium arvense*), and various grass species such as orchardgrass (*Dactylis glomerata*) and common velvetgrass (*Holcus lanatus*).

The upland area in the southern portion of the site contains a gravel fill pad covered with various grass species and a dense Himalayan blackberry thicket. Some of the upland areas surrounding Miller Creek and drainage swales were created from side cast material from past dredging and maintenance activities in the stream and swales. Cultivated areas have been ditched and drained.

## Farmed Wetland Vegetation

Nine farmed wetlands are present on the Vacca Farm site (FWs 1, 2, 3, 5, 6, 8, 9, 10, and 11; see Figure 2.1-4). Farmed wetlands are areas that contain wetland hydrology and soils, but lack wetland vegetation because of farming activities. Additional descriptions of the farmed wetlands can be found in the *Wetland Delineation Report* (Parametrix 2000c). Due to the site's agricultural history, an extensive network of drainage ditches and tile drains exists on the site.

These areas have hydric soils and soil saturation within 12 inches of the soil surface for more than 15 consecutive days during the growing season. It is likely that these areas were wetlands before being converted to active farmland. However, these areas lacked inundation for at least 15 consecutive days during the early growing season and therefore do not meet the criteria for farmed wetlands according to the Food Security Act (Section 514.22).

**Forested, Shrub, and Emergent Wetland Vegetation**

A single large wetland (Wetland A1, approximately 4.66 acres) occurs in the central portion of the Vacca Farm site (see Figure 2.1-4). Wetland A1 is a forested, shrub, and emergent wetland complex located south of Lora Lake and extending south through the center of the Vacca Farm site. The northern portion of this wetland contains red alder and black cottonwood in the tree canopy with willow, hardhack, and common cattail (*Typha latifolia*) in the understory. A narrow band of Wetland A1 continues south and contains scrub-shrub and emergent wetland habitat that bisects the farmed agricultural fields. This wetland area is associated with a large north-south drainage ditch that parallels Miller Creek and ultimately drains into Miller Creek to the south (see Figure 2.1-4). Dominant species in wetlands associated with the ditch include Pacific willow (*Salix lucida*), Himalayan blackberry, common cattail, and reed canarygrass.

Wetlands A2, A3, and A4 are seasonally saturated shrub wetlands located in the center of the Vacca Farm site, in tilled farmland. These wetland islands are dominated by Himalayan blackberry with creeping buttercup (*Ranunculus repens*) around the edges.

#### 5.1.2.7 Vacca Farm Floodplain and Wetland Restoration Design

This mitigation plan will replace lost flood storage by excavating approximately 9,585 cy of soil that is currently above the 100-year floodplain on the Vacca Farm site. This action will compensate for lost floodplain storage and wetland impacts from construction activities for the third runway fill embankment and portions of relocated South 154$^{th}$ Street. The farmed fields at the Vacca Farm site will be regraded to restore wetland hydrology and planted with native tree, shrub, and herbaceous plant species to restore the historic riparian/floodplain wetland. In addition, a portion of an existing forested, shrub, and emergent wetland (Wetland A1) will be enhanced by planting native shrubs in the area currently dominated by non-native blackberry species. Key elements of the mitigation design are presented below. Specific details on construction sequencing and construction methods for the project are included in the implementation section for Vacca Farm projects (Section 5.1-4).

**Grading Design**

Prior to grading, existing structures and fences will be removed from the site and existing ditches and drains will be filled or removed to restore site hydrology. The mitigation design objectives for the floodplain grading will be achieved by excavating and grading approximately 6 acres of the Vacca Farm site between elevations 262 and 266. An initial step will be to remove the top 6 inches of topsoil where floodplain grading will occur to remove potential pesticide residues from past farming activities. This soil will be disposed of off-site at an approved upland disposal facility.

To prevent water from accumulating on the new floodplain surface and potentially attracting waterfowl, a primary drainage swale with secondary side channels will be graded through the middle of the floodplain. The primary channel will be centrally located and approximately 1 to 2 ft wide. Side cast material from creating these channels will be incorporated into the site grading plan to create microtopographic relief. Microtopography will consist of mounds and ridges at a density of approximately 4 features per acre. Depressional areas will not be created due to the potential for attracting hazard wildlife. This microtopographic relief provides habitat complexity that will increase the diversity of plant species that can be supported on the site (Appendix A, Sheet C7.1). Large woody debris will also be added to the floodplain to increase habitat complexity and increase organic matter on the floodplain (Appendix A, Sheet C1.1).

Immediately after grading, the two floodplain wetland planting zones (see Figure 5.1-5) will be hydroseeded with a native grass mix to establish understory plants in these zones. All other areas that have been graded will be hydroseeded with a seed mixture designed to prevent soil erosion and sedimentation to Miller Creek and/or Lora Lake (Table 5.1-11). The seed mixture will stabilize any exposed soils that will not be brought to final grade or permanent vegetation cover within 30 days of exposure. This seed mix should be applied during the period between April 1 through June 30 and September 1 through October 31. If seeding occurs between July 1 and August 31, irrigation may be required to ensure germination and establishment.

**Table 5.1-11. Proposed seed mix for erosion control.**

| Scientific Name | Common Name | Percent by Weight |
|---|---|---|
| *Agrostis alba* | Redtop | 10 |
| *Lolium multiflorum* | Annual rye | 40 |
| *Festuca rubra* var. *commutata* | Chewings red fescue | 40 |
| *Trifolium repens* | White clover | 10 |

All soils left exposed for greater than 48 hours from October 1 through March 31 (or greater than 7 days from April 1 through September 30) will be covered with jute matting, or other appropriate BMPs.

As described above, soils at the Vacca Farm site consist primarily of peat and some mineral topsoil. Therefore, it is anticipated that soil amendments will not be necessary after grading activities occur. To the extent practicable, existing organic soils (below the top 6 inches) and sands from the site will be used to create a suitable planting medium, and match the proposed final graded surface (Appendix A, Sheet C6). Where use of existing organic soils is not practicable, a prepared topsoil will be tilled into the subgrade and match proposed graded surface prior to planting. Newly graded slopes will be tracked at right angles to the contour to reduce soil erosion.

Temporary irrigation will be installed following grading to provide flexibility in plant installation and to maximize successful establishment, survival, and early growth of hydroseeded cover crops and plant stock. It is important to note that irrigation will not be used to provide site hydrology (see below), but to ensure success during the initial critical stages of plant establishment. The system will be designed so that above-ground portions can be removed after a few years, when the option to use irrigation will no longer be needed. Irrigation will use municipal water purchased by the Port. Use of the irrigation system is described more fully in the Implementation section, Section 5.1-4.

**Expected Hydrology**

The high groundwater table throughout the Vacca Farm site suggests that post-construction hydrology will result in soils that are saturated to the surface from the onset of autumn rains through early summer (early to mid July). Standing water, ranging in depth from 2 to 6 inches, is also expected to occur for short periods during the fall, winter, and spring months. To deter waterfowl from using areas of standing water, dense shrub plantings will be located throughout the site. The upland zones may become saturated during some winter months in years of normal rainfall, but would likely be dry by early summer. Because of a high water table on the site, dewatering may be necessary before grading activities occur (see Implementation Section, Section 5.1.4).

**Wildlife Considerations**

Flocking birds, raptors, and waterfowl pose the greatest concern for aircraft safety at STIA. Therefore, a landscape planting approach has been developed to aid in deterring these species from using the new mitigation sites as foraging areas or roost sites. Guidance obtained from Port wildlife managers and information gathered through literature searches have directed development of the overall landscape planting plan. For example, Lyon and Caccamise (1981) found that roost stands for European starlings were generally composed of deciduous trees 18 to 35 years of age with stem densities greater than 290 trees per acre (average of about 700 trees per acre). The minimum roost size was 0.32 acre, although the average was about 4.5 acres. Conclusions from this study indicate that these birds typically select roost sites composed of dense stands of young trees that allow the birds to roost in a compact formation, and also provide some thermal protection after leaf fall.

Waterfowl typically prefer to forage in open areas, such as open water, emergent marshes, or mowed lawn, because their view of potential predators is unobstructed. An obstructed view is perceived as dangerous and waterfowl will not typically forage in such an area. Therefore, the planting plan will focus on installing dense shrubs with scattered small trees to obstruct views and landing paths. This strategy will also exclude waterfowl during the winter by creating a dense barrier of stems to cover standing water that is likely to be present.

Geese or waterfowl exclusion measures will likely be necessary during the initial years of the mitigation because the site will be dominated by low vegetation and will be fairly open. Geese exclusion measures will include dense planting of trees and shrubs on the restoration site and the elimination of areas of open, ponded water. During the monitoring period, geese exclusion may also include physical barriers to prevent geese from landing or entering the site.

**Landscape Plan**

**Planting Plan**

Six planting zones will be created in the Miller Creek floodplain enhancement and wetland restoration area: Upland Buffers, Existing Wetland Enhancement, Floodplain Zone 1, Floodplain Zone 2, Miller Creek Riparian Buffer, and Miller Creek Channel Planting (see Figure 5.1-5; and Table 5.1-11; Appendix A, Sheet L1). To minimize wildlife hazards, all the planting plans for the in-basin mitigation actions are designed to be unattractive to flocking birds and waterfowl. Plants used in the in-basin mitigation areas (Table 5.1-12) produce few fruits, berries, or nuts.

*Upland Buffers*

Upland Buffers (see Figure 5.1-6; Appendix A, Sheet L1) are located east and west of the floodplain area, and will be planted with species adapted to seasonally wet, upland soil conditions. Upland buffers will typically be located above the 100-year floodplain (approximately at the 265-ft elevation). The landscape plan for the upland area will focus on planting trees and shrubs in a dense vegetated buffer to protect the floodplain enhancement area from surrounding land uses. Installed tree densities will be at least 280 stems per acre. Trees will be installed according to the planting plan and field locations will approved by the landscape architect or wetland biologist. Installed shrub densities will be greater than 2,100 individuals per acre (see Table 5.1-7). The planting scheme in the upland areas will place coniferous and deciduous tree species in patches to create a broken canopy.

*Existing Wetlands to be Enhanced*

Existing wetlands on the Vacca Farm site will be enhanced by removing non-native invasive species in selected areas and infill planting with native tree and shrub species. A portion of Wetland A1, south of Lora Lake, contains an area that historically has been disturbed by agricultural and other activities. As a result of this disturbance, non-native invasive species such as Himalayan blackberry have become dominant in this portion of the wetland. Therefore, an enhancement plan has been developed for this area to promote a native wetland vegetation community. Patches of blackberry will be removed and the wetland will be planted with native small tree and shrub species (primarily willows) to create a native shrub/tree community and to reduce cover of non-native species. Planting densities for infill tree planting will be greater than 250 stems per acre and for shrub planting will be greater than 1,700 individuals per acre. Infill planting densities are slightly lower than planting densities in cleared and/or graded areas because some native vegetation already exists in areas to be infill planted.

*Floodplain Wetlands (Planting Zone 1 and Planting Zone 2)*

Floodplain wetlands will be restored to native small tree and shrub wetland plant communities following grading. The landscape plan for the wetland floodplain restoration area will be similar to that described above with regard to wildlife attractants. Shrubs will be planted in dense patches to provide continuous shrub cover, with western redcedar and some deciduous trees on microtopographic high points interspersed in the shrub planting (Figure 5.1-7). Floodplain Zone 1 is the wettest zone on the floodplain and will be planted with species tolerant of the prolonged saturation and periods of inundation that will occur below elevation 262.5 ft. Floodplain Zone 2 will be slightly drier than Zone 1 and will consist of wetland plant species tolerant of the wet and saturated soil conditions that occur between elevations 262.5 ft and 265 ft. Figure 5.1-6 and Sheet C1.2 in Appendix A show a typical cross section of the Vacca Farm floodplain following grading and planting.

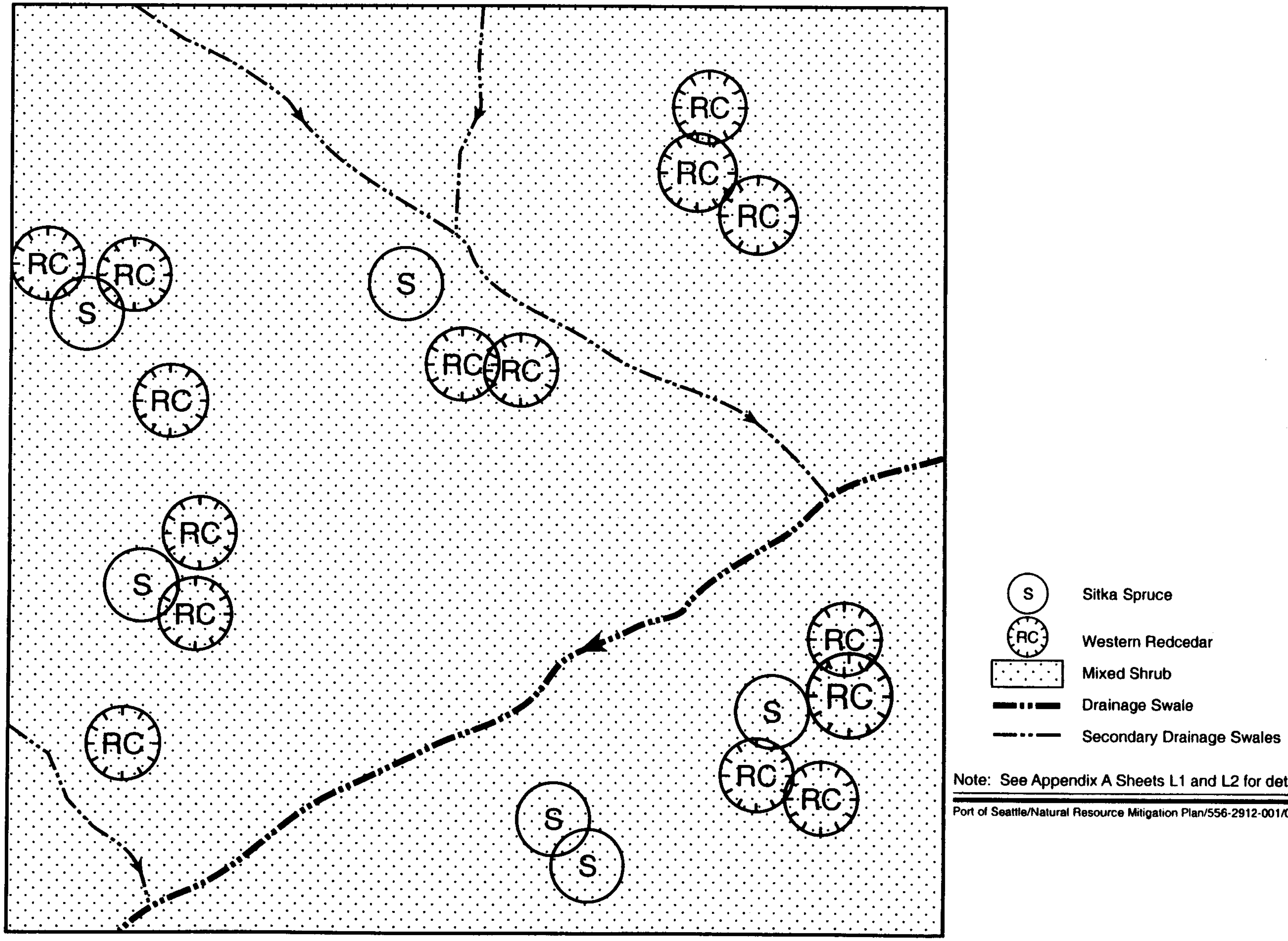
**Table 5.1-12. Proposed plant list for mitigation projects in Miller and Des Moines Creek basins.**

| Scientific Name | Common Name | Size and Condition [1] | Approximate Spacing (ft/oc)[2] | Upland Zone | Floodplain Zone 1 | Floodplain Zone 2 | Riparian Zone |
|---|---|---|---|---|---|---|---|
| **Trees** | | | | | | | |
| *Abies grandis* | Grand Fir | 3 – 4' B&B | 10 to 15 | X | | | |
| *Acer macrophyllum* | Bigleaf maple | 3 – 4' B&B | 10 to 15 | X | | X | X |
| *Alnus rubra* [3] | Red alder | 3 – 4' B&B | 10 to 15 | X | | | X |
| *Fraxinus latifolia* | Oregon ash | 3 – 4' B&B | 10 to 15 | | X | X | X |
| *Picea sitchensis* [3] | Sitka spruce | 3 – 4' B&B | 10 to 15 | X | | X | |
| *Populus trichocarpa* | Black cottonwood | 3 – 4' B&B/live stake | 10 to 15 | | | X | X |
| *Pseudotsuga menziesii* [c] | Douglas fir | 3 – 4' B&B | 10 to 15 | X | | | |
| *Rhamnus purshiana* | Cascara | 3 – 4' B&B | 10 to 15 | | | X | X |
| *Thuja plicata* | Western redcedar | 3 – 4' B&B | 10 to 15 | X | | X | |
| *Tsuga heterophylla* | Western Hemlock | 3 – 4' B&B | 10 to 15 | X | | | |
| **Shrubs** | | | | | | | |
| *Acer circinatum* | Vine maple | 2 gal | 4 to 6 | X | | | X |
| *Philadephus lewisii* | Mock Orange | 2 gal | 4 to 6 | X | | | |
| *Physocarpus capitatus* | Pacific ninebark | 2 gal | 4 to 6 | | | X | X |
| *Rosa nutkana* | Nootka rose | 2 gal | 4 to 6 | X | | X | |
| *Rosa pisocarpa* | Clustered rose | 2 gal | 4 to 6 | | | X | X |
| *Salix hookeriana* | Hooker willow | live stake [4] | 4 to 5 | | X | X | X |
| *Salix lucida* | Pacific willow | live stake [4] | 4 to 5 | | X | X | X |
| *Salix sitchensis* | Sitka willow | live stake [4] | 4 to 6 | | X | X | X |
| *Salix scouleriana* | Scouler's willow | live stake [4] | 4 to 5 | | | X | X |
| *Spiraea douglasii* | Hardhack spirea | 2 gal | 4 to 5 | | X | X | |
| **Grasses** | | | | | | | |
| *Agrostis exarata* | Spike bentgrass | Seed | | | X | X | |
| *Beckmannia syzigachne* | Slough grass | Seed | | | X | | |

**Table 5.1-12. Plant list for mitigation projects in Miller and Des Moines Creek basins (continued).**

| Scientific Name | Common Name | Size and Condition [1] | Approximate Spacing (ft/oc)[2] | Upland Zone | Floodplain Zone 1 | Floodplain Zone 2 | Riparian Zone |
|---|---|---|---|---|---|---|---|
| *Calamagrostis canadensis* | Canada reed | Plug or seed | 2 | | X | X | |
| *Deshampsia cespitosa* | Tufted hairgrass | Seed | | | X | X | |
| **Sedges and Rushes** | | | | | | | |
| *Carex amplifolia* | Ample-leafed sedge | Seed | | | X | X | |
| *Carex practicola* | Meadow sedge | Seed | | | X | | |
| *Carex stipata* | Sawbeaked sedge | Plug/seed | 2 | | X | X | |
| *Scirpus cyperinus* | Wool-grass | Seed | | | X | X | |
| **Herbaceous** | | | | | | | |
| *Aster subspicatus* | Douglas aster | Seed | | | | X | X |
| *Solidago canadensis* | Canada goldenrod | Seed | | | | X | |

1 Depending on availability and season, plant condition may be substituted. B&B refers to ball and burlap.
2 All shrub plantings for the Miller Creek floodplain wetland restoration, Miller Creek drainage channel replacement, and Tyee Valley Golf Course will be planted 3 to 4 ft on center
3 These species will not be a dominant component of the planting plan in order to limit the potential to attract flocking birds.
4 Live stake material will typically be used in the Miller Creek relocation buffer planting and in other buffer/floodplain plans, where appropriate. Spacings for line stakes may range from 18 inches to 3 ft on-center.




Note: See Appendix A Sheets L1 and L2 for details

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**Figure 5.1-7**
**Typical Planting Plan for the Miller Creek Floodplain, Zone 2**

Installed tree densities will be at least 280 stems per acre. Trees will be installed according to the planting plan and field locations will approved by the landscape architect or wetland biologist. Installed shrub densities will be greater than 2,100 individuals per acre.

Herbaceous understory species will be established in the two floodplain wetland zones by hydroseeding a native grass/sedge/forb mix in these zones in early fall, following grading (see Table 5.1-11). The hydroseed mix will contain seeds and a wood fiber mulch/tackifer to stabilize soils and enhance germination. Plant species included in the mix are designed to provide for rapidly germinating species that can provide initial cover, as well as later germinating species that will add to the cover and species diversity of the herbaceous vegetation of the floodplain communities.

*Miller Creek Riparian Buffer and Channel Planting*

In addition to the upland buffers along the northwest and east sides of the site, riparian buffers will be established along Miller Creek and around Lora Lake (see Figure 5.1-5; Appendix A, Sheets L1 and L2). Species proposed to be planted in the riparian buffer include black cottonwood, Pacific willow, Sitka willow, Scouler's willow, bigleaf maple, Oregon ash, red alder, Pacific ninebark, and vine maple. An average 50-ft buffer will be established on both sides of the relocated segment of Miller Creek, although in some areas, the buffer will be less than 50 ft wide due to the location of the embankment and South 154th Street/South 156th Way. The immediate channel banks of the newly relocated channel will be planted with live willow stakes (Appendix A, Sheets L1 and L2). A typical cross section of the proposed buffer area around Miller Creek appears in Figure 5.1-6 and in Appendix A, Sheet C1.2.

**Planting Approach**

Planting will occur whenever possible in late fall (October to November) or early spring (March or April), when soil moisture and plant conditions are optimal for installing plants. However, it may not always be possible or desirable to plant only during the winter months. For example, soils may be frozen or too wet at times during the winter months, limiting the amount of planting that can take place. Irrigation will be installed on the site to make it possible to plant during times of the year other than winter or early spring. Planting will take place during summer or early fall months only if irrigation is available. Trees of varying heights (between approximately 36 and 48 inches) will be planted to provide height diversity, and trees and shrubs will be planted in a mosaic of species and heights to simulate natural patchiness. Trees and shrubs will be planted at densities (see Table 5.1-12) sufficient to attain the performance standards in Table 5.1-7. A landscape architect or wetland scientist will be on-site to observe placement and installation of the plant material to ensure that plants are installed according to the planting plan and specifications.

To reduce potential competition with non-native species, mulch or landscape fabric will be placed around the base of trees and shrubs. Girdling or other damage from small or large mammal grazing will be reduced or prevented through the use of collars, or the stems of installed plant material may be painted with a mixture of pruning wax and a natural deterrent such as cayenne pepper.

### 5.1.2.8 Monitoring and Performance Standards

The Vacca Farm floodplain and wetland mitigation site will be monitored consistent with the approach and schedules outlined in Chapter 4 of this document. Specific performance standards and contingency measures for the Vacca Farm floodplain are included in Table 5.1-7. The general monitoring schedule for the Vacca Farm projects is provided in Table 5.1-8. Monitoring objectives specific to the Vacca Farm site are designed to evaluate the functioning of the relocated channel (discussed above in Section 5.1.1.8), floodplain hydrology, wetland indicators, and the establishment of the upland and wetland plant communities (Table 5.1-13). Monitoring for hazard wildlife will also be conducted at the Vacca Farm site, as described above in Chapter 4.

**Floodplain Hydrology**

Floodplain groundwater hydrology will be monitored at the Vacca Farm site for at least a 10-year period following completion of all mitigation construction. The primary purpose of monitoring groundwater levels is to verify that shallow groundwater continues to support wetland hydrology on the site, and that seasonal groundwater levels are sufficient to support the wetland plant communities planted on the site. Groundwater hydrology will be monitored at the Vacca Farm site consistent with the methods and approach outlined in Chapter 4 of this document.

**Vegetation Monitoring**

Vegetation will be monitored in all planting zones at the Vacca Farm site to verify that performance standards are being met, and to develop contingency measures as necessary (see Table 5.1-7, Table 5.1-13). Vegetation monitoring will be consistent with the approach, methods, and schedules provided in Chapter 4 of this document.

### 5.1.2.9 Site Protection

The Port will execute and file a restrictive covenant for the mitigation area. Copies of proposed restrictive covenants are included in Appendix G.

The perimeter of all mitigation sites will be protected by fencing approved by ACOE. Site perimeters will also be marked by permanent signs that clearly designate the area as a protected wetland mitigation site. Signs will be inspected regularly and maintained in good condition by the Port.

### 5.1.2.10 Maintenance and Contingency Plans

Routine maintenance tasks (e.g., maintaining irrigation systems, removing trash, mulching, mowing), and adaptive management contingency measures (e.g., re-planting, weed controll) will be implemented consistent with the approach outlined in Chapter 4. If the Vacca Farm site does not meet performance standards during the monitoring period, contingency measures will be implemented using the adaptive management approach outlined in Chapter 4. Specific contingency measures are provided for each performance standard in Table 5.1-7.

Table 5.1-13. **Monitoring schedule for wetland restoration and floodplain enhancement at Vacca Farm.**

| Feature | Activity | Timing | Data Collection Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Floodplain Storage | A topographic survey of the site. | Immediately after grading is complete | X | | | | | | | | | | |
| Hydrology | Measure the maximum depth and approximate duration of inundation. | Monthly | X | X | X | X | | | | | | | |
| | | Once during winter, late spring/early summer, and fall | | | | | X | X | X | X | X | X | X |
| | Measure depth to groundwater. | Monthly | X | X | X | X | | | | | | | |
| | | Once during winter, late spring/early summer, and fall | | | | | X | X | X | X | X | X | X |
| Establishment of Vegetation | Calculate percent plant survival. | Once late spring to early summer | X | X | X | X | | | | | | | |
| | Vegetation mapping. | Once in late spring to early summer | X | X | | X | | X | | X | | | X |
| Achieve an early successional wetland plant community | Measure tree/shrub cover. | Once in late spring to early summer in year 3, 5, 7, 10 | | | | X | | X | | X | | | X |
| | Photographic documentation and walk-through survey. | Once in spring | X | X | X | X | | X | | X | | | X |

Meeting the performance standards for non-native invasive species at Vacca Farm will likely require implementation of contingency measures during the 10-year monitoring period. Potential invasive species of concern at the Vacca Farm site include, but are not limited to, reed canarygrass, Himalayan blackberry, Japanese knotweed, and purple loosestrife. These species are a concern because they already occur at Vacca Farm and may be difficult to eliminate, or because propagules of these plants are likely to continuously re-invade the site from upstream aquatic sources or from the surrounding area. Successfully establishing native vegetation on the site will be a key component in reducing and controlling invasive species in the long term at the mitigation site. In the short term (i.e., during the 10-year monitoring period), contingency measures specified in Table 5.1-7 will be implemented as necessary to control invasive species on the site.

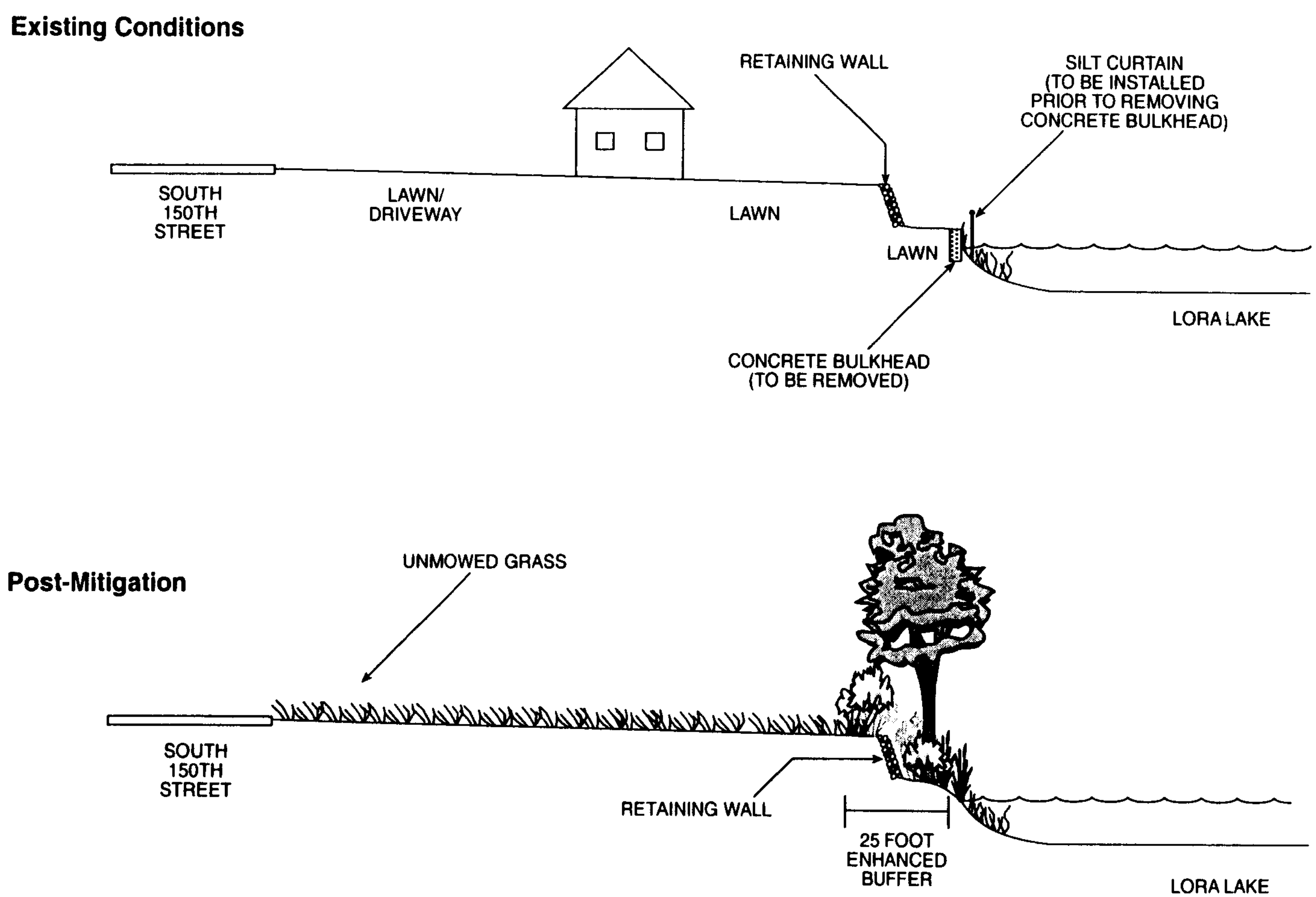
Possible contingency measures that may be implemented to reduce hazard wildlife attractants specific to Vacca Farm are included in Table 5.1-7. Contingencies include eliminating areas of standing water on the floodplain by planting shrubs or minor regrading to eliminate depressions. Measures to control wildlife hazards will be consistent with the Port's WHMP approach described in Chapter 4.

Examples of the types of contingency actions that may need to be implemented at Vacca Farm include:

- If topographic surveys reveal inadequate floodplain storage capacity, additional grading will be undertaken to replace the lost floodplain area.
- If standing water persists on the site for extended periods such that waterfowl use of the site is regular, then corrective actions will be taken to plant densely with shrubs or create positive flow of surface water off the site to Miller Creek.
- If invasive species cover is greater than specified in the performance standards, or if native plant survival is reduced by competition with non-native invasive species, then invasive species removal and/or control will be implemented.
- Replacement plants will be installed if survival is less than 80 percent in the first 3 years.
- If plant species exhibit greater than 20 percent mortality within the first 3 years, site conditions would be re-evaluated to determine whether the conditions could support the species. If the site cannot support the original plant species, then those species may be replaced with species of similar form and function and tolerance to hydrologic conditions on the site.

### 5.1.3 Lora Lake Shoreline Enhancement

Mitigation at Lora Lake includes removing a concrete bulkhead from the west and north shore of the lake, removing residential structures from the area adjacent to the shoreline, and planting a 25-ft forested buffer around the lake (Figure 5.1-8; Appendix A, Sheet C3.3)(see Table 5.1-1). Replacing concrete bulkheads with a vegetated shoreline, and establishing forested buffers around Lora Lake provide the opportunity to enhance water quality in Lora Lake and Miller Creek. Buffers around the lake will also enhance the functions and viability of the restored wetlands in the Vacca Farm floodplain. Removal of existing residences, lawns, and structures will eliminate future sources of



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VERTICAL SCALE 1" = 40'
HORIZONTAL SCALE 1" = 40'

**Figure 5.1-8**
**Typical Cross-Section of Lora Lake Buffer Enhancement**

nutrients and pollutants to the lake and stream. Mitigation at this site also provides an opportunity to reduce existing hazard wildlife attractants near the airport by reducing habitat for waterfowl that graze on the existing lawn around the lake.

#### 5.1.3.1 Goals, Objectives, and Design Criteria

The goal of the buffer enhancement project is to protect and enhance the aquatic habitats in Lora Lake and the upper reaches of Miller Creek by removing shoreline bulkheads and planting native vegetation. Specific design objectives are described in Table 5.1-14.

**Table 5.1-14. Mitigation design objectives, and design criteria for the buffer enhancement projects at Lora Lake.**

| Goals and Design Objectives | Design Criteria |
|---|---|
| Improve ecological function of the Lora Lake shoreline to the aquatic habitat of the Lake. | Plant a 25-ft buffer (0.60 acre) around Lora Lake with native trees and shrubs. |
| | All structures within the 25-ft buffer will be demolished and failing septic systems (if present) will be removed shrubs. |
| | Plant native tree species at densities of approximately 280 per acre). |
| | Plant native shrub species at densities of approximately 2,100 per acre. |
| Restore more natural shoreline to Lora Lake by removing concrete bulkhead. | Concrete bulkhead will be removed and shoreline graded to a stable slope configuration. |

#### 5.1.3.2 Lora Lake Mitigation Site Description

Lora Lake is a man-made pond excavated from a natural wetland and located in the northern portion of the Miller Creek floodplain. Lora Lake flows into Miller Creek via a 12-inch concrete culvert on the southeast corner of the lake or via flow over the earthen berm that forms the southern shore of the lake.

The area surrounding the lake consists of cement block bulkhead and riprap retaining walls around most of the shoreline on the north and west sides of the lake. Upland areas are located behind the retaining wall and consist of single-family residences, outbuildings, landscaping, mowed lawn, and impervious surfaces such as roads and driveways. Existing septic systems, runoff from roads and rooftops, lawn fertilizers, and pesticides are existing sources of potential pollutants to Lora Lake and Miller Creek. Residential lawns along the lake also attract waterfowl that graze on the turf grasses.

A narrow band of emergent wetland extends around Lora Lake between the cement bulkhead and the riprap retaining wall, and along the south shore of the lake. Just south of Lora Lake is a large deciduous forested wetland (Wetland A1). Detailed descriptions of Lora Lake and Wetland A1 are included in the *Wetland Delineation Report* (Parametrix 2000c).

#### 5.1.3.3 Ownership

The Port owns all of the parcels within the mitigation area surrounding Lora Lake.

#### 5.1.3.4 Rationale for Selection

Enhancing the shoreline and buffers around Lora Lake provides the opportunity to enhance water quality in Lora Lake and Miller Creek, as well as to enhance the function of the restored wetlands in the Vacca Farm floodplain. Removal of existing residences, lawns, and structures will eliminate future sources of nutrients and pollutants to the lake and stream. The overall function of the Vacca Farm projects will be enhanced by providing buffer protection around the lake and the upper reaches of Miller Creek. Mitigation at this site also provides an opportunity to reduce existing hazard wildlife attractants near the airport.

#### 5.1.3.5 Constraints

There are no constraints associated with implementing this mitigation action.

#### 5.1.3.6 Ecological Assessment of the Mitigation Site

**Vegetation**

Cement block and riprap bulkheads are located around most of the shoreline on the north and west sides of the excavated lake. Most of the area surrounding Lora Lake on the north and west is impervious surface (i.e., turf grass lawn or buildings and roadways). Vegetation is predominantly non-native turf grasses and ornamental landscaping.

A vegetated berm is located along the southern shore of the lake, with a deciduous forested wetland located south of the berm (Wetland A1). An upland shrub area is located to the east. Dominant species on the vegetated berm include red alder, Himalayan blackberry, and various grass species. The forested wetland contains a prevalence of red alder, black cottonwood, willow, Himalayan blackberry, hardhack, and common cattail. The upland shrub area consists of some Douglas fir, with red alder and dense thickets of Himalayan blackberry.

**Soils**

Soils in the wetland areas surrounding Lora Lake and Miller Creek are composed of organic peat deposits from 3.5 ft to 10 ft thick, interbedded with alluvial sands and silts. Fill material associated with buildings around Lora Lake comprises most of the soils in the upland areas. Soils in the area immediately south of Lora Lake have been amended with sands and organic material imported from off-site to improve the soils for farming.

#### 5.1.3.7 Lora Lake Mitigation Design

To enhance the aquatic functions of Lora Lake, a 25-ft buffer will be established and enhanced around portions of the Lora Lake shoreline, and the concrete bulkhead lining the shoreline will be removed. Figure 5.1-8 shows a typical cross section of Lora Lake before and after restoration.

### Demolition and Grading

Residences and various outbuildings, the majority of which are located around Lora Lake, will be demolished prior to implementing this plan. The design includes necessary BMPs to be used throughout demolition activities to prevent sediment from entering the lake or associated wetlands.

Minor grading activities will be associated with establishing the buffers. Prior to planting the buffer areas, grading activities may include roughening the surface, removing portions of lawn, or tilling soil that has been compacted during demolition activities or construction staging. During and following grading, standard TESC measures such as tracking soil surfaces on slopes parallel to the contours, will be implemented to prevent erosion.

### Expected Hydrology

It is anticipated that the area located below elevation 265.4 immediately adjacent to Lora Lake will become inundated during 100-year flood events. The groundwater table is high immediately adjacent to the lake shore and this area is expected to be wetland.

### Wildlife Considerations

The landscape plan has been designed to be consistent with the WHMP and to avoid attracting flocking birds, raptors, and waterfowl. Dense plantings of shrubs broken by scattered trees will discourage use by flocking birds and waterfowl. To deter raptor use of the mitigation sites, deciduous and coniferous trees with stiff branches (such as Sitka spruce or Douglas fir) will be planted in limited quantities. These species will also break up the deciduous tree canopy. This will limit roosting habitat for raptors such as red-tailed hawks. The primary coniferous tree species used in the upland and transitional zones will be western redcedar because its limp branches do not provide ideal raptor perching habitat.

### Landscape Plan

Species to be planted in the Lora Lake buffer are identified in Table 5.1-11. The planting plan for the buffer is shown in Figure 5.1-5 and 5.1-8 and included in Appendix A, Sheets L1 and L2. The Lora Lake buffer includes species such as black cottonwood and willows for the wetter areas immediately adjacent to the lake shore, as well as species such as bigleaf maple and red alder for the drier areas of the buffer.

## 5.1.3.8 Implementation

Implementation details for Lora Lake are included with the rest of the Vacca Farm projects in Section 5.1.4.

## 5.1.3.9 Monitoring and Performance Standards

Monitoring for the Lora Lake buffers will follow the overall monitoring approach described in Chapter 4. Detailed performance standards and contingency measures for the Lora Lake buffer are included in Table 5.1-7. Post-construction monitoring will occur for 10 years after installation of the plant material consistent with the schedule in Table 5.1-13.

Monitoring of Lora Lake will focus primarily on vegetation monitoring to evaluate establishment of native vegetation, consistent with the approach described in Chapter 4. The Lora Lake site will also be monitored for hazard wildlife, consistent with the monitoring approaches described in Chapter 4.

#### 5.1.3.10 Site Protection

The Port will execute and file restrictive covenants for the mitigation area. Copies of proposed restrictive covenants are included in Appendix G.

The site perimeter will be protected by fencing approved by ACOE. Site perimeters will also be marked with permanent signs that clearly designate the area as a protected wetland mitigation site. Signs will be inspected regularly and maintained by the Port.

#### 5.1.3.11 Maintenance and Contingency Plans

A maintenance plan will be developed for the Lora Lake buffers, as described in Chapter 4, to guide routine maintenance tasks. Specific contingency measures will be implemented as necessary, consistent with the adaptive management approach. Contingency measures for Lora Lake are listed in Table 5.1-7.

### 5.1.4 Implementation of the Vacca Farm Mitigation Projects

Construction associated with building the proposed third runway, including the relocation of the South 154th Street roadway and sewer line, will be part of the first phase of the proposed MPU implementation. Relocation of Miller Creek must occur prior to embankment construction, which will fill a portion of the existing channel. The new stream channel must be constructed and stabilized before stream flow can be diverted from the existing channel and before the existing channel can be filled. Construction of the Vacca Farm mitigation projects is therefore currently scheduled to begin during the first construction season (i.e., early summer) following issuance of permits for the project. A general schedule for implementation of the Vacca Farm projects is provided in Table 5.1-15. Detailed plan sheets for the Vacca Farm projects are included in Appendix A; design details for the grading and restoration of the banks of Miller Creek at the South 154th/South 156th bridge relocation are included in Appendix B, Sheets P1 through P3.

#### 5.1.4.1 General Construction Sequencing

Construction of the Vacca Farm projects is currently scheduled to begin during the 2001 construction season (see Table 5.1-15), but the actual schedule is dependent on receipt of federal, state, and local permits (e.g., Clear Water Act [CWA] Section 404 and 401). Excavation and grading for the floodplain and stream channel is expected to occur during the driest time of the year, taking approximately 15 weeks, beginning in late June and ending by early October. Instream work associated with the channel relocation will be subject to permit conditions associated with the HPA, and will likely occur between July 15 and September 15.

Construction of the mitigation site will be coordinated with the embankment construction, the South 154th Street relocation (including South 156th bridge relocation), and the relocation of the sewer line to ensure that these projects do not impact the mitigation site. In particular, prior to commencing plant installation, contractors will be required to complete all other work on the site to ensure that plants are not damaged once they are installed.

Table 5.1-15. Proposed Implementation Timeline for Vacca Farm Mitigation Projects.

| Project/Activity | Year (Year One Starts with the First Construction Season After the Date Permits Are Issued[1]) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year 1 | | | | | | | | | | | | Year 2 | | | | | | | | | | | | Year 3 | | | | | | | | | | | |
| | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D |
| **Miller Creek Relocation** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Preconstruction meeting | | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TESC, Site Preparation | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Excavate new stream channel | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Install in-stream habitat features and stream gravels | | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Produce record drawings of new channel | | | | | | | | | | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Install stream diversion measures at tie-ins | | | | | | | | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Trap and relocate fish in existing stream channel | | | | | | | | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Excavate channel tie-ins | | | | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Construct new channel banks, install bioengineering and plant channel banks | | | | | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Divert water to new channel | | | | | | | | | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Monitor new channel | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Vacca Farm Floodplain and Lora Lake Buffers** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Preconstruction meeting | | | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TESC, Site Preparation | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Implement dewatering | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mass grade floodplain | | | | | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fine grade floodplain | | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Install irrigation system | | | | | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Install monitoring wells | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydroseed/mulch graded areas | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Closeout (remove construction debris and equipment, staging areas, access roads, etc.) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Produce grading record drawings | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |



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Table 5.1-15. Proposed Implementation Timeline for Vacca Farm Mitigation Projects (continued).

| Project/Activity | Year (Year One Starts with the First Construction Season After the Date Permits Are Issued[1]) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year 1 | | | | | | | | | | | | Year 2 | | | | | | | | | | | | Year 3 | | | | | | | | | | | |
| | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D |
| Install plants in Vacca Farm floodplain and buffer, and along Miller Creek riparian zone | | | | | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Install plants in Lora Lake buffer | | | | | | | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | |
| Produce planting plan record drawings | | | | | | | | | | | | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | | |
| Conduct baseline monitoring | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | |
| Begin maintenance/monitoring period | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |

1 Plant procurement for all projects will be implemented 6 to 12 months prior to the anticipated planting date to ensure that plants in the specified quantities and species are available by the scheduled planting date. Implementing mitigation projects may vary from this proposed schedule depending upon coordination with other MPU projects and contract obligations.

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Construction of Vacca Farm projects will likely take place in several phases. Phase 1 will include most of the earthwork for the Miller Creek channel relocation and floodplain. During Phase 1, the Vacca Farm floodplain will be graded and irrigation installed, the new channel will be excavated, and the channel banks stabilized with bioengineering and planted with live stakes. After the new channel grading is complete, tie-ins will be constructed at either end of the new channel where it connects with the existing channel (Appendix A, Sheets C1.1 and C5). Connecting the new channel to the existing channel will require installing water control devices to divert water to the new channel, and implementing measures to protect fish in the existing channel during construction. The connection of the existing stream channel to the new channel and the diversion of water into the new channel, and stabilizing will occur during the first construction season. Grading of the Miller Creek floodplain adjacent to the new channel will occur concurrently with channel excavation. Removal of Lora Lake bulkheads and grading of the Lora Lake shoreline may also be included in Phase 1 (Appendix A, Sheet C2), although this work is not dependent on the Miller Creek relocation.

Following completion of Phase 1 earthwork, all open areas on the site (i.e., the channel, floodplain areas and Lora Lake buffers) will be hydroseeded and mulched to provide weed barrier and erosion control prior to winter rains and plant installation. Hydroseeding and mulch should be applied by mid-September to ensure that the site is adequately stabilized before the rainy season.

During Phase 2, the old channel will be filled for construction of the runway embankment, and planting floodplain wetlands and buffers during the first fall and/or winter following completion of grading. Completion of buffer planting east of Miller Creek will be coordinated with roadway relocation and will likely not be completed until roadway construction is complete. Phase 2 planting includes the enhancement planting of the existing wetlands, planting the newly graded areas of the floodplain and riparian zone of Miller Creek, and planting new and enhanced buffer areas along Lora Lake, and the east and west sides of the mitigation site (Appendix A, Sheets L1 and L2). Plant installation in these areas may require more than one construction season to complete.

## Phase 1: Site Preparation, Grading, and Channel Relocation

Earthwork for this phase includes site preparation, installation of sediment and erosion control measures, dewatering if necessary, grading, installation of irrigation, and site stabilization following grading.

### Site Preparation and Erosion Control

No work will begin until the TESC plan is implemented (Appendix A, Sheets TE1 and TE2), nor until any protected or restricted access areas (e.g., wetlands or streams) have been flagged and/or fenced. The TESC plan includes installation of silt fences around the existing wetlands to be enhanced southeast of Lora Lake, and the Lora Lake shoreline, to prevent sediment from the construction site entering these waters (Appendix A, Sheet TE1). A temporary berm will be constructed and a silt fence installed to protect adjacent properties to the south of the mitigation site and prevent water from the construction site from entering the drainage ditch that runs through the center of Wetland A1.

Water from the construction site will likely be directed to the temporary sediment settling pond at the lowest (i.e., southern) end of the proposed floodplain (Appendix A, Sheet TE1). Water from this pond will be allowed to settle until particulates and sediment have settled out. Water from the site can then be discharged via the outlet, quarry spalls, and straw bale filters to Miller Creek (Appendix A, Sheet TE2). Alternatively, construction stormwater runoff may be diverted or pumped to TESC Pond C. Water in the sediment ponds and discharge will be monitored to ensure that turbid water is not discharged to the stream.

Additional TESC measures include placing silt fence around work areas and staging areas, and placing straw bales at key locations within the project limits. Clearing and brush removal will be limited to only those work areas that the contractor is scheduled to begin within the following 2 weeks.

Prior to the start of grading, construction access, staging, and stockpile areas will be set up, and dewatering may be necessary. Temporary access routes and staging areas identified on the western side of the site will be set up and flagged (Appendix A, Sheets C2, TE1). The site will be cleared of debris (e.g., existing tile drains, storm drains and piping, trash, structures).

Construction sequencing of the mitigation site and the roadway/embankment will be carefully coordinated to prevent impacts to the completed mitigation site from roadway construction. Measures to protect the mitigation site from adjacent construction may include orange barrier fencing, sediment and erosion control fencing, and possibly the temporary installation of ecology blocks or rock gabions to prevent the intrusion of construction machinery into the mitigation site.

**Dewatering**

Due to the high groundwater table throughout the Vacca Farm site, excavation of the floodplain and new channel will likely require dewatering. The dewatering pumps, temporary storage ponds, and sediment and erosion control measures will be installed prior to the start of new channel excavation or floodplain grading. The dewatering system may include excavating dewatering trenches and installing French drains or sumps. The exact location of dewatering trenches and temporary storage ponds will be determined by the contractor. The location of these dewatering features may change as the excavation and final grading of the floodplain proceeds; however, all dewatering wells, temporary storage ponds, and/or trenches will be within the area to be excavated for the floodplain grading (Appendix A, Sheets C2, TE2). In addition, all water from dewatering areas will be directed to sediment settling ponds and any sediment will be allowed to settle prior to being discharged via a quarry spall outfall and straw bale filters to Miller Creek (see Appendix A, Sheet TE2). All dewatering features will either be removed as a consequence of the ongoing excavation (e.g., trenches, drains) or removed and the area graded once they are no longer needed (e.g., temporary storage ponds).

**New Channel Excavation and Floodplain Grading**

New channel construction includes excavation of the new channel, stabilization of channel banks, installation of stream gravels and woody debris, implementation of fish protection measures, construction of the tie-ins to the existing channel, diversion of water to the new channel, and filling in the old channel. Construction in the existing channel will likely take place between July 15 and September 15, consistent with conditions in the HPA.

The new channel will be excavated and water diverted from the existing channel within the same construction season. The new channel banks are expected to be adequately stabilized to carry dry and wet season flows for the following reasons. The new channel banks will be stabilized using bioengineering (e.g., coir lifts with live stakes, erosion control fabric) (Appendix A, Sheets C5 and L2). Channel banks will be planted densely with willow stakes to provide additional stabilization and channel roughness. The dry and wet season base flows in this portion of Miller Creek are typically low (< 5 cfs) and the new channel slope is very gradual. Therefore, even during storm events, flows in Miller Creek through this reach will not have large amounts of energy. Furthermore, the channel has been designed with a low flow channel inside a wider channel meander zone, which can accommodate up to annual peak flows (Appendix A, Sheet C5). Flows greater than annual peak flows will flood onto the floodplain, rapidly attenuating the energy and erosive force of stormflows.

The sequence of steps required to divert existing flows to the new channel will be consistent with HPA permit conditions and will be conducted to reduce stress and impacts on aquatic organisms. Prior to constructing tie-ins and diverting Miller Creek to the new channel, the section of the existing channel to be diverted will be closed off, and fish within the existing channel will be captured and relocated to a point downstream of South 160$^{th}$ Street where suitable habitat exists. Fish capture and relocation will be done under the supervision of a qualified fish biologist with a collection permit from the WDFW.

Immediately following fish capture, the tie-ins will be constructed, and flow from the existing channel will be intermittently introduced to the new channel section to allow the streambed gravels to sort and stabilize. Flows will be intermittently introduced to the new channel with a gate valve or other control structure to allow flows to be metered. During this time a collection sump located at the downstream end of the new channel will collect water. Turbid water will be conveyed to a sediment pond until the new channel flows clear. After diversion of stream flow has been successfully completed, the existing channel will be filled during embankment construction.

Excavation of the floodplain grades at Vacca Farm may occur concurrently with the new channel excavation. Floodplain grading will begin as soon as the contractor can control the groundwater sufficiently for excavation. Grading will occur on all areas of the mitigation site with the exception of the existing wetland to the east of Lora Lake (i.e., between Lora Lake and Miller Creek) and the area of upland buffer along the western portion of the site (Appendix A, Sheets C1.1 and L1). Existing drainage ditches on the site will be filled and removed during grading to restore site hydrology. A swale will be constructed through the floodplain to allow the floodplain to drain gradually to the south (Appendix A, Sheet C2) and to prevent standing water on the floodplain (Appendix A, Sheet C2). Cross sections are provided in the plan sheets that show the proposed site elevations following grading (Appendix A, Sheets C1.2 and C4). In addition to floodplain grading, existing bulkheads along the north and west shoreline of Lora Lake will be removed and a more gradual slope will be restored to the lake shoreline. Removal of the bulkheads prior to planting buffer vegetation will enhance the function of the buffer to be planted along Lora Lake.

**Installation of Temporary Irrigation and Site Stabilization**

Once the new floodplain grades have been established and verified by field survey, the temporary irrigation system will be installed. A temporary irrigation system will be used to provide flexibility in the planting schedule, to provide contingencies against seasons of extreme drought during the first few growing seasons, and to maximize plant survival and growth during the initial years of the mitigation. Allowing for maximum plant growth during the first years of the restoration will result in more rapid establishment of cover and shade on the site, as well as more rapid production of biomass, vertical habitat structure, and organic litter. The use of irrigation is a standard feature of wetland mitigation construction in the Puget Sound Lowlands due to the region's pronounced summer drought. Irrigation will be designed for the entire area to be graded at Vacca Farm; however, irrigation may not be necessary in some areas. If, following grading, the wetland scientist determines that irrigation is not needed in some areas, it will not be installed. Irrigation will be accomplished using city water. The irrigation system will be decommissioned and all above-ground parts removed at the direction of the wetland scientist following two to three growing seasons.

The site will be stabilized following completion of grading and prior to the onset of winter rains. A hydroseed/mulch mix designed to provide temporary erosion control and a weed barrier will be applied to the graded floodplain areas by mid-September.

**Phase 2: Establish Native Vegetation in the Miller Creek Channel, Floodplain, and Buffer**

Planting plans submitted in the Mitigation Plan have been refined based on the ongoing design, comments received on the Public Notice, and agency consultation (Appendix A, Sheets L1 and L2). The channel area will be planted as soon as channel excavation is complete. In areas with irrigation, planting will not be limited to fall or winter planting seasons, but in areas lacking irrigation, planting will occur only during the fall and/or winter months. Planting of the stream buffer and adjacent floodplain can occur as soon as site grading and irrigation installation are complete and hydroseed has become established.

It is anticipated that floodplain and buffers, stream riparian zone and buffers, and Lora Lake buffer planting will begin the first fall (i.e., October or November) following completion of grading and irrigation installation. Planting of the entire site will likely require more than 1 year to complete. Immediately following plant installation, the area between plants will be mulched or covered with a weed control fabric to reduce establishment of weeds. Plant collars or other herbivore deterrents may be installed to reduce damage from rodents and other herbivores.

Soils on the Vacca Farm site are a mix of interbedded peats, sands, silts, and gravels below the plowed layer. Following excavation and grading, the material exposed at the surface will likely vary from predominantly peat to a mix of sands, gravels, and silts. To ensure a medium suitable for plant establishment, 12 to 14 inches of prepared topsoil will be spread over the surface following grading. Where feasible, the prepared topsoil will be comprised of native materials from the site, mixed to obtain a topsoil with a 3:1 mineral to organic material mix. Where not feasible, prepared topsoil will be a 3:1 mix of clean sand with organic compost that is free of weed seed or other unsuitable material.

Plant material used in the mitigation will be obtained from commercial nurseries. Nurseries will be required to certify that the plant material is legally procured and from the appropriate geographic sources. The appropriate geographic sources for plant material used in the mitigation is the area that is bounded on the north by the Fraser River Valley of British Columbia, on the east by the 1,000-

foot elevation of the Cascades, on the west by the 1,000-foot elevation in the Olympic or Coast ranges, and on the south by the Willamette Valley.

#### 5.1.4.2 Construction Steps

The following sections provide a general outline of the construction and post-construction steps necessary to implement the Mitigation Plan for the Vacca Farm area.

**General Conditions**

- On award of the contract, the contractor will provide the Port with any required pre-construction submittals, work plans, and schedules.
- A pre-construction meeting will be held with the contractor, architect/engineer, and wetland scientist to review submittals, work plans, schedules, and permit conditions.
- The contractor will be responsible for ensuring that the work is performed in compliance with all permit conditions and shall maintain a copy of permits on-site.
- Work will be coordinated to avoid re-entry and damage to areas that have previously been planted; work will be conducted so that no other work will impact completed landscape work.
- Areas where any landscape work has been completed will be off limits to all vehicular traffic, and pedestrian traffic will be strictly limited.
- All site work will be performed in accordance with permit conditions; any instream work or work below Ordinary High Water (OHW) will take place only during the allowable work times, consistent with HPA permit conditions (i.e., July 15 to September 15).
- Plant procurement shall be coordinated with the grading and irrigation installation schedules and be done 6 to 12 months prior to the scheduled planting season to ensure that plants are available in the quantities and species required by the planting plan.

**Site Preparation**

- Establish vertical and horizontal site controls and maintain through construction to record drawings.
- Identify and flag limits of work for mitigation site.
- Identify staging areas and temporary access/haul roads.
- Implement TESC plan, install TESC measures for all projects, including the Miller Creek channel relocation, floodplain grading, Lora Lake buffer planting, and Miller Creek buffer enhancement areas.
- Identify and flag sewer manholes and sewer easement.
- Install fencing (orange barrier) around areas to be protected (e.g., existing wetlands, outlet ditches, sewer manholes).
- Maintain security of the site through construction.

- Establish temporary access/haul roads.
- Establish staging and stockpile areas.
- Implement a spill control plan and identify fueling areas.
- Install site dewatering equipment and structures (e.g., pumping wells, manifold piping, temporary storage ponds, discharge structure).

**Clearing, Excavation, and Grading**

- Clear and grub the site.
- Implement dewatering for new channel construction, if necessary.
- Fill in or remove drainage ditches.
- Excavate new channel subgrades (except at tie-in areas).
- Confirm new channel subgrades with field survey.
- Install log weirs and quarry spalls.
- Place streambed material and grade low-flow channel.
- Confirm new channel finish grades.
- Construct new channel banks; install coir fabric-wrapped streambank material.
- Install coir logs and coir mattresses.
- Install instream habitat features in new channel.
- Install channel plantings and bioengineering.
- Remove weeds (e.g., grub out blackberry and reed canarygrass; apply herbicide if appropriate per specifications) and clear brush in wetland buffer enhancement areas.
- Mass and fine grade floodplain.
- Install microtopography/large woody debris on floodplain.

**Construct New Channel Tie-Ins to Existing Channel**

- Implement fish-protection and erosion control measures for tie-in construction.
- Install sheeting and base flow stream diversion sumps at tie-in areas.
- Excavate new channel grades at tie-in areas.
- Install transition area log weirs and quarry spalls at tie-in areas.
- Place streambed (spawning) gravel and grade low-flow channel at tie-in areas.
- Confirm new channel finish grades.
- Construct new channel banks.
- Install coir logs and coir mattresses at tie-in areas.
- Install bioengineering.

- Divert water into new channel.
- Place fill in existing channel at tie-in areas.
- Prepare grading record drawings for new channel and floodplain; modify planting plans as needed to match as-built grades and site conditions

**Irrigation and Landscaping**

- Install and test irrigation system in floodplain.
- Apply hydroseed to graded portion of the floodplain.
- Winterize irrigation system.
- Begin planting in fall/winter following grading.
- Plant riparian/buffer zone of new channel.
- Plant Miller Creek floodplain and other wetland enhancement areas.
- Plant upland buffer adjacent to floodplain and Lora Lake buffers.
- Place sterile organic mulch (e.g., wood fiber) 4 to 6 inches deep between planted stock as a weed barrier.

**Closeout**

- Complete site cleanup by removing temporary haul/access roads, TESC berm, and staging areas.
- Remove construction equipment and debris.
- Hydroseed and/or install plants in temporary staging areas or access roads within the mitigation site boundaries.
- Hydroseed erosion control mix in temporary staging areas/access roads outside the mitigation boundaries.

**Record Drawings, Monitoring, and Maintenance**

- Produce record drawings (including grading, instream habitat, and planting) for all project areas (e.g., Lora Lake buffers and shoreline, Miller Creek floodplain, relocated channel, and Miller Creek buffer between new channel and South 154$^{th}$ Street/South 156$^{th}$ Street Bridge).
- Complete a baseline report, including record drawings and final monitoring plan (e.g., locations of monitoring plots, baseline conditions).
- Begin compliance monitoring during the first growing season after all grading and planting are complete; submit annual monitoring reports for 10-year monitoring period.
- Conduct maintenance (e.g., weed management, WHMP) and implement any necessary contingency measures to meet performance standards.

## 5.2 MILLER CREEK RIPARIAN AND INSTREAM ENHANCEMENT PROJECTS

Mitigation along Miller Creek from the Vacca Farm site to Des Moines Memorial Drive is designed to establish a large, contiguous habitat corridor extending approximately 6,500 ft along the stream, connecting habitats that are currently fragmented by urban land uses. Within this corridor, instream, wetland, and non-wetland riparian habitats will be restored and enhanced. Instream habitat in Miller Creek will be restored by removing channel armoring, restoring more natural channel morphology, and installing habitat features. Riparian wetlands along Miller Creek will be enhanced by removing structures and impervious surfaces, removing non-native vegetation, and planting with native wetland vegetation. Non-wetland riparian buffers along Miller Creek will be enhanced to stabilize soil; retain sediments and nutrients; and provide shade, organic matter and woody debris to the stream.

Mitigation measures along Miller Creek will also be implemented to compensate for filling existing drainage channels, to maintain the hydrology of wetlands between Miller Creek and the new runway embankment, and to mitigate for temporary construction impacts to wetlands. These mitigation actions are designed to prevent indirect hydrologic impacts to wetlands downslope of the embankment. Replacement drainage channels will be constructed to maintain inputs from surface water runoff and groundwater seepage to wetlands downslope of the new embankment, and wetlands temporarily impacted by construction will be restored to pre-construction conditions.

To compensate for unavoidable project impacts to wetlands and streams, the Miller Creek buffer and instream enhancement projects include the following specific mitigation actions:

- Restoring and enhancing functions in approximately 7.4 acres of riparian wetlands along both sides of a 6,500-ft reach of Miller Creek between the Vacca Farm site and Des Moines Memorial Drive.
- Restoring and enhancing a native, forested riparian buffer corridor along the east and west sides of this 6,500-ft section of Miller Creek, to protect and improve aquatic habitat in the stream, associated drainage channels, and riparian wetlands.
- Establishing a large, contiguous, protected riparian habitat corridor connecting the upper and lower reaches of Miller Creek.
- Restoring fish and aquatic habitat to degraded, highly modified reaches of Miller Creek by adding LWD and boulders, reconstructing natural stream channels, removing man-made obstructions, and reshaping or stabilizing streambanks (Section 5.2.2).
- Replacing approximately 1,290 linear ft of drainage channels near 12th Avenue to compensate for existing drainage channels that will be filled by the third runway embankment (Section 5.2.3).
- Restoring approximately 2.05 acres of riparian wetland that will be temporarily impacted by construction of the runway embankment (Section 5.2.4).
- Encouraging and promoting additional local stream restoration efforts in the basin; the Port will create a $150,000 trust fund to be used for stream restoration projects in the Miller Creek basin (Section 5.2.5).

### 5.2.1 Miller Creek Riparian Corridor Wetland and Buffer Enhancement Plan

The physical and biological functions provided by riparian vegetation will be enhanced along approximately 6,500 ft of Miller Creek. Protection and enhancement of the buffer will enhance the physical functions forested buffers provide, including reducing stream water temperatures, reducing erosion and suspended sediment releases to streams, influencing channel morphology by contributing large woody debris to the channel, and stabilizing the banks. Riparian restoration will also enhance biological functions of stream buffers, such as increasing nutrient cycling and retention, increasing organic carbon export to the stream, and providing habitat and food resources to aquatic organisms.

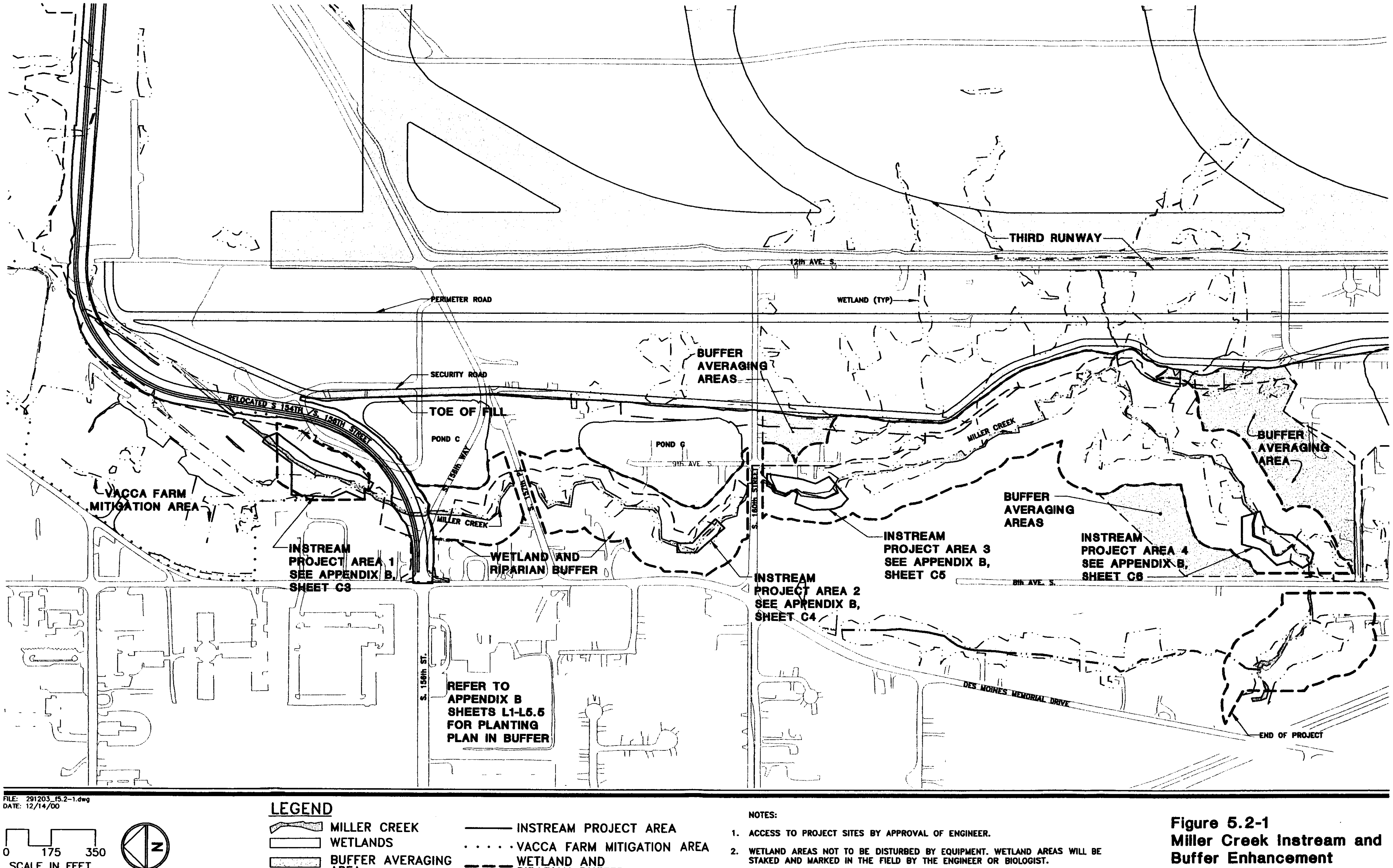
As a consequence of past development in the Miller Creek watershed, buffers have been removed or degraded along much of the stream. Native forested vegetation has been replaced by impervious surfaces, ornamental turf grasses, or landscaping. These alterations reduce the ability of the existing buffer to support the biological and physical functions necessary to maintain quality habitat in adjacent streams.

To restore functions to aquatic resources, riparian wetlands, and buffer along Miller Creek, a buffer area that averages 100 ft wide on both banks of the stream (approximately 40 acres) will be enhanced (Figure 5.2-1; Appendix B). Approximately 7.4 acres of riparian wetland habitat and approximately 32 acres of buffer will be enhanced. Buffer and wetland enhancement activities along Miller Creek include removal of all residential structures and associated impervious surfaces, underground oil storage tanks, and septic systems. Non-native, invasive species will be removed from wetlands and riparian areas where they would prevent the establishment of native vegetation, and where removal will not destabilize stream banks or result in increased sedimentation. These specific areas are shown as shaded zones in Appendix B, Sheets L1 through L5. The wetlands and riparian buffer will be enhanced by planting areas of existing lawn, predominantly non-native vegetation, or disturbed areas (i.e., from which structures or impervious surfaces have been removed) with native, predominantly forested vegetation (Figure 5.2-2 and in Appendix B, Sheet L1 through L5.1). Wetland or riparian buffer areas which currently have predominantly native forested or shrub vegetation will be enhanced with in-fill planting of native trees or shrubs.

Design of the Miller Creek wetland and riparian buffer enhancements has been coordinated with the design and location of stormwater detention ponds, the South 156$^{th}$ Way bridge replacement, location of airport security roads and utility easements, as well as with design of replacement drainage channels (see Section 5.2.3). Appropriate BMPs will be implemented and construction activities sequenced to ensure that there are no impacts to buffer enhancement projects from other mitigation or MPU construction activities (see Implementation, Section 5.2.2.10 for details).

#### 5.2.1.1 Goals, Objectives, and Design Criteria

The primary goals of the buffer enhancement plan are to enhance functions in riparian wetlands and in aquatic habitat within and downstream of the Miller Creek riparian corridor by restoring a forested buffer along the entire length of Miller Creek in the acquisition area Table 5.2-1).

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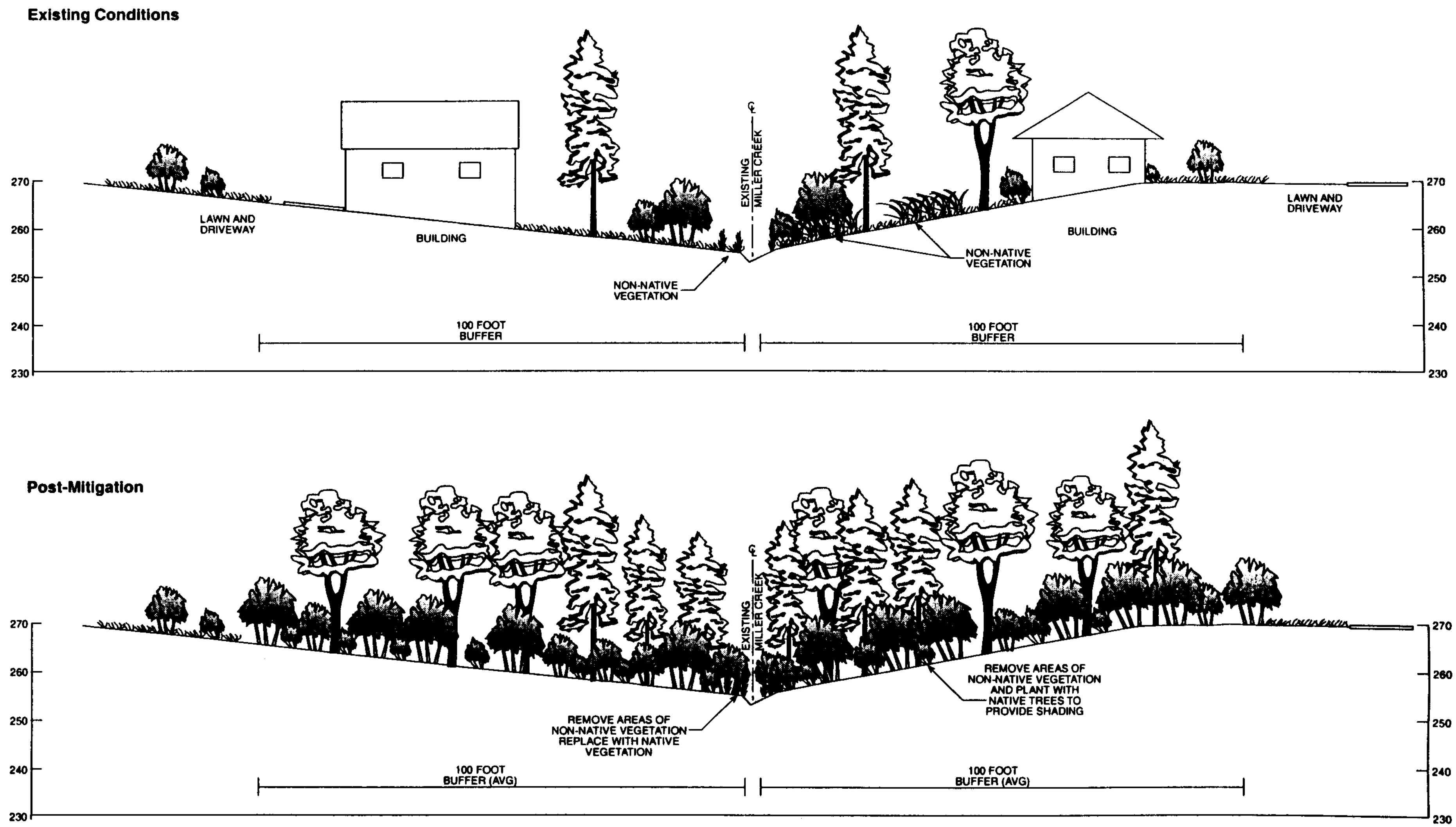
LEGEND

- MILLER CREEK
- WETLANDS
- BUFFER AVERAGING AREA
- INSTREAM PROJECT AREA
- VACCA FARM MITIGATION AREA
- WETLAND AND RIPARIAN BUFFER

NOTES:

1. ACCESS TO PROJECT SITES BY APPROVAL OF ENGINEER.
2. WETLAND AREAS NOT TO BE DISTURBED BY EQUIPMENT. WETLAND AREAS WILL BE STAKED AND MARKED IN THE FIELD BY THE ENGINEER OR BIOLOGIST.

**Figure 5.2-1**
**Miller Creek Instream and Buffer Enhancement**

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VERTICAL SCALE 1" = 30'
HORIZONTAL SCALE 1" = 30'

**Figure 5.2-2**
**Typical Cross Section of Miller Creek Stream Buffer Enhancement**

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**Table 5.2-1. Mitigation goals , design objectives, and design criteria for the Miller Creek wetland and buffer enhancement project.**

| Goals and Design Objectives | Design Criteria |
|---|---|
| **Goal: Enhance aquatic habitat in the Miller Creek by establishing a forested buffer.** | |
| Restore approximately 40 acres of riparian buffer along Miller Creek. | Demolish existing structures, remove maintained lawn, landscaping, and portions of non-native vegetation located within 100 ft of Miller Creek (or its adjacent wetlands), and buffer averaging areas (40-acres total). |
| | Remove potential water quality impacts such as failed septic systems and untreated stormwater runoff from the buffer area. |
| Enhance wetland and riparian. | Riparian buffer areas that are cleared or disturbed during demolition will be planted with native forested and shrub vegetation. |
| | Plant native tree species at densities of greater than 280 per acre. |
| | Plant native shrub species at densities of greater than 2,100 per acre. |
| | Lawn areas and other areas dominated by non-native species, will be enhanced by planting native forested vegetation. |
| Increase shade and detritus input to the aquatic environment. | Densely plant the portion of the buffer adjacent to the stream with native trees and shrubs where applicable to provide overhanging vegetation to provide future sources of LWD to the stream. |
| Reduce erosion and sedimentation to Miller Creek. | Remove existing structures, such as riprap walls and bridges, to reduce channel scouring.<br>Increase sediment retention in the buffer by planting trees and shrubs. |
| Provide long term protection to the Miller Creek Buffer. | Establish restrictive covenants to permanently protect buffer. |
| | Install fencing and signs to designate area as protected mitigation site. |

### 5.2.1.2 Mitigation Site Description

The section of Miller Creek included in the riparian enhancement projects is located along both sides of Miller Creek between the southern portion of the Vacca Farm site and where the stream flows under Des Moines Memorial Drive (Appendix B, Sheet C2).

The Miller Creek buffer was established by adding a 100 ft buffer from the OHWM of Miller Creek or from the edge of riparian wetlands (riparian wetlands are those that are directly associated with Miller Creek). Approximately 4.8 acres of permanent detention ponds, relocated South 154$^{th}$/South 156$^{th}$ Street, and the third runway embankment encroached into this buffer. Additionally, an existing sanitary sewer line and a 20-ft easement, totaling approximately 1.7 acres, was calculated as an encroachment. Buffer averaging was applied at three locations along the stream to compensate for these encroachments. The buffer and buffer averaging areas total approximately 40 acres (Appendix F).

The riparian buffer vegetation consists primarily of turf grass lawns, areas of ornamental non-native landscaping, or non-native invasive plant species such as Himalayan blackberry, English ivy (*Hedera helix*) , and Japanese knotweed (see Figure 5.2-2). Existing land uses in the buffer area include residential structures (such as houses and outbuildings), roads, small stock farms, and horse pastures. In small patches along the channel and in several wetland areas adjacent to the stream, native tree and shrub species occur such as red alder, black cottonwood, Pacific (*Salix lasiandra*) and Sitka willow (*Salix sitchensis*), hardhack, lady fern (*Athyrium felix-femina*), horsetail (*Equisetum* sp.), and various native and non-native grasses.

Twenty-one wetlands are present within the proposed Miller Creek wetland, Riparian buffer and buffer averaging areas (see Table 3.1-4). These wetlands are 18, 37a, A1, A9, A10, A11, A13, A16, R1, R2, R3, R4, R4b, R5, R5b, R6, R6b, R7, R7a, R8, R9, R9a, R10, R11, R12, R13, R14a, R14b, R15a, R15b, and R17. A complete description of these wetlands is provided in the *Wetland Delineation Report Master Plan Update Improvements Seattle-Tacoma International Airport* (Parametrix 2000c).

#### 5.2.1.3 Ownership

All parcels within the riparian wetland and buffer enhancement area shown in Figure 5.2-1 are owned by the Port.

#### 5.2.1.4 Rationale for Selection

Restoring the riparian habitat along this reach of Miller Creek provides on-site and in-kind mitigation opportunities to replace wetland and stream functions impacted by the project. Despite past degradation, the downstream reaches of Miller Creek contain habitat for salmonids. Acquisition, permanent protection, and restoration of a significant portion of Miller Creek has the potential to significantly enhance wetland and aquatic habitats in the Miller Creek basin, including downstream segments not within the project area. Removing residential land uses and associated non-point source pollution and physical impacts, such as clearing and dumping, will enhance the wetland and riparian plant communities, as well as water quality and aquatic habitat within the stream.

The planned restoration and enhancement of the Miller Creek riparian corridor provides an exceptional opportunity to remove anthropogenic impacts, and to establish a large contiguous riparian habitat corridor within a highly urbanized watershed. Few such opportunities exist to perform habitat restoration at this scale on significant salmonid-bearing streams in urban environments.

#### 5.2.1.5 Constraints

There are no constraints to implementing the mitigation as proposed. Specific mitigation actions have been limited in portions of the mitigation area affected by steep slopes or existing native vegetation. For example, in areas that cannot be accessed without causing increased erosion, or disturbance to desirable vegetation, enhancement actions are not planned.

#### 5.2.1.6 Ecological Assessment of the Mitigation Site

Ecological conditions relevant to the mitigation design and implementation are discussed in this section.

**Hydrology**

The majority of the proposed buffer zone contains uplands and areas of riparian wetlands. Seasonal soil saturation can occur in some of the upland areas near the stream. Inundation of some riparian wetlands occurs during the high flow periods that may occur in late fall, winter, and spring. Soils in most of the riparian wetlands remain moist during the summer months, and portions of some wetlands (e.g., Wetland 18 and 37) remain perennially saturated. Non-riparian wetlands in the buffer area are typically saturated during the late fall through early summer period.

Evaluations of project impacts to wetlands (Parametrix 2000b) demonstrate that, with the proposed mitigation, groundwater will continue to be available to support wetlands protected by the Miller Creek buffer. Mitigation to further protect and monitor these wetlands is discussed in Section 5.2.3.

**Soils**

The project area has not been mapped by the Soil Survey of King County Area Washington (Snyder et al. 1973). However, various soil test pits were dug during field investigations for wetland delineations within the Miller Creek area. Alluvial soils with high organic matter were found in the small riparian wetlands. Soils throughout the remainder of the Miller Creek riparian corridor, south of the Vacca Farm site, are disturbed due to residential development, but appear to be typical Alderwood soils (Snyder et al. 1973). Alderwood series are primarily made up of moderately well-drained soils forming on glacial till. In some areas, soils were predominantly a sandy loam, with a soil profile that corresponds to Indianola soils (Snyder et al. 1973).

**Vegetation**

South of the Vacca Farm site, between South 156th Street and South 160th Street, the riparian vegetation is a complex mix of types. Areas of residential landscaping, such as lawns and ornamental plantings, and areas of non-native invasive vegetation, are intermixed with areas of native upland and wetland vegetation. Non-native dominant plants include such invasive species as Himalayan blackberry, Japanese knotweed (*Polygonum cuspidatum*), and English ivy.

Riparian vegetation south of South 160th Street is more often dominated by native plant species than the area between Vacca Farm and South 160th Stree.. Common species identified in the canopy layer include red alder, western redcedar (*Thuja plicata*), English holly (*Ilex aquifolium*), and some Douglas fir (*Pseudotsuga menziesii*). Dominant species in the shrub layer consist of Himalayan blackberry, salmonberry (*Rubus spectabilis*), willow, and Indian plum (*Oemleria cerasiformis*), with horsetail species, lady fern, swordfern (*Polystichum munitum*), and various upland and wetland grasses in the herbaceous layer.

To assess the extent of non-native vegetation located within 100 ft of the stream, a vegetation survey was conducted along each parcel that borders Miller Creek. Detailed descriptions of the vegetation in each parcel within the riparian buffer are provided in Appendix B, Sheets L1 through L6.

#### 5.2.1.7 Miller Creek Wetland and Riparian Buffer Enhancement Mitigation Design

Conditions along Miller Creek vary widely in terms of existing vegetation, presence of structures, and percent cover of non-native invasive species. Due to this variation, a single mitigation design is not appropriate for the entire buffer area. Given the range of existing conditions, four different buffer-enhancement actions will be implemented, depending on site-specific conditions (Table 5.2-2 and Appendix B, Sheets L1 through L5). Specific performance standards for the buffer enhancement area are provided in Table 5.2-3. Depending on existing conditions in a given part of the buffer, mitigation actions in may include one of the following:

- Removing structures and/or existing non-native invasive vegetation, and re-planting with native vegetation (i.e., clearing and re-planting).
- Controlling and managing patches of non-native invasive vegetation, and re-planting with native vegetation (i.e., invasive management and re-planting.
- Retaining the existing native vegetation matrix but infill planting to increase species diversity and habitat structure (i.e., infill planting).
- Retaining and protecting existing native vegetation with the designated buffer (i.e., protection).

**Removal of Structures and Impervious Surfaces**

All structures, underground storage tanks and septic systems, roads, and driveways within the proposed buffer along the Miller Creek riparian corridor will be demolished and removed. If abandoned underground pipes or other structures do not pose risks to water quality, they may be left plugged and in place.

Demolition will be designed to minimize disturbance to existing native vegetation and soils. The contractor responsible for demolition of structures within the stream buffer areas will follow BMPs to prevent erosion and sedimentation to the stream. The Port has already demolished many residential structures within the stream buffer using sediment and erosion control BMPs to prevent erosion and sedimentation to the stream or wetlands. Standard practice prior to any demolition activity is to install an orange barrier fence and a sediment fence between the demolition site and any wetland or water feature. These standard BMPs will continue to be used throughout the demolition activities associated with the Miller Creek buffer enhancement plan. Materials removed from the buffer area during demolition will be disposed of off-site at an approved upland disposal facility.

**Grading and/or Clearing**

Grading activities will include removing existing structures, fill material, and driveways in the designated buffer areas. Additional minor grading will remove landscape features such as retaining walls. Clearing of large patches of non-native invasive species from accessible areas along the stream is propposed. On parcels where large areas of blackberry or other invasive species will be removed (such as Parcels 255, 256, and 260), the top 6 to 12 inches of topsoil may be tilled and removed if necessary to remove the root stocks of invasive species.

**Table 5.2-2. Enhancement planting approach along the Miller Creek buffer.**

| Enhancement Activity | Explanation and Comments |
|---|---|
| Remove structures and/or non-native invasive vegetation and re-planting. | This enhancement approach includes planting disturbed areas after structures have been removed from the site. Activities may include grading within the existing buffer to remove houses, driveways, and other structures. If necessary, soil will be scarified and/or amended with organic material.<br><br>Non-native invasive species such as Himalayan and evergreen blackberry (*Rubus laciniatus*), Japanese knotweed, bamboo (*Bambusa* sp.), English holly will be removed from certain portions of the buffer; these areas are shown as shaded areas in Appendix B, Sheets L1 through L5.1. Removal of non-native invasive plants will depend upon vehicular access, the potential risk of sedimentation in wetlands or Miller Creek from vegetation removal, and whether or not invasive species can be controlled adequately without removal. Areas of non-native invasive species will be wholly removed only where there is appropriate access and if existing desirable vegetation will not be adversely affected.<br><br>Re-vegetation will consist of planting native trees and shrubs in areas, such as lawns associated with residences, that do not currently have an overstory of vegetation. Under-planting will occur under existing tree canopies where an understory is absent or lacks diversity. Native trees and shrubs to be used in these enhancements are listed in Table 5.1-12. |
| Invasive vegetation control and/or management, and re-planting with native vegetation. | Non-native invasive species such as Himalayan and evergreen blackberry, Japanese knotweed, bamboo, English holly will be controlled and managed in certain portions of the buffer where removal is not necessary or possible. For example, invasive species within the buffer may be left in place if removal could cause erosion or sedimentation to the stream or adjacent wetlands.<br><br>In some areas, patches of invasive species may be treated with herbicide and/or physically removed. These patches may range in size from approximately 200 to 600 $ft^2$. Coniferous tree species will be planted in the open area to promote reforestation that would eventually shade out invasive species. These plantings will also provide diversity, seed stock, and recruitment of LWD into the riparian buffer.<br><br>Native trees and shrubs will be planted to increase (1) the amount of shade over Miller Creek, (2) LWD recruitment, and (3) colonization of native trees. |
| Infill planting in existing native/non-native vegetation. | Native trees and shrubs will be planted to increase (1) the amount of shade over Miller Creek, (2) LWD recruitment, and (3) colonization of native trees. |
| No enhancement action needed. | These areas either (1) contain well-vegetated buffer that does not require enhancement activities, (2) are inaccessible or cannot be enhanced without causing harm to desirable vegetation. |

**Table 5.2-3. Final performance standards, evaluation approach, and contingency measures for wetland and buffer enhancement along Miller Creek.**

| Design Criteria | Performance Standard | Evaluation Approach | Contingency Measures[1] |
|---|---|---|---|
| Demolish existing structures, remove maintained lawn, landscaping, and portions of non-native vegetation located within 100 ft of Miller Creek (or its riparian wetlands), and buffer averaging areas (40-acres total). | Structures, landscaped lawns, gardens, etc and gardens will be absent from the 40 acre Miller Creek wetland and buffer enhancement area. The enhancement area will total 40 acres. | Verify with record drawings and field surveys. | If necessary remove additional structures to be consistent with design.<br>Add additional area if as-built condition is not consistent with design. |
| Remove potential water quality impacts such as failed septic systems. | No septic systems will remain in the buffer area. | Verify with demolition records. | Remove any additional septic tanks if present. |
| Riparian buffer areas that are cleared or disturbed during demolition will be planted with native forested and shrub vegetation (these are shaded in Appendix B, Sheets L1 through L5.1). Plant native tree species at densities of greater than 280 per acre). Plant native shrub species at densities of greater than 2,100 per acre. | Average survival of planted stock will be at least 80% in the first 3 monitoring years. At this time, tree density will be at least 280 stems/acre; shrub density will be at least 2,100 individuals per acre.<br>By the end of year 3, plant diversity in each stratum will not decrease by more than 10% from the number and type of plants installed at baseline.<br>Canopy cover of native species will be at least 80% at monitoring year 10.<br>Canopy cover of non-native, invasive species will not be more than 10% at monitoring year 10 (see Appendix B, Sheets L1 through L5.1 for locations where this standard will apply). | Vegetation sampling (plots, transects, or plotless techniques) to estimate cover, density, mortality, and invasive species. | If standards are not met:<br>• Select species that are better adapted to existing hydrologic conditions.<br>• Install additional plant material.<br>• Install protective collars to reduce herbivore damage.. |
| Lawn areas and other areas dominated by non-native species, will be enhanced by planting native forested vegetation. | Average survival of planted stock will be at least 80% in the first 3 monitoring years. At this time, tree density will be at least 280 stems/acre; shrub density will be at least 2,100 individuals per acre.<br>By the end of year 3, plant diversity in each stratum will not decrease by more than 10% from the number and type of plants installed at baseline. | See above. | See above. |

**Table 5.2-3. Final performance standards, evaluation approach, and contingency measures for wetland and buffer enhancement along Miller Creek (continued).**

| Design Criteria | Performance Standard | Evaluation Approach | Contingency Measures[1] |
|---|---|---|---|
| | Canopy cover of native species will be at least 80% at monitoring year 10. | | |
| Densely plant the portion of the buffer adjacent to Miller Creek with native trees and shrubs where applicable to provide future sources of LWD to the stream. | Percent of stream with overhanging canopy cover is the same as or greater than baseline (as-built) conditions. | See above. | See above. |
| | Density of trees in buffer is at least 280 stems/acre. | | |
| Remove existing structures, such as riprap walls and bridges, to reduce channel scouring. | Natural channel banks will be present in the buffer, as shown on plans. | Record drawings and field surveys. | Remove any structures found inconsistent with design sheets. |
| Establish restrictive covenants to permanently protect buffer. | A minimum of 40 acres of buffer is protected by restrictive covenants. | Record survey and comparison to design sheet.<br>Verify restrictive covenants have been filed. | Implement any enhancement shown on plan sheets. |
| Install fencing and signs to designate area as protected mitigation site. | Signs and fencing clearly mark the buffer edge as a protected mitigation site. | Check signs and fencing during annual monitoring visits | Repair and/or re-install damaged or missing signs. |

[1] For all performance standards, monitoring periods may be extended if performance standards are not met.

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### Expected Hydrology

The hydrologic regime within the buffer area along Miller Creek varies widely because of topography, soil conditions, and proximity to the stream or associated wetlands. Surface grades will be changed as little as possible to retain existing drainage and flow patterns. Therefore, no changes to the existing hydrologic regime are anticipated to occur from implementing this mitigation plan.

### Hazard Wildlife Considerations

A landscape planting approach has been developed consistent with the WHMP to aid in deterring flocking birds, raptors, and waterfowl from using the buffer areas along Miller Creek as habitat. Mitigation actions in the buffer, such as replacing the existing open areas (i.e., lawns) along the stream with forested and shrub vegetation, will reduce hazard wildlife attractants by covering and screening open water.

To deter raptor use of the mitigation sites, deciduous and coniferous trees with stiff branches (such as Sitka spruce or Douglas fir) will be planted in limited quantities to limit roosting habitat for raptors such as red-tailed hawks. The primary coniferous tree species used in the upland and transitional zones will be western redcedar because its limp branches do not provide ideal raptor perching habitat.

### Landscape Plan

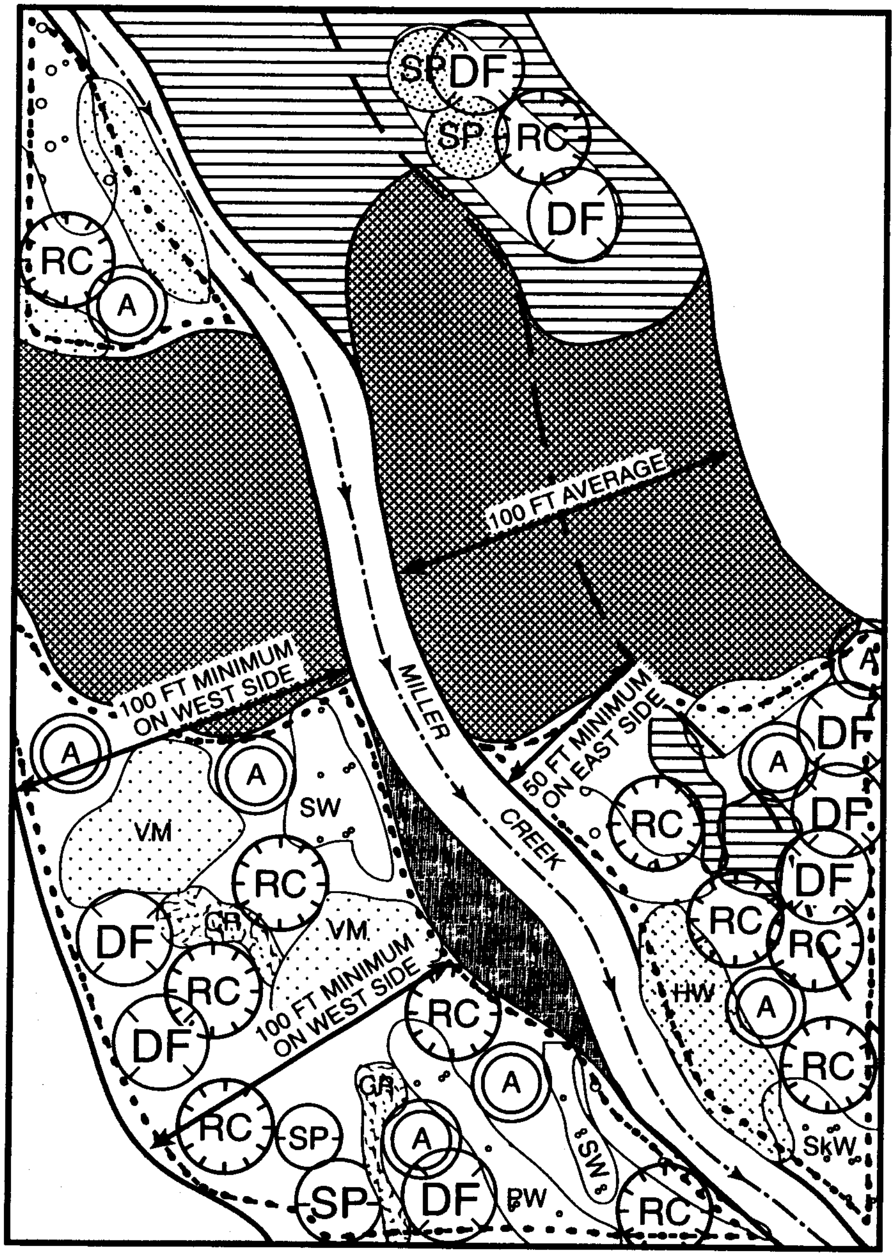
Specific planting plans for each area within the buffer have been designed using the buffer area inventory and the four enhancement alternatives (see Table 5.2-2). Plant communities and specific planting zones are shown in detail on plan sheets included in Appendix B, Sheets L1 through L5.1.

A list of plant species similar to that identified for the Miller Creek floodplain and wetland restoration (see Table 5.1-12) will be used in the Miller Creek riparian corridor buffer enhancement plan. Sun-tolerant species, such as Douglas fir and red alder, will be planted in open sunny areas, while species that prefer shade, such as vine maple (*Acer circinatum*), will be planted in shady areas under existing vegetation. A typical planting plan (Figure 5.2-3) depicts how these planting approaches will be applied.

Temporary irrigation will be provided within the buffer areas. Irrigation will only be used during the plant establishment phase and will wither be removed (if installed above ground) or abandoned in place (if installed below ground).

## 5.2.1.8 Implementation

Miller Creek buffer projects will be closely coordinated with the instream enhancement projects, as well as related Master Plan Update improvements, such as construction of the embankment. Construction methods, sequencing, and steps necessary to implement both the riparian wetland and buffer enhancement projects and the instream enhancement projects are discussed in Section 5.2.2.10.




Existing vegetation to remain

Area of existing non-native invasive plant species to be removed and replaced with native riparian trees and shrubs

Areas for partial non-native plant removal. Native coniferous trees will be planted to provide shading

**Riparian Floodplain Zone**

**TREES**

RC Western Redcedar

A Red Alder

OA Oregon Ash

**SHRUBS**

SkW Sitka Willow

PW Pacific Willow

HW Hooker's Willow

Hydroseed Mix/ Natural Colonization

**Upland Zone**

**TREES**

DF Douglas Fir

SP Sitka Spruce

WRC Western Red Cedar

A Red Alder

**SHRUBS**

VM Vine Maple

CR Clustered Rose



SCALE IN FEET

0 25 50

N

**Figure 5.2-3**
**Typical Planting Plan for the Miller Creek Upland and Streamside Buffer Planting Zones**

Miller Creek
Enhancement Project

#### 5.2.1.9 Monitoring and Performance Standards

Monitoring for the wetland and riparian buffer projects will be consistent with the monitoring approach and schedule outlined in Chapter 4. Specific performance standards will be evaluated regularly during the monitoring period to ensure that the wetland and riparian buffer enhancement projects are meeting project goals and objectives (see Table 5.2-3). If performance standards are not met, specific contingency measures listed in Table 5.2-3 may be implemented, following the adaptive management approach described in Chapter 4. Monitoring schedules specific to the riparian buffer are provided in Table 5.2-4.

#### 5.2.1.10 Site Protection

The Port will execute and file a restrictive covenant for the Mitigation area. Copies of proposed restrictive covenants are included in Appendix F.

The Miller Creek buffer mitigation will be marked with permanent signs and protected by fencing as approved by ACOE. Signs will clearly mark the area as a protected wetland mitigation site. The Port will inspect and maintain signs and fencing on a regular basis.

#### 5.2.1.11 Maintenance and Contingency Plans

Routine maintenance tasks (e.g., maintaining irrigation system, removing trash) and adaptive management/contingency measures (e.g., weed management, replacing plants) will be implemented consistent with the approach outlined in Chapter 4. Specific contingency actions for each wetland and riparian buffer performance standard are provided in Table 5.2-3.

### 5.2.2 Miller Creek Instream Habitat Enhancement Plan

Four major instream enhancement projects, as well as general instream habitat enhancements to restore and improve the quality of fish habitat in Miller Creek. Instream habitat quality is currently degraded as a result of historic residential land uses and overall urbanization in the basin (see Chapter 2).

The section of Miller Creek between the Vacca Farm site and Des Moines Memorial Drive was surveyed in February and March 1999 to identify areas within the stream channel that would benefit from habitat enhancement. As a result of this survey, four enhancement projects have been identified (Appendix B, Sheet C2). Habitat enhancement in these four projects includes removal of channel armoring, weirs, concrete walls, and footbridges, and installing instream features such as root wads, gravel, and large woody debris. In addition to these four instream enhancement projects, large woody debris will be added at selected locations along the 6,500-ft section of Miller Creek to enhance overall channel function and habitat (Appendix B, Sheets C7 and C10). Instream enhancement projects will be coordinated with the wetland and riparian buffer enhancement projects. The streambed and bank of Miller Creek adjacent to the South 156$^{th}$ Street bridge will also be restored after the existing bridge over South 156$^{th}$ Street is removed and reconstructed as part of relocating South 154$^{th}$ Street (see Figure 5.2-1).

**Table 5.2-4. Monitoring schedule for the Miller Creek buffer and wetland enhancement project.**

| | | | Data Collection Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Feature** | **Method** | **Duration** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Plant survival | Calculating plant survival. | Once late spring to early summer | X | X | X | X | | X | | | | | |
| Tree and shrub density/cover | Vegetation sampling | Once late spring to early summer | X | X | X | X | | X | | X | | X | X |
| Vegetation structure | Describe from walk-through surveys, incorporating data from above analysis as available. | Once late spring to early summer | X | X | X | X | | X | | X | | X | X |

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### 5.2.2.1 Goals, Objectives, and Design Criteria

The overall goal of the Miller Creek instream enhancement projects is to alleviate historic human disturbances by increasing the amount, quality, and continuity of instream fish habitat. Specific design objectives in the instream enhancement projects are:

- Enhance instream fish habitat by increasing channel complexity.
- Stabilize bed and bank erosion along Miller Creek.
- Remove instream man-made debris and channel armoring.
- Enhance instream substrate conditions for fish and invertebrates.
- Restore the streambed and bank after relocating the bridge over South 156$^{th}$ Street.

To implement the goal identified above, specific objectives and design criteria were developed (Table 5.2-5).

**Table 5.2-5. Mitigation goals, design objectives, and design criteria for instream enhancement projects in Miller Creek.**

| Goals and Design Objectives | Design Criteria |
|---|---|
| **Goal 1: Enhance habitat by increasing channel complexity** | |
| Create pools and riffle habitat. | Remove cemented riprap along banks, encourage natural formation of meander bends and cut benches. |
| Create undercut banks and other habitat features for juvenile rearing and high-flow refugia. | Increase the amount of geomorphically stable large organic debris in the channel. |
| Create instream diversity. | |
| **Goal 2: Stabilize bed and bank erosion** | |
| Identify locations of in-channel or bank erosion and stabilize those areas. | Stabilize those areas of excessive erosion by using native vegetation and large woody debris. |
| **Goal 3: Remove trash** | |
| Channel will be free of trash. | Remove all trash from the channel that could be harmful to fish habitat aesthetics, and water quality. |
| **Goal 4: Enhance instream substrate** | |
| Enhance substrate. | Add gravel to degraded reaches where natural recruitment is limited. |
| **Goal 5: Restore the bed and bank after relocating the bridge at South 156$^{th}$ Street** | |
| Reduce fine sediment load. | Reduce upstream erosion by vegetating banks and replanting the Vacca Farm site. |

#### 5.2.2.2 Mitigation Site Description

The four instream enhancement projects, and the general habitat enhancements are located in Miller Creek between the Vacca Farm site and Des Moines Memorial Drive (see Figure 5.2-1; Appendix B, Sheet C2).

Between Vacca Farm and South 160th Street, the stream channel is slightly less altered than the ditched and channelized reach on the Vacca Farm site. South of Vacca Farm, the stream contains some meanders, pools and riffles, and some large woody debris in the channel. The substrate is predominantly silty, mixed with areas of sand and till in the northern portions of this reach. Further downstream the substrate consists largely of gravel and gravel-sand bars. Unconfined channel widths in this reach range from 7 to 10 ft and gravel bars are approximately 5 ft wide. Because this stream reach has been surrounded by residences and yards, several stream portions are modified with riprap, retaining walls, bridge abutments, footbridges, and other bank-side structures that restrict natural channel morphology. The vegetated upland buffer in this area mostly consists of lawn and some bushes and trees planted by homeowners, but there is very little native riparian vegetation.

The stream channel between South 160th Street and SR 509 is less disturbed than the upstream reaches, with channel widths ranging from 7 to 10 ft. With the exception of a few small stretches within this reach, which have been modified with riprap, tire walls, or fences, this reach is characterized by meanders, large woody debris jams, riparian vegetation, pools and riffles, and gravel bars. Generally, residential development is located farther from the stream than in the upstream reaches. As a result, long stretches of the stream have intact riparian vegetation on both banks, reducing the impact of urbanization. Gravel and sandbars are present in many portions of this reach and substrate in the majority of the channel is gravel.

#### 5.2.2.3 Ownership

The Port owns the entire area to be included in the Miller Creek riparian and instream enhancement mitigation.

#### 5.2.2.4 Rationale for Selection

Mitigation sites for the specific instream enhancement projects were selected based on several criteria. An initial survey of existing conditions was conducted to identify locations where development adjacent to the channel or alterations to the channel were directly impairing habitat and/or water quality in Miller Creek. These sites were then evaluated based on the severity and type of impact and opportunity for restoration. Type of impact included the loss of habitat complexity, channel armoring, erosion, man-made debris in the channel, and unstable or uniform geomorphology. Opportunity for significant improvement at potential enhancement sites was determined based on benefits to upstream and downstream reaches, access to the site, coordination with buffer revegetation projects, and potential negative impacts during construction.

#### 5.2.2.5 Constraints

There are no significant constraints to the implementation of the mitigation projects. However, instream work must be performed during low-flow periods, and all work will be designed and performed consistent with conditions of the HPA permit for the projects.

#### 5.2.2.6 Ecological Assessment of the Enhancement Sites

Urban development in the Miller Creek watershed has degraded instream habitat and water quality throughout the basin. Specifically, within the project reach, aquatic habitat has been degraded by altered hydrology; channelization; excess fine sediments; altered water quality due to inputs of pollutants, stormwater discharges, and agricultural and residential herbicides, pesticides, and fertilizers; loss of habitat complexity; and loss of vegetated buffers (Table 5.2-6). However, Miller Creek continues to support populations of coho salmon, anadromous and resident cutthroat trout, three-spine sticklebacks, white crappie (*Pomoxis annularis*), and pumpkinseed sunfish.

**Table 5.2-6. Summary of existing conditions in Miller Creek between South 156th Street and Des Moines Memorial Drive.**

| Parameter | Description |
|---|---|
| Fish Habitat | Pool habitat and high-flow refugia quality are relatively poor, which is related to the lack of LWD in the channel. This problem (and other factors) may limit the sizes of resident and anadromous fish populations supported by Miller Creek. |
| Fine Sediment | High turbidity was observed (and reported) in Miller Creek during winter base flow rates. This problem is primarily found in the upper reaches where the channel has been straightened and confined by riprap on both banks. |
| Geomorphic Complexity | Numerous footbridges and riprap confine the stream to a narrow straight channel in many reaches. |
| Man-made Debris | Man-made debris (tires, shopping carts, metal pipes, and car parts) and fences that restrict upstream and downstream fish movement are common throughout the stream. |

Between South 156th Street and the South 160th Street culvert, Miller Creek has been degraded by substantial development adjacent to the banks. Segments of the stream have been straightened and the banks in these reaches are lined with riprap or cement. Substrate in this reach consists of silt and fine sands. Numerous footbridges and weirs influence channel morphology and reduce habitat complexity. Most of the footbridges confine the channel, creating straightened reaches of high-velocity flows and bed scouring. Riparian vegetation consists primarily of lawn and some trees adjacent to the channel; however, the vegetation does not provide shade, bank stabilization, or habitat complexity. A fish survey conducted in 1998 found that sticklebacks were the dominant fish in this reach; white crappies were also found (Parametrix 1998). Although cutthroat trout were found upstream of waterfall north of 160th Street during an electroshocking fish survey on November 10, 1998 (Parametrix 1998), they were not found during that survey in the upper reaches of Miller Creek north of South 156th Street.

Specific conditions in each of the four instream project reaches are described in the following section.

**Instream Enhancement Project 1**

Instream Project 1 is located between the downstream end of the Miller Creek relocation project and South 156th Street (see Figure 5.2-1). The project area includes approximately 650 ft of Miller Creek, which is confined along most of the project length by riprap (Figure 5.2-4; Appendix B, Sheet C3). Historically, this area was a wetland that may have lacked a defined streambed. When this area was drained for farmland, Miller Creek was channelized along the eastern edge of Wetland A1. A small side channel, or ditch, draining Wetland A1 flows into Miller Creek at the south end of Wetland A1 (see Figure 5.2-4). This project is located on Parcels 63, 87, 88, 89, 90, 91, 97, 98, 100, and 101.

In this reach Miller Creek is a low-gradient stream, although the valley becomes more confined downstream of the confluence with the side channel. The project site has two distinct areas: upstream of the confluence with the side channel (Parcels 88, 89, and 90), and downstream of the confluence where the valley narrows (Parcels 91, 99, 100, and 101). Substrate in the upstream reach is composed primarily of silt and fine gravel; however, some coarse gravel exists where riprap has fallen into the channel and created a riffle. Substrate in the side channel and downstream of the confluence consists of fine silt. Five footbridges cross Miller Creek upstream of the confluence, and a fence crosses the channel at the upstream end of the project site. Two footbridges and a fence cross the side channel.

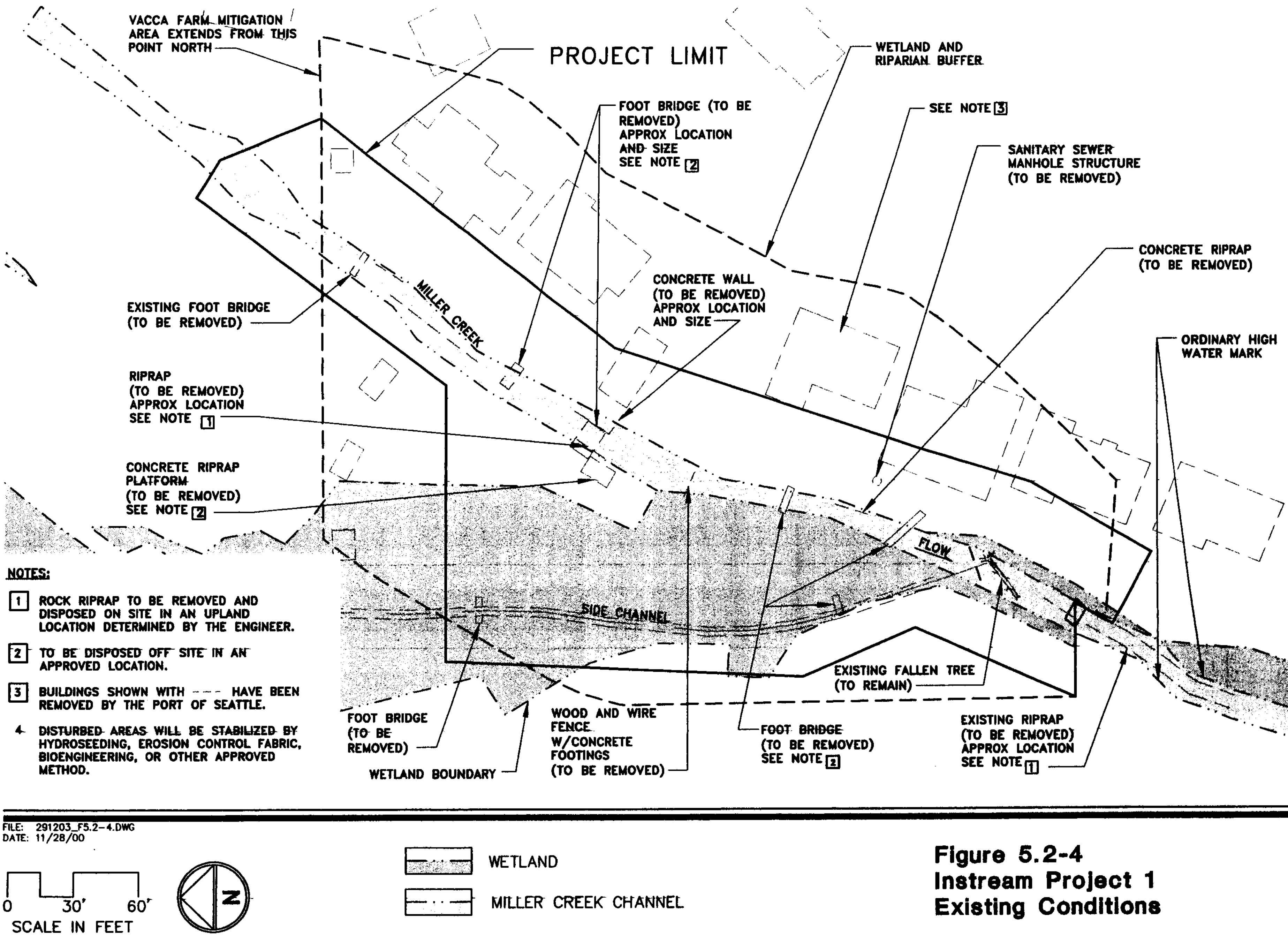
During high-flow events, both Miller Creek and the side channel overtop their banks and flood the adjacent wetland. Vegetation within this reach is predominantly grass; the site also has several large western redcedar trees and some non-native and invasive species. Downstream of the confluence several large trees are located along the channel; however, the remainder of vegetation is lawn and invasive or exotic species.

**Existing Conditions: Instream Enhancement Project 2**

Instream Project 2 is located approximately 150 ft upstream of South 160th Street (see Figure 5.2-1). A narrow ravine confines Miller Creek and its floodplain throughout this reach.

Construction of two weirs in this reach has altered the channel profile and resulted in a uniform channel with little habitat diversity (Figure 5.2-5; Appendix B, Sheet C4). The first (downstream) weir is approximately 3 ft high and constructed of large boulders. The second (upstream) weir is constructed of cement, located approximately 70 ft upstream of the first weir, and is approximately 2 ft high. A footbridge crosses Miller Creek just upstream of the second weir. Miller Creek is confined by riprap on both banks downstream of the first weir and upstream of the second weir. Both weirs may impede fish passage at summer low flows.

Between the weirs, riprap armors the left bank, while the right bank is covered with lawn. During storm events, a pool forms behind the downstream weir and floods the right bank. An emergent wetland lies adjacent to the left bank of Miller Creek throughout the project area.




**NOTES:**

1. ROCK RIPRAP TO BE REMOVED AND DISPOSED ON SITE IN AN UPLAND LOCATION DETERMINED BY THE ENGINEER.
2. TO BE DISPOSED OFF SITE IN AN APPROVED LOCATION.
3. BUILDINGS SHOWN WITH - - - HAVE BEEN REMOVED BY THE PORT OF SEATTLE.
4. DISTURBED AREAS WILL BE STABILIZED BY HYDROSEEDING, EROSION CONTROL FABRIC, BIOENGINEERING, OR OTHER APPROVED METHOD.

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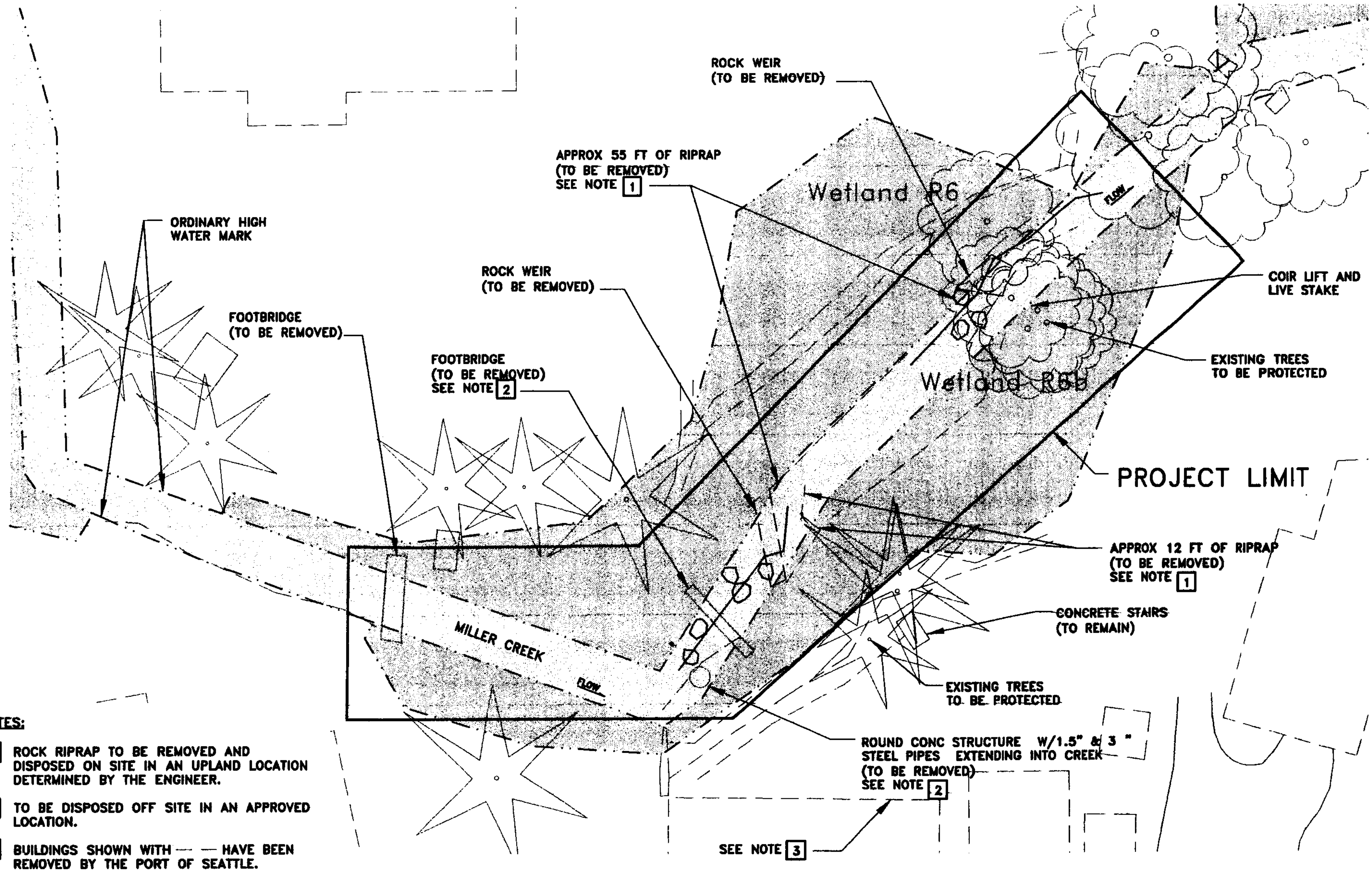
**Figure 5.2-4**
**Instream Project 1**
**Existing Conditions**

Parametrix, Inc.




NOTES:

1 ROCK RIPRAP TO BE REMOVED AND DISPOSED ON SITE IN AN UPLAND LOCATION DETERMINED BY THE ENGINEER.

2 TO BE DISPOSED OFF SITE IN AN APPROVED LOCATION.

3 BUILDINGS SHOWN WITH — — HAVE BEEN REMOVED BY THE PORT OF SEATTLE.

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DATE: 11/28/00

0 15' 30'
SCALE IN FEET

N

WETLAND

MILLER CREEK CHANNEL

**Figure 5.2-5**
**Instream Project 2**
**Existing Conditions**

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Vegetation in the project area is predominantly turf grass lawns; however, a stand of large cottonwood trees is located on the right bank near the downstream weir. The project site is easily accessible on the right bank, although heavy equipment access may be limited by a retaining wall on the left bank.

## Instream Enhancement Project 3

The site of Instream Project 3 extends from a scour pool and debris area immediately downstream of a culvert at South 160th Street to approximately 600 ft downstream (see Figure 5.2-1; Appendix B, Sheets C2 and C5). This project is located on Parcels 256, 257, 258, 259, 260, and 276. Miller Creek is confined in the middle and upper portions of this site by a narrow ravine. However, along the lower project reaches, the valley widens and an extensive floodplain and wetland are associated with the stream.

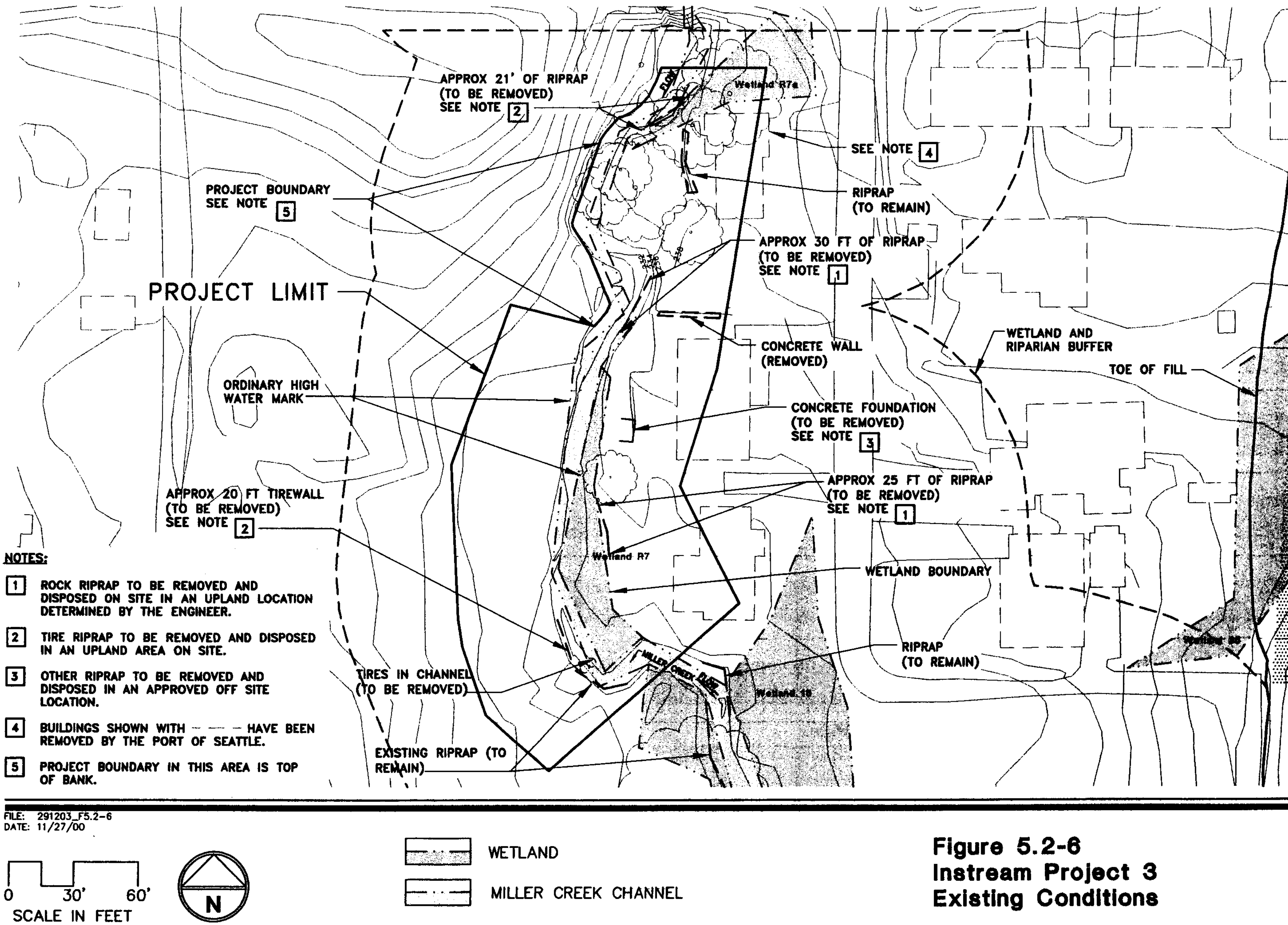
Tire riprap has been placed along the left bank downstream of the scour pool, while the right bank is steep and shows evidence of erosion and downcutting. In the middle of the project site, Miller Creek becomes confined to a narrow channel, the gradient increases to a slope of approximately 3 percent, and the velocity increases. At the lower end of the steep reach, Miller Creek has a sharp meander bend that is protected by riprap (Figure 5.2-6; Appendix B, Sheet C5). Tire riprap lines the channel approximately 40 ft upstream of this meander. A deep scour pool with large cobble substrate has formed on the outside edge of the meander. Another meander immediately downstream has also been lined with riprap.

Vegetation throughout this reach is dominated by blackberry species and turf grass lawn, with a few large trees scattered along the banks. Access to the site is limited by steep banks on the right bank immediately downstream of the culvert. However, the project area is easily accessible along the left bank.

## Instream Enhancement Project 4

Enhancement Project 4 extends from a point east of 8th Avenue South to a private driveway approximately 820 ft upstream (see Figure 5.2-1). Project 4 is located on Parcels 314, 316, 317, and 321. Many reaches of Miller Creek throughout this project area are unconfined by riprap and have pool and riffle sequences; small pieces of in-channel wood are present throughout this reach as well. Riprap lines the bank downstream of the private driveway (Figure 5.2-7; Appendix B, Sheet C6). Large cement pieces line Miller Creek on the right bank, constricting the channel. A collapsed footbridge has created a backwater pool and trapped debris on the upstream side during winter base flow conditions. At the downstream portion of the project area, two rock walls line the stream and a fence spans the channel. The upstream wall, located along the left bank, influences the flow pattern of the stream; however, there is evidence of bank erosion downstream of this wall. Miller Creek is channelized by the second wall, which lines both banks.

Riparian vegetation in the project site includes many large (>30 ft) western redcedar and red alder trees; however, little understory exists, and ground cover is primarily grass, gravel, and invasive species such as blackberry. Steep banks at specific locations on the left bank would limit site access. Miller Creek is easily accessible in most places along the right bank.




**NOTES:**

1. ROCK RIPRAP TO BE REMOVED AND DISPOSED ON SITE IN AN UPLAND LOCATION DETERMINED BY THE ENGINEER.
2. TIRE RIPRAP TO BE REMOVED AND DISPOSED IN AN UPLAND AREA ON SITE.
3. OTHER RIPRAP TO BE REMOVED AND DISPOSED IN AN APPROVED OFF SITE LOCATION.
4. BUILDINGS SHOWN WITH – — – HAVE BEEN REMOVED BY THE PORT OF SEATTLE.
5. PROJECT BOUNDARY IN THIS AREA IS TOP OF BANK.

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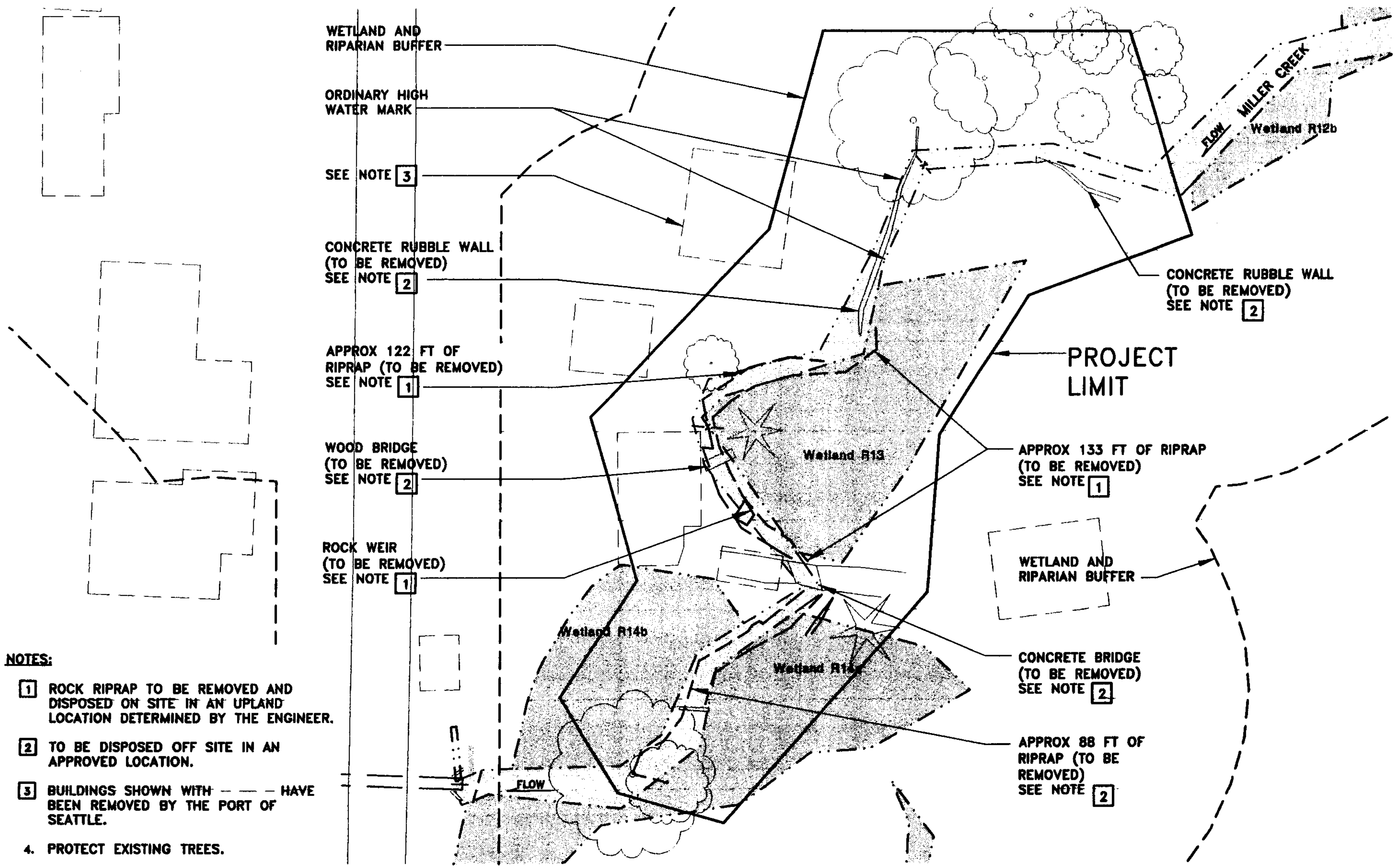
DATE: 11/27/00

**Figure 5.2-6**
**Instream Project 3**
**Existing Conditions**




**NOTES:**

1. ROCK RIPRAP TO BE REMOVED AND DISPOSED ON SITE IN AN UPLAND LOCATION DETERMINED BY THE ENGINEER.
2. TO BE DISPOSED OFF SITE IN AN APPROVED LOCATION.
3. BUILDINGS SHOWN WITH — — — HAVE BEEN REMOVED BY THE PORT OF SEATTLE.
4. PROTECT EXISTING TREES.

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DATE: 11/28/00


**Figure 5.2-7**
**Instream Project 4**
**Existing Conditions**

### 5.2.2.7 Instream Habitat Enhancements Mitigation Design

The following sections describe the mitigation actions proposed for the four specific instream habitat enhancement projects, the general in-stream habitat enhancement along Miller Creek, and the restoration of the stream for the South 156th Street bridge relocation.

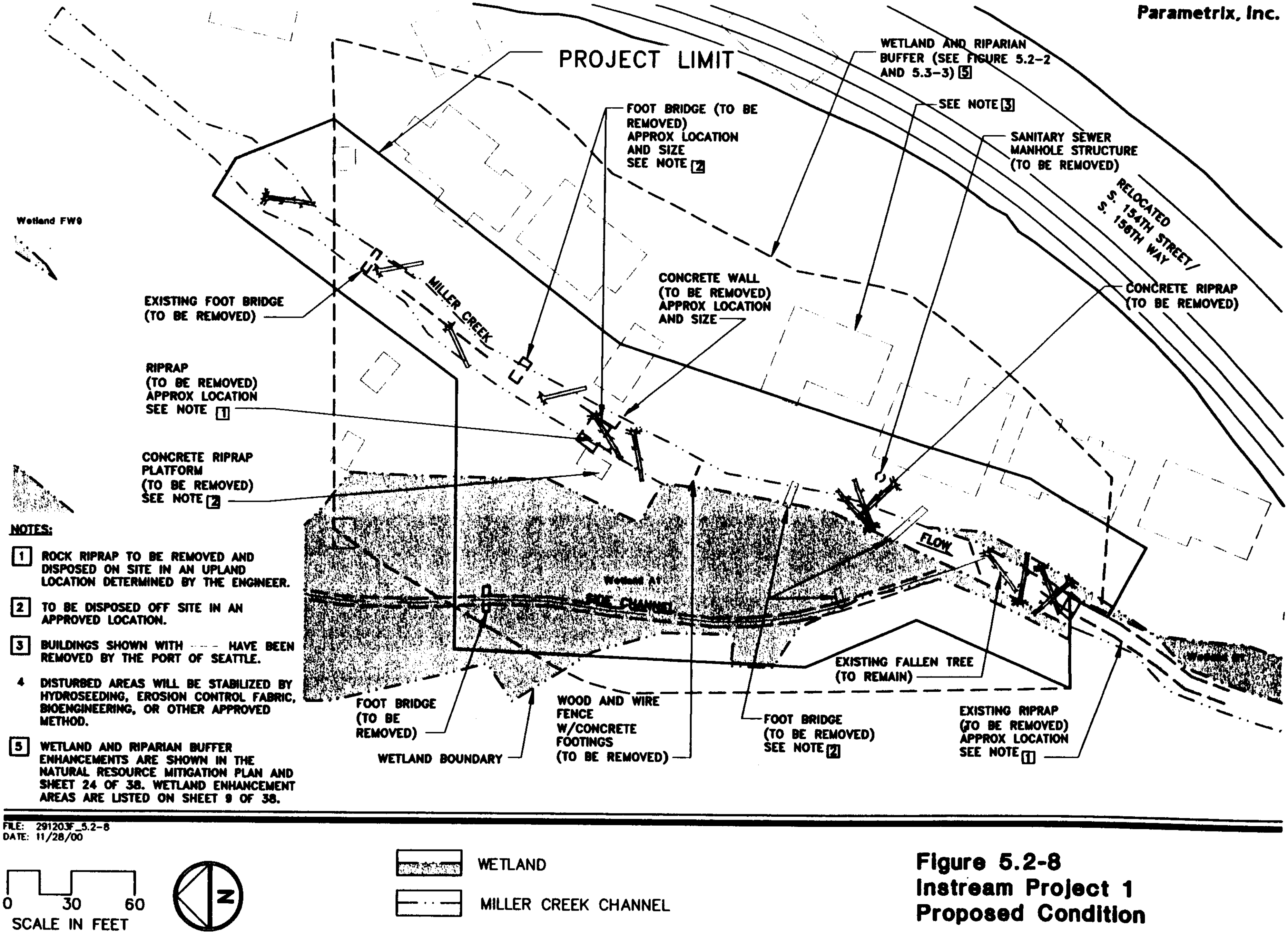
Most channel armoring, rock walls, weirs, and footbridges along this reach of Miller Creek will be removed. For example, the existing rock weirs located at Instream Project 2 will be removed because they impede fish passage. However, at several locations some riprap will be left in the channel to avoid creating significant erosion or construction impacts (Figures 5.2-8 through 5.2-11).

Prior to developing the enhancement designs, cross sections were surveyed in three relatively undisturbed reaches in Miller Creek. These cross sections (Figure 5.2-12) are used as reference sites for proposed instream enhancement projects. The geomorphic and habitat benefits associated with each enhancement feature are summarized in Table 5.2-7.

**Table 5.2-7. Habitat and geomorphic benefits of Miller Creek instream enhancement features.**

| Enhancement Feature | Geomorphic Function | Habitat Function |
|---|---|---|
| Large Woody Debris (LWD) | Stabilizes banks | Increases habitat complexity |
| | Promotes deposition of fine sediment | Promotes pool formation<br>Provides instream cover |
| Riparian Vegetation | Stabilizes banks | Moderates temperature |
| | Provides a source for LWD recruitment | Provides organic matter |
| | Increases roughness, promotes deposition of fine sediment | Promotes undercut banks<br>Provides instream cover |
| Meander Bends | Creates pool/riffle sequences | Increases habitat complexity |
| | Promotes overbank flows, reduces channel incision | Creates spawning reaches |
| | Creates variations in flow regime | |
| | Creates depositional areas | |
| Boulders | Promotes variation in channel width | Provides instream cover |
| | Creates variations in flow regime | Creates variations in flow regime |
| Erosion Control | Reduces sediment loading | Reduces spawning habitat degradation |
| | Stabilizes banks | Increases macroinvertebrate production |
| Remove Instream Barriers | Promotes natural geomorphic processes (i.e., widening, meandering, deposition) | Increases habitat availability/continuity |
| Debris Removal | NA | Enhances aesthetics |
| | | Reduces potential pollutants |
| Remove Footbridges/Riprap | Allows for natural channel movement (i.e., widening, meandering, deposition) | Increase habitat complexity |

NA = Not applicable




**NOTES:**

[1] ROCK RIPRAP TO BE REMOVED AND DISPOSED ON SITE IN AN UPLAND LOCATION DETERMINED BY THE ENGINEER.

[2] TO BE DISPOSED OFF SITE IN AN APPROVED LOCATION.

[3] BUILDINGS SHOWN WITH ---- HAVE BEEN REMOVED BY THE PORT OF SEATTLE.

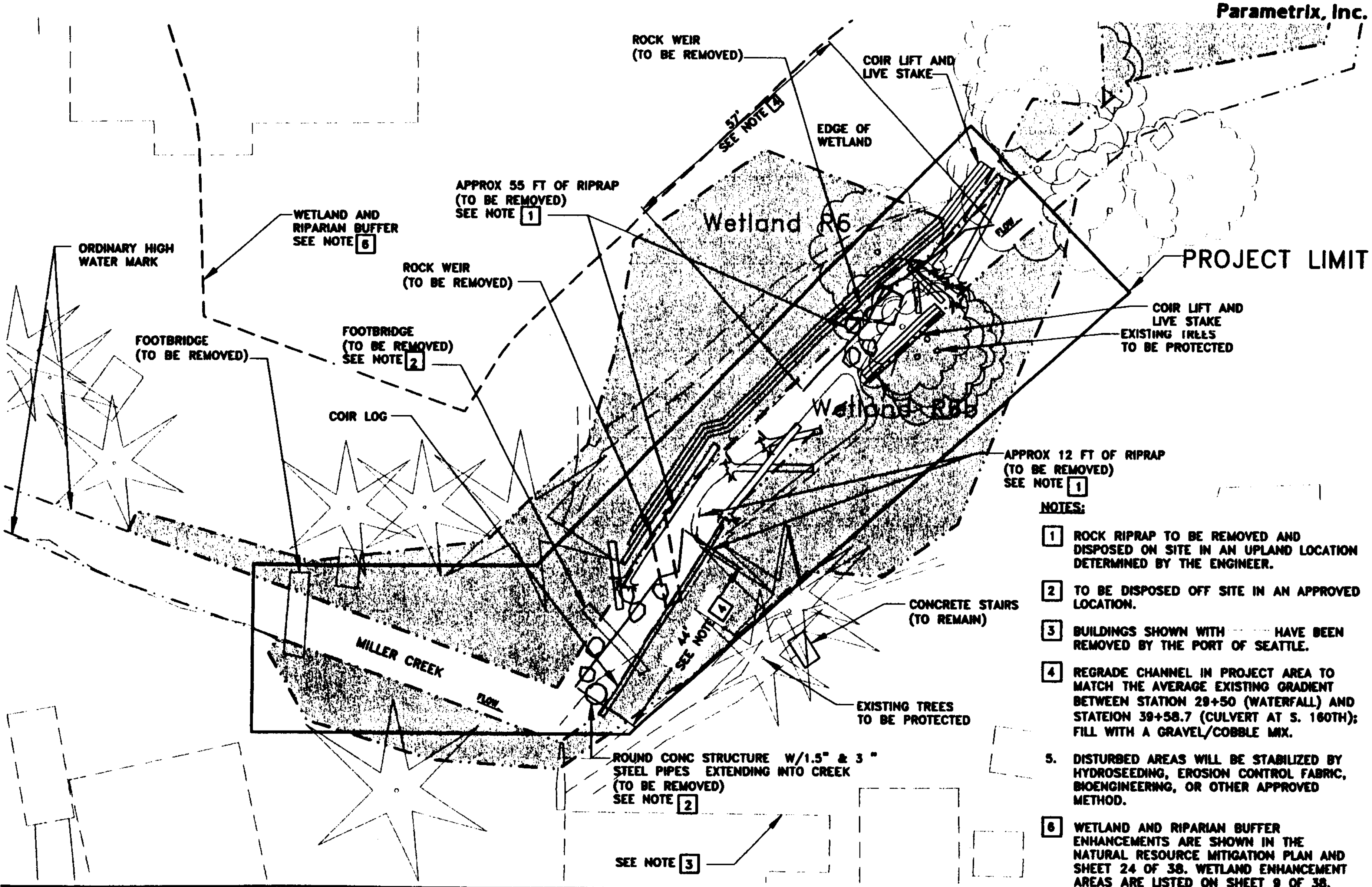
4 DISTURBED AREAS WILL BE STABILIZED BY HYDROSEEDING, EROSION CONTROL FABRIC, BIOENGINEERING, OR OTHER APPROVED METHOD.

[5] WETLAND AND RIPARIAN BUFFER ENHANCEMENTS ARE SHOWN IN THE NATURAL RESOURCE MITIGATION PLAN AND SHEET 24 OF 38. WETLAND ENHANCEMENT AREAS ARE LISTED ON SHEET 9 OF 38.

FILE: 291203F_5.2-8
DATE: 11/28/00

**Figure 5.2-8**
**Instream Project 1**
**Proposed Condition**

Parametrix, Inc.




NOTES:

1. ROCK RIPRAP TO BE REMOVED AND DISPOSED ON SITE IN AN UPLAND LOCATION DETERMINED BY THE ENGINEER.
2. TO BE DISPOSED OFF SITE IN AN APPROVED LOCATION.
3. BUILDINGS SHOWN WITH - - - HAVE BEEN REMOVED BY THE PORT OF SEATTLE.
4. REGRADE CHANNEL IN PROJECT AREA TO MATCH THE AVERAGE EXISTING GRADIENT BETWEEN STATION 29+50 (WATERFALL) AND STATEION 39+58.7 (CULVERT AT S. 160TH); FILL WITH A GRAVEL/COBBLE MIX.
5. DISTURBED AREAS WILL BE STABILIZED BY HYDROSEEDING, EROSION CONTROL FABRIC, BIOENGINEERING, OR OTHER APPROVED METHOD.
6. WETLAND AND RIPARIAN BUFFER ENHANCEMENTS ARE SHOWN IN THE NATURAL RESOURCE MITIGATION PLAN AND SHEET 24 OF 38. WETLAND ENHANCEMENT AREAS ARE LISTED ON SHEET 9 OF 38.

FILE: 291203F_5.2-9
DATE: 11/28/00

0 15 30
SCALE IN FEET

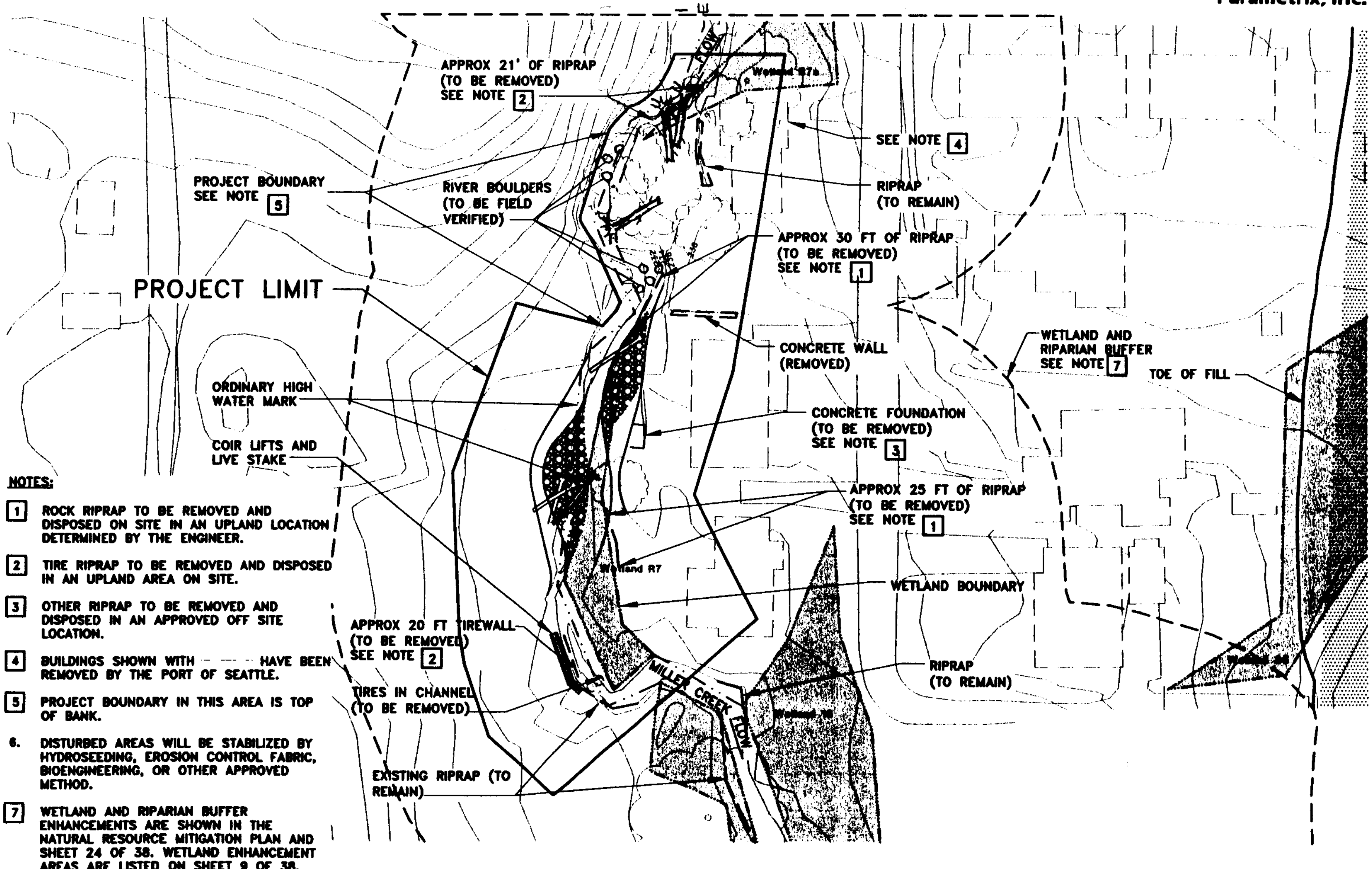
N

WETLAND

MILLER CREEK CHANNEL

**Figure 5.2-9**
**Instream Project 2**
**Proposed Conditions**

Parametrix, Inc.




**NOTES:**

1. ROCK RIPRAP TO BE REMOVED AND DISPOSED ON SITE IN AN UPLAND LOCATION DETERMINED BY THE ENGINEER.
2. TIRE RIPRAP TO BE REMOVED AND DISPOSED IN AN UPLAND AREA ON SITE.
3. OTHER RIPRAP TO BE REMOVED AND DISPOSED IN AN APPROVED OFF SITE LOCATION.
4. BUILDINGS SHOWN WITH — — — HAVE BEEN REMOVED BY THE PORT OF SEATTLE.
5. PROJECT BOUNDARY IN THIS AREA IS TOP OF BANK.
6. DISTURBED AREAS WILL BE STABILIZED BY HYDROSEEDING, EROSION CONTROL FABRIC, BIOENGINEERING, OR OTHER APPROVED METHOD.
7. WETLAND AND RIPARIAN BUFFER ENHANCEMENTS ARE SHOWN IN THE NATURAL RESOURCE MITIGATION PLAN AND SHEET 24 OF 38. WETLAND ENHANCEMENT AREAS ARE LISTED ON SHEET 9 OF 38.

FILE: 291203F_5.2-10
DATE: 11/28/00

0 30 60
SCALE IN FEET

N

WETLAND

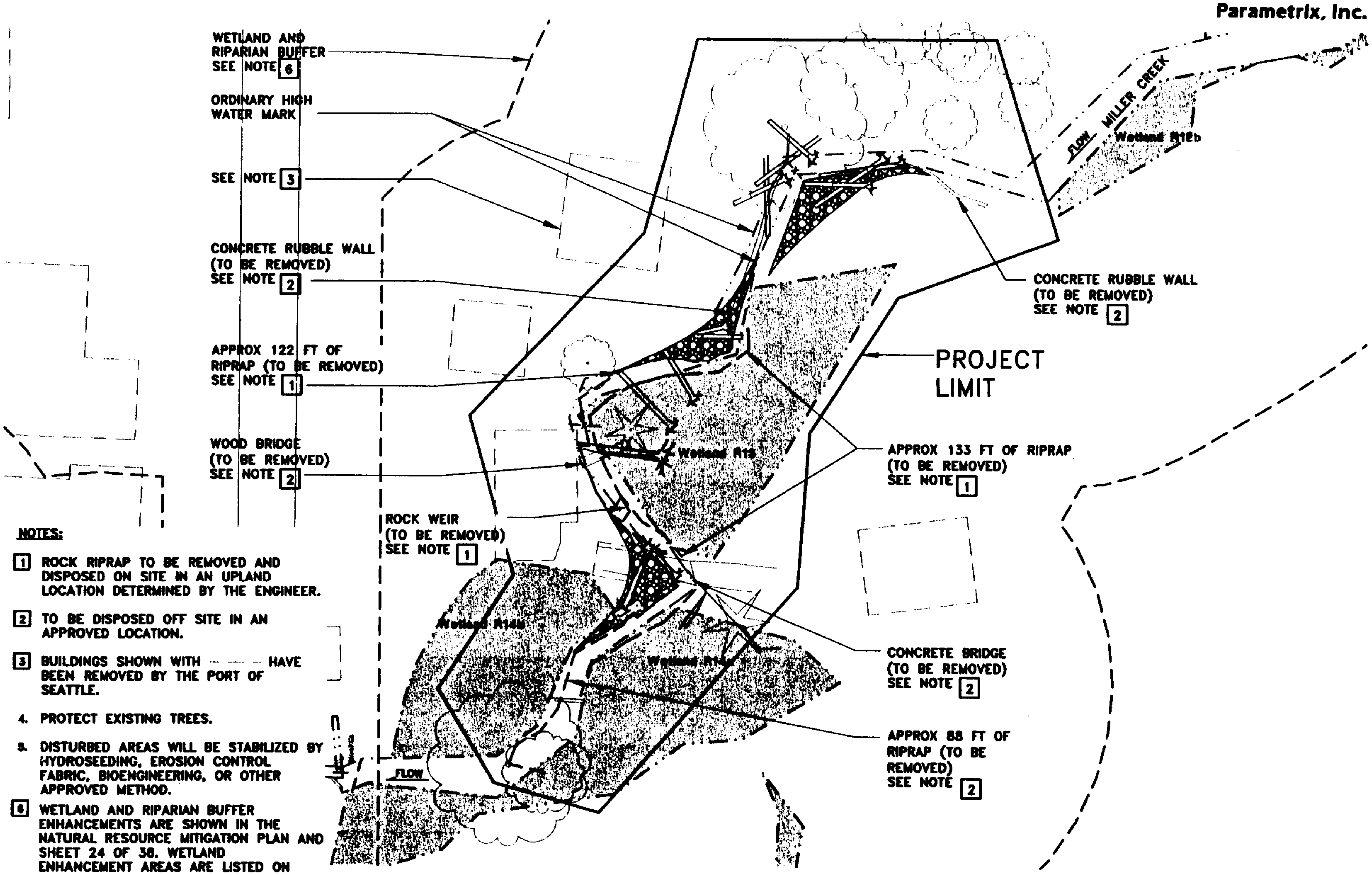
MILLER CREEK CHANNEL

GRAVEL BAR

**Figure 5.2-10**
**Instream Project 3**
**Proposed Conditions**

AR 009822

Parametrix, Inc.




NOTES:

1. ROCK RIPRAP TO BE REMOVED AND DISPOSED ON SITE IN AN UPLAND LOCATION DETERMINED BY THE ENGINEER.
2. TO BE DISPOSED OFF SITE IN AN APPROVED LOCATION.
3. BUILDINGS SHOWN WITH — — — HAVE BEEN REMOVED BY THE PORT OF SEATTLE.
4. PROTECT EXISTING TREES.
5. DISTURBED AREAS WILL BE STABILIZED BY HYDROSEEDING, EROSION CONTROL FABRIC, BIOENGINEERING, OR OTHER APPROVED METHOD.
6. WETLAND AND RIPARIAN BUFFER ENHANCEMENTS ARE SHOWN IN THE NATURAL RESOURCE MITIGATION PLAN AND SHEET 24 OF 38. WETLAND ENHANCEMENT AREAS ARE LISTED ON SHEET 9 OF 38.

FILE: 291203F_5.2-11
DATE: 11/28/00

0 25 50
SCALE IN FEET

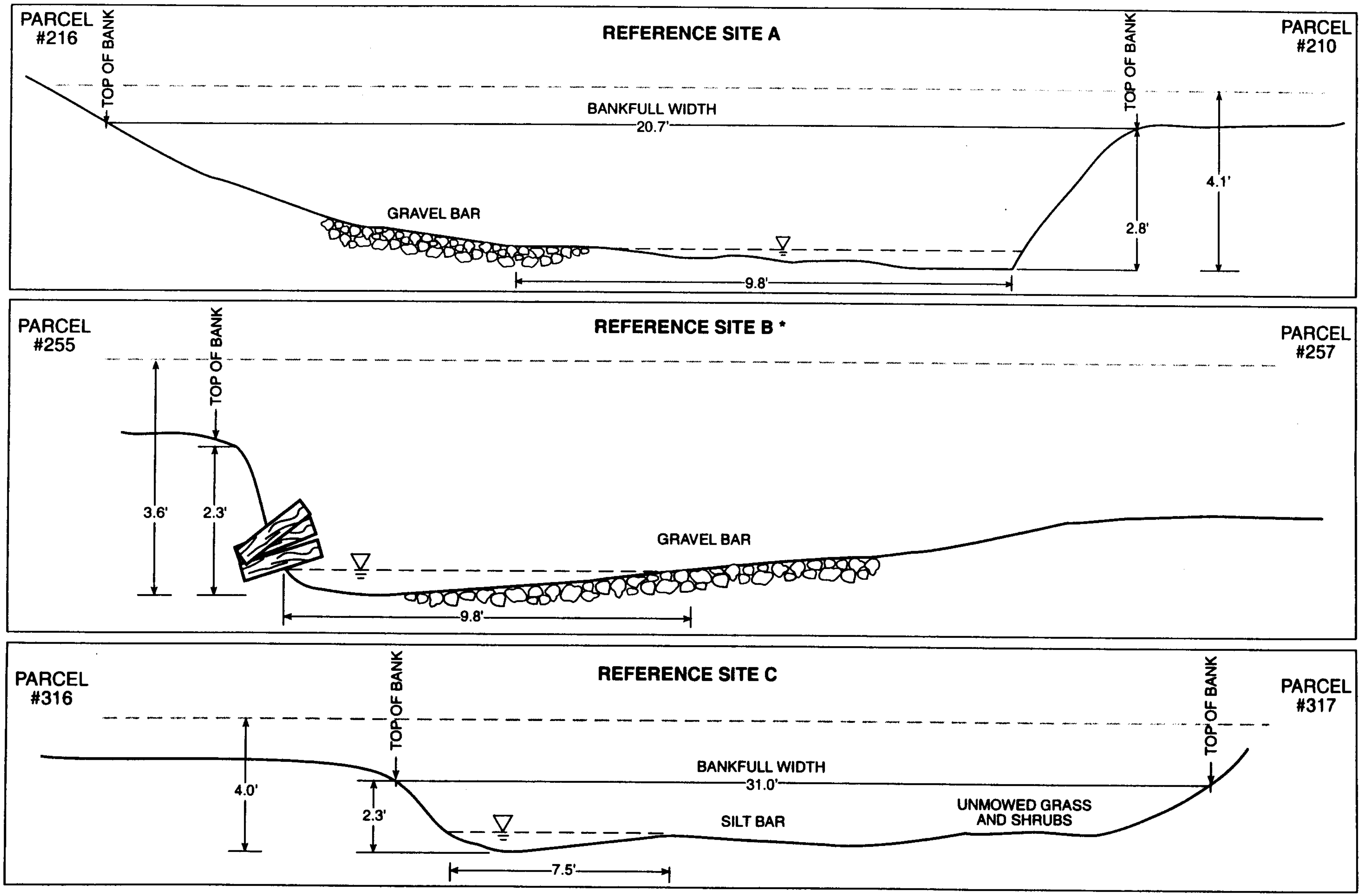
N

WETLAND

MILLER CREEK CHANNEL

GRAVEL BAR

**Figure 5.2-11**
**Instream Project 4**
**Proposed Conditions**




Port of Seattle/Natural Resource Mitigation Plan/556-2912-001/01(03) 11/00 (K)

NOT TO SCALE

FEMA – 100 year floodplain in elevation
Water surface elevation at winter base flow (4/28/99)
* Bankfull width not determined for reference site B

**Figure 5.2-12**
**Representative Cross Sections of Miller Creek Reference Sites (Surveyed at Parcels 210, 216, 255, 257, 316, and 317)**

## Instream Enhancement Project 1

Activities at Instream Project 1 will enhance approximately 470 ft of Miller Creek and 300 ft of a side channel extending from the Miller Creek relocation and Vacca Farm project to the downstream side of the existing South 156th Street bridge (see Figures 5.2-1 through 5.2-8). The primary goal of the enhancement features is to create a geomorphically stable, low-gradient stream. Other goals include increasing the frequency of overbank flow for sediment deposition, enhancing instream habitat, and enhancing the side channel.

Project 1 includes removing riprap, footbridges, railroad ties, and fences along Miller Creek and placing woody debris in the channel to increase instream habitat complexity (see Figure 5.2-8; Appendix B, Sheet C3). Riprap currently located upstream of the South 156th Street bridge will be removed as part of the bridge replacement project. Portions of the area may be regraded to match grading associated with the Vacca Farm project and to promote flooding near the confluence with the side channel. The reach currently located under the existing bridge will be restored by adding some wood and large rocks, providing erosion control along the banks, and replanting the riparian area once this bridge has been replaced.

Addition of woody debris and native vegetation will create more diverse instream habitat for fish and other aquatic organisms. Native riparian and wetland vegetation will be planted along the banks. The side channel will be enhanced by adding woody debris and planting native vegetation adjacent to the banks.

The entire project site is easily accessible to people and heavy equipment on both banks. Therefore, construction of instream enhancement features and replanting of riparian vegetation would be unrestricted. Specific access routes will be identified in the field to protect sensitive areas located within the project boundary.

## Instream Enhancement Project 2

Proposed enhancements at Instream Project 2 include removing riprap and the two instream weirs, placing large woody debris and river boulders in the channel, and replanting with native wetland and riparian vegetation (see Figure 5.2-9; Appendix B, Sheet C4). The goal of this project is to improve fish passage and enhance instream and riparian habitat along approximately 234 ft of Miller Creek. Approximately 100 ft of the channel profile will be regraded to match average upstream and downstream gradients.

Approximately 55 ft of riprap will be removed along the left bank between the two weirs and approximately 12 ft of riprap will be removed along the right bank. All of the riprap associated with the two weirs, as well as the two weirs, will be removed from the stream. Two footbridges will also be removed. Coir logs and coir lifts will be used to restabilize areas where riprap is removed (Appendix B, Sheets C4 and C9). Stream gravel will be placed in the channel and large woody debris and river boulders will be used to stabilize the regraded reach. Native wetland and riparian vegetation will be planted to provide shade and reduce bank erosion.

A temporary diversion of Miller Creek and dewatering of an approximately 120-ft section will be required to remove the instream weirs and install new grade controls in the channel (Appendix B, Sheet TE2). Diversion and dewatering are necessary to prevent sedimentation impacts to downstream portions of the stream during removal of the weirs. Diversion of the stream and construction steps to remove weirs will be implemented only during low-flow conditions and will be consistent with conditions of the HPA permit for the project.

Measures to protect fish (e.g., trapping and relocating fish) in the section of the stream to be dewatered will be implemented prior to diverting flows and will be conducted by a qualified fish biologist consistent with conditions of the HPA permit. To divert the stream, the section of stream to be dewatered would be temporarily blocked with silt curtains, fish trapped and relocated, and the water diverted via a temporary dam, pumps, and pipes. The project area will then be dewatered, weirs and riprap removed and new grade controls installed, banks stabilized, and the stream diverted back into the project area. If necessary, the initial portions of the re-introduced flow would be captured downstream of the project area and pumped into upland areas for biofiltration prior to discharging back into Miller Creek. Diversion of the stream will be conducted only during the work hours when the weirs are being removed (i.e., one or two work days). At the end of each work day, work will be complete enough to allow water to be diverted back into the existing channel.

**Instream Enhancement Project 3**

Major factors degrading the stream along this reach are erosion and downcutting upstream of a riprapped meander located approximately 300 ft downstream of the South 160th Street culvert. The primary goals of the enhancement are to remove constrictions that channelize flow (i.e., instream tire retaining walls) and stabilize the profile of Miller Creek. Other goals at this site include adding erosion control features along the banks, replanting native riparian and wetland species, removing riprap along both banks, removing a fence along the left bank, and enhancing instream habitat (see Figure 5.2-10; Appendix B, Sheet C5).

All instream tires will be removed throughout this reach, including tires along the left bank immediately downstream of the South 160th Street culvert and those that currently provide erosion control on the right bank upstream of the meander. Erosion control measures and replanting of native vegetation will be used to stabilize the banks where they have been disturbed during construction activities. Upstream of the riprapped meander, the banks will be regraded to create a high-flow channel and two gravel bars (see Figure 5.2-10; Appendix B, Sheet C5). Large woody debris and river boulders will be used to stabilize the channel and reduce velocities. Large woody debris and boulders will also enhance instream habitat. The removal of riprap will allow the stream to naturally meander. The high-flow benches will be planted with native vegetation. Non-native and invasive species will be replaced at the site with native riparian species.

**Instream Enhancement Project 4**

Gravel bar enhancement features are included in Project 4 (see Figure 5.2-11; Appendix B, Sheet C6). The primary goal of this project is to reduce channel constrictions, which are causing bank erosion and scour, and enhance existing instream and riparian habitat. Two rock walls along the left and right streambanks, as well as an existing driveway, will be removed. Removal of the rock walls and driveway will restore natural channel geomorphology in this reach. Erosion control measures (e.g., sediment fencing and straw bales, erosion control fabric) will be used along the banks if needed. Large woody debris will be placed in the channel and on the gravel bars to maintain the existing channel grade, reduce erosion, and enhance instream habitat.

Removal of the two concrete rubble walls in the downstream reaches will enhance stream morphology and create more diverse instream habitat with pools and bars. It will also require erosion control along the banks; placement of woody debris will be used to stabilize gravel bars and promote deposition of suspended sediment.

Native riparian vegetation and wetland vegetation will be planted along the right bank within the project area and along the left bank where the site is accessible. The planted vegetation will provide shade and bank stability, as well as structural and species diversity to the riparian understory and forest. Invasive and non-native species will be removed from the site.

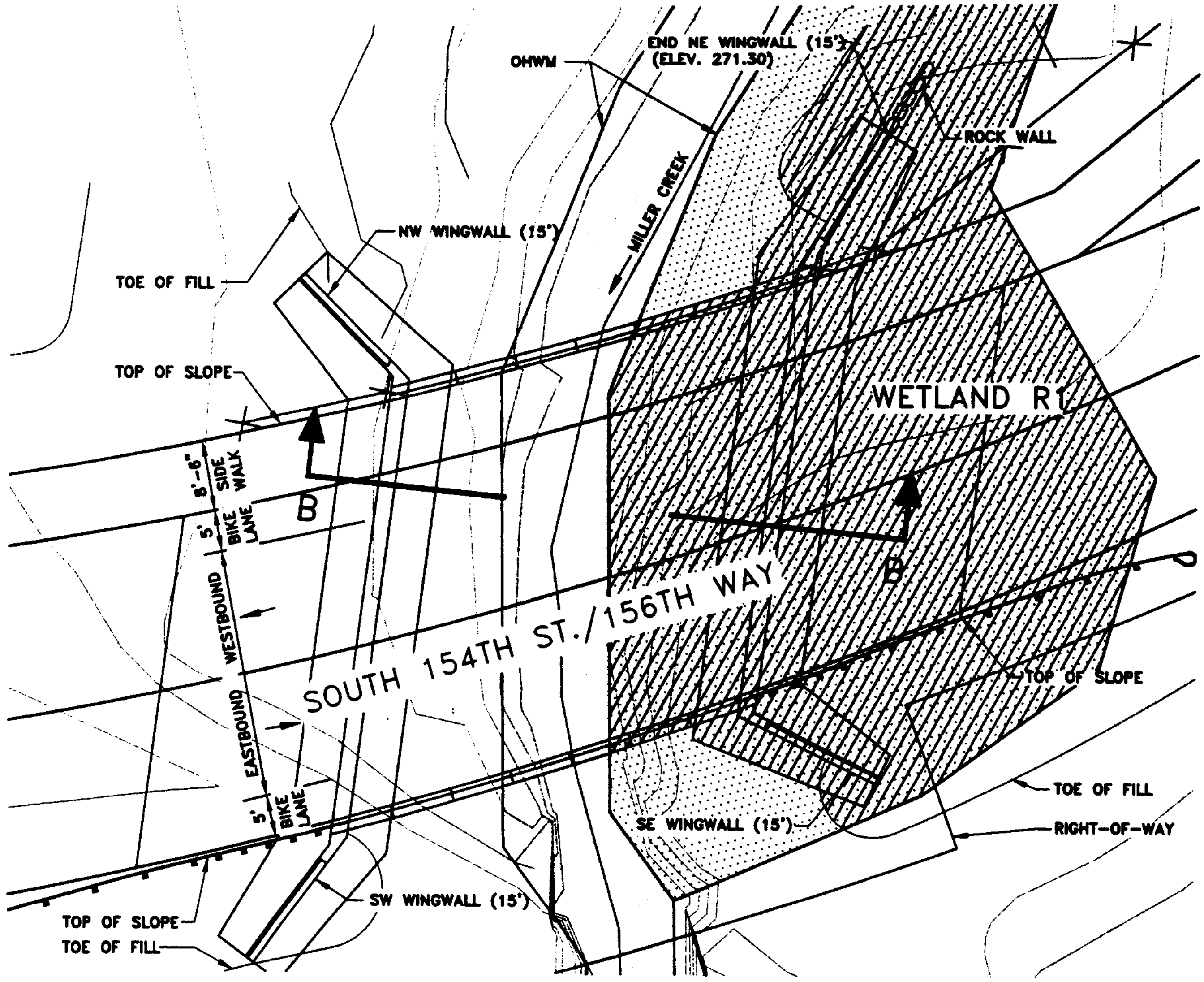
**General Instream Habitat Enhancement**

Large woody debris placement will generally conform to existing WDFW guidelines and be consistent with conditions of the HPA permit. The species (western redcedar, Douglas fir, and western hemlock [*Tsuga heterophylla*]) and size will be determined during the final design. The number and location of woody debris at each project site is shown on the detailed plan sheets in Appendix B (Sheets C3 through C6), and large woody debris will be field-placed by the project engineer or habitat biologist during construction. Large woody debris will be designed to be stable in the stream. Natural anchoring methods, such as partially burying or locating the woody debris outside the low-flow channel, will be preferred over conventional anchoring methods (Appendix B, Sheet C10). The general locations of large woody debris will vary from site to site, depending on the design objective. Much of the woody debris can be salvaged from existing forested areas on the MPU project site that will be filled by embankment construction. This salvage woody debris will have root wads attached.

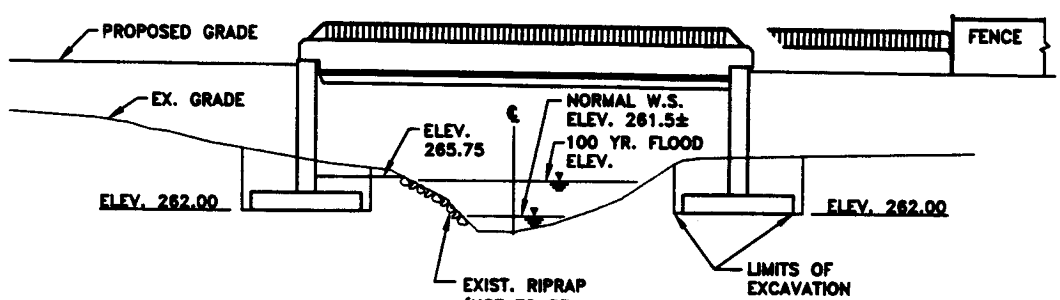
**South 154th Street/156th Way Bridge Relocation**

To accommodate the RSAs for the third runway, it will be necessary to relocate South 154th Street north and west of its current alignment. The existing and proposed alignment of South 154th Street connects with South 156th Way. As a result of relocating this roadway, it will be necessary to replace and relocate the existing bridge over Miller Creek at South 156th Way. The existing timber bridge will be removed and replaced with a new bridge that will span the 100-year floodplain of the stream (see Figure 5.2-1; Appendix B, Sheets L1, L1.1, P1, and P2).

Elements of this bridge relocation will require restoring the streambanks after the existing timber bridge is removed. The existing stream channel under the bridge is armored with riprap and confined by the timber walls of the bridge. As a result of construction for the timber bridge, this segment of the stream was widened, and the channel bed here is wider than the segments to the north and south. After removing the bridge, restoration activities will focus on re-establishing the streambanks. To accomplish this, a portion of the channel will be filled to restore the natural channel width (Figure 5.2-13; Appendix B, Sheet P1). Loose riprap will remain along the edge of the stream channel under the bridge segments only to provide stabilization under the bridge (see Figure 5.2-13; Appendix B, Sheets P1 and P2). Streambanks will be planted with native riparian vegetation (Table 5.2.8).




PLAN
SCALE 1"=20'




NOTE:
ALL DISTURBED AREAS WILL BE
STABILIZED USING APPROPRIATE BMPS.

SECTION – B
SCALE 1"=20'

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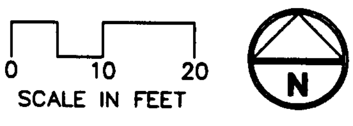


LEGEND
WETLAND R1
WETLAND IMPACTS

**Figure 5.2-13**
**South 156th Way**
**Bridge Relocation**

**Table 5.2-8. Final performance standards, evaluation approach, and contingency measures for instream habitat enhancements in Miller Creek.**

| Design Criteria | Performance Standard | Evaluation Approach | Contingency Measures[1] |
|---|---|---|---|
| Remove cemented riprap along banks, encourage natural formation of meander bends and cut benches. | Channel reach in project area is free of man-made debris that could affect water quality (e.g., tires, metal debris).<br><br>Channel armoring, walls, and riprap are removed from the channel in each project reach per design specifications. | Record drawings to verify removal of riprap and other in-channel structures consistent with design.<br>Baseline monitoring to establish as-built number and type of habitat features (pools and riffles). | Remove riprap or other structure consistent with design.<br><br>Add LWD to create additional channel complexity and promote formation of pools and riffles. |
| Increase the amount of geomorphically stable large woody debris in the channel. | Number of large woody debris features in stream remains stable or increases compared to baseline (as-built) conditions. | Record survey and visual inspection of channel | Add LWD to create additional channel complexity. |
| | Number and density of habitat features (e.g., pools, riffles, bars, undercut banks) remain stable or increase compared to baseline (as-built) conditions. | Record survey and visual inspections.<br>Measure density and number of habitat features | Add LWD to create additional channel complexity and promote formation of pools and riffles. |
| Stabilize those areas of excessive erosion by using native vegetation and large woody debris. | Streambank vegetation in enhancement areas provides at least 50% cover on channel banks.<br><br>No evidence of bank erosion (for example rill, surface sour, or sediment deposition) is present above the OHWM. | Site inspections and record drawings. | Repair damaged bank if necessary.<br><br>Stabilize banks with bioengineering, planting live stakes, or seeding. |
| Remove all trash from the channel that could be harmful to fish habitat, and water quality. | Channel reaches in project area are free of debris (e.g., tires, metal debris, wire, pipe, etc.). | Site inspections. | Clear any remaining trash in the buffer. |
| Add gravel to degraded reaches where natural recruitment is limited. | Substrate is predominantly gravel on bars and benches. | Assess substrate composition with pebble counts.<br>Visual inspection | Evaluate source of sediment and remove/control.<br><br>Add channel features (e.g., large wood, and boulders) to reduce bedload movement. |
| Reduce erosion by vegetating banks and replanting the Vacca Farm site. | No evidence of surface erosion in newly planted stream buffers. | Site inspections. | Repair damaged bank if necessary.<br><br>Stabilize banks with bioengineering, planting live stakes, seeding, or erosion control material. |

[1] For all performance standards, monitoring periods may be extended if performance standards are not met.

#### 5.2.2.8 Monitoring and Performance Standards

The monitoring approach, methods, schedules, and reporting for the instream habitat projects will be consistent with the approach outlined for all MPU mitigation projects (Chapter 4). Specific performance standards developed for the instream projects will be evaluated to ensure that the projects are meeting overall objectives and goals (Table 5.2-9).

**Table 5.2-9. Monitoring schedule for the instream enhancement projects.**

| | | | Data Collection Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Feature** | **Activity** | **Frequency** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Habitat Structures | Inspection, stability of habitat features | Annually (May), or after flows in excess of the 2-year peak flow during the first 3 years | X | X | X | X | | X | | X | | X | X |
| Substrate | Pebble counts | Semiannually (February/August) | X | X | X | X | | X | | X | | X | X |
| Erosion or Scouring | visual evidence of erosion or scouring | Annually (May), or after flows in excess of the 2-year peak flow during the first 3 years | X | X | X | X | | X | | X | | X | X |
| Structures | Evidence of cavitation or scouring | Annually (May), or after flows in excess of the 2-year peak flow during the first 3 years | X | X | X | X | | X | | X | | X | X |
| Adverse Flooding | Inspect channel banks and riparian zone for ponded water | Twice yearly (February/November) | X | X | X | X | | X | | X | | X | X |

**Instream Habitat Conditions**

Instream habitat will be monitored and evaluated against performance standards to ensure that these features provide the desired habitat and bank stabilization functions, and that instream large woody debris is stable, creating pools and meanders as designed. Table 5.2-8 lists specific performance standards, methods/parameters, and contingency measures for ensuring that the instream enhancements are meeting project goals and objectives. Monitoring for instream habitat enhancement projects will focus primarily on evaluating parameters related to aquatic habitat quality such as habitat complexity (e.g., pool/riffle morphology, undercut banks), habitat features (e.g., large woody debris, gravel bars), and overall stream condition (e.g., lack of sedimentation or erosion, lack of man-made debris).

Monitoring methods and schedule for the instream enhancement projects are listed in Table 5.2-9. The schedule includes routine inspections and emergency inspections to be conducted following major flood events.

**Biological Conditions**

The instream enhancement projects are designed to enhance biological as well as physical functions in Miller Creek and therefore, as part of the monitoring program for the Miller Creek instream projects, biological conditions will be evaluated and compared to existing or baseline conditions in the stream. Biological conditions will be assessed using the benthic index of biotic integrity (BIBI) (Kerans and Karr 1994; Fore et al. 1995; Kleindl 1995). Aquatic invertebrate populations will be sampled from representative riffles in Miller Creek, and the data will be analyzed to determine the BIBI score. The BIBI score integrates several physical and chemical conditions in the stream and watershed.[7]

Information gathered from this study will be used to evaluate changes in the invertebrate assemblages and relate them to other monitoring parameters and changes at the mitigation sites through the monitoring period. The BIBI scores obtained each year during the monitoring period will be compared to baseline values obtained from Miller Creek prior to mitigation, as well as to values obtained in other urban streams in the Puget Sound region. Since this methodology has not been widely applied to mitigation, BIBI data will be used to generally assess how the mitigation projects affect biotic integrity, but will not be linked to performance standards.

**Vegetation**

Riparian and channel vegetation installed as part of the instream projects will be monitored and evaluated against the performance standards for the wetland and riparian buffer plantings described in Table 5.2-3. Monitoring methods and schedule for evaluating riparian vegetation at the instream projects are listed in Table 5.2-4.

#### 5.2.2.9 Maintenance and Contingency Plans

Routine maintenance and contingency measures will be implemented consistent with the approach described in Chapter 4. A design goal for the instream enhancement features is that each enhanced reach function as a natural channel, requiring little or no maintenance. As indicated in Tables 5.2-8 and 5.2-9, periodic maintenance may be required to correct a variety of detrimental conditions to ensure that the projects meet performance standards.

In the event that contingency measures are necessary, the Port will use an adaptive management plan, as outlined in Chapter 4, to assess factors contributing to poor performance and design appropriate measures to change the contributing factors. Specific contingency measures for each of the performance standards for the instream projects are listed in Table 5.2-8.

All of the proposed enhancement projects have similar basic criteria for performance standards: (1) maintain minimum flow depths and velocities for fish passage, water quality, and sedimentation; (2)

[7] The BIBI is a numerical analysis of stream invertebrate data that is used to assess the degree to which macroinvertebrate populations have been altered by human disturbance. A strong correlation between levels of urbanization and BIBI scores exists (Fore et al. 1996; Horner et al. 1996). While BIBI measurements will monitor changes in the invertebrate assemblages in the stream, the values will also reflect activities in the watershed upstream of the mitigation, and thus cannot be used to unequivocally determine the effect of mitigation actions.

provide capacity for peak flows; and (3) reduce erosion of the bed and banks. The enhancement features were designed to meet these criteria; however, if flow rates and stream hydraulics differ substantially from the design flows used to develop the enhancement features, these features may not function as designed. If this occurs, reaches with enhancement features can be modified by:

- Modifying channel widths to reduce velocities and improve capacity.
- Adding additional bank stabilization and erosion control methods.
- Adding or modifying channel profile structures (e.g., log weirs) to reduce velocities.

#### 5.2.2.10 Implementation of Buffer and Instream Enhancement Projects

Implementation of the buffer and instream projects along Miller Creek will be coordinated with each other, and will be constructed in a manner consistent with federal, state, and local permits (e.g., CWA 404, HPA). In addition, construction of the mitigation projects will be coordinated with construction of the third runway embankment, security roads, utility relocations, South 156th Street bridge relocation, and stormwater management facilities to ensure that implementation of the mitigation projects is not impacted by other construction activities. A proposed implementation time line is resented in Table 5.2-10. Details regarding implementation steps, construction methods, and sequencing are included in this section.

**General Construction Sequencing**

Landscape work for the buffer enhancement will be coordinated with the instream enhancement projects (Section 5.2.2). Wetland and riparian enhancements will start with installation of TESC measures, demolition of existing structures (e.g., buildings, driveways, fences), clearing and grubbing the site to remove non-native vegetation, and preparing the site for planting. Temporary irrigation may be installed for some enhancement areas if necessary. Wetland and riparian vegetation will be planted in the fall immediately following site preparation (Appendix B, Sheets L1 through L6). BMPs for sediment and erosion control during these activities will minimize impacts to the stream and adjacent wetlands (Appendix B, Sheets TE1 through TE5). Measures include placing silt fence around work areas and staging areas, and placing straw bales at key locations within the project limits. Clearing and brush removal will be limited to only those work areas that the contractor is scheduled to begin within the following 2 weeks. The disturbed areas will be stabilized immediately after work in that area is completed. TESC measures will remain in place and be maintained until the entire site has stabilized.

Instream work will be scheduled during dry weather, when base flows are at a minimum, and will be restricted to allowable work times consistent with the HPA (i.e., July 15 to September 15). Prior to the start of any other construction activities, the TESC plan for the instream projects will be implemented and the TESC elements will be in place (Appendix B, Sheets TE1 through TE5). Once the temporary facilities are in place, the contractor will implement a plan for controlling water in areas requiring instream work. This may include excavating dewatering trenches, French drains, and sumps.

**Table 5.2-10. Proposed Implementation Timeline for Miller Creek In-Stream, Wetland, and Riparian Buffer Enhancements Projects**

| Project/Activity | Year (Year One Starts with the First Construction Season After the Date Permits Are Issued[1]) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year 1 | | | | | | | | | | | | Year 2 | | | | | | | | | | | | Year 3 | | | | | | | | | | | |
| | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D |
| **Miller Creek In-Stream Enhancements** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Preconstruction meeting | | | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TESC, Site Preparation | | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Install silt curtains and silt fencing | | | | | | | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clear site and grade per plan | | | | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Remove bridges, channel rip-rap or other structure per plan | | | | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Install LWD, stream gravel, bioengineering | | | | | | | | | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hydroseed/implement planting plan | | | | | | | | | | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | |
| Remove silt curtain and TESC measures | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | |
| Produce record drawings, conduct baseline monitoring | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | | |
| Begin compliance monitoring | | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Wetland and Riparian Buffer Enhancements** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Preconstruction meeting | | | | ■ | | | | | | | | | | | | ■ | | | | | | | | | | | | | | | | | | | | |
| TESC, Site Preparation | | | | | ■ | ■ | ■ | | | | | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | | |
| Remove debris and structures per plan | | | | | | ■ | ■ | ■ | | | | | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | |
| Remove non-native plants per plan | | | | | | | | ■ | ■ | | | | | | | | | | | ■ | ■ | | | | | | | | | | | | | | | |
| Install plants per planting plan | | | | | | | | | | ■ | ■ | ■ | ■ | | | | | | | | | ■ | ■ | ■ | ■ | | | | | | | | | | | |
| Produce record drawings | | | | | | | | | | | | | ■ | ■ | | | | | | | | | | | ■ | ■ | | | | | | | | | | |
| Conduct baseline monitoring | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | | | | |
| Begin maintenance and compliance monitoring | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ |

[1] Plant procurement for all projects will be implemented six to twelve months prior to the anticipated planting date to ensure that plants in the specified quantities and species are available by the scheduled planting date. Implementing mitigation projects may vary from this proposed schedule depending upon coordination with other MPU projects and contract obligations.

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Temporary berms (using sandbags or other structures that would not be driven into the channel) may be used to divert flows around bank work. Silt curtains will be installed prior to any LWD placement except for channel spanning LWD (Appendix B, Sheet TE5). Silt curtains would extend completely around the project site. Any turbid water inside the silt curtain would be pumped out and directed through settling ponds and straw bale filters prior to being discharged back into the stream. All instream work will be performed in a manner to protect fish and other aquatic organisms, consistent with the HPA permit conditions.

Large woody debris will be anchored without the use of cables or ecology blocks by excavation and partial burial (Appendix B, Sheet C10). Placement and excavation for LWD will be accomplished by hand tools or from the streambank using equipment with extendable arms (e.g., backhoe). No equipment will be allowed to drive into or cross the stream channel. Access to project sites will avoid wetlands where possible. If access through non-wetland areas is infeasible, protective plywood mats will be placed over access paths and work areas to protect wetlands and the stream. Silt fences will be installed along all access routes. Vegetation clearing will be limited, and vegetation will be mowed rather than removed wherever possible to gain access to project sites. Access routes will be stabilized and revegetated immediately following construction.

Plant material used in the mitigation will be obtained from commercial nurseries. Nurseries will be required to certify that the plant material is legally procured and from the appropriate geographic source. The appropriate geographic source for plant material used in the mitigation is defined as the area that is bounded on the north by the Fraser River Valley, British Columbia; on the east by the 1,000-foot elevation of the Cascades; on the west by the 1,000-foot elevation in the Olympic or Coast ranges; and on the south by the Willamette Valley.

**Construction Steps**

Construction steps required to implement the instream and buffer enhancement projects are provided below. General construction steps, as well as construction steps for each of the four instream projects and placement of large woody debris in the stream within the project area, are included.

**General Conditions**

- On award of the contract, the contractor will provide the Port with any required pre-construction submittals, work plans, and schedules.
- A pre-construction meeting will be held with the contractor, architect/engineer, and wetland scientist to review submittals, work plans, schedules, and permit conditions.
- The contractor will be responsible for ensuring that the work is performed in compliance with all permit conditions and shall maintain a copy of permits on-site.
- Work will be coordinated to avoid re-entry and damage to areas that have previously been planted; work will be conducted so that no other work will impact completed landscape work.
- Areas where any landscape work has been completed will be off-limits to all vehicular traffic, and pedestrian traffic will be strictly limited.

- Construction will take place during the dry season; any instream work or work below the OHWM will take place only during the allowable work times, consistent with HPA permit conditions (i.e., July 15 to September 15).
- Plant procurement shall be coordinated with the grading schedules, and irrigation installation if necessary, and be secured 6 to 12 months prior to the scheduled planting season to ensure that plants are available in the quantities and species required by the planting plan.

**Site Preparation**

- Establish vertical and horizontal site controls and maintain through construction to record drawings.
- Identify and flag limits of work for mitigation site.
- Identify staging areas and temporary access/haul roads.
- Implement TESC plan and install TESC measures.
- Install fencing (orange barrier) around areas to be protected (e.g., stream channel, existing wetlands, vegetation/trees to be retained).
- Maintain security of the site through construction.
- Establish temporary access/haul roads.
- Establish staging and stockpile areas.
- Implement a spill control plan and identify fueling areas.

**Clearing, Excavation, and Grading**

- Clear and grub portions of the site as specified; clear structures and impervious surfaces and existing non-native vegetation in selected areas.
- In selected areas, grade per specifications.
- Install irrigation as specified in selected areas.

**Instream Project 1 (Appendix B, Sheets C3, C9, C10, and TE1)**

- Install silt curtains and silt fencing per specifications. This can be done in phases as approved by the engineer.
- Remove riprap, footbridges, railroad ties, and fences identified on plan sheet.
- Regrade portions of the area as needed to meet grading from Vacca Farm projects.
- Install LWD in the main channel and side channel.
- Implement planting plan for the main channel and side channel.
- Seed disturbed areas (including any access roads and staging areas).
- Maintain TESC measures adjacent to restored stream bank until adjacent riparian buffer has been planted and stabilized.

- Remove silt curtain and TESC measures once the site is stabilized and approved by the engineer and wetland scientist.

**Instream Project 2 (Appendix B, Sheets C4, C8 through C10, TE2)**

- Install silt curtains and silt fencing per specifications.
- Clear and grade the minimum area required for construction of the project.
- Remove two footbridges identified on plan sheet.
- Remove riprap associated with two weirs; remove the two weirs.
- Install coir logs and coir lifts to stabilize areas where riprap is removed.
- Install LWD, river boulders, and stream gravel.
- Seed disturbed areas.
- Implement planting plan for stream banks, wetland, and riparian areas adjacent to project site.
- Remove silt curtain and TESC measures once the site is stabilized and approved by the engineer and wetland scientist.

**Instream Project 3 (Appendix B, Sheets C5, C8 through C10, TE3)**

- Install silt curtains and silt fencing per specifications.
- Clear and grade the minimum area required for construction of the project.
- Remove instream tires lining left and right banks; remove riprap.
- Construct high-flow benches and gravel bars.
- Install LWD, river boulders, and stream gravel.
- Install coir lifts, coir logs and plant banks with live stakes to stabilize new banks.
- Seed disturbed areas.
- Implement planting plan for channel banks, wetland, and riparian areas adjacent to the project site.
- Remove silt curtain and TESC measures once the site is stabilized and approved by the engineer and wetland scientist.

**Instream Project 4 (Appendix B, Sheets C6, C8 through C10, TE4)**

- Install silt curtains and silt fencing per specifications.
- Clear and grade the minimum area required for construction of the project.
- Remove riprap rock walls and existing driveway.
- Construct three high-flow benches and gravel bars; construct new channel banks.
- Install LWD, river boulders, and stream gravel.
- Place geotextile over new banks.

- Seed disturbed areas.
- Implement planting plan for new channel banks, wetland, and riparian areas adjacent to the project site.
- Remove silt curtain and TESC measures on the east bank once the site is stabilized and approved by the engineer and wetland scientist.

**Closeout**

- Complete site cleanup by removing temporary haul/access roads and staging areas.
- Remove construction equipment and debris.
- Hydroseed and/or install plants in any temporary staging areas or access roads within the mitigation site boundaries.
- Hydroseed erosion control mix in temporary staging areas/access roads outside the mitigation boundaries.
- Install permanent fence and/or signs along buffer boundary.

**Record Drawings, Monitoring, and Maintenance**

- Produce grading record drawings (i.e., 'as-builts') for instream enhancement projects and planting plan record drawings for wetland and buffer enhancement areas.
- Complete a baseline report, including record drawings, buffer boundaries along Miller Creek, and final monitoring plan (e.g., locations of monitoring plots, baseline conditions).
- Begin compliance monitoring during the first growing season after planting is complete. Submit annual monitoring reports for the 10-year monitoring period.
- Conduct maintenance (e.g., weed management, WHMP) and implement any necessary contingency measures to meet performance standards.

### 5.2.3 Drainage Channel Replacement Plan

Three small intermittent drainage channels (Waters or Drainage Channels A, B, and W) are located in the acquisition area on the west side of the existing runway (see Chapter 2, Figure 2.1-2).[8] These drainage channels currently convey water (groundwater and surface water) from the hillside on the western edge of the airport to Miller Creek and the wetlands adjacent to Miller Creek. Channel A is located immediately east of 12th Avenue South in a roadside drainage ditch. Channel B originates in Wetland 37f and is located west of 12th Avenue. Channel B provides a surface water connection between Wetland 37f and Wetland R9. Channel W is located east of the existing perimeter road within the current Airport Operation Area (AOA). This channel originates in Wetland 20b and flows northwest through a culvert and under the perimeter road; it ultimately empties into Channel A.

[8] A ditch on the Vacca Farm (see Section 3.4) is not included in this mitigation because its functions are enhanced as part of the Vacca Farm Restoration Projects (see Section 5.1).

Approximately 1,290 linear ft of existing drainage channels will be filled as a result of third runway construction (Chapter 3). The Port proposes to mitigate for filling these channels by replacing and restoring their functions on-site. A subsurface drainage system in the fill embankment will collect water infiltrating the embankment and direct this water to surface water channels at the base of the embankment. Water from the replacement drainage channels will be directed to riparian wetlands along Miller Creek (Figure 5.2-14). The surface water channels will be designed to replace the 100-year flow conveyance capacity of the channel lengths being filled. Replacement drainage channels will be permanent features and their construction will be coordinated with the Miller Creek buffer enhancement projects, embankment construction activities, and stormwater facility construction.

#### 5.2.3.1 Goals, Objectives, and Design Criteria

To replace the functions of existing channels, four replacement drainage channel areas will be designed along the west side of the perimeter roadway at the base of the fill embankment. The goals of this mitigation action are listed below and described in Table 5.2-11.

- The replacement drainage channels will provide adequate flow (100-year flow) conveyance functions.
- The replacement drainage channels will collect seepage from the embankment to maintain base flows in Miller Creek and hydrology of down slope wetlands.
- The replacement drainage channels will provide open channel lengths equivalent to the existing drainage channels lengths.
- The replacement drainage channels will be planted with a vegetated buffer to provide shade to enhance water quality in Miller Creek and other wetlands.

**Table 5.2-11. Mitigation goals, design objectives, and design criteria for replacement drainage channels.**

| Design Objectives | Design Criteria |
|---|---|
| **Goal 1: The replacement drainage channels will provide adequate flow conveyance functions (100-year flow)** | |
| Provide channel flow capacity for expected runoff. | Construct the replacement channel to convey the 100-year, 24-hour design storm. |
| | Channel depths will be a minimum of 2 ft deep with side slopes of 3:1 or flatter; or if slopes are steeper, log and rock weirs will protect channel banks. |
| **Goal 2: The replacement channel will collect seepage to maintain base flows and wetland hydrology** | |
| Integrate channel into embankment drainage layer so groundwater can be collected. | Construct channel down gradient and hydrologically connected to the drainage layer of the embankment. |
| Convey water to riparian wetlands down slope from the embankment. | Direct water in drainage channels to discharge points in or adjacent to riparian wetlands along Miller Creek (Wetlands A13, 18, 37, 39, 44a, and A9). |
| **Goal 3: The replacement channels will provide an open channel of equivalent length as the existing channel** | |
| Construct new channels with equivalent length, substrate, and streamside vegetation. | Construct new channels with a minimum length of 1,290 ft. |
| | Channel substrate will be stable, and have slopes of less than 3:1. Where steeper channel slopes are required, protect from downcutting with log weirs. |
| **Goal 4: Plant a vegetated buffer along the length of channel to provide shade which will enhance water quality** | |
| Provide a vegetated buffer along the length of the mitigation channel. | Plant native shrubs at greater than 2,100 individuals per acre along channel banks. |
| | Plant native trees greater than 280 trees per acre along channel banks. |

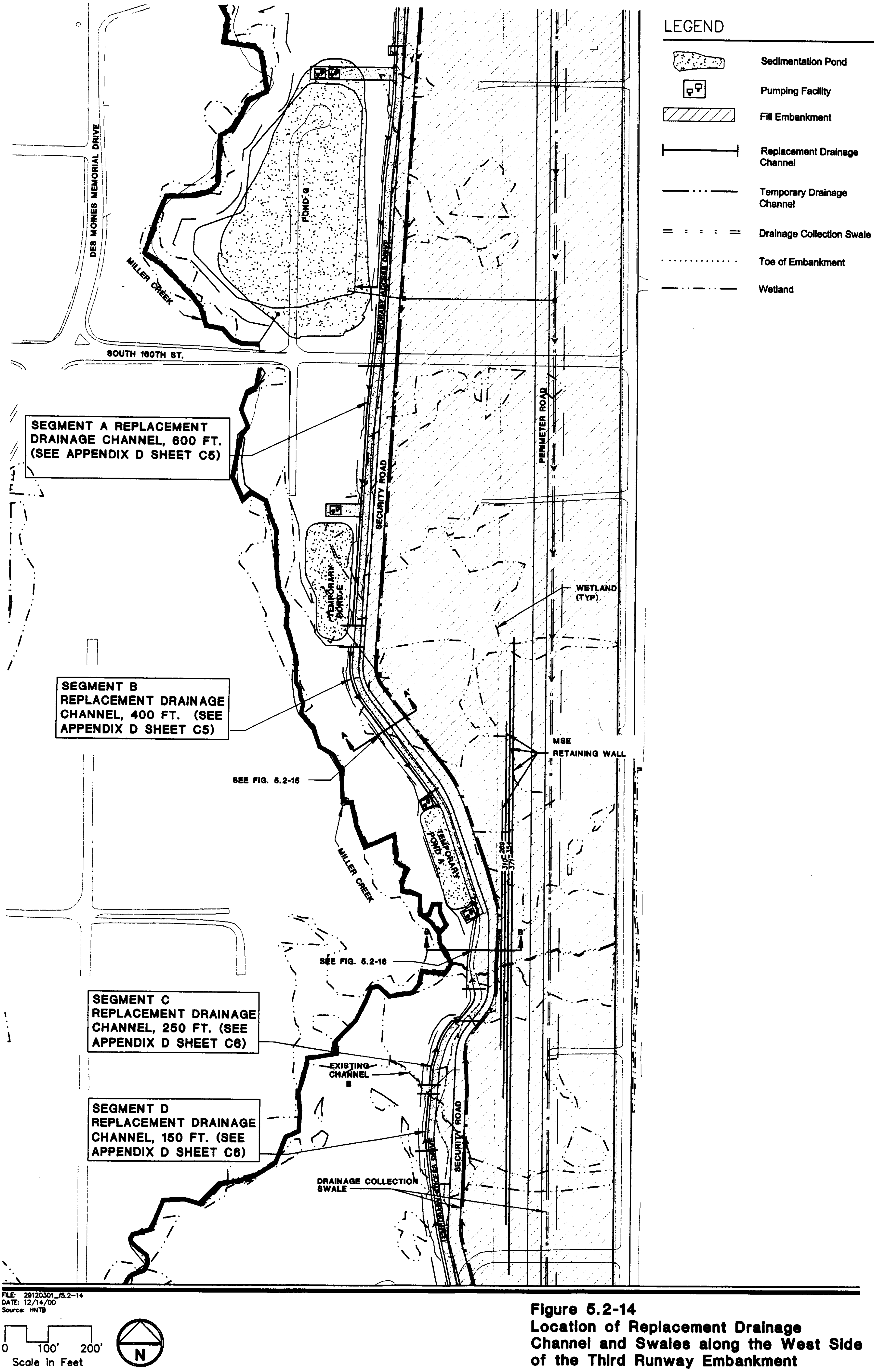


**Figure 5.2-14**
**Location of Replacement Drainage Channel and Swales along the West Side of the Third Runway Embankment**

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#### 5.2.3.2 Mitigation Site Description

The replacement channels will be located in areas that are currently predominantly residential lawns, upland forest, or emergent wetlands. The replacement drainage channels will be constructed on the west side of the perimeter road that will run immediately west of the new embankment for the third runway (see Figure 5.2-14).

#### 5.2.3.3 Ownership

The Port owns the property where the replacement drainage channels will be relocated.

#### 5.2.3.4 Rationale For Selection

The drainage channel mitigation replaces the water conveyance functions of the channels that will be impacted by the project. Replacement drainage channels will be constructed as close to the original channel location as possible. The existing channels currently convey water from the hillslope to the west of STIA to downgradient wetlands and Miller Creek. The channels are designed to ensure that the discharge of water to wetlands adjacent to Miller Creek continues.

#### 5.2.3.5 Constraints

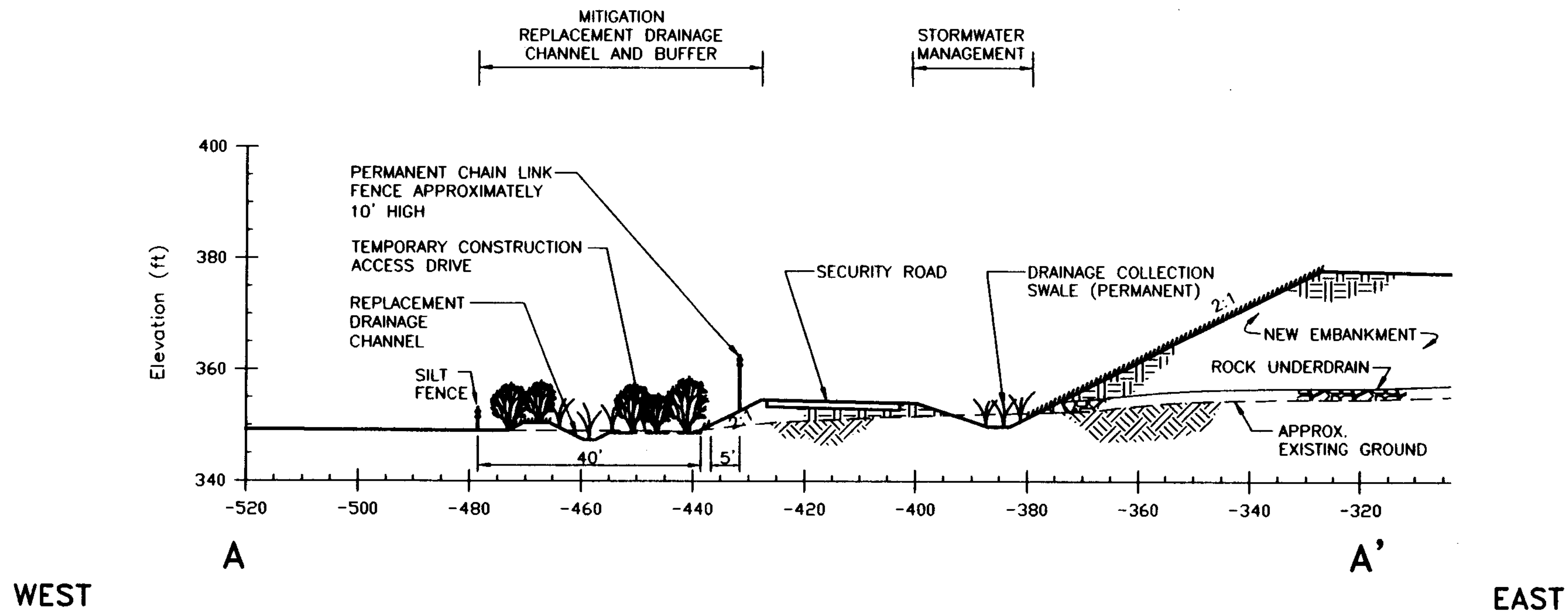
There are no constraints that affect implementation of the planned mitigation action.

#### 5.2.3.6 Ecological Assessment of the Mitigation Site

The replacement channels will be located in areas that are currently residential, upland forest, or emergent wetlands. A detailed description of ecological conditions at these sites is given in the *Wetland Delineation Report* (Parametrix 2000c).

#### 5.2.3.7 Replacement Drainage Channel Mitigation Design

A permanent drainage collection swale will be constructed at the toe of the embankment to intercept surface water runoff from the embankment, which will be directed to the stormwater facilities. The replacement drainage channels on the west side of the security road will receive water from the underdrain system that will collect water infiltrating into the embankment or from the collection swale at the base of the embankment (see Figure 5.2-14 through 5.2-16; Appendix D, Sheet C3.1). The replacement channels will then direct this water to down slope wetlands.

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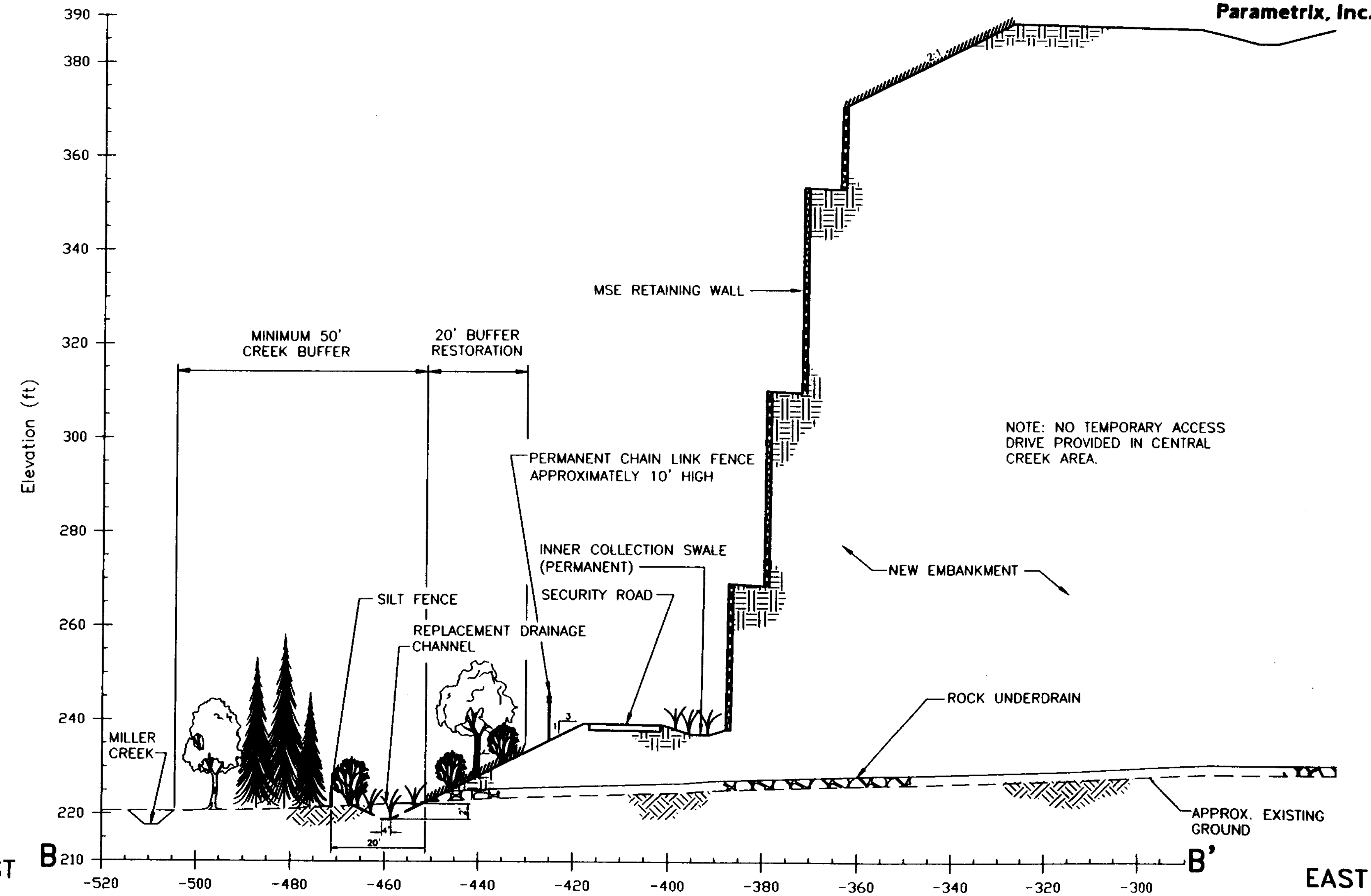
*SCALE: HORIZONTAL 1"=30'*
*VERTICAL 1"=30'*

**Figure 5.2-15**
**Cross Section A-A' of the Replacement Drainage Channel, Drainage Collection Swale, and Third Runway Embankment**

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SCALE: HORIZONTAL 1"=30'
VERTICAL 1"=30'

**Figure 5.2-16**
**Cross Section B-B' of the Replacement Drainage Channel, Drainage Collection Swale, and Third Runway Retaining Wall**

During construction of the embankment and retaining wall west of the third runway, the collection swale will collect construction runoff from the outermost portion of the embankment and route the water to a sedimentation and water treatment facility. After construction of the embankment and retaining walls is complete, the collection swale will be retained to intercept surface water runoff from the embankment and direct it to the replacement drainage channels via culverts under the perimeter road. The replacement drainage channels (a minimum of 1,290 linear ft) will convey groundwater and seepage from the embankment and runoff water to adjacent wetlands (see Figure 5.2-14; Appendix D, Sheet C3, and Sheets C5 through C8).

**Channel Size and Slope**

The drainage channels will be designed to convey the 100-year peak flow rate. The maximum flow depth in the channel will be determined by anticipated flow conditions; the channel depth will range from 2 to 4 ft with 3:1 side slopes. The bottom width will be controlled by the flow minimum design depth (0.5 ft) and channel slope, but will be a minimum of 3 ft wide. Check dams, log weirs, or channel widening will be used to prevent erosion, sedimentation, scouring, and downstream deposition impacts.

**Discharge Points**

The drainage channels will discharge into selected wetlands to maintain wetland hydrology and base flows in Miller Creek (i.e., Wetlands A13, 18, 37, 39, 44a, and R9; Appendix D, Sheets C4 through C7). At the discharge points, the channels will be designed to prevent erosion or scouring impacts in the receiving channel or wetlands through the use of dispersal trenches or similar construction. These designs will include installing log weirs and/or bank stabilization (i.e., live stakes, branch packs) at discharge points to prevent erosion.

**Groundwater Seepage and Hydrology**

Existing channels convey seepage and stormwater to downstream wetlands and Miller Creek. The replacement drainage channels will collect seepage water that discharges from the embankment and distribute it to downslope wetlands using rock berms or infiltration swales. The hydrology of wetlands down slope of the new embankment will be monitored following construction to ensure that wetland hydrology is maintained.

### 5.2.3.8 Implementation

The replacement drainage channel will be constructed as part of the stormwater facilities for the third runway embankment. Channel construction and planting of the vegetated buffers will be coordinated with construction of the embankment and stormwater facilities, the Miller Creek riparian wetland and buffer enhancements, and temporary restoration of wetland impacts. Implementation of the replacement drainage channel is described in Section 5.2.5.

**Landscape Plan**

The landscape plan for the replacement channels has been designed to be consistent with the Port's WHMP. The side slopes and buffers along the channels will be planted with native vegetation to provide shade. The vegetation will also contribute organic matter to the drainage channels and ultimately to Miller Creek. The vegetated buffer will extend from the edge of the channel to approximately 10 ft west of the security road (see Figures 5.2-15 and 5.2-16; Appendix D, Sheets C5 and C8). This distance is designed to provide a minimum of 5 ft of unvegetated area on either side of the perimeter fence as required for airport security. Native plant species that will not attract hazard wildlife (see Table 5.1-12) will be planted adjacent to the channel.Monitoring and Performance Standards

The drainage channels will be monitored consistent with the monitoring approach, methods, schedules, and reporting outlined in Chapter 4. Hazard wildlife will be monitored consistent with the Port's WHMP (Port of Seattle 2000). Monitoring and performance standards for the replacement drainage channels will evaluate not only the functioning of the drainage channels (flow conveyance, stability of substrate, evidence of erosion) and the vegetated buffers, but the hydrology of down slope wetlands as well. Specific performance standards, types of parameters to evaluate, and contingency measures for the replacement drainage channels are provided in Table 5.2-12. Replacement drainage channels will be monitored following the schedule and methods provided in Table 5.2-13.

**Hydrology**

The replacement drainage channel design provides surface water to support the hydrology of down slope wetlands to ensure that existing wetland functions are maintained. The depth and duration of soil saturation will be monitored periodically during the 10-year monitoring period in wetlands between the embankment and Miller Creek (i.e., Wetlands 18 and 37). Groundwater monitoring will use standard groundwater monitoring wells installed in the wetlands between the embankment and Miller Creek. Groundwater levels will be monitored monthly for the first 5 years of the monitoring period, and then every other month for the remainder of the monitoring period. Specific performance standards and contingency measures for maintaining hydrology in down slope wetlands are included in Table 5.2-12.

**Vegetation**

Vegetation in the drainage channel buffers will be monitored to evaluate plant survival, native plant cover, invasive species cover, plant density, and overall health and vigor consistent with the approach outlined in Chapter 4.

#### 5.2.3.9 Site Protection

The channels will be protected from adjacent airport development by fencing and signs that designate the area as permanently protected mitigation sites. The area will be covered by the restrictive covenants drafted to permanently protect the mitigation sites (Appendix G).

**Table 5.2-12. Final performance standards, evaluation approach, and contingency measures for replacement drainage channels.**

| Design Criteria | Performance Standard | Evaluation Approach | Contingency Measures[1] |
|---|---|---|---|
| Construct the replacement channel to convey the 100-year, 24-hour design storm.<br>Channel depths will be a minimum of 2 ft deep with side slopes of 3:1 or flatter; or if slopes are steeper, log and rock weirs will protect channel banks. | Replacement channels will meet or exceed design criteria for high flow.<br>No evidence of channel erosion (bank cutting or scour) will be present. | Verify with record drawings. Monitor flows in channel. | Enlarge channel if conveyance is inadequate.<br>Re-contour side slopes if greater than 3:1. |
| Construct channels down gradient and hydrologically connected to the drainage layer of the embankment. | Drainage channel is hydrologically connected to the drainage layer of the embankment. | Verify with record drawings | Modify channel to meet design standards. |
| Direct water in drainage channels to discharge points in or adjacent to riparian wetlands along Miller Creek (Wetlands A13, 18, 37a, 39, 44a, R9). | Flowing water will be present in the lower portions of the channels from December to June in years of normal rainfall .<br>Water is directed to downslope wetlands and the hydrology of downslope wetlands will be maintained:<br>• Wetlands with predominantly organic soils (Portions of Wetland 18, 37a, R14a, A14b, and 44a) will have soils saturated in the upper part to mid-June in years of normal rainfall.<br>• Other wetlands with predominantly mineral soils will have soils saturated in the upper part to mid-April in years of normal rainfall. | Measurements of channel baseflow by installing weirs that allow quantity of water flowing through channels to be determined.<br>Monitor duration and depth to water table in wetlands to determine if wetland hydrology persists. | Modify discharge points from channel to wetlands to meet performance standards.<br>Divert treated stormwater from up slope stormwater ponds to drainage channels.<br>Improve drainage paths to convey water to wetlands.<br>Remove obstructions and/or enlarge channels as needed.<br>Reconfigure drainage channels to maintain flows (i.e., longer drainage channels to collect more water for distribution to wetlands).<br>Divert treated stormwater from up slope stormwater ponds to drainage channels (the source of this stormwater could be from biofiltration swales, filter strips, etc. treating runoff from the perimeter road).<br>Reconfigure discharge (i.e., location, size and number of discharges that distribute water to wetlands from drainage channels). |
| Construct new channels with a minimum length of 1,290 ft. | A total of 1,290 ft of new channel lengths will be constructed. | Record drawings. | Construct channel length according to design plans. |

**Table 5.2-12. Final performance standards, evaluation approach, and contingency measures for replacement drainage channels (continued).**

| Design Criteria | Performance Standard | Evaluation Approach | Contingency Measures[1] |
|---|---|---|---|
| Channel substrate will be stable. | Substrate materials will be a mix of sands and gravel.<br>No evidence of erosion (sloughing banks) or scouring of substrate. | Visual observations following flood events and during monitoring visits to determine if scour is present. | Install additional bioengineering and bank stabilization.<br>Install log weirs, check dams to prevent erosion in channels. |
| | Channel depths will be a minimum of 2 ft deep with side slopes of 3:1 or flatter; or where slopes are steeper, log weirs will protect channel banks. | Record drawings. | Reconstruct to meet design criteria. |
| Plant native shrubs at greater than 2,100 individuals per acre and native trees greater than 280 trees per acre. along channel banks. | Shrub density will be at least 2,100 individuals per acre. Tree density will be at least 280 stems per acre.<br>Average tree and shrub survival will be at least 80% in the first 3 monitoring years.<br>Average canopy cover of native species will be at least 80% by monitoring year 10.<br>By the end of year 3, plant diversity in each stratum will not decrease by more than 10% from the number and type of plants installed at baseline.<br>Canopy cover of non-native invasive species will be no more than 10% by monitoring year 10. | Vegetation sampling (plots, transects, or plotless techniques) to estimate cover, density, mortality, and invasive species. | If standards are not met:<br>• Select species that are better adapted to existing hydrologic conditions.<br>• Install additional plant material.<br>• Install protective collars to reduce herbivore damage. |

[1] For all performance standards, monitoring periods may be extended if performance standards are not met.

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**Table 5.2-13. Monitoring schedule for the replacement drainage channels.**

| | | | Data Collection Year (calculated as years following completion of mitigation) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Feature** | **Method** | **Frequency of Inspection** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Substrate | Inspect for evidence of erosion or scouring | Annually (May) or after 2-year storm during the first 3 years | X | X | X | X | X | X | | X | | X | X |
| Hydrology | Inspect following flood events; measure base flow | Twice yearly (February/November) | X | X | X | X | X | X | | X | | X | X |
| Downslope Wetlands | Groundwater monitoring | Monthly | X | X | X | X | X | X | | X | | X | X |
| Buffer Vegetation | Vegetation sampling | Annually (late spring or early summer) | | X | X | X | X | X | | X | | X | X |

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#### 5.2.3.10 Maintenance and Contingency Plans

Routine maintenance and contingency measures will be implemented for the replacement drainage channels consistent with the overall approach outlined in Chapter 4.

Specific contingency measures for the drainage channels are provided in Table 5.2-12. If flow rates and hydrology are substantially different from the design flows used to develop this plan, the channels may not function as designed and the channel section can be modified by:

- Widening the base flow channel to reduce velocities and improve capacity
- Narrowing the base flow channel with logs or boulders to increase base flow depth and velocity
- Widening the flood flow portion of the channel (above 0.5 ft) to improve capacity and reduce velocity
- Adding log weir steps—to flatten stream slope, reducing velocity and increasing base flow depth
- Adjusting discharge points to Wetlands A13, 18, 37a, 39, 44a and R9 or other wetlands as necessary

### 5.2.4 Wetland Restoration Plan for Temporary Construction Impacts

Construction of the third runway embankment will result in some temporary wetland impacts (described in Section 5.2.4.2). Temporary impacts to wetlands are those that do not involve permanent filling or excavation, and include clearing of wetland vegetation; use of a wetland for temporary construction access roads, staging areas, or temporary stormwater management ponds; or minor disturbances associated with placement of barrier and sediment fencing. Temporary impacts will last 1 to 5 years. A maximum of 2.05 acres of wetlands (including 1.15 acres of forest, 0.46 acres of shrub, and 0.44 acres of emergent wetland) may be impacted temporarily by construction activities (Table 5.2-14). However, not all of these wetlands will necessarily be impacted by construction activities. During construction, all practicable means will be used to minimize and avoid temporary impacts, for example by reducing staging area or access road footprints, minimizing pond sizes, or re-routing access roads. Therefore, actual temporary construction impacts may be less than 2.05 acres. All wetlands temporarily impacted by construction activities will be restored and monitored to ensure performance standards are met (Table 5.2-15).

Following construction, wetlands temporarily impacted by clearing or filling will be restored by removing all temporary fill material, re-establishing pre-disturbance conditions, and planting with native forested and shrub vegetation. Wetlands with only minor disturbances that do not involve clearing of vegetation or filling (e.g., sediment fencing placed along the edge of a wetland) will be restored by removing sediment fencing, removing any other construction debris, and replacing any wetland vegetation disturbed by these activities.

**Table 5.2-14. Summary of wetlands subject to temporary construction-related impacts.**

| Wetland | Classification [1] | Total Temporary Impact Area (acres) | Forest | Vegetation Type Impacted (acres) Shrub | Emergent |
|---|---|---|---|---|---|
| **Runway Safety Area Extension** | | | | | |
| 4 | Forested [2] | 0.20 | 0.20 | 0.00 | 0.00 |
| 5 | Forested /Shrub [2] | 0.20 | 0.10 | 0.10 | 0.00 |
| 9 | Forested/Emergent | 0.16 | 0.11 | 0.00 | 0.05 |
| **Third Runway** | | | | | |
| 18 | Forested/Shrub/Emergent | 0.22 | 0.04 | 0.07 | 0.11 |
| 37 | Forested/Shrub/Emergent | 0.71 | 0.50 | 0.10 | 0.11 |
| 44a | Forested/Shrub | 0.28 | 0.18 | 0.10 | 0.00 |
| A1 | Forested/Shrub/Emergent [2] | 0.05 | 0.01 | 0.01 | 0.03 |
| A12 | Shrub | 0.03 | 0.00 | 0.03 | 0.00 |
| A13 | Forested | 0.01 | 0.01 | 0.00 | 0.00 |
| R2 | Emergent | 0.02 | 0.00 | 0.00 | 0.02 |
| **South Aviation Support Area** | | | | | |
| 52 | Forested/Shrub/Emergent [2] | 0.17 | 0.00 | 0.05 | 0.12 |
| **TOTAL** | | **2.05** | **1.15** | **0.46** | **0.44** |

[1] All wetlands are palustrine, based on USFWS wetland classification system (Cowardin et al. 1979).
[2] Temporary impacts will be limited to installation of sediment fencing and other standard BMPs such as temporary seeding, straw mulch, interception swales, etc.

**Table 5.2-15. Mitigation design objectives and criteria for restoration of temporary wetland impacts.**

| Goal and Design Objectives | Design Criteria |
|---|---|
| Restore wetlands to pre-construction conditions. | Grade areas to pre-construction elevations if pre-construction grades have been modified, amend soils with topsoil. |
| Provide wetland hydrology appropriate for each wetland vegetation cover type. | Grade to reestablish pre-construction hydrology. If removal of fill and/or grading does not re-establish wetland hydrology, water from the replacement drainage channels will supplement hydrology. |
| Re-vegetate impacted wetland areas. | Restore impacted areas with native forest vegetation. Emergent wetland communities will be replanted with forest vegetation to increase wetland functions and reduce potential use by waterfowl. |
| Stabilize soils in upland areas adjacent to restoration areas. | Disturbed ground within 50 ft of the wetlands will be hydroseeded or otherwise stabilized to prevent erosion impacts to the wetland. |

### 5.2.4.1 Goal, Objectives, and Design Criteria

The primary goal of this plan is to ensure no net loss of wetland functions by restoring wetlands temporarily impacted by construction activities to their pre-construction size with an overall increase in function (e.g., replace non-native emergent vegetation with native forested vegetation).

Design objectives and design criteria were developed (see Table 5.2-15) to ensure that restoration goals have been met at the end of the 10-year monitoring program.

#### 5.2.4.2 Wetlands Site Description

A total of 11 wetlands (see Table 5.2-14) may be temporarily disturbed by MPU project construction activities (see Figure 3.1-3; Appendix D, Sheets C2 and C3 through C7). These wetlands lie within three general project areas: the RSA and South 154th Street relocation, the third runway embankment and the SASA. Wetlands subject to temporary construction related impacts are listed in Table 5.2-14. A complete description of these wetlands is included in the *Wetland Delineation Report* (Parametrix 2000c).

**Runway Safety Areas and South 154th Street Relocation**

Wetlands 4 and 5 are located near the north end of the existing runways where required RSA extensions will be built. As part of the safety extensions, South 154th Street will be relocated several hundred feet to the north, adjacent to these wetlands. Temporary disturbance to small portions of Wetlands 4 and 5 (about 0.40 acre) could result from placement of silt fences and required temporary erosion and sediment control actions.

**Third Runway Embankment**

Eight wetlands occur near the edge of fill for the third runway embankment. Temporary disturbance will occur in portions of Wetlands A1 (0.05 acre), A12 (0.03 acre), A13 (0.01 acre), R2 (0.02), 18 (0.22 acre), and 44a (0.28 acre) outside the area of permanent fill. During the relocation of South 154th Street, portions (0.16 acre) of Wetland 9 will be temporarily disturbed by construction activity. Minor disturbance could occur in limited portions of these wetlands as a result of installing silt fences around the construction area.

In addition to the impacts described above, approximately 0.71 acre of Wetland 37a will be directly disturbed from the construction of temporary stormwater management facilities, including a detention pond. The pond will be used to temporarily store construction stormwater that is pumped to an upland sedimentation pond. These stormwater facilities will be removed and the wetland area restored after the completion of the third runway. Permanent stormwater facilities will be located outside of wetland areas.

**South Aviation Support Area (SASA)**

Wetland 52 (i.e., Tyee Pond) is adjacent to the SASA project. Temporary impacts (approximately 0.17 acre) may occur during construction of the taxiway connecting the SASA to the airfield. Impacts to the wetland could include minor sedimentation or soil disturbance resulting from construction.

**Temporary Impacts Resulting from Mitigation Projects**

Approximately 38.8 acres of wetland area (in both on- and off-site mitigation areas) will be subject to enhancement and restoration activities such as grading, weed control, and planting (see Table 3.1-4). In general, these activities occur to Category III or Category IV wetlands that are farmed or dominated by non-native vegetation. For example, approximately 3.74 acres of Wetland A1, a

Category II riparian wetland, would be temporarily disturbed by construction associated with the relocation of Miller Creek, floodplain grading, and planting. Two emergent Category III wetlands at or near the off-site mitigation area in Auburn, Washington (see Chapters 4 and 7) will be altered by the placement of temporary construction access roads. All of these wetlands will be enhanced or restored by the proposed mitigation actions, with an overall increase in wetland function resulting from the mitigation action. These actions are described in detail in the sections discussing the individual mitigation projects.

#### 5.2.4.3 Rationale for Selection

Those wetlands temporarily impacted from construction activities will be restored on-site. Mitigation of temporary impacts provides the opportunity to enhance or restore functions in wetlands that are currently degraded. Following mitigation of temporary impacts, these wetlands will be vegetated with native forested and shrub wetland species, and wetlands will be protected by 50-ft-wide upland buffers where possible.

#### 5.2.4.4 Constraints

No significant constraints have been identified that would preclude implementing restoration plans for temporarily impacted wetlands.

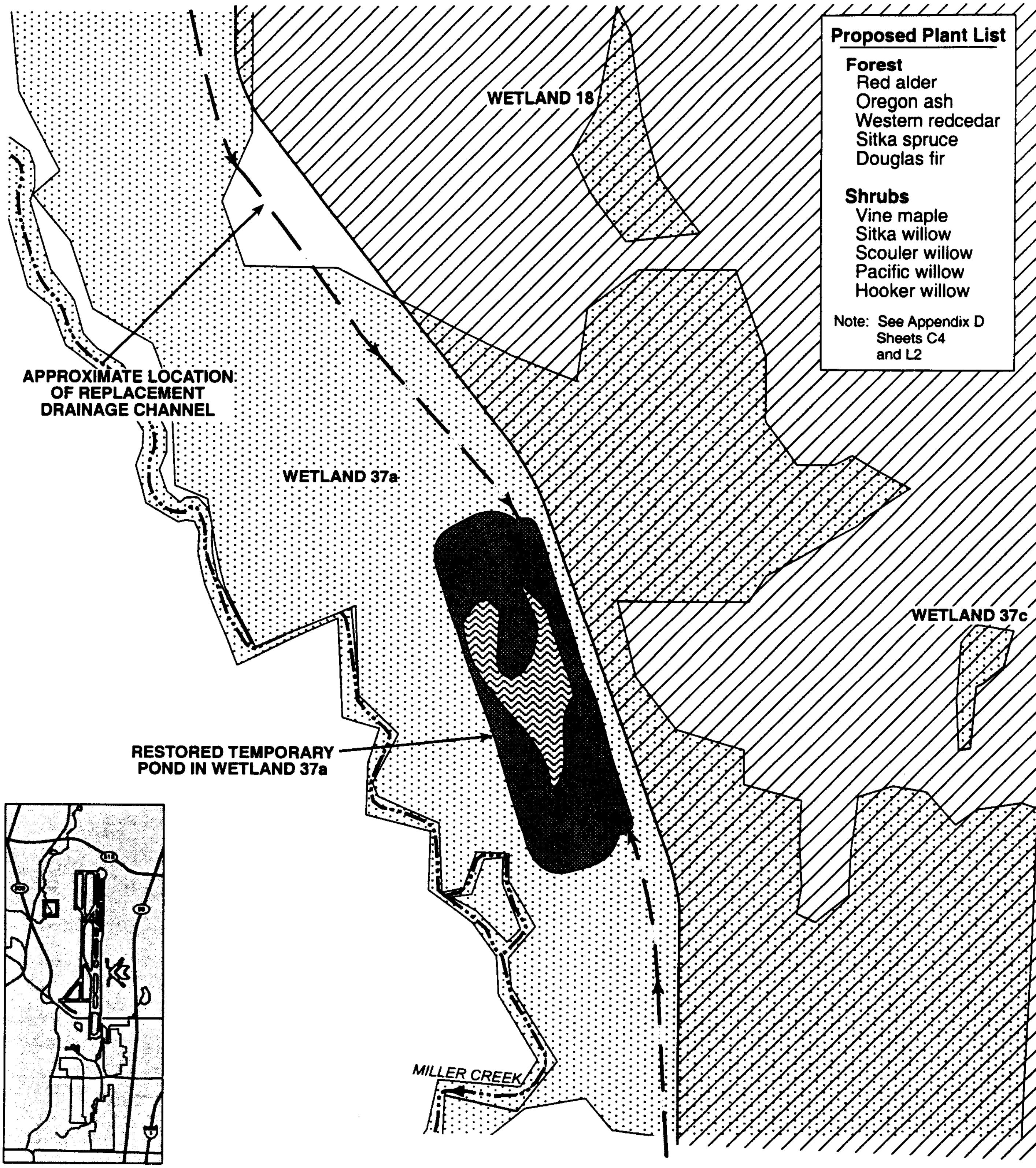
#### 5.2.4.5 Ecological Assessment of the Mitigation Sites

Ecological conditions in the temporarily impacted wetlands are discussed in detail in the *Wetland Delineation Report: Seattle-Tacoma Internationa Airport Master Plan Update Improvements* (Parametrix 2000c). A general description of existing conditions in these wetlands is included in Chapter 2 of this report.

#### 5.2.4.6 Temporary Impact Mitigation Design

Mitigation of temporary impacts varies on the nature of the impact, and specific mitigation plans are included in Appendix D. On completion of construction, all fill material and any construction material, equipment, or debris will be removed from the wetland. The area will be regraded if necessary to re-establish pre-disturbance topography. Hydrology will be re-established, if impacted, by directing seepage from the fill slopes to the wetlands via the replacement drainage channels. If necessary, tilling or discing of the soils to loosen compacted soils and addition of soil amendments will ensure a suitable planting medium. Native forested and shrub wetland vegetation will be restored by planting species such as Sitka spruce, black cottonwood, western redcedar, Pacific willow, Oregon ash, Pacific ninebark, and Sitka willow (Figures 5.2-17 and 5.2-18).

Wetlands with temporary impacts that do not include clearing of vegetation or temporary filling (i.e., installation of sediment or barrier fencing) will be restored by removing all construction materials or debris. Vegetation disturbed by construction activities in these areas will be replaced.

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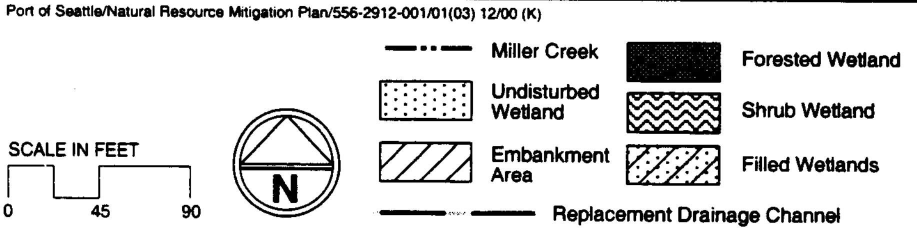


**Figure 5.2-17**
**Typical Planting Plan for Wetland 37 Restoration**

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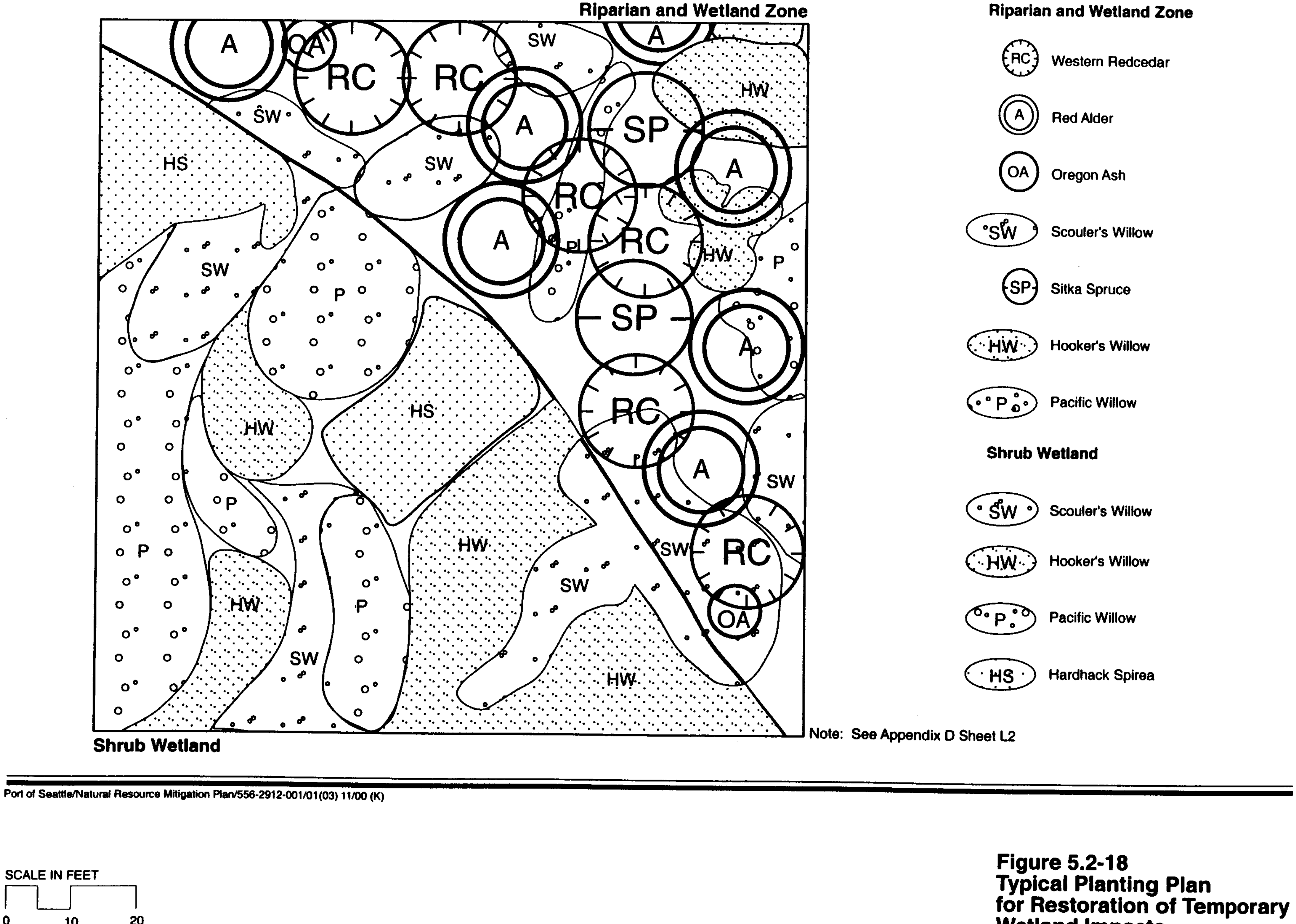


Note: See Appendix D Sheet L2



**Figure 5.2-18**
**Typical Planting Plan for Restoration of Temporary Wetland Impacts**

Finally, any areas outside of wetlands or wetland buffers that are disturbed by construction will be hydroseeded with a standard erosion control seed mix to stabilize the soils and prevent erosion. Hydroseeding will also provide ground cover and reduce the amount of habitat available for non-native weedy species that could affect the success of the wetland mitigation sites.

Mitigation plans for temporary wetland impacts will be coordinated as needed with the mitigation actions for the adjacent Miller Creek wetland and riparian buffer enhancement projects (Sections 5.2.1 and 5.2.2).

**Wildlife Considerations**

Planting plans developed for the temporary impact mitigation are similar to those developed for the Miller Creek wetland and riparian buffer enhancement projects. These plans are consistent with the Port's WHMP and include species that are not likely to attract hazard wildlife (see Table 5.1-12; Appendix D, Sheet L1).

**Landscape Plan**

Specific landscape plans for temporarily disturbed wetland areas are shown in Appendix D, Sheet L1. A typical planting plan (see Figure 5.2-18) shows how the wetland areas will be replanted after construction is completed.

**Expected Hydrology**

All temporarily impacted wetlands will be restored to pre-disturbance conditions (including topography) and therefore it is anticipated that hydrology in the restored wetlands will be similar to pre-construction conditions. The replacement drainage channel system is designed to ensure that hydrology in wetlands down slope of the embankment will be maintained. Performance standards and monitoring for wetlands down slope of the embankment are provided in Tables 5.2-11 and Table 5.2-12.

### 5.2.4.7 Performance Standard and Contingency

Performance standards, types of parameters measured, and contingency measures for temorary impact mitigation are listed in Table 5.2-16. The monitoring schedule for temporarily impacted mitigation sites is provided in Section 5.2.4.9.

### 5.2.4.8 Implementation

Temporary impact mitigation projects will be coordinated with third runway construction activities, as well as with Miller Creek riparian wetland and buffer enhancement projects. Implementation of the replacement drainage channels and the temporary impacts mitigation is described in Section 5.2.4.12.

**Table 5.2-16. Final performance standards, evaluation measures, and contingency measures for restoration of temporary wetland impacts.**

| Design Criteria | Performance Standard | Evaluation Methods | Contingency Measures[1] |
|---|---|---|---|
| Grade areas to pre-construction elevations if pre-construction grades have been modified, amend soils with topsoil. | Pre-disturbance wetland topography is restored, as determined by comparing to pre-construction contour maps. | Comparison of pre- and post-construction topography. | Minor regrading if necessary. |
| Grade to reestablish pre-construction hydrology. If removal of fill and/or grading does not re-establish wetland hydrology, water from the replacement drainage channels will supplement hydrology. | Wetland areas will meet wetland criteria (hydrophytic vegetation, hydric soils, hydrology) following restoration.<br><br>Soils in wetlands will be saturated in the upper 10 inches for a minimum of 2 weeks during the growing season, in years of normal rainfall. | Monitor the depth to and the duration of soil saturation. | Install additional plant material.<br><br>Install protective collars.<br><br>Control/reduce non-native invasive species. |
| Restore impacted areas with native forest vegetation. Emergent wetland communities will be replanted with forest vegetation to increase wetland functions and reduce potential use by waterfowl. | Average survival of planted stock will be at least 80% in the first 3 monitoring years. Canopy cover of native species will be at least 80% by the end of the 10-year monitoring period. In re-vegetated wetlands, canopy cover of non-native invasive species will be no more than 10% at the end of the 10-year monitoring period. Re-vegetated wetlands will be a tree density of at least 280 stems per acre and a shrub density of at least 2,100 individuals per acre. | Vegetation sampling (plots, transects, or plotless techniques) to estimate mortality, cover, density, and presence of invasive species. | If standards are not met:<br><br>Select species that are better adapted to existing hydrologic conditions.<br><br>Install additional plant material.<br><br>Install protective collars to reduce herbivore damage. |
| Disturbed ground within 50 ft of the wetlands will be hydroseeded or otherwise stabilized to prevent erosion impacts to the wetland. | By the end of year 3, plant diversity in each stratum will not decrease by more than 10% from the number and type of plants installed at baseline.<br><br>No evidence of soil erosion (rilling, scour) or sediment transport (deposition) in the wetland is visible. | Verify with record drawings; monitor wetlands for evidence of erosion or sediment deposition | Install erosion control fabric.<br><br>Install additional hydroseed or plants in uplands areas. |

[1] For all performance standards, monitoring periods may be extended if performance standards are not met.

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### 5.2.4.9 Monitoring and Performance Standards

The overall monitoring approach for the temporary impact mitigation will be consistent with the monitoring approach outlined for all MPU mitigation projects in Chapter 4 of this report. Monitoring tasks specific to the temporary impact mitigation projects are described in this section. Performance standards, methods and parameters, and contingency measures for the temporary impact mitigation are listed in Table 5.2-16. The monitoring schedule for temporarily impacted mitigation sites is provided in Table 5.2-17.

**Table 5.2-17. Monitoring schedule for restoration of temporary wetland impacts.**

| | | | Data Collection Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Feature** | **Activity** | **Frequency** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Wetland hydrology | Groundwater monitoring | Monthly | X | X | X | | | | | | | | |
| | | Once winter, late spring/ early summer, and fall | | | | X | X | X | X | X | X | X | X |
| Vegetation communities | Vegetation sampling | Once late spring or early summer | X | X | X | X | | X | | X | | | X |

#### Hydrology

Monitoring of temporarily impacted wetlands, as well as wetlands between the embankment and Miller Creek will focus particularly on evaluating wetland hydrology. To ensure that performance standards are met, and to aid in determining appropriate contingency measures, monitoring will include a pre-construction topographic survey and groundwater monitoring. A topographic survey of all wetlands within the temporarily impacted area will be conducted before grading for the runway embankment. This survey will be used as a baseline to re-establish pre-construction contours. Shallow groundwater monitoring wells will be installed within restored wetlands following mitigation regrading and planting. Groundwater levels will be monitored monthly to determine presence of wetland hydrology sufficient to maintain existing or planted vegetation.

#### Vegetation

Temporarily impacted wetlands that are replanted will be restored as palustrine forested wetlands and therefore will be monitored for at least 10 years. Vegetation will be monitored using the approach outlined in Table 5.2-16.

### 5.2.4.10 Site Protection

Areas subjected to temporary impacts will be protected as established in the restrictive covenants (Appendix G) and other federal, state, and local regulations that protect wetlands.

#### 5.2.4.11 Maintenance and Contingency Plans

Routine maintenance and contingency measures will be implemented for the temporarily impacted mitigation sites consistent with the overall approach outlined in Chapter 4.

Contingency measures for each performance standard for the temporary impact mitigation projects are listed in Table 5.2-16. Contingency measures will be consistent with the adaptive management approach outlined in Chapter 4.

#### 5.2.4.12 Implementation of Replacement Drainage Channel and Temporarily Impacted Mitigation Projects

The locations of the wetlands subject to temporary impacts and drainage channel mitigation sites are shown in Appendix D. Implementation of mitigation activities for temporarily impacted wetlands is dependent on phasing for the construction of the third runway embankment and decommissioning of temporary stormwater detention ponds for the runway embankment construction. Drainage channel construction will occur before and during construction of the embankment (approximately 2000 to 2005). Temporary wetland impact restoration will occur immediately after completion of individual projects impacting wetlands (i.e., South 154$^{th}$ Street relocation embankment).

Prior to the start of construction, a pre-construction meeting between the contractor, engineer, and wetland scientist will determine the exact areas needed for construction activities. These temporary construction impact areas will be located to avoid and minimize impacts to wetlands. Construction limits will be clearly marked in the field to avoid impacts to wetlands outside the temporarily impacted areas.

On completion of construction, all construction debris and equipment will be removed from temporarily impacted areas. Any temporary access roads will be removed. Any fill material will be removed. Temporarily impacted areas will be returned to pre-disturbance conditions and drainage channels will be graded per specifications (Appendix D, Sheets L1 and C9). Soils that have been compacted by construction activities will be deep ripped if necessary, and will be tilled to a depth of 10 to 14 inches to provide suitable conditions for planting. Disturbed areas will be hydroseeded to stabilize the soil and native plant species installed to establish forested wetland vegetation (Appendix D, Sheets L1 and C9). Planting will occur during the early fall following temporary mitigation or drainage channel construction. Sediment and erosion control measures may be removed 1 full year after planting if these sites are stable. Replacement drainage channel buffers will also be planted with native trees and shrubs. Temporarily impacted and drainage channel mitigation sites will be monitored annually for a period of 10 years to ensure they are meeting performance standards.

### 5.2.5 Miller Creek Basin Trust Fund for Watershed Rehabilitation

To provide opportunities for additional restoration projects in the Miller Creek basin, the Port will establish a trust fund to support watershed rehabilitation projects. The trust fund will focus on portions of Miller Creek not owned by the Port, and where the Port is unable to independently implement stream enhancement projects. The Port will make these trust funds available and defer to other governmental agencies or interested groups in the selection of appropriate projects. Restoration or enhancement projects supported by the trust fund are independent of the environmental review and permit process for MPU projects (e.g., CWA 404/401, HPA), and would not be covered by any permit conditions on Port MPU construction or mitigation projects.

#### 5.2.5.1 Goal

The goal of this mitigation action is to provide a funding source to local agencies and groups to enhance instream or riparian habitat for salmonids and other aquatic organisms in the Miller Creek basin. The trust fund provides an opportunity to involve the local community and community groups (i.e., Trout Unlimited) in planning meaningful restoration for Miller Creek.

#### 5.2.5.2 Description

The trust fund for watershed restoration will provide $150,000 for restoration projects in the Miller Creek basin. Potential projects eligible for funding by the trust fund are based on information provided in the Stream Survey Report for Miller Creek (Appendix F of the Final EIS for the Master Plan Update Projects [Port of Seattle 1997]). The projects identified below are a preliminary list and are proposed to address habitat problems in Miller Creek identified in the stream survey. Examples of projects eligible for full or partial funding could include instream fisheries habitat improvements similar to those proposed for Miller Creek in this plan (see Figures 5.2-8 through 5.2-11), riparian buffer enhancement, removal of fish passage barriers, and removal of failed septic systems.

While specific projects are not selected, a suite of potential projects is identified with their respective goals, general performance standards, and general monitoring requirements. Additional planning and engineering of selected projects will result in specific project designs, performance standards, monitoring requirements, and contingency measures.

The trust fund will have a sunset period of 2 years, with the 2-year period beginning once permits are issued for the MPU projects. If after a 2-year period trust fund projects are not designed and environmental permits sought,[9] the Port will use the money to implement projects in the Miller Creek basin that would provide water quality or aquatic habitat benefits. The projects to be implemented will be at the discretion of the Port, but with approval from Ecology and ACOE.

#### 5.2.5.3 Eligibility

The Port, or the designated administrator of the trust fund, will consider requests for monies from the watershed trust fund to implement stream habitat enhancement projects. Requests must be made by King County, City of SeaTac, City of Des Moines, City of Burien, City of Normandy Park, special districts, tribal governments, non-profit organizations, or combinations of such governments through inter-local agreements. Organizations requesting funding must comply with general liability insurance requirements established by the Port.

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[9] Project proponents will be responsible for obtaining all federal, state, and local permits required to implement habitat enhancement projects.

Key criteria to be used to evaluate proposals to implement projects in Table 5.2-18, as well as other projects within the watershed, are:

- A demonstrated benefit to salmon or aquatic habitat without creating significant avian wildlife habitat within 10,000 ft of runways at STIA.
- Consistency with watershed management plans, or with prescriptions/recommendations identified using watershed analysis or stream assessment procedures.
- Clearly defined project goals, implementation plans, performance standards, and post-project monitoring.
- Preference for resolving underlying causes of problems rather than treating symptoms.
- Cost-effectiveness.

#### 5.2.5.4 Implementation

The Miller Creek Basin Committee, the King County Watershed Coordinator, or other responsible entity will administer the fund. The administrator will establish eligible project criteria, create application forms, set project cost limits, and set implementation and monitoring requirements. The Port will review and approve all project goals, plans, performance standards, and monitoring requirements to enhance ultimate success of the projects.

#### 5.2.5.5 Site Protection

Site protection measures for enhancement projects will be coordinated with property owners and the fund administrator.

#### 5.2.5.6 Monitoring and Contingency Plans

The fund administrator will review project design, implementation, and the as-built plans to verify that intended benefits have been built. Contingency actions associated with establishment or operation of the fund will be reviewed with the Port, ACOE, Ecology, and the fund administrator.

**Table 5.2-18. Potential trust fund projects in the Miller Creek watershed.**

| Project | Goals | Description | Performance Standards | Monitoring |
|---|---|---|---|---|
| Pool Habitat Improvements<br>(RM 2.0 to 3.3) | Increase high-flow refugia and over-wintering habitat for resident and anadromous fish species. | Modify stream channel to increase size, depth, and cover of existing pools.<br>Create additional pools through placement of LWD complexes (4 to 6 logs each) instream channel. | Established pools and riffles will remain stable, or pool/riffle ratio shall remain within 10% of established value over 10 years. | Assess functions of pool/riffle complex annually at the end of the wet season to determine habitat quality of existing and created pools. |
| Streambank Stabilization<br>(RM 2.0 to 3.3) | Increase quality spawning gravels and escape cover for juvenile salmonids and habitat for aquatic invertebrates by increasing stability of streambanks prone to slump and landslide activity. | Apply prescriptive stabilization designs to eroding banks, landslide areas, slumps, and debris jams that are major contributors to sediment loading. | Streambank stabilization projects shall remain intact for the 10-year monitoring period. | Assess stabilized streambanks annually at the end of the wet season, noting soil stability, evidence of sediment loading in the stream channel, and potential for sediment loading. |
| Streambank Re-vegetation<br>(RM 2.0 to 3.3) | Decrease seasonal water temperature fluctuation through shading stream channel with native vegetation. | Install native riparian vegetation to provide overhead cover and shading of stream channel. | Installed plant materials shall have minimum 80% survival after 3 years, and shall provide a minimum of 80% cover of native species by year 10. | Assess installed plant materials and percent cover of non-native invasive vegetation species annually at the end of the growing season. |

**Des Moines Creek Restoration Projects**

## 5.3 DES MOINES CREEK BASIN RESTORATION PROJECTS

MPU improvement projects will result in approximately 3.88 acres of permanent wetland impacts in the Des Moines Creek basin (Borrow Area 1, Haul Road, and SASA; see Table 3.1-2). These unavoidable impacts will result from the development of the SASA and excavation activities in the borrow areas. Therefore, to mitigate for these impacts in the Des Moines Creek basin, the Port proposes restoration and enhancement projects designed to increase wetland function, enhance aquatic habitat, and improve stream conditions within Des Moines Creek. These mitigation projects are designed to ensure that new wildlife hazards are not created near the airport. This integrated set of projects is designed to meet the following overall objectives:

- Restore wetland functions to a portion of the Tyee Valley Golf Course by restoring a native wetland shrub community.
- Enhance aquatic habitat and improve stream functions by restoring a forested riparian buffer along a 870-ft of the west branch Des Moines Creek, also located on the Tyee Valley Golf Course.
- Establish a $150,000 trust fund for restoration projects located in the Des Moines Creek basin.
- Provide for additional stream enhancement projects and local restoration efforts.

To provide additional protection to Des Moines Creek, the Port will plant a 100-ft buffer along Des Moines Creek from the edge of the wetland mitigation site at the Tyee Valley Golf Course south to the proposed South Access Freeway ROW. This buffer is not included as mitigation credit for project impacts, but is an action the Port will take to provide additional protection to the aquatic habitat in Des Moines Creek.

### 5.3.1 Mitigation Plans

Projects in the Des Moines Creek basin are designed to mitigate for unavoidable project impacts to wetlands and aquatic resources by restoring wetland and stream functions. To mitigate for wetland impacts and improve aquatic habitat in the Des Moines Creek watershed existing emergent wetland at the Tyee Valley Golf Course will be enhanced by establishing a native shrub wetland community (Figure 5.3-1). Approximately 4.5 acres of wetland enhancement will occur in the Tyee Valley Mitigation area and approximately 1.0 acre will occur ni the west branch Des Moines Creek buffer. This mitigation will increase infiltration, reduce pollutant runoff, increase sediment retention, improve nutrient cycling functions in the wetland, and improve water quality and habitat in adjacent Des Moines Creek. Replacing the existing golf course turf grass by planting a native shrub community will also decrease hazard wildlife attractants within 10,000 ft of the airfield (as required by the FAA), by reducing use of the golf course by waterfowl.

To enhance water quality and aquatic habitat in Des Moines Creek, approximately 5 acres of buffers will be established along Des Moines Creek at the Tyee Valley Golf Course. A 100-ft buffer (approximately 3.4 acres) will be enhanced on both sides of the west branch of Des Moines Creek (see Figure 5.3-1) and approximately 1.7 acres within the Tyee Valley Golf Course Mitigation Area. These buffers will be planted with native forested and shrub riparian vegetation. Species planted in the buffer will be selected to avoid attractants to hazard wildlife, consistent with the Port's WHMP.

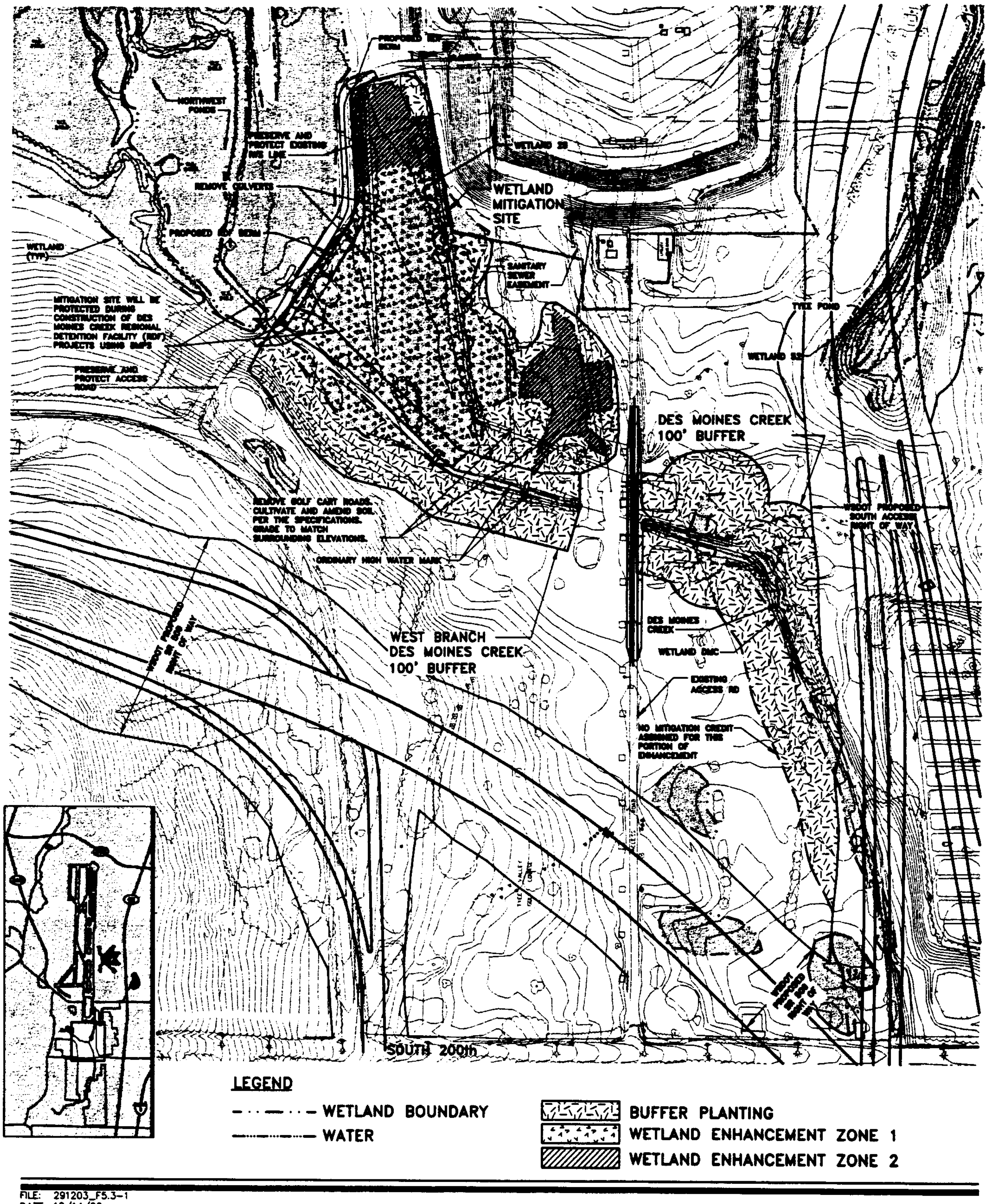


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**Figure 5.3-1**
**Location of Wetland Enhancement On the Tyee Valley Golf Course, Des Moines Creek Basin**

Enhancement of this buffer will increase infiltration in the buffer area; reduce sediment, nutrient, and pollutant inputs to the stream; and provide shade, large woody debris, and organic matter inputs to Des Moines Creek.

#### 5.3.1.1 Goals, Objectives, and Design Criteria

The following section describes the goals, objectives, and design criteria identified for the Des Moines Creek projects. Goals identified for this plan include:

- Establish a total of 5.5 acres of native shrub wetland in a currently degraded emergent wetland (i.e., golf course turf) to improve water quality, fish habitat, and stream conditions in Des Moines Creek (4.5 acres in Tyee Valley Golf Course Mitigation Area and 1.0 acre in west branch Des Moines Creek buffer; see Table 4.1-3).
- Reduce hazard wildlife (e.g., Canada goose and other waterfowl species) use of the golf course area by replacing turf grass wetland with shrub wetland.
- Improve water quality and aquatic habitat in Des Moines Creek by planting a 100-ft forested buffer along both banks of an 870-ft section of Des Moines Creek.

Specific design objectives and criteria developed to ensure that the Des Moines Creek projects meet mitigation goals are listed in Table 5.3-1.

**Table 5.3-1. Mitigation goals, design objectives, and design criteria for wetland and buffer enhancement on the Tyee Valley Golf Course.**

| Goals and Design Objectives | Design Criteria |
|---|---|
| **Goal 1: Enhance degraded wetlands to provide improved water quality and aquatic habitat functions to Des Moines Creek** | |
| Enhance existing turf-dominated wetland at the Tyee Valley Golf Course. | Plant 5.5 acres of the golf course wetland with native wetland shrub species (inlcude wetland area on left and right bank west branch Des Moines Creek). |
| | Shrub and small trees planted density will be 3,375 individuals per acre |
| **Goal 2: Reduce waterfowl use of the golf course area** | |
| Reduce habitat value of the mitigation area for water fowl. | Plant are with shrub vegetation to discourage use of wetland by waterfowl. |
| **Goal 3: Improve water quality and aquatic habitat in Des Moines Creek by restoring riparian buffers.** | |
| Establish protected buffers 100 ft wide riparian buffers. | Plant 100-ft-wide riparian buffers on each side of Des Moines Creek (approximately 3.38 acres of buffer area). |
| | Plant native riparian forested and shrub plant species within the 100-ft buffer along Des Moines Creek. |

### 5.3.1.2 Mitigation Site Descriptions

**Tyee Valley Golf Course**

The Tyee Valley Golf Course is an active golf course located at the southern end of the STIA runways (see Figure 2.1-1). The golf course occurs in the eastern portion of Wetland 28, an approximately 35-acre wetland complex associated with the Northwest Ponds and Des Moines Creek. The portion of the wetland associated with the Northwest Ponds (west of the golf course) contains forest, shrub, emergent, and open-water wetland habitat. The golf course portion of Wetland 28 contains an approximately 9.75-acre emergent turf-grass wetland. Wetland enhancement will occur in emergent turf-grass wetland (see Figure 5.3-1). A detailed description of Wetland 28 is provided in the *Wetland Delineation Report* (Parametrix 2000c).

**Des Moines Creek**

The west branch of Des Moines Creek originates at the Northwest Ponds or Wetland 28 (see Figure 2.1-3). The Northwest Ponds, located southwest of the existing runways between South 192nd Street and South 196th Street, were excavated as a source of peat by the previous property owners, and subsequently incorporated into the airport's stormwater management system. The east fork of Des Moines Creek originates in Bow Lake, east of the airport, and flows south, mostly via closed pipes, to the Tyee Valley Golf Course detention pond (Tyee Pond; Wetland 52). From Tyee Pond, the east branch flows through a culvert to join the west branch southeast of the proposed wetland mitigation site (see Figure 5.3-1). South of the confluence, Des Moines Creek flows through the Tyee Valley Golf Course to South 200th Street and then generally south to Puget Sound

### 5.3.1.3 Ownership

The Port owns the property in the Des Moines Creek mitigation areas (i.e., golf course, buffer zone of Des Moines Creek). The golf course is currently leased to a golf course operation, which will cease before implentation.

### 5.3.1.4 Rationale for Selection

The Des Moines Creek mitigation projects provide an opportunity to mitigate for wetland impacts on-site in the Des Moines Creek basin. Mitigation will occur through restoring portions of a historic peat wetland adjacent to the upper reaches of Des Moines Creek, enhancing riparian buffers along Des Moines Creek, and mitigating for potential indirect impacts to wetlands down slope of the project area.

Historic land uses resulted in converting a native peat wetland to a golf course, as well as replacing forested wetlands and riparian areas along Des Moines Creek with open turf grass areas or areas of non-native invasive species. These alterations have degraded aquatic habitat in Des Moines Creek, increased sediment and nutrient inputs to the stream, and removed the buffering influence of riparian vegetation. Using the Tyee Valley Golf Course as a mitigation site provides a unique opportunity to enhance an existing wetland and restore a native wetland shrub habitat adjacent to a salmon-bearing stream. This mitigation site also provides the opportunity to improve the aquatic habitat of Des Moines Creek by reducing pollutant runoff, increasing sediment retention, and increasing nutrient cycling by restoring both wetlands and riparian buffers along the stream.

Finally, the turf grass and seasonal flooding that occur on the Tyee Valley Golf Course attract a large number of waterfowl (e.g., Canada geese and widgeon) that forage on the mown lawn of the golf course. These waterfowl pose a threat to aircraft operation and safety, and establishing shrub vegetation will eliminate waterfowl from portions of the golf course and reduce aviation hazards.

#### 5.3.1.5 Constraints

Mitigation design for these projects is constrained by the proximity of the mitigation sites to the airfield and runways. Proximity to the airfield affects the choice of plant species used in the design to ensure that wildlife hazards are not created. The size of buffer areas is constrained by nearby RSAs and embankments. Two separate and unrelated construction projects are also potential constraints that have affected the design and implementation of the Des Moines Creek projects. These projects are the King County Regional Detention Facility (RDF) proposed at the Northwest Ponds and the Washington State Department of Transportation (WSDOT) SR 509 extension and South Access Freeway.

These constraints will not prevent the plan from being implemented, but they could affect implementation steps (e.g., construction sequencing) or design (e.g., protective barriers around mitigation plantings). In addition, concerns have been raised by ACOE and Ecology regarding the hydrology of the wetland mitigation area. Although this is not a constraint on the mitigation, these concerns are addressed in this section. Finally, there are no constraints on mitigation for indirect hydrology impacts at the borrow areas.

**Buffer Size**

Site constraints preclude the installation of extensive forested buffers around the wetland mitigation site. Within the wetland mitigation site itself, there are shrub buffers on the north side of the enhanced wetland edge and the surrounding golf course (Appendix C, Sheet C2). On the south side, 100-ft buffers along Des Moines Creek will protect the wetland mitigation site and the stream. Wetland buffers cannot be enhanced east of the wetland mitigation site because these areas are within designated RSAs and runway embankment. In this area, emergency and non-emergency access, flexibility to maintain or modify vegetation, vegetation height limits, and the flexibility to maintain or supplement navigation equipment or other airfield facilities must be retained for the safe operation of the airport. However, these restrictions will preclude high-impact uses near the wetland mitigation site, thereby providing an effective land use barrier.

**Wildlife Hazards**

The FAA and USDA-WSD staff have evaluated the mitigation proposed for the Des Moines Creek basin for potential wildlife hazards to aviation. These agencies have determined that the mitigation results in a decrease in wildlife hazards near the airfield. New road construction (i.e., SR 509 extension and South Access Freeway) near the airport is not expected to increase wildlife hazards. Overall, modification of waterfowl habitat through the Port's mitigation (planting of existing emergent wetlands and buffers with shrub and forested vegetation) will reduce wildlife hazards.

## Site Hydrology and Relationship to the King County/Des Moines Creek Regional Detention Facility

### Hydrology

The Tyee Valley Golf Course wetland mitigation will occur on an existing peat wetland that historically supported forested and shrub vegetation. Existing soils and hydrology on the site would support forested or shrub wetland under existing conditions, in the absence of active measures to maintain the emergent turf grass vegetation of the golf course. Existing wetland conditions at the mitigation site are maintained by high groundwater and by precipitation during the winter months. Grading will not be necessary to create the hydrologic conditions necessary to restore shrub wetlands at the Tyee Valley Golf Course site because the site already has wetland hydrology sufficient to support native shrub wetlands.

### Regional Detention Facility

The Des Moines Basin Planning Committee identified a preferred alternative for the RDF in November 1999. The objective of the RDF is to control erosive flows reaching Des Moines Creek and thereby restore salmon habitat (King County Capitol Improvement Project Design Team 1999). The proposal includes increasing storage capacity in the Northwest Ponds and some channel reconstruction in Des Moines Creek to deepen the channel south of the wetland mitigation site.

Wetland hydrology of the mitigation site will not be affected by the operation of the RDF because hydroperiods within the mitigation site will not be significantly affected by the RDF. The Tyee Valley Golf Course currently is inundated by overbank flow from Des Moines Creek to some extent during flood events. The 100-year floodplain of Des Moines Creek (under existing conditions) is entirely within the mitigation site, and within the boundaries of Wetland 28 (Appendix C, Sheet C3). Construction of the RDF will result in a slight decrease in flooding on the mitigation site because of proposed reconstruction of the stream channel adjacent to the mitigation and increased water storage in Wetland 28.

Using data from the King County RDF plan (King County Capital Improvement Design Team 1999), King County compared current water levels on the mitigation site as a result of the 10-year, 25-year, and 100-year floods, with water levels predicted to occur during these flood events after construction of the RDF. In all cases, water levels and the extent of inundation on the site are somewhat lower with the proposed RDF than under current conditions (Appendix C, Sheets C3 and C4). For example, under existing conditions without the RDF, 100-year flood elevations are approximately at the 250.5-ft contour, while with the RDF, the 100-year flood elevations are a foot lower, at the 249.5-ft contour. Under existing conditions, inundation by the 100-year flood at the mitigation site is approximately 3.1 acres, while with the RDF in operation, the 100-year flood would inundate approximately 2.1 acres. Therefore, construction of the RDF will slightly decrease inundation of the site during flood events. However, because wetland hydrology on the site is not driven by flood events, this decrease will not affect implementation of the mitigation plan. Even with the slightly lower levels of inundation during flood events predicted after construction of the RDF, the Tyee site will support the planned wetland shrub vegetation. The site will continue to support wetland vegetation and hydrology because the current wetland is maintained by a high groundwater table that results in saturated soil conditions, and not by overbank flooding.

The preferred alternative for the RDF includes a berm adjacent to the west side of the Tyee Valley Golf Course mitigation site and enhancement of a portion of Des Moines Creek south of the wetland mitigation site (Appendix C, Sheet C2). The Port will protect the wetland mitigation site from RDF construction by placing sediment fencing or other TESC measures, and orange barrier fencing at the edge of the mitigation site to ensure that any potential impacts from construction are avoided. Protection will include ecology blocks or rock gabions to protect the wetland mitigation site during RDF construction activities to ensure that construction equipment does not enter the wetland mitigation site or riparian buffer.

Riparian buffer enhancement (the area extending out a horizontal distance of 100 ft from the OHWM of the stream or from the edge of riparian wetlands, whichever is greater), along Des Moines Creek will be coordinated with construction of the RDF and will be planted by the end of 2004.

**<u>SR 509 Extension/South Access Freeway</u>**

The WSDOT SR 509 extension and South Access Freeway project will not constrain implementation of the Port's mitigation plan in the Des Moines Creek basin. These two projects involve extending SR 509 south of the proposed RDF and construction of an access road between SR 509 and the airport terminal ramps. All wetland mitigation has been designed to avoid conflicts with the preferred alternative for these projects.

The Port's proposed mitigation at the Tyee Valley Golf Course and along Des Moines Creek avoids the preferred alternative for SR 509 and the South Access Freeway (Appendix G). Surface water runoff from these roadways can be collected, treated, and diverted to prevent runoff impacts to the mitigation sites. Therefore, these projects would not affect the hydrologic or riparian functions desired for the mitigation site.

#### 5.3.1.6 Ecological Assessment of the Mitigation Area

Detailed additional descriptions of wetlands, Borrow Areas, and Des Moines Creek in the mitigation projects area are provided in the *Wetland Delineation Report* (Parametrix 2000c).

**<u>Des Moines Creek</u>**

The west branch of Des Moines Creek originates at the Northwest Ponds, flows through the golf course to the confluence with the east branch, and the mainstem then flows south to Puget Sound. The channel and riparian zone of Des Moines Creek upstream of South 200$^{th}$ Street have been significantly altered as a result of golf course development. Des Moines Creek is on the 303(d) list for fecal coliform of unknown origin. The channel substrate in the reach of Des Moines Creek through the golf course is predominantly composed of sands and silts, with some scattered areas of gravels and cobble, and some areas of heavy accumulation of fine sediments. Riparian vegetation along Des Moines Creek in the golf course area is primarily turfgrass. Between the confluence and South 200$^{th}$ Street, there is a riparian zone approximately 25 ft wide vegetated with trees and shrubs. Existing riparian vegetation provides very little shade or organic matter inputs to Des Moines Creek.

Reduced use of the site by geese following conversion of the golf course to shrub wetland will reduce inputs of fecal coliform and nutrients to the stream. In addition, planting the golf course with native shrubs, as well as establishing a forested/shrub buffer along Des Moines Creek, will increase nutrient cycling and retention in the buffer and is likely to further reduce nutrient inputs to the stream.

**Tyee Valley Golf Course Wetland (Wetland 28)**

Historically, the Tyee Valley Golf Course was a peat wetland that was farmed until about 1970. At this time, portions of the original wetland were converted to a golf course and stormwater management ponds.

**Vegetation**

The proposed wetland mitigation site is located on an active golf course consisting primarily of fairways, greens, and roughs. Several roadways used for emergency access or golf cart roads are constructed on fill and cross the mitigation site. Vegetation on the Tyee Valley Golf Course is predominantly non-native turf grasses (e.g., *Poa* sp., *Agrostis* sp.), with scattered patches of coniferous and deciduous trees. No native wetland plant communities currently exist on the golf course. Portions of Wetland 28 to the west of the proposed mitigation site are dominated by native shrubs such as Pacific and Sitka willows and red elderberry (*Sambucus racemosa*), with some scattered trees such as black cottonwood and red alder.

**Soils**

In the golf course area of Wetland 28, the wetland soil is primarily a black or dark brown histic peat to a depth of greater than 18 inches. Small areas of the site consist of very dark gray silty loam mineral soils, or very dark mucks and loams (Parametrix 2000c). Upland soils are very dark grayish brown silty loams.

**Hydrology**

Hydrology within the wetland is maintained by a high groundwater table, occasional flooding from Des Moines Creek, and precipitation. Wetland hydrology in the western portion of the golf course is supported by groundwater and some overbank flow from Des Moines Creek. Wetland hydrology in the eastern portion of the wetland is primarily maintained by shallow groundwater and precipitation that perches above a relatively impermeable layer of clay. Groundwater seeps are also found along the northern arm and in the southwest portion of the wetland. Soils in these wetland areas are typically saturated to the surface during the fall, winter, and spring months.

### 5.3.1.7 Mitigation Design

**Tyee Valley Wetland Mitigation**

The design for the wetland mitigation site is to plant a minimum of 4.5 acres of the golf course area wetland, which is currently dominated by non-native turfgrass, with native shrub species (see Figure 5.3-1; Appendix C, Sheets C2 and L1). Additionally, approximately 1.6 acres of upland area adjacent to the wetland will be planted with native shrub species

**Clearing and Site Preparation**

The design for the wetland mitigation site does not include significant changes to site topography by grading or excavation on the site. Prior to installing plants, culverts and golf cart roads will be removed. Very minor grading may take place attendant to the removal of golf course roads and existing culverts. Appropriate TESC measures will be installed prior to site preparation or clearing activities to protect the adjacent wetland and stream.

**Expected Hydrology**

The wetland enhancement area typically would be saturated to the surface during the fall, winter, and spring months. Soil saturation and wetland hydrology, which is maintained by high seasonal groundwater levels, will not be affected by the mitigation design. As discussed previously under Constraints, if the RDF is constructed, flood levels during storm events will be slightly lower than they are now.

**Landscape Plan**

The planting plan consists of native shrub or small tree species that tolerate water level fluctuations, tolerate saturated soils during the fall-spring months, are typically found growing in peat soils, and are unlikely to attract significant numbers of avian wildlife (see Section 5.1.2.8; Appendix C, Sheet C2 and L1). Species tolerant of such conditions include hardhack and willows (Taylor 1993). Pacific willow, Sitka willow, and hardhack commonly occur in floodplain wetlands and are tolerant of flooding and inundation for prolonged periods. Plants will be installed in patches of varying species compositions and heights to provide the mosaic of vegetation heights that is consistent with reducing hazard wildlife attractants (Port of Seattle 2000). A temporary irrigation system may be installed in the drier portions of the golf course mitigation site to provide flexibility in planting schedules and to optimize growth rates during the initial plant establishment phase. Irrigation would use municipal water purchased by the Port.

**Des Moines Creek Buffers**

The reach of the west branch of Des Moines Creek south of the Tyee Valley Golf Course wetland mitigation site will be enhanced by planting native riparian trees and shrubs along both banks of the stream (Appendix C, Sheet C2). The riparian buffers[10] will extend 100 ft from the OHWM of the stream. Buffer plants will include black cottonwood, red alder, western red cedar, vine maple, and Nootka rose.

A temporary irrigation system will be installed in the Des Moines Creek buffer to provide flexibility in planting schedules and to optimize growth rates during the initial plant establishment phase. Irrigation would use municipal water purchased by the Port.

### 5.3.1.8 Performance Standard and Contingency

Performance standards, variables to be evaluated (e.g., survival, cover) and specific contingency measures for Des Moines Creek projects are included in Table 5.3-2 and the monitoring schedule is presented in Table 5.3-3.

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[10] A buffer area will be designated around the Tyee Pond (Appendix C); however, no enhancement or mitigation credit is sought for this area.

**Table 5.3-2. Final Performance Standards, Evaluation Approach, and Contingency Measures the Tyee Valley Golf Course and Des Moines Creek Buffer Mitigation Projects.**

| Design Criteria | Performance Standard | Evaluation Approach | Contingency Measures[1] |
|---|---|---|---|
| Plant 5.5 acres of the golf course wetland with native wetland shrub species includes wetland area on left and right branch Des Moines Creek. | Shrub wetland vegetation will be planted on 5.5 acres of golf course. Upland shrub vegetation will occur in about 1.57 acres of buffer. | Verify area requirements with record drawings | Plant additional areas if as-built conditions are not consistent with design |
| | Soils will be saturated within 10 inches of the surface (for at least 2 weeks during the growing season) in years of normal rainfall. | Monitor depth and duration of soil saturation. | Wetland hydrology currently exists on this site, and no changes are likely.<br>Modify surface drainage features |
| Shrub and small trees planted density greater than 3,375 stems per acre | Average survival of planted stock will be at least 80% in the first 3 monitoring years.<br>Canopy cover of native species will be at least 80% by monitoring year 10.<br>Canopy cover of non-native invasive species will be no more than 10% by monitoring year 10. | Vegetation sampling (plots, transects, or plotless techniques) to estimate mortality, cover, density, and presence of invasive species. | If standards are not met:<br>• Select species that are better adapted to existing hydrologic conditions.<br>• Install additional plant material.<br>• Install protective collars to reduce herbivore damage. |
| Plant are with woody vegetation to discourage use of wetland by waterfowl. | Woody vegetation will provide 80% to 100% cover in the wetland mitigation area.<br>No emergent wetland areas will be present occur on the mitigation site. | See above. | See above. |
| Plant 100-ft-wide riparian buffers on each side of Des Moines Creek (approximately 3.38 acres of buffer area). | Designated buffers will total about 3.38 acres and will be outside the location of preferred alternatives for SR 509, South Access Freeway, and RDF construction. | Record drawings and review of planning documents. | Redesign buffer design drawing. |
| Plant native riparian forested and shrub plant species within the 100-ft buffer along Des Moines Creek. | Average survival of planted stock will be at least 80% in the first 3 monitoring years. At this time, tree density will be at least 280 stems per acre and shrub density will be at least 2,100 individuals per acre. By the end of year 3, plant diversity in each stratum will not decrease by more than 10% from the number and type of plants installed at baseline.<br>Tree and shrub canopy cover will be at least 80% by monitoring year 10.<br>Cover of non-native invasiv especies willnot be more than 10% at monitoring year 10. | See above. | See above. |

[1] For all performance standards, monitoring periods may be extended if performance standards are not met.



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**Table 5.3-3. Monitoring schedule for Des Moines Creek Basin Mitigation Projects.**

| Feature | Activity | Duration | Data Collection Year | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Hydrology | Permanent shallow-groundwater measurements will be installed in the planting area. | Monthly for the first three years; Semi-monthly thereafter | X | X | X | X | | X | | X | | X | X |
| Vegetation | Measure plant survival | Late spring or early summer | X | X | X | X | | X | | X | | X | X |
| | Vegetation sampling to determine cover | Late spring or early summer | X | X | X | X | | X | | | | X | X |

### 5.3.1.9 Implementation of Des Moines Creek Projects

The Tyee wetland mitigation and Des Moines Creek buffer enhancements will be coordinated with construction of the RDF. The Port will protect the mitigation sites from RDF construction impacts by placing TESC measures and orange barrier fencing at the edge of the mitigation sites. Ecology blocks will be used to further protect the mitigation sites from RDF construction impacts. Inspections will take place throughout the mitigation construction period to ensure that plans are being implemented as specified, permit conditions are met, and BMPs are installed and operating properly.

A proposed implementation plan for Tyee Wetland Mitigation and Des Moines Creek buffer commencements are presented in Table 5.3-4. Plants in both the wetland mitigation and riparian buffer projects will be installed to reduce hazard wildlife attractants. A landscape architect or wetland scientist will observe plant installation to ensure that plants are installed correctly and according to the plans and specifications.

Plant material used in the mitigation will be obtained from commercial nurseries. Nurseries will be required to certify that the plant material is legally procured and from the appropriate geographic source. The appropriate geographic source for plant material used in the mitigation is defined as the area that is bounded on the north by the Fraser River Valley, B.C.; on the east by the 1,000-foot elevation of the Cascades; on the west by the 1,000-foot elevation in the Olympic or Coast ranges; and on the south by the Willamette Valley.

### 5.3.1.10 Construction Steps

**General Conditions**

- On award of the contract, the contractor will provide the Port with any required pre-construction submittals, work plans, and schedules.
- A pre-construction meeting will be held with the contractor, architect/engineer, and wetland scientist to review submittals, work plans, schedules, and permit conditions.
- The contractor will be responsible for ensuring that the work is performed in compliance with all permit conditions and shall maintain a copy of permits on-site.
- Work will be coordinated to avoid re-entry and damage to areas that have previously been planted; work will be conducted so that no other work will impact completed landscape work.
- Areas where any landscape work has been completed will be off-limits to all vehicular traffic, and pedestrian traffic will be strictly limited.

Plant procurement shall be completed 6 to 12 months prior to the scheduled planting season to ensure that plants are available in the quantities and species required by the planting plan.

**Table 5.3-4. Proposed Implementation Timeline for Tyee Valley Golf Course and Des Moines Creek Buffer Projects.**

| Project/Activity | Year (Year One Starts with the First Construction Season After the Date Permits Are Issued[1]) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year 1 | | | | | | | | | | | | Year 2 | | | | | | | | | | | | Year 3 | | | | | | | | | | | |
| | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D |
| **Tyee Valley Golf Course and Des Moines Creek Buffers** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Preconstruction meeting | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TESC, Site Preparation | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Conduct minor site grading as necessary per plans | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Install plants per planting plan | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Produce record drawings | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Conduct baseline monitoring | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Begin maintenance and compliance monitoring | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

[1] Plant procurement for all projects will be implemented six to twelve months prior to the anticipated planting date to ensure that plants in the specified quantities and species are available by the scheduled planting date. Implementing mitigation projects may vary from this proposed schedule depending upon coordination with other MPU projects and contract obligations.

**Pre-construction Meeting and Site Preparation**

- Establish vertical and horizontal site controls and maintain through construction to record drawings.
- Identify and flag limits of work for mitigation site.
- Identify staging areas, stockpile areas, and temporary access/haul roads.
- Implement TESC plan and install TESC measures.
- Install orange barrier fencing around the site and any vegetation to be protected.
- Install fencing and TESC measures around wetlands to be avoided in borrow areas.
- Maintain security of site through construction.
- Implement a spill control plan and identify fueling areas if needed.

**Clearing, Excavation, and Grading**

- Clear roads and/or culverts from the wetland mitigation site; clear and grub the riparian buffer site.
- Install hydrology monitoring wells at the wetland mitigation site.
- Prepare grading record drawings; modify planting plans as needed to match as-built grades and site conditions.

**Irrigation and Landscaping**

- Install and test irrigation (irrigation will be designed for the wetland mitigation and buffers; however it may not be needed at the wetland mitigation site).
- Apply hydroseed to any areas of exposed soils.
- Winterize the irrigation system.
- Plant shrub wetland and forested buffer vegetation in fall/winter following grading.
- Place sterile organic mulch (e.g., wood fiber) 4 to 6 inches deep between planted stock as a weed barrier.

**Closeout**

- Complete site cleanup by removing temporary haul/access roads and staging areas.
- Remove construction equipment and debris.
- Hydroseed and/or install plants in temporary staging areas or access roads within the mitigation site boundaries.
- Hydroseed erosion control mix in temporary staging areas/access roads outside the mitigation boundaries.
- Install permanent fence and/or signs along mitigation site boundary.
- Install barrier fencing, rock gabions, or ecology blocks at the mitigation site boundary if necessary to protect the site from RDF construction activities.

Record Drawings, Monitoring, and Maintenance

- Produce grading and planting record drawings (i.e., 'as-builts') for wetland mitigation site and riparian buffers.
- Complete a baseline report, including record drawings and final monitoring plan (e.g., locations of monitoring plots, baseline conditions), for the wetland site, riparian buffers, and borrow areas.
- Begin compliance monitoring during first growing season after planting (or excavation for borrow areas) is complete; submit annual monitoring reports for 10-year monitoring period.
- Conduct maintenance (e.g., weed management, WHMP) and implement any necessary contingency measures to meet performance standards.

### 5.3.1.11 Monitoring and Performance Standards

Monitoring for the Des Moines Creek projects will be performed consistent with the approach, methods, and schedule outlined in Chapter 4 of this report. The focus of monitoring for the Des Moines Creek basin mitigation projects will be to:

- Evaluate the establishment of native wetland and riparian vegetation in the Tyee Valley Golf Course wetland and the Des Moines Creek buffers.
- Monitor groundwater and surface water levels at the Tyee Valley Golf Course wetland mitigation site.

Hydrology, vegetation and hazard wildlife monitoring will be conducted consistent with the approach and methods described in Chapter 4. Groundwater monitoring will be conducted on the Tyee Valley Golf Course mitigation site to evaluate seasonal variation in groundwater levels on the site.

Hydrologic Monitoring

A series of permanent shallow-groundwater monitoring wells will be installed in the enhanced wetland area at the Tyee Valley Golf Course to evaluate seasonal variation in groundwater levels on the site. Groundwater levels will be recorded monthly for the first 5 years of the mitigation and every other month thereafter. The exact number and location of the wells will be determined after location of the enhancement area has been established. Wells will be installed by a licensed well-driller and recorded with Ecology.

Vegetation Monitoring

The plantings at the Tyee Valley Golf Course wetland mitigation site and within the Des Moines Creek riparian buffer will be monitored over a minimum 10-year period that begins when plant installation is complete. Monitoring activities will take place n years 0, 1, 2, 3, 5, 7, 9, and 10 to determine species composition, survivorship, height, percent cover, density, and general health and vigor (see Table 5.3-3). Specific performance standards, parameters to measure and contingency measures for the Des Moines Creek projects are given in Table 5.3-2. Vegetaion monitoring will follow standard vegetaion sampling protocols as described in Chapter 4.

**Wildlife Monitoring**

The Port will perform wildlife monitoring in the wetland enhancement area according to requirements of the Wildlife Hazard Management Plan (Port of Seattle 2000). Based on the results of the wildlife monitoring, alterations to vegetation or hydrologic conditions may be necessary to comply with FAA requirements and the Wildlife Hazard Management Plan.

#### 5.3.1.12 Site Protection

The Port will execute and file a restrictive covenant for the Des Moines Creek mitigation area. Copies of proposed restrictive covenants are included in Appendix G.

#### 5.3.1.13 Maintenance and Contingency Plan

Routine maintenance tasks (e.g., maintaining irrigation system, removing trash) and adaptive management/contingency measures (e.g., weed management, re-placing plants) will be required during the monitoring period. Routine maintenance and contingency measures will be implemented consistent with the approach described in Chapter 4. Specific contingency actions for each wetland and riparian buffer performance standard are given in Table 5.3-2.

### 5.3.2 Des Moines Creek Basin Trust Fund for Watershed Rehabilitation

The Port will establish a trust fund for watershed rehabilitation projects in the Des Moines Creek basin in direct response to requests by the public and agencies to implement additional mitigation actions that would enhance stream and aquatic habitat throughout the Des Moines Creek watersheds. The trust fund would focus on portions of Des Moines Creek not owned by the Port. The Port is committed to making the funds available and deferring to other governmental agencies and interested groups in the selection of appropriate projects.

#### 5.3.2.1 Goals

The goal of this mitigation action is to enhance instream or riparian habitat for salmonids and other aquatic organisms of Des Moines Creeks on land not owned by the Port.

#### 5.3.2.2 Description

The trust fund for watershed restoration provides $150,000 for restoration projects in the Des Moines Creek basin. Project information for potential projects eligible for funding by the trust fund is based on information provided in the Des Moines Creek Basin Plan (Des Moines Creek Basin Committee 1997) (Table 5.3-5). The trust fund would be established by the Port to fund watershed projects that result in direct habitat benefits to aquatic life in the streams or to remove documented water quality impacts.

Examples of projects eligible for full or partial funding could include instream fisheries habitat improvements (e.g., see Figures 5.2-8 through 5.2-11) riparian buffer enhancement, removal of fish passage barriers, and removal of failed septic systems. Additional planning and engineering of selected projects would result in specific project designs, performance standards, monitoring requirements, and contingency measures.

The trust fund would have a sunset clause of 2 years following issuance of MPU permits. If after a 2-year period projects are not designed and permits have not been sought,[11] the Port would use the money to implement those project(s) identified in the Des Moines Creek Basin Plan that provide water quality or aquatic habitat benefits. Project proponents will be responsible for obtaining any federal, state, and local permits required to implement the projects. The project(s) to be implemented would be at the discretion of the Port, but with approval from Ecology and the ACOE.

#### 5.3.2.3 Eligibility

The Port, or designated administrator, will consider requests for monies from the watershed trust fund to implement stream habitat enhancement projects. Requests must be made by King County, the cities of SeaTac or Des Moines, tribal governments, non-profit organizations, or combinations of such governments through interlocal agreements. Organizations requesting funding must comply with general liability insurance requirements established by the Port.

Key criteria to be used in evaluating proposals to implement projects in Table 5.3-5, as well as other projects within the watershed include the following:

- A demonstrated benefit to salmon or aquatic habitat without creating significant avian wildlife habitat within 10,000 ft of runways at STIA
- Consistency with watershed management plans, or with prescriptions/recommendations identified using watershed analysis or stream assessment procedures
- Clearly defined project goals, implementation plans, performance standards, and post-project monitoring
- Preference for resolving underlying causes of problems rather than treating symptoms
- Cost-effectiveness

#### 5.3.2.4 Implementation

The Des Moines Creek Basin Committee, the King County Watershed Coordinator, or other responsible entity would administer the fund. The administrator would establish eligible project criteria, application forms, project cost limits, implementation and monitoring requirements, etc.

#### 5.3.2.5 Site Protection

Areas located within property owned by the Port, specifically within Des Moines Creek watershed, would be protected in perpetuity and development actions restricted. Site protection of enhancement projects would be coordinated with property owners and the fund administrator.

[11] The project proponents will be responsible for obtaining federal, state, and local permits required to implement the projects.

**Table 5.3-5. Summary of potential trust fund projects in the Des Moines Creek watershed (projects are as described in the Des Moines Creek Basin Plan, 1997).**

| Project | Goals | Description | Performance Standards | Monitoring | Cost Estimate[1] |
|---|---|---|---|---|---|
| **Habitat Improvements** | | | | | |
| Ravine reach [2] (River Mile [RM] 1.0-1.85) | Stabilize steep channel.<br>Provide channel geometry that responds positively to predicted flows. | Construct 20 rock weirs throughout the reach. | Rock weirs remain secure/intact for 10 years. | Assess function and any movement of rock weirs once a year at end of wet season. | $50,000 |
| Treatment plant [2] (RM 0.4-1.0) | Provide pool habitat.<br>Increase channel complexity.<br>Reduce the risk of bank failure adjacent to sewer line access road by diverting high-velocity flows away from road. | Place 4 LWD complexes (4 to 6 logs each) on outside bends and/or channel spanning; install 15 small rock deflectors, each spanning 40% of channel (half immediately upstream of LWD complexes, half in high-velocity areas diverting flow from bank); place five small groups (3 to 5 rocks per group) of fish and turning rocks. | LWD complexes, rock deflectors, fish and turning rocks remain secure/intact for 10 years. | Assess functions of LWD complex, rock deflectors, fish and turning rocks; document shifting or accumulation of debris once a year at end of wet season. | $130,000 |
| Park reach [2] (RM 0.0-0.4) | Increase pool habitat.<br>Increase channel complexity. | Place one LWD complex (4 to 6 logs) on outside bend and/or channel spanning; install four small rock deflectors each spanning 40% of channel (half immediately upstream of LWD complexes, half in high-velocity areas diverting flow from bank); install one small group (3 to 5 rocks) of fish and turning rocks. | LWD complexes, rock deflectors, fish and turning rocks remain secure/intact for 10 years. | Assess function of LWD complexes, rock deflectors, fish and turning rocks; document shifting or accumulation of debris once a year at end of wet season. | $50,000 |
| Wetland reach (RM 1.85-2.15) | Maintain/enhance natural flood storage function of wetland system. | Add woody debris to stream and/or buffer. | Installed habitat features remain secure/intact instream channel for 10 years. | Assess functions of installed habitat features; document shifting or accumulation of debris once a year at end of wet season. | $10,000 |
| **Septic systems** [2] | | | | | |
| | Reduce fecal coliform levels and improve other water quality parameters in Des Moines Creek. | Identify houses within areas not connected to sanitary sewer.<br>Connect chronic septic system problems to sewer lines. | Identified houses are connected to sewers and septic systems are decommissioned. | As-built monitoring to verify completion. | $ 150,000 |

1 This cost estimate reflects 1997 dollars.
2 Identified as "regional high priority" in the basin plan.



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#### 5.3.2.6 Monitoring and Contingency

The fund administrator would review project design, implementation, and as-built plans to verify that intended project had been built. Contingency actions associated with establishment or operation of the fund will be reviewed with the Port, ACOE, Ecology, and the fund administrator.

### 5.3.3 Indirect Impacts to Borrow Area Wetland Hydrology

Borrow Areas 1 and 3 will be excavated to provide fill material for the third runway and embankment construction (see Figure 4.1-2). Borrow area excavations have been designed to the extent practicable to avoid direct impacts to wetlands. Hydrological studies conducted by Hart-Crowser (Hart Crowser 2000a, 2000b) indicate that the potential for indirect impacts to the hydrology of wetlands near the borrow areas is low. To avoid and minimize potential indirect impacts, the borrow areas will be graded to provide drainage systems to collect surface runoff and/or groundwater seepage and direct this water to the wetlands.

Following construction, groundwater levels will be monitored in wetlands near the borrow areas to verify that wetland hydrology is present and able to maintain existing vegetation (Table 5.3-6). Actions taken to avoid, minimize, and mitigate for potential indirect impacts to wetland hydrology adjacent to the borrow areas are not included in the calculation of mitigation credit for the MPU projects.

#### 5.3.3.1 Borrow Area Site Description

The borrow areas are located south of the airfield between 24th Avenue South and 15th Avenue South, and between South 200th Street and South 216th Street (see Figure 1.3-1). Most of this area was formerly residential neighborhoods. Between 5 and 20 years ago, the area was acquired and cleared as part of STIA's noise abatement program.

Borrow Area 1 is located to the east of Des Moines Creek. The area slopes toward Des Moines Creek. Nine wetlands are located in Borrow Area 1 (Wetlands B1, B4, B11, B12, B14, B15a, B15b, 32 and 48).

Borrow Area 3 is located to the west of Des Moines Creek. The borrow area is bordered on the west by a relatively level plateau that slopes steeply down to a series of depressions in the southeast portion of the borrow area (Appendix G, Figure 1). The northern half and the western edge of the borrow area are high points approximately 40 ft to 120 ft higher than the low point in the southeast corner. Eight wetlands occur in Borrow Area 3 (Wetlands B5, B6, B7, B9a, B9b, B10, 29, and 30).

#### 5.3.3.2 Hydrology of Borrow Area Wetlands

Borrow Area 1 contains both groundwater dominated and precipitation dominated wetlands. Wetlands B1, B11, B14, and 32 are depressional wetlands maintained by precipitation and surface water runoff. Wetlands B4, B12, B15 and 48 are slope wetlands maintained by groundwater seepage. Water surfacing in these slope wetlands flows downslope to Des Moines Creek. Surface water hydrology in the general vicinity of Borrow Area 1 has been altered by the system of storm drains, culverts, and drainage ditches constructed when the area was developed. Since clearing of

**Table 5.3-6. Final Performance Standards, Evaluation Approach, and Contingency Measures for Monitoring Borrow Area Wetlands.**

| Design Criteria | Performance Standard | Evaluation Approach | Contingency Measures[1] |
|---|---|---|---|
| Maintain wetland hydrology by redirecting surface water runoff to the wetlands near Borrow Area 1. | Soils in Wetlands near Borrow Area 1 (48, B15a, 15b) will have soils saturated to the surface from December to March or April in years of normal rainfall. | Shallow groundwater monitoring wells | Minor regrading to direct surface water runoff to wetlands |
| Maintain wetland hydrology by directing groundwater seepage and surface water runoff via an interceptor swale to wetlands in and near Borrow Area 3. | Soils in Wetland 30 will be saturated to the surface from December to May in years of normal rainfall. | Shallow groundwater monitoring wells | Adjust length and discharge points of interceptor swale system |
| | Wetland 30 will have shallow standing water during the breeding season for resident amphibians (i.e., December to April). | | |
| | Wetland 29 will have soils saturated to the surface from December to April in years of normal rainfall. | Shallow groundwater monitoring wells | Adjust length and discharge points of interceptor swale system |

[1] For all performance standards, monitoring periods may be extended if performance standards are not met.

the area for the noise abatement program, these surface drainage features have been abandoned and begun to deteriorate to such an extent that past drainage patterns are changing.

In Borrow Area 3, Wetland 29 occurs on the hillside at the west edge of the borrow area. Hydrology in this wetland is supported by groundwater seeps discharging on the face of the slope from a zone of perched groundwater that extends to the north and west (Hart-Crowser 2000a, b, c). Wetlands 30, B7, B6, and B5 occupy a series of depressions in the lower southeastern corner of Borrow Area 3. These wetlands may be supported by some shallow subsurface flow or interflow moving down slope from Wetland 29 (Hart-Crowser 2000c), and by precipitation. Since these wetlands occur below the main perched groundwater layer on this site the groundwater is available to support wetland hydrology. Water is held in these wetlands by the relatively impermeable soils lining the depressions, promoting shallow perched conditions (Hart-Crowser 2000c).

#### 5.3.3.3 Actions to Avoid, Minimize, and Mitigate Indirect Impacts

**Borrow Area 1**

The excavation in Borrow Area 1 has been designed to avoid direct impacts to Wetlands B1, B4, B15a, B15b, 32, and 48 (see Figure 3.1-2). Indirect impacts to wetlands which are downslope of the borrow area will be minimized by not excavating portions of the borrow area that lie within the watershed of these wetlands. Hydrology in these wetlands appears to be maintained by seasonal groundwater that perches on the till soils following periods of high rainfall. The existing stormwater drainage system on 20th Avenue South collects surface runoff and directs it away from these wetlands. This stormwater drainage system forms the eastern edge of the watershed for Wetlands 48, B15a, and B15b. Since excavation will not occur west of 20th Avenue South, the watersheds of these wetlands will not be altered and indirect hydrologic impacts are not expected to occur.

Wetland hydrology will be monitored in Wetlands 48, B15a, and B15b to verify that wetland hydrology continues to be present in these wetlands (see Table 5.3-6).

**Borrow Area 3**

A drainage swale will be installed following excavation of Borrow Area 3 to convey groundwater to Wetland 29 and replace the potential loss of seepage from the perched groundwater zone (Appendix G, Figures 3, 7, 8). This swale will collect groundwater seepage from the excavated slope face on the north and west sides of Borrow Area 3. Flow in this swale will be collected and conveyed south in a swale that drains into Wetland 29 (Appendix G, Figure 3).

Since the swale will extend for the full length of the seepage face in the borrow area, it may convey flows in excess of those needed to support hydrology in Wetland 29 and downslope wetlands (i.e., Wetland 30 which receives overland flow and shallow interflow from Wetland 29). To manage excess flows and to optimize the distribution of water to Wetland 29, two measures will be used. A flow control structure (weir and diversion structure) will be constructed in the swale just before it flows into Wetland 29 (Appendix G, Figure 9). This control structure will allow a controlled flow rate to be directed into Wetland 29 and enable diversion of other flows away from the wetland and into the base of Borrow Area 3. Diverted flows will either be allowed to infiltrate at the base of

Borrow Area 3 or be diverted to stormwater management facilities that will be constructed to manage runoff from the remainder of the borrow area. The length of the collector swale can also be modified (consistent with the adaptive management approach) based on post-construction monitoring to control the amount of seepage and runoff that is collected in the swale and diverted to Wetland 29.

Studies of borrow area hydrology indicate that impacts to the hydrology of the remaining wetlands in Borrow Area 3 (B5, B6, B7, B9a, B9b, B10, and 30) are not anticipated (Hart Crowser 2000a, b, c). Wetlands in Borrow Area 3 will be monitored before, during, and after excavation to verify that wetland hydrology will remain. If Wetlands 29 and 30 do not meet hydrologic performance standards developed for them (see Table 5.3-6), then contingency measures will be implemented. The collector swale system also can be used to divert additional water to Wetlands 29 if necessary.

### 5.3.3.4 Hydrology Monitoring

Permanent shallow groundwater monitoring wells will also be installed in wetlands near borrow areas to verify there are no indirect hydrologic impacts. Groundwater levels will be recorded monthly for the first 5 years, and then every other month thereafter. In addition, a staff gage will be installed in Wetland 30 to allow monitoring of the extent and duration of surface water ponding that provides habitat for amphibians. Surface water levels will be recorded monthly for the 5 five years, and then every other month thereafter.

Stormwater
Management

# 6. HYDROLOGIC IMPACTS AND MITIGATION

This chapter describes actions incorporated into the STIA Master Plan Update improvements to mitigate potential impacts to water quantity and quality in the Miller, Walker, and Des Moines Creek basins. Existing water quantity and quality conditions, future changes in land use that affect surface water runoff, and projected future conditions under the Master Plan Update improvements and the proposed mitigation actions are summarized in this chapter.

Section 6.1 describes the proposed stormwater management program to control stormwater peak flow rates and flow durations from both newly developed project areas and existing airport areas. Proposed facilities, including approximately 319.2 acre-ft of new stormwater detention storage at 14 locations, will mitigate the impacts of new impervious surfaces on flows in Miller, Walker, and Des Moines Creeks. Section 6.2 summarizes actions to mitigate water quality impacts, including water quality treatment using BMPs and source controls, erosion and sediment control, and elimination of existing activities that degrade water quality. The flow control and water quality mitigation activities summarized below are based on stormwater information provided in the *Comprehensive Stormwater Management Plan* (SMP) (Parametrix 2000a).

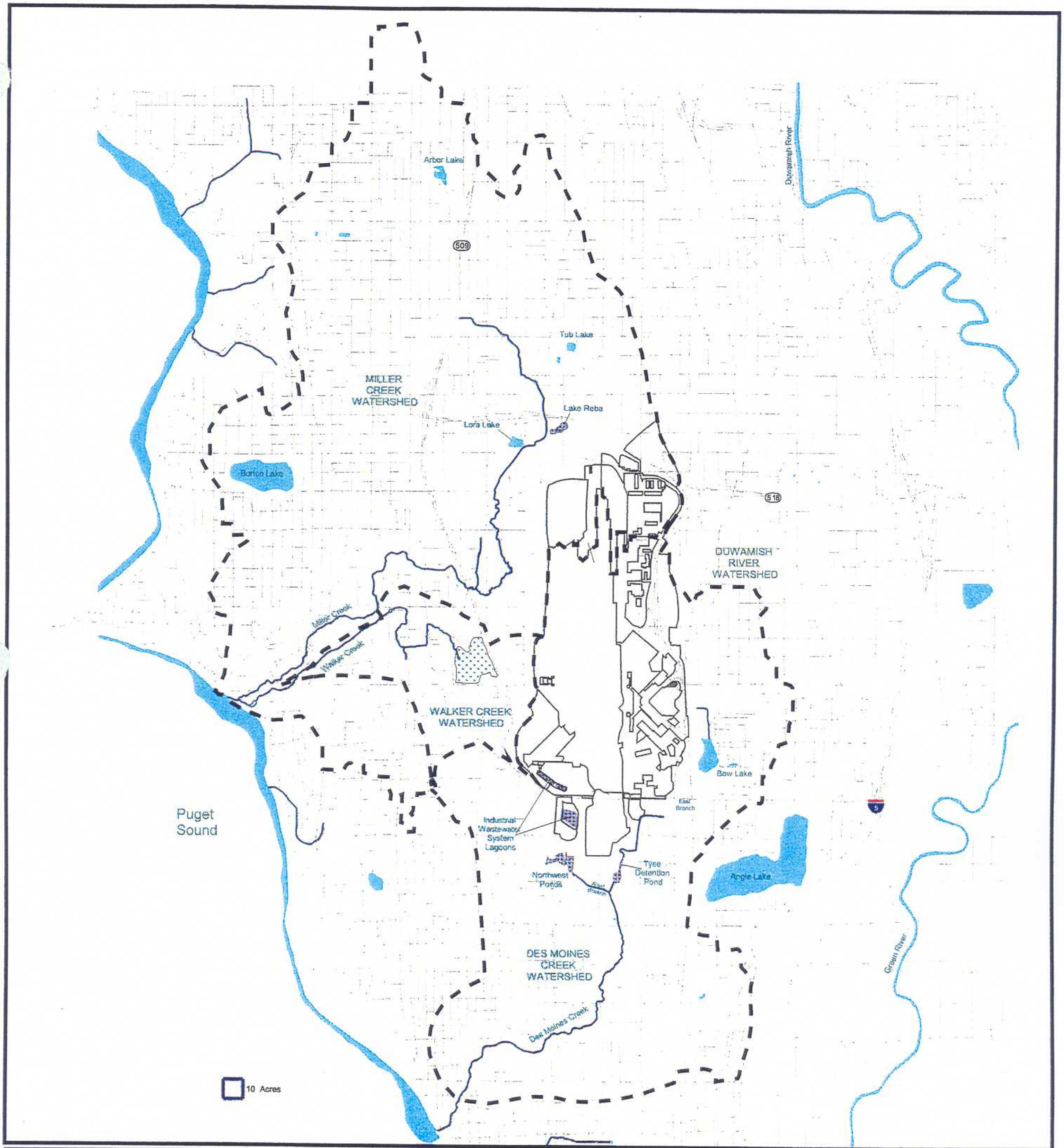
## 6.1 WATER QUANTITY

The Master Plan Update improvements could increase peak flows and reduce base flows in Miller, Walker, and Des Moines Creeks (Figure 6.1-1), thereby impacting aquatic habitat in these streams. The addition of new impervious area associated with the Master Plan Update improvements affecting the hydrology of these streams is discussed in the following sections, along with associated mitigation measures that compensate for these actions.

### 6.1.1 Stormflow Impacts

The activities associated with the Master Plan Update improvements will include adding new impervious surfaces (new runways, taxiways, parking, and roadways) and filling wetlands. This action, if unmitigated, could change the hydrologic flow regime of Miller, Walker, and Des Moines Creeks, including increased peak flow magnitude and frequency, and increased elevated flow duration. The potential effects of high-flow impacts in the stream are increased erosion and sedimentation, habitat damage from scouring flows, and impaired habitat use during high-flow periods.

Proposed peak flow mitigation reduces peak flows from existing levels in both streams, which will reduce bank and channel erosion as well as sedimentation in downstream reaches, including estuaries. Additional detail on hydrology and stormwater management are provided in the SMP (Parametrix 2000a). The plan includes modeling conducted to estimate the impacts of the project on the Miller, Walker, and Des Moines Creek systems. The Hydrologic Simulation Program – FORTRAN (HSPF) model was used for this purpose.




Parametrix, Inc. Sea-Tac Airport Stormwater Management Plan/556-2912-001(28) 6/00 File: K:\Gis\2912\Arcview\BAFig1.apr
Source: Roads based on King County data. Water bodies derived from USGS hypsography data. Detention boundaries are approximate.
Note: Subbasin boundaries shown outside of STIA area are for illustration and reference only.
STIA subbasins assume future (2006) conditions.

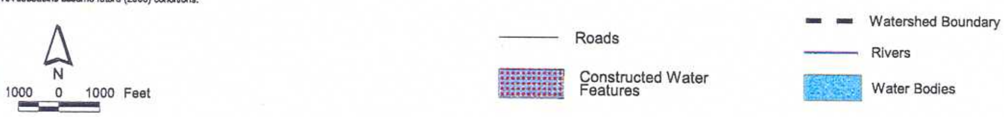



**Figure 6.1-1**
**Miller, Walker, and Des Moines Creek Watersheds**

#### 6.1.1.1 Wetland Fill

The potential impacts to the hydrology of Miller, Des Moines, and Walker Creeks from filling 18.37 acres of wetlands are the loss of stormwater storage, groundwater recharge, and groundwater discharge. These functions are discussed below, and all wetland hydrologic functions are accounted for in the HSPF model, which assesses runoff impacts by various input parameters and calibration.

**Stormwater Storage**

Most wetlands filled by the project provide limited stormwater storage because the wetlands do not occur in closed basins or basins with restricted outlets that would allow water to pond during storms, and release water slowly following storms. Most wetlands occur on moderate to gentle slopes and are free-draining (seldom, if ever, ponding water).

In contrast, flood storage functions are provided by the riparian wetlands located in the 100-year floodplain of Miller Creek. Approximately 8,455 cy of flood storage would be filled at Vacca Farm, and approximately 9,589 cy of new floodplain will be excavated adjacent to the stream. All flood storage, including that provided by wetlands, is accounted for in the calibration of the HSPF model; design of stormwater detention facilities using this model will assure that flow mitigation is provided to account for impacted wetlands.

**Groundwater Discharge**

Several wetlands are sites of groundwater discharge, and thereby potentially provide base flow support to streams during all or portions of the year. Where fill occurs in these wetlands, the project has been designed to allow these discharge functions to continue. For example, the third runway embankment is designed with an internal drainage system that will collect water that currently infiltrates on the airfield and discharges in wetlands near 12th Avenue South. The drainage system will also collect water that infiltrates into the new embankment, and discharge it to wetlands and Miller Creek (see Chapter 5). Drainage systems associated with the retaining wall, which will be constructed to reduce wetland impacts, will also convey groundwater downslope to wetlands and the stream. Groundwater discharge effects on base flow are accounted for in the calibration of the HSPF model.

**Groundwater Recharge**

Most wetlands affected by fill are unlikely to have significant groundwater recharge functions because most of these wetlands occur on till soils, where layers of till restrict groundwater recharge. These low permeabilities result in poor drainage conditions, which in combination with topography and surface drainage features, promote the development of wetlands. Other wetlands occur in areas of known groundwater discharge (i.e., wetlands formed by local groundwater discharges) and thus cannot recharge groundwater. However, the HSPF model is based on the premise that all wetlands infiltrate; thus the model conservatively accounts for potential impacts to groundwater recharge as a result of filling these wetlands. Overall, development of impervious surfaces from Master Plan Update improvements could reduce groundwater recharge and eventual groundwater discharge to streams. These functions are accounted for in the HSPF model, and mitigation for these effects is included in the activities discussed in Chapters 5 and 7 of this document, as well as in the SMP (Parametrix 2000a).

#### 6.1.1.2 Indirect Hydrologic Impacts/ Impact Avoidance

Where feasible and practicable, direct and indirect impacts to the hydrologic functions of wetlands (base flow, groundwater discharge, and stormwater storage) have been avoided (Parametrix 2000a,b). For example, within the three borrow areas, direct and indirect impacts to hydrologic functions of wetlands were avoided or minimized by protecting several wetlands and their upslope watersheds from excavation. Wetlands located downslope of excavation or fill areas will continue to receive ground and surface water from upslope areas because BMPs for water quality, site grading, and other surface water management features will allow clean water to continue to discharge to them. Additionally, rainwater will continue to infiltrate on the borrow sites because no impervious surface will be added, and this water will be available to recharge downslope wetlands and Des Moines Creek.

#### 6.1.1.3 Impervious Area

In the Miller Creek Basin, Master Plan Update improvement projects will result in a net increase of 105.6 acres[12] of impervious surface area (Table 6.1-1), increasing the overall impervious area in the basin by about 1 percent above the existing baseline condition (about 23 percent of impervious surface; Parametrix 1999). In the Walker Creek Basin, Master Plan Update improvements will result in a net increase of 6.2 acres of impervious surface. In the Des Moines Creek Basin, Master Plan Update improvements will result in a net increase of 128.2 acres of impervious surface, increasing the overall impervious area in the basin by about 4 percent above the existing base condition (approximately 32 percent impervious surface; Parametrix 1999).

The new impervious surfaces could increase stormwater runoff rates (FAA 1996) and volumes. Unless mitigated, changes in runoff would be expected to increase flooding and erosion, and would degrade instream habitat and water quality in Miller, Walker, and Des Moines Creeks downstream of stormwater inputs from the improved areas. As discussed below, the Port's SMP includes mitigation to manage runoff from newly developed Master Plan Update improvement areas. In addition, existing hydrologic impacts from existing impervious surfaces will be mitigated.

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[12] The net change in impervious area includes removal of approximately 50 acres of impervious surfaces (streets, driveways, and rooftops) that will result when existing houses and streets are removed in the acquisition area. Demolition in these areas is ongoing and is expected to be completed by 2002.

**Table 6.1-1. Summary of Miller, Walker, and Des Moines Creek drainage areas at STIA and change in impervious area between 1994 baseline and 2006 future conditions (acres).**

| | 1994 Baseline | | | 2006 Future Condition | | | Increase in Impervious Area |
|---|---|---|---|---|---|---|---|
| | Pervious | Impervious[1] | Total | Pervious | Impervious[1] | Total | |
| **Miller Creek** | | | | | | | |
| SDN1 | 6.2 | 9.9 | 16.1 | 3.5 | 12.7 | 16.1 | 2.8 |
| SDN1LWR | 5.0 | 0.4 | 5.4 | 4.9 | 0.6 | 5.4 | 0.2 |
| SDN1OFF | 25.8 | 10.5 | 36.3 | 28.3 | 8.0 | 36.3 | -2.5 |
| SDN2X | 7.2 | 0.3 | 7.5 | 5.3 | 2.2 | 7.5 | 1.9 |
| SDN3 | 33.4 | 14.5 | 47.9 | 23.6 | 24.3 | 47.9 | 9.8 |
| SDN3A | 28.6 | 1.9 | 30.5 | 22.2 | 8.2 | 30.5 | 6.3 |
| SDN3X | 25.4 | 0.0 | 25.4 | 25.4 | 0.0 | 25.4 | 0.0 |
| SDN4 | 27.7 | 2.6 | 30.3 | 18.1 | 12.3 | 30.3 | 9.7 |
| SDN4X | 14.1 | 1.1 | 15.2 | 11.0 | 4.2 | 15.2 | 3.1 |
| SDW1A | 52.0 | 0.9 | 52.8 | 37.4 | 15.4 | 52.8 | 14.5 |
| SDW1B | 92.5 | 4.3 | 96.9 | 69.9 | 27.0 | 96.9 | 22.7 |
| NEPL | 41.4 | 0.9 | 42.3 | 10.0 | 32.3 | 42.3 | 31.4 |
| CARGO | 7.0 | 1.1 | 8.1 | 0.0 | 8.1 | 8.1 | 7.0 |
| Other STIA[2] | 246.5 | 15.1 | 261.8 | 247.8 | 13.8 | 261.8 | -1.3 |
| **Total** | | | | | | | **105.6** |
| **Walker Creek** | | | | | | | |
| SDW2 | 41.3 | 3.3 | 44.6 | 35.1 | 9.5 | 44.6 | 6.2 |
| M8 | 22.2 | 6.6 | 28.8 | 22.2 | 6.6 | 28.8 | 0.0 |
| M9 | 76.1 | 22.5 | 98.6 | 76.1 | 22.5 | 98.6 | 0.0 |
| **Total** | | | | | | | **6.2** |
| **Des Moines Creek** | | | | | | | |
| SDE4 | 50.7 | 115.5 | 166.2 | 40.1 | 126.1 | 166.2 | 10.6 |
| SDS1 | 0.9 | 16.8 | 17.7 | 1.4 | 16.3 | 17.7 | -0.5 |
| SDS2 | 7.7 | 1.5 | 9.2 | 8.1 | 1.0 | 9.2 | -0.5 |
| SDS3 | 165.5 | 178.0 | 343.5 | 144.3 | 199.2 | 343.5 | 21.2 |
| SDS3A | 62.7 | 7.1 | 69.8 | 34.6 | 35.1 | 69.8 | 28.0 |
| SDS4 | 45.4 | 19.2 | 64.6 | 32.1 | 32.5 | 64.6 | 13.3 |
| SDS5 | 32.1 | 0.4 | 32.5 | 28.3 | 4.2 | 32.5 | 3.8 |
| SDS6 | 12.5 | 4.3 | 16.7 | 13.5 | 3.2 | 16.7 | -1.1 |
| SDS7 | 83.2 | 8.0 | 91.3 | 55.1 | 36.2 | 91.3 | 28.2 |
| SASA | 25.3 | 8.9 | 34.3 | 0.0 | 34.3 | 34.3 | 25.4 |
| Other STIA[3] | 136.1 | 57.7 | 194.4 | 136.0 | 57.5 | 193.5 | -0.2 |
| **Total** | | | | | | | **128.2** |
| **IWS** | | | | | | | |
| NCPS | 6.9 | 28.8 | 35.7 | 4.8 | 30.9 | 35.7 | 2.1 |
| NSMPS | 6.6 | 0.0 | 6.6 | 4.7 | 2.0 | 6.6 | 2.0 |
| NSPS | 0.3 | 13.5 | 13.8 | 0.3 | 13.4 | 13.8 | -0.1 |
| Primary | 24.9 | 277.6 | 302.6 | 13.5 | 289.1 | 302.6 | 11.5 |
| SASA | 51.8 | 6.5 | 58.3 | 0.1 | 58.3 | 58.4 | 51.8 |
| **Total** | | | | | | | **67.3** |
| **TOTAL** | **1465.0** | **839.7** | **2305.8** | **1157.7** | **1147.0** | **2304.9** | **307.3** |

Note: Rows may not total exactly as shown due to rounding. Source: GIS coverage.
[1] Impervious area includes impervious area, lakes, and detention ponds.
[2] Includes subbasins M6, MC1, MC2, MC3, MC4, MC5, MC6, MC7.
[3] Includes subbasins D5, D6, D11, D13.

### 6.1.1.4 Flow Control for New Master Plan Update Improvements and Retrofitting for Existing Airport Areas: Level 2

To protect instream and estuarine habitat, the Port has committed to achieving stream flows that maintain or reduce existing peak flow magnitude and duration in Miller and Des Moines Creeks. The Level 2 flow control standard, as defined by the King County Manual (King County DNR 1998), requires matching or improving post-developed flow duration to pre-developed flow durations[13] for all flow magnitudes between 50 percent of the 2-year event and the full 50-year event.

The Level 2 analysis is more protective than stormwater control standards that have been used in the past. Previous controls allowed using an "event model," which is a hydrologic model that compares pre-development runoff with post-project runoff using a hypothetical design storm; only peak flows were evaluated for compliance with standards. The Level 2 analysis used in the SMP requires that a "continuous simulation" model (HSPF) be used and actual precipitation runoff is modeled. Pre-development runoff is compared with post-project flows over a range of probable flows. Level 2 flow analysis evaluates flow protection and mitigation measures over a wide range of erosive stormflows, whereas Level 1 analysis and event models are only protective of certain peak flows or flooding events. Level 2 is more protective of stream morphology, habitat (such as stream substrate), and hydrologic flow patterns.

The pre-developed condition for the Level 2 standard will be based on a *target flow regime*. The target flow regime used assumes that the existing watershed land cover is 10 percent impervious (or less if the existing impervious area is less that 10 percent impervious), 15 percent pervious "grass," and 75 percent pervious "forest."[14] Basing target flow on theoretical basin development of 10 percent (Miller Creek and Des Moines Creek existing impervious areas are 23 percent and 32 percent, respectively) is expected to reduce existing peak flows and be beneficial in maintaining stable stream channels (Parametrix 1999).

In the Des Moines Creek Basin, the target flow regime was determined in a study by the University of Washington (King County CIP Design Team 1999). The flow regime determined for Des Moines Creek coincides with a target flow regime that would occur with an effective watershed impervious area of 10 percent. In studies of several Puget Sound streams, Booth and Jackson (1997) identified an approximately 10 percent impervious area threshold above which stream channel instability and habitat degradation occur.

The net result of flow retrofitting in the watersheds will be to reduce existing stormwater peak flows downstream of STIA in Miller and Des Moines Creeks *before flow impacts and controls for the Master Plan Update improvements are considered*. That is, even though the Miller Creek and Des Moines Creek watersheds have an existing impervious area of about 23 and 32 percent, respectively

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[13] Flow duration control refers to limiting the duration of geomorphically significant flows (i.e., those flows that initiate bedload movement) to baseline (pre-Master Plan Update) conditions.

[14] In areas where existing impervious area is less than 10 percent, the impervious area is not changed and the difference between actual percent impervious and 10 percent is assumed to be grass.

(Parametrix 1999), the flows from areas draining the airport would be reduced to a level corresponding to approximately 10 percent impervious area.[15]

#### 6.1.1.5 Estimated Detention Storage Requirements

Proposed stormwater detention facilities for the Master Plan Update improvements were designed based on the drainage area served by each facility, the detention standard, the detention storage volume required to meet the flow control standards, and potential for waterfowl attraction. Approximately 326 acre-ft of new stormwater detention storage will be needed to mitigate the impacts of increased stormwater runoff (Table 6.1-2) associated with Master Plan Update improvements. The locations of new facilities are shown in Figure 6.1-2.

For sub-watersheds draining to the Des Moines Creek RDF or the Miller Creek Detention Facility, additional future analysis by the Port or the Basin Committees may show that the target flow and Level 2 standards can be met in the regional facilities. Stormwater detention facilities shown by the Port may be modified, with approval by Ecology, to reflect using available detention in the regional facilities. In either case, the objective to meet the target flow using the Level 2 standard for both streams will be achieved.

**Pond and Vault Construction and Operation**

The feasibility of proposed stormwater ponds and vaults is demonstrated by the recent construction of similar facilities at STIA, including the NEPL Vault (1997) and the Interconnecting Taxiways Vault (1998). Only the SASA detention pond will displace wetlands, a 0.06-acres shrub wetland. All other on-site detention facilities will be constructed in non-wetland areas. The primary discharge from the detention facilities will be surface discharge (not infiltration). However, infiltration is proposed at two stormwater facilities, SDW1A and SDW1B, to enhance base flows and reduce detention facility size. Detention facilities will consist of dry ponds with live storage[16] and will not include wet ponds with dead storage.[17]

**Net Result of Hydrologic Mitigation**

The net result of flow controls for the Master Plan Update improvements will be to maintain or reduce peak flows in Miller, Walker, and Des Moines Creeks to a stable flow regime downstream of STIA discharges (Tables 6.1-3 and 6.1-4). Stormwater facilities will retrofit existing flows to the target watershed flow regime pre-development conditions before new development is considered. The net effect of flow controls for Miller, Walker, and Des Moines Creeks (Figures 6.1-3, 6.1-4, 6.1-5, and 6.1-6) will be to maintain stormflows below existing conditions or the target watershed flow regimes following Master Plan construction and peak flow mitigation, whichever is less. The target flow regime will reduce flows in the stream channels, thereby reducing erosion and improving channel stability.

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[15] The HSPF model was calibrated with recorded flow data and actual basin land use prior to simulation of adding Level 2 flow control retrofits. The calibration accounts for flows attributable to each type of land use, based on existing conditions. Flows for other land use and hydrologic control conditions (such as 10 percent impervious surfaces and the Level 2 flow control retrofit) were then simulated using the HSPF model.

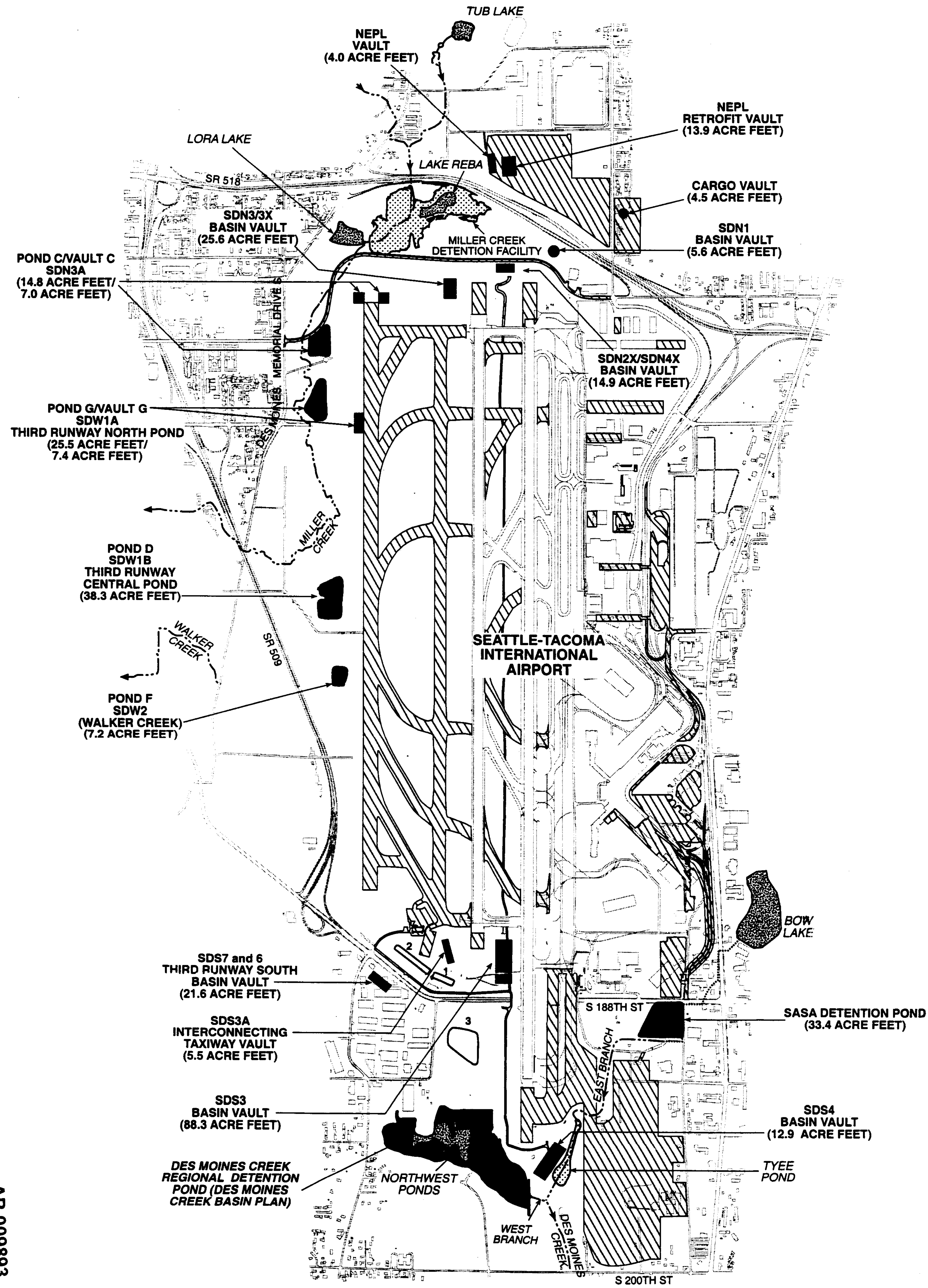
[16] Live storage is that volume of stormwater stored in a detention facility that drains following the storm. Live storage is used for hydrologic benefit to reduce flow peaks and durations.

[17] Stormwater for supplemental low stream flow may be stored as dead storage in vaults.

**Table 6.1-2. Summary of required detention facility volumes.**

| Watershed | Hydrologic Evaluation Point | Volume Required (acre-ft) | Type of Facility[1] | Comments |
|---|---|---|---|---|
| **Miller Creek** | NEPL | 13.9[2] | Vault | In addition to existing 4 ac-ft |
| | CARGO | 4.5 | Vault | |
| | SDN2x + SDN4x | 14.9 | Vault | |
| | SDN3/3x | 25.6 | Vault | |
| | SDN1 | 5.6 | Vault | |
| | SDN3A | Pond: 14.8 / Vault: 7.0 | Pond/Vault | |
| | SDW1A | Pond: 25.5 / Vault: 7.4 | Pond/Vault | Infiltration used |
| | SDW1B | 38.3 | Pond | Infiltration used |
| **Total Miller Creek** | | **157.5** | | |
| **Walker Creek** | SDW2 | 7.2 | Pond | |
| **Total Walker Creek** | | **7.2** | | |
| **Des Moines Creek** | SASA Detention Facility | 33.4[3] | Pond | |
| | Interconnecting taxiway (SDS3A) | 5.5 | Vault | |
| | Third Runway South (SDS7 and 6) | 21.6 | Vault | |
| | SDS3 | 88.3 | Vault | |
| | SDS4 | 12.9 | Vault | |
| **Total Des Moines Creek** | | **161.7** | | |
| **Total** | | **326.4** | | |

1 Types of facilities: Vault – enclosure with multiple orifice outlets on vertical riser with overflow spillway; Pond – open earth construction with netting or other means to provide wildlife deterrent.
2 Volume needed to retrofit existing facility.
3 Retrofit STIA area only.




AR 009893



Water Features

Proposed Stormwater Detention Facilities (With Simulated Maximum Storage Volume)

Master Plan Projects

Creek

Piped Creek

Detention Facility

SCALE IN FEET
0 750 1,500

N

**Figure 6.1-2**
**Detention Facilities for Master Plan Projects**

**Table 6.1-3. Summary of flood peak flow frequency results for Miller/Walker Creek subbasins (all values are cubic feet per second).**

| Return Period Peak | NEPL | | CARGO | | SDW2 | | SDW1B | | SDN3A (Vacca) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pre-Project | Project | Pre-Project | Project | Pre-Project | Project | Pre-Project | Project | Pre-Project | Project |
| 1/2 $Q_2$ | 0.61 | 0.22 | 0.12 | 0.05 | 1.65 | 0.58 | 0.68 | 0.20 | 0.27 | 0.09 |
| $Q_2$ | 1.22 | 0.44 | 0.24 | 0.09 | 3.30 | 1.16 | 1.35 | 0.40 | 0.53 | 0.18 |
| $Q_{10}$ | 1.70 | 0.73 | 0.33 | 0.14 | 6.22 | 3.14 | 2.11 | 0.71 | 0.75 | 0.32 |
| $Q_{25}$ | 1.96 | 0.96 | 0.38 | 0.18 | 7.71 | 5.06 | 2.57 | 1.04 | 0.87 | 0.44 |
| $Q_{50}$ | 2.16 | 1.18 | 0.42 | 0.21 | 8.82 | 7.13 | 2.96 | 1.04 | 0.96 | 0.56 |
| $Q_{100}$ | 2.37 | 1.46 | 0.46 | 0.25 | 9.92 | 9.95 | 3.39 | 1.89 | 1.05 | 0.70 |

| Return Period Peak | SDWIA | | SDN3, SDN3X | | Combined SDN2X/SDN4/SDN4X | | Miller Creek at Detention Facility | |
|---|---|---|---|---|---|---|---|---|
| | Pre-Project | Project | Pre-Project | Project | Pre-Project | Project | Pre-Project | Project |
| 1/2 $Q_2$ | 0.15 | 0.006 | 0.71 | 0.25 | 0.57 | 0.20 | 19.66 | 19.78 |
| $Q_2$ | 0.30 | 0.01 | 1.41 | 0.50 | 1.15 | 0.39 | 39.31 | 39.56 |
| $Q_{10}$ | 0.58 | 0.05 | 2.01 | 0.83 | 1.61 | 0.68 | 56.11 | 56.41 |
| $Q_{25}$ | 0.79 | 0.12 | 2.33 | 1.06 | 1.86 | 0.95 | 64.06 | 64.38 |
| $Q_{50}$ | 0.99 | 0.25 | 2.58 | 1.27 | 2.06 | 1.22 | 69.82 | 70.17 |
| $Q_{100}$ | 1.24 | 0.52 | 2.84 | 1.52 | 2.26 | 1.57 | 75.47 | 75.85 |

| Return Period Peak | Miller Creek at SR509 | | Walker Creek at South 12th Street | | SDN1 | |
|---|---|---|---|---|---|---|
| | Pre-Project | Project | Pre-Project | Project | Pre-Project | Project |
| 1/2 $Q_2$ | 22.81 | 22.72 | 1.65 | 0.58 | 0.28 | 0.12 |
| $Q_2$ | 45.62 | 45.44 | 3.30 | 1.16 | 0.56 | 0.24 |
| $Q_{10}$ | 67.23 | 65.61 | 6.22 | 3.14 | 0.79 | 0.40 |
| $Q_{25}$ | 77.29 | 74.82 | 7.71 | 5.06 | 0.91 | 0.54 |
| $Q_{50}$ | 84.53 | 81.38 | 8.82 | 7.13 | 1.00 | 0.67 |
| $Q_{100}$ | 91.58 | 87.72 | 9.92 | 9.95 | 1.10 | 0.82 |

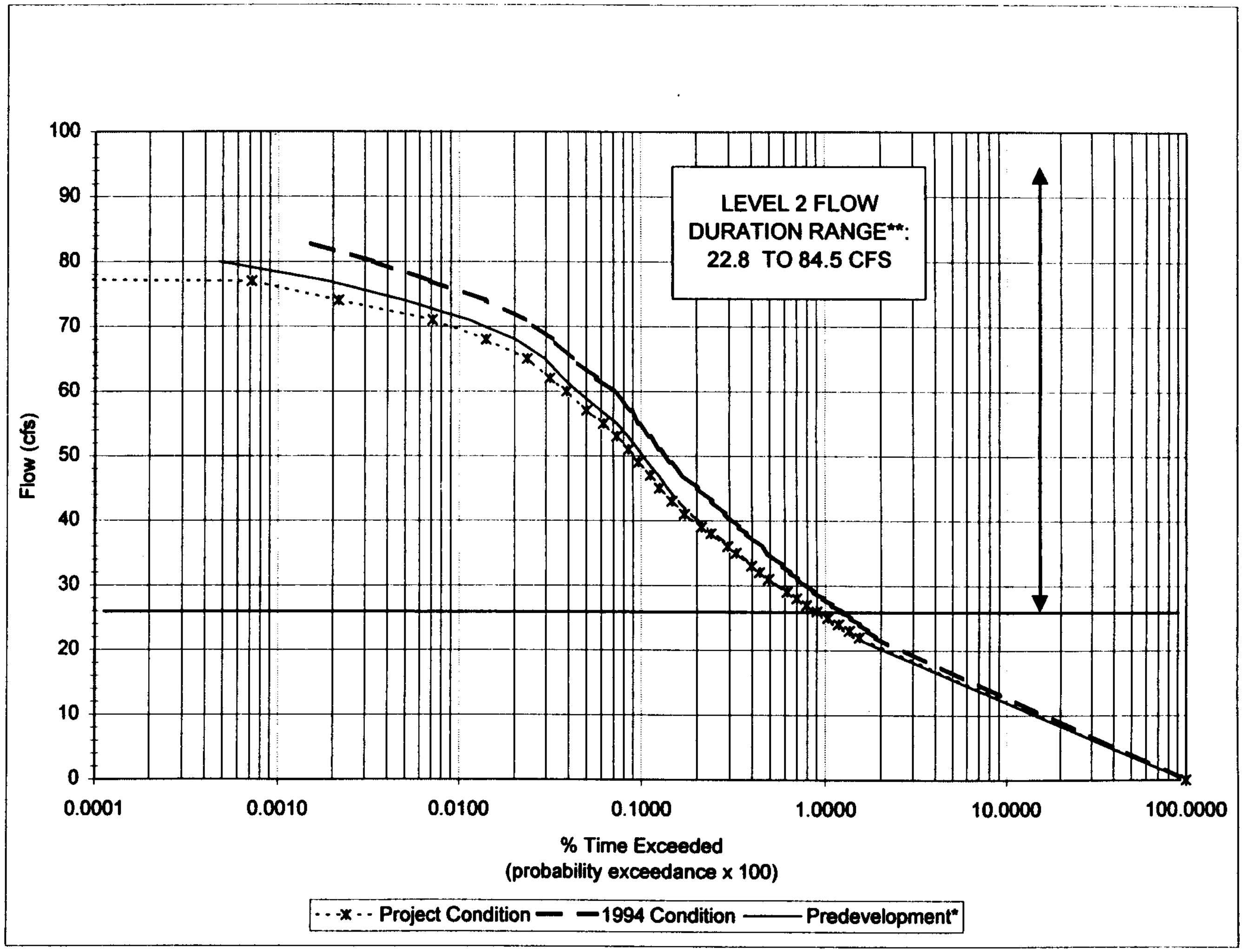
**Table 6.1-4. Summary of flood peak flow frequency results for Des Moines Creek subbasins (all values are cubic feet per second).**

| Return Period Peak | SASA[1] | | SDS3 | | SDS3A | |
|---|---|---|---|---|---|---|
| | Pre-Project | Project | Pre-Project | Project | Pre-Project | Project |
| 1/2 $Q_2$ | 31.95 | 13.57 | 6.03 | 2.40 | 1.23 | 1.52 |
| $Q_2$ | 63.90 | 27.13 | 12.06 | 4.79 | 2.45 | 3.05 |
| $Q_{10}$ | 97.35 | 44.54 | 21.07 | 10.85 | 4.28 | 7.80 |
| $Q_{25}$ | 116.65 | 56.20 | 26.92 | 16.51 | 5.47 | 12.09 |
| $Q_{50}$ | 132.17 | 66.34 | 31.92 | 22.46 | 6.49 | 16.50 |
| $Q_{100}$ | 148.69 | 77.82 | 37.52 | 30.39 | 7.62 | 22.26 |

| Return Period Peak | SDS4 | | SDS - Point of Compliance | |
|---|---|---|---|---|
| | Pre-Project | Project | Pre-Project | Project |
| 1/2 $Q_2$ | 0.86 | 0.35 | 8.06 | 4.35 |
| $Q_2$ | 1.72 | 0.69 | 16.11 | 8.71 |
| $Q_{10}$ | 2.65 | 1.29 | 28.45 | 18.58 |
| $Q_{25}$ | 3.21 | 1.80 | 36.55 | 26.66 |
| $Q_{50}$ | 3.67 | 2.29 | 43.51 | 34.51 |
| $Q_{100}$ | 4.17 | 2.92 | 51.33 | 44.30 |

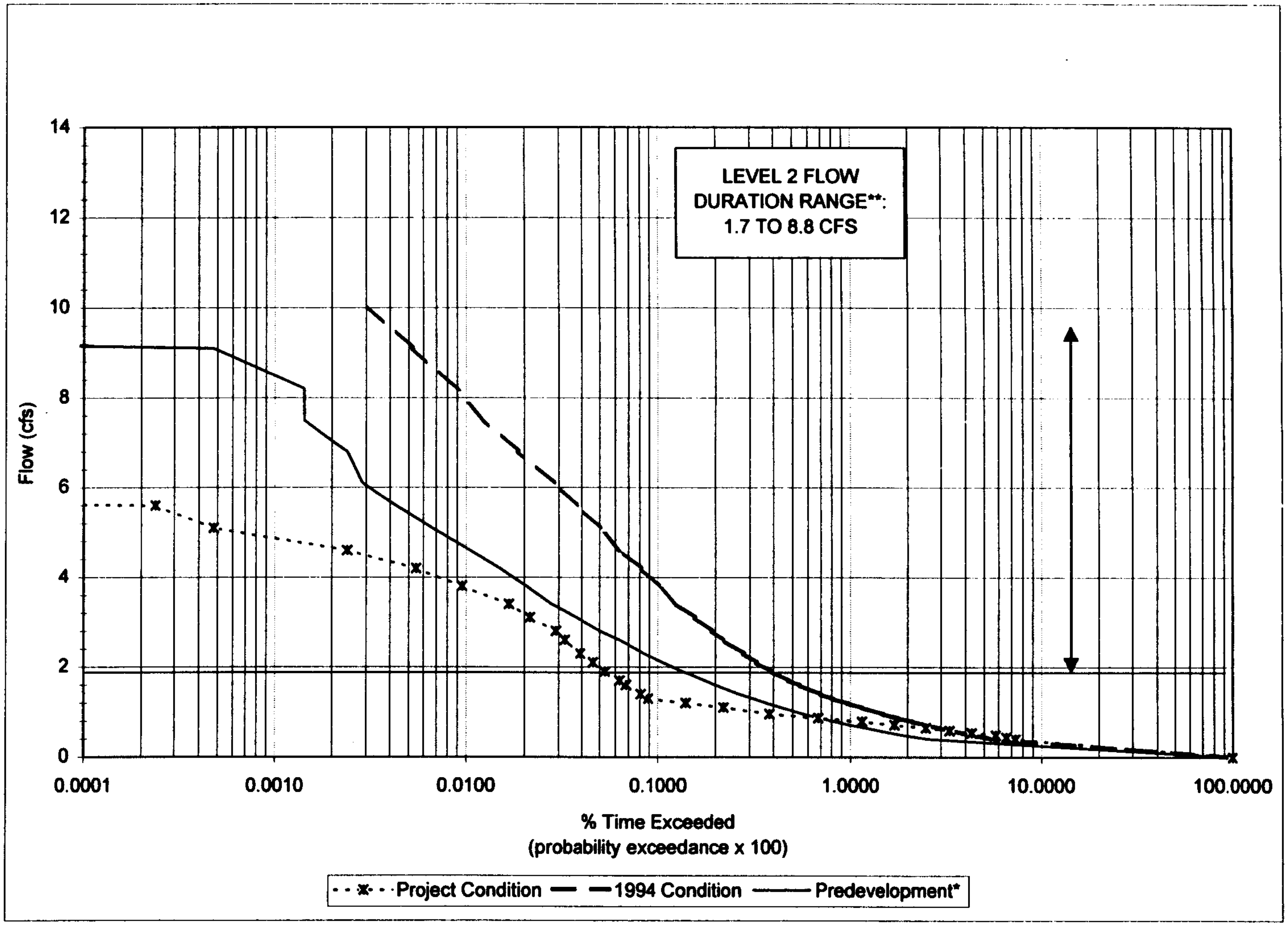
| Return Period Peak | SDS7 | | Des Moines Creek @ South 200 Street | |
|---|---|---|---|---|
| | Pre-Project | Project | Pre-Project | Project |
| 1/2 $Q_2$ | 1.47 | 0.64 | 55.72 | 36.29 |
| $Q_2$ | 2.94 | 1.28 | 111.45 | 72.58 |
| $Q_{10}$ | 5.23 | 2.84 | 184.86 | 117.11 |
| $Q_{25}$ | 6.73 | 4.45 | 231.02 | 145.08 |
| $Q_{50}$ | 8.03 | 6.25 | 269.81 | 168.55 |
| $Q_{100}$ | 9.48 | 8.77 | 312.64 | 194.44 |

[1] STIA basins plus non-STIA basins D1 and D2 routed to pond. Retrofitting applied only to STIA drainage areas.



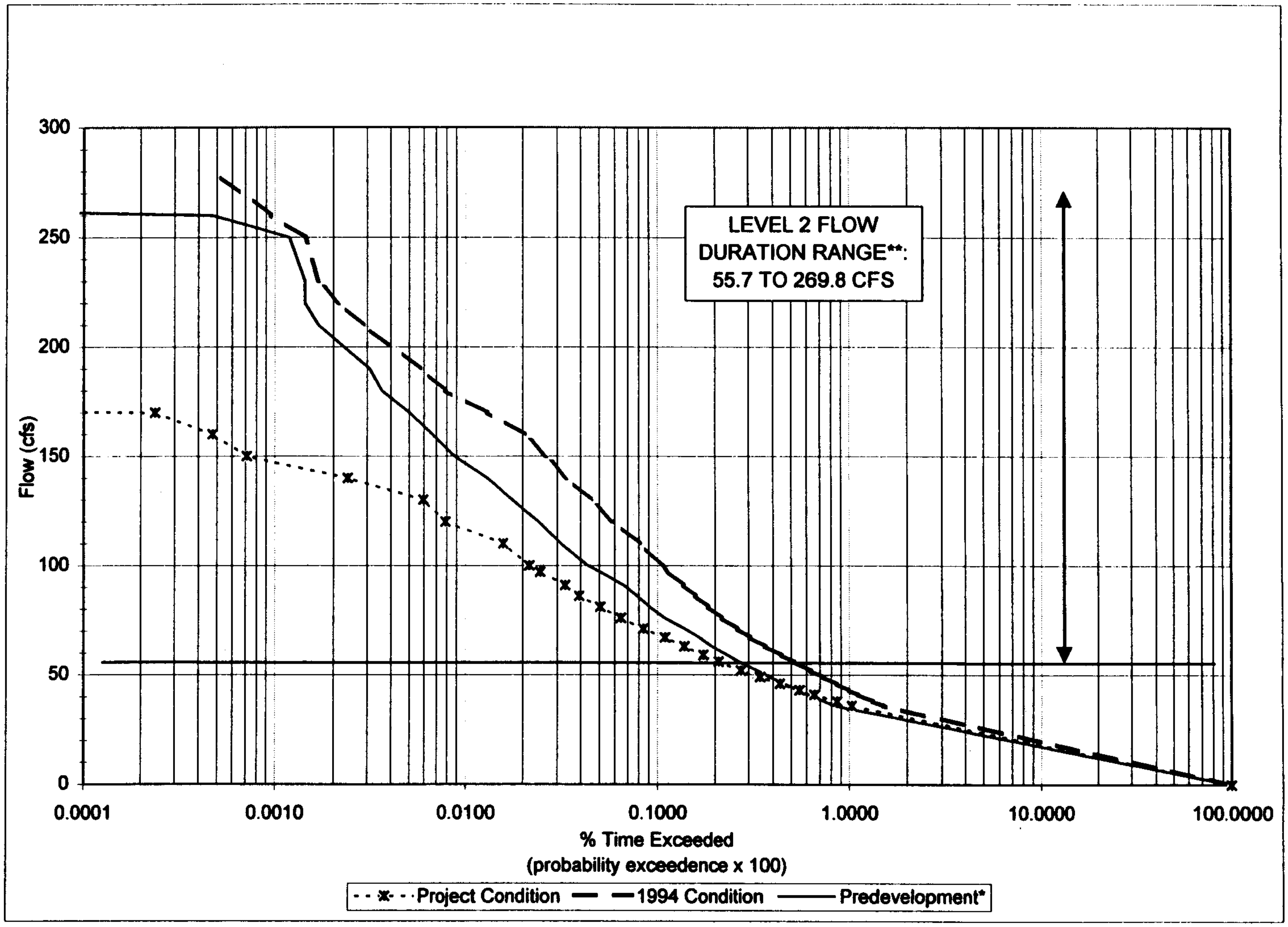

* Port basins use target flow regime (10-75-15). Off-site basins use 1994 conditions.
** For the target flow regime.

**Figure 6.1-3**
**Flow Duration Curve for Miller Creek at SR509**



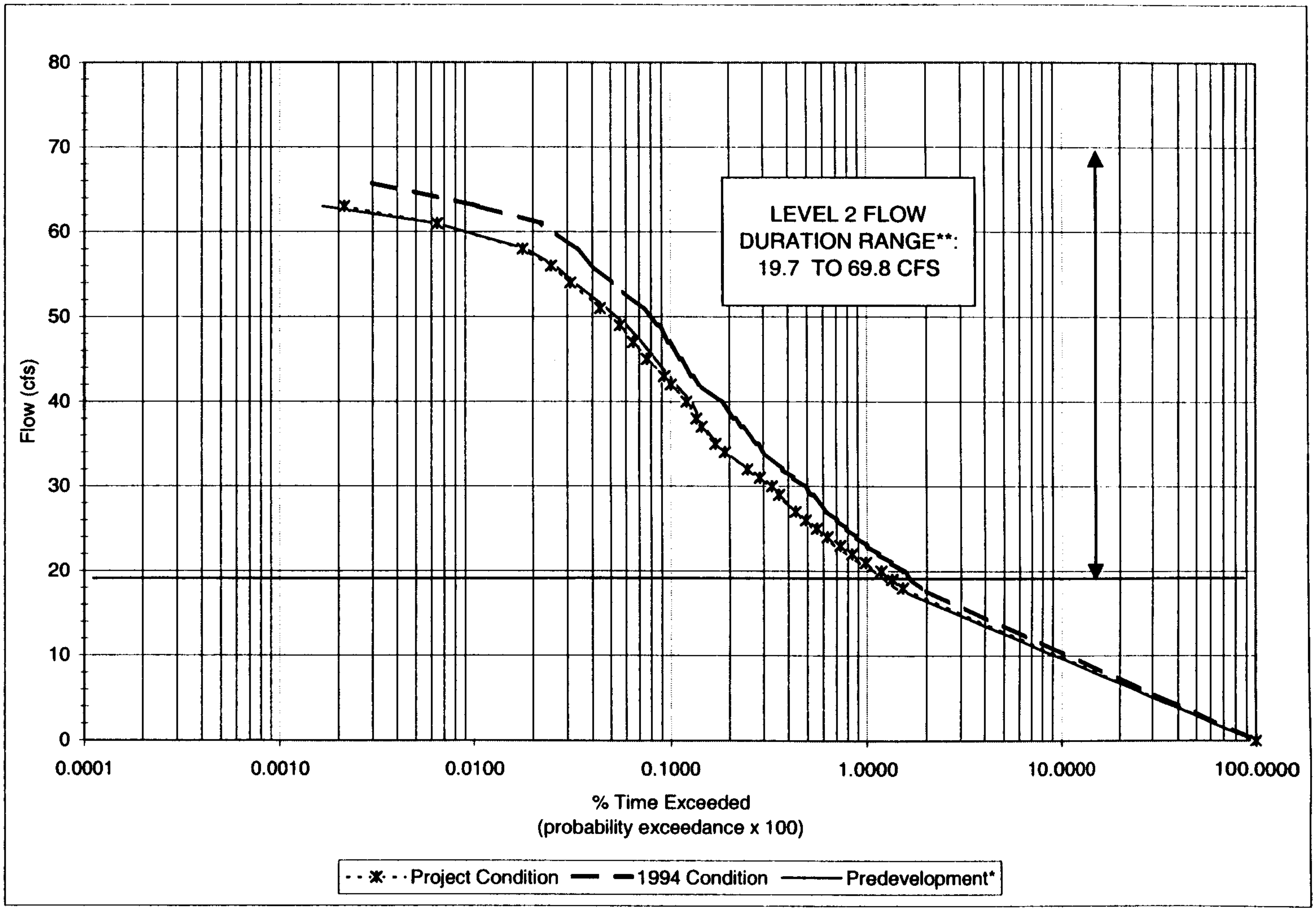

* Port basins use target flow regime (10-75-15). Off-site basins use 1994 conditions.
** For the target flow regime.

**Figure 6.1-4**
**Flow Duration Curve for**
**Walker Creek at South 12th Street**




* Port basins use target flow regime (10-75-15). Off-site basins use 1994 conditions.
** For the target flow regime.

**Figure 6.1-5**
**Flow Duration Curves for Des Moines Creek at South 200th Street**




* Port basins use target flow regime (10-75-15). Off-site basins use 1994 conditions.
** For the target flow regime.

**Figure 6.1-6**
**Flow Duration Curve for**
**Miller Creek at MCDF**

### 6.1.2 Base Flow Impacts

Hydrologic modeling has also demonstrated a potential base flow impact due to the Master Plan Update improvements (Parametrix 2000a). The HSPF model was used to analyze the potential hydrologic effects on stream base flow[18] after construction of the project in pervious areas. Results for the pre-project base condition (1994) were compared to the developed project condition (2006) in Miller, Walker, and Des Moines Creeks. Potential base flow changes were evaluated using a comparison between pre-project and project streamflow conditions during the typically driest times of year (August and September). Using HSPF, average changes in streamflow were simulated as shown in Table 6.1-5 (EarthTech 2000).

**Table 6.1-5. Estimated Low Stream Flow Changes.**

| | Average Flows (cfs) | | | | | |
|---|---|---|---|---|---|---|
| | 1994 | | 2006 | | Change | |
| | Aug | Sept | Aug | Sept | Aug | Sept |
| Miller Creek | 1.27 | 1.50 | 1.10 | 1.40 | - 0.17 | - 0.1 |
| Walker Creek | 0.033 | 0.035 | 0.031 | 0.039 | - 0.002 | + 0.004 |
| Des Moines Creek | 1.08 | 1.64 | 1.07 | 1.73 | - 0.01 | + 0.09 |

If base flow impacts are large enough, the wetted stream area could be reduced and adversely affect critical habitat. However, base flow impacts estimated for Miller, Walker, and Des Moines Creeks are insignificant and would not measurably change the wetted area of critical habitat.

While the HSPF modeling summarized in Table 6.1-5 indicates reduced low stream flow, some mitigative elements of project hydrology have not been calculated and are beyond the capability of the HSPF model to closely evaluate. For example, stormwater from detention ponds SDW1A and SDW1B in the Miller Creek basin will be infiltrated. Infiltration will offset some low flow reduction, as water will be infiltrated in trenches near Miller Creek to slowly seep through the soil back into the stream long after the rain has stopped. Also, stormwater that infiltrates into the fill embankment (a large soil mass that will collect, store, and transmit water) and slowly leaks out has not been accounted for in the HSPF model due to limitations in the model to simulate these constructed systems. The relatively small reductions in low flow shown on Table 6.1-5 will in fact be even less due to the limitations of the HSPF model to model these positive effects. Additional details on base flow impacts are provided in the *Seattle-Tacoma Airport Master Plan Update Improvements Low Streamflow Analysis* (Earth Tech 2000).

#### 6.1.2.1 Effects of Peat Removal at Vacca Farm

Peat soils are often identified as having the ability to store water during wet periods and then release it slowly during dry periods, thereby augmenting base flows of associated streams. Excavation of peat soils during construction could alter hydrology and potentially affect base flow in Miller Creek.

[18] Base flow is defined as the stream flow generated by groundwater in undeveloped watersheds. It is sometimes referred to as dry-weather flow.

The peat soil at the Vacca Farm site is identified as "Rifle" peat–fibrous, woody peat. It forms in depressions on top of glacial outwash soils such as the Vashon advance outwash, a medium dense sand soil series mapped in the vicinity of the Miller Creek valley. The Soil Conservation Service (SCS) estimates the permeability of similar peat soils to be on the order of 0.63 to 2 inches per hour (moderate permeability). An estimate of field capacity (the soil water content after gravity drainage from the peat has ceased), based on SCS data, is 0.4 (relatively high soil water retention). In comparison, the underlying dense sand in the outwash material has a permeability estimated at less than 1.4 inches per hour, and an available water capacity of about 0.1. The total porosity of the peat is assumed to be 0.8 (relatively high, thus a conservative assumption of greater maximum water storage).

The quantity of peat removed that could potentially provide water storage is about 10,000 cy. Therefore, the peat could store (10,000 cy) x (27 cf/cy) x (0.8 - 0.4) = 108,000 cubic ft of water. If the release rate to the stream were uniform during the drier months (May through September), the average daily flow would be on the order of (108,000 cubic ft)/(160 days x 24 hours x 60 minutes x 60 seconds) = 0.008 cfs. This estimate is high because it neglects evapotranspiration, which reduces the amount of water actually available to release as streamflow. Furthermore, the timing of the release of water stored in the peat is not likely to be uniform throughout the summer–most release would occur during late spring and early summer (May and June), prior to minimum streamflows. Thus, the potential impact on base flows from peat removal is likely considerably less than 0.008 cfs; this is unlikely to affect aquatic habitat in Miller Creek. In addition, the mitigation actions described in Chapter 5 include removal of drainage ditches, which will slow soil drainage at the Vacca Farm site.

## 6.2 WATER QUALITY

The Port's mitigation of potential water quality impacts is described in the SMP (Parametrix 2000a). Stormwater quality mitigation elements in the plan include the following:

- BMPs will meet or exceed stormwater quality treatment standards. BMPs will be applied to all new and redeveloped pollution-generating impervious surfaces (PGIS), and BMPs will be retrofitted to treat runoff from existing untreated PGIS where practicable. Upon completion of the Master Plan Update improvements and other anticipated projects (e.g., north terminal expansion), an estimated 490.3 acres (86 percent) of the STIA stormwater drainage system (SDS) will have water quality treatment BMPs, out of a total SDS PGIS area of 570.3 acres.

- Source control BMPs will be implemented for all PGIS, and regularly reviewed for additional or improved methods. Source controls are planned and implemented via the Port's Stormwater Pollution Prevention Plan (SWPPP) for Airport Operations (Port of Seattle 1998).

- A landscape management plan is included in the SWPPP. The landscape management portions of the SWPPP are intended to control water quality impacts from managed vegetated areas, including chemical use, container disposal, integrated pest management, fertilizer application, weeding, pruning, and a prohibition of herbicide application near water courses.

- The IWS, a source control BMP, is designed to treat industrial wastewater from aircraft maintenance, fueling, and de-icing areas. The IWS is being upgraded so that storage overflows do not occur. The upgrade includes expansion of IWS Lagoon 3. The IWS upgrades are not a Master Plan Update project.

- Existing sources of stormwater pollutants will be removed from urban drainage areas. This includes removal of septic tanks, underground fuel storage tanks, untreated flows from lawns, streets, and driveways, and cultivated land located in stream floodplains and buffers.

- Projects will be implemented to enhance water quality such as flow augmentation, wetland restoration, stream restoration, and enhancement of riparian buffer zones within the Miller and Des Moines Creek basins.

- Hydrologic controls (peak flow and flow duration control, discussed in the flow control sections of the SMP) will reduce instream erosion.

- During construction, TESCs will be applied in excess of Ecology Manual (Ecology 1992) minimum requirements. TESC activities will include planning and implementing construction SWPPPs and monitoring plans for every individual Master Plan Update improvement activity, applying conventional TESC BMPs, providing advanced stormwater treatment where necessary and appropriate, supervising contractor erosion control compliance with an erosion control and stormwater specialist, and funding independent third-party oversight of construction erosion control and stormwater management and compliance.

As demonstrated in the SMP, concentrations of pollutants in STIA stormwater are generally less than those in runoff from other residential, urban, and industrial areas in the region. As the Master Plan Update improvements will consist of similar activities and BMPs, these actions are expected to mitigate or prevent impacts. The Port's ongoing compliance with the Clean Water Act and, in turn, protection of STIA's receiving waters, are demonstrated through compliance with its Section 402 (NPDES) Permit, administered in Washington by Ecology (Ecology 1998). As stated in the associated Fact Sheet for the Permit, "compliance with the effluent limitations and other conditions in this permit constitutes compliance with the Federal Water Pollution Control Act... and the Washington Water Pollution Control Act (RCW 90.48)."



AR 009902

# 7. OFF-SITE HABITAT MITIGATION: AUBURN WETLAND MITIGATION

The proposed Auburn Wetland Mitigation Site is a 67-acre parcel of land located within the City of Auburn immediately west of the Green River (see Figure 1.2-1). This mitigation project is designed to provide restoration and enhancement of forested, shrub, emergent, and open-water wetland habitats on over 65 acres of the 67-acre site to compensate for wetlands unavoidably impacted by the Master Plan Update improvements. The overall goal is to replace wetland habitat functions (especially for avian species) in an off-site location, in compliance with FAA Advisory Circular 150/5200-33 (FAA 1997b). The Port proposes to restore or enhance existing emergent wetland with diverse forest, shrub, emergent, and open-water wetland habitat, and restore buffer areas at the Auburn site as mitigation for habitat impacts. A summary of wetland impacts resulting from the Master Plan Update projects, proposed compensatory mitigation for each wetland type, and the overall replacement ratios provided by the Auburn mitigation site are provided in Table 7.1-1.

**Table 7.1-1. Summary of wetland impacts and off-site compensatory design objectives for the proposed Master Plan Update improvements.**

| Project Impact | Compensatory Design Objectives | Acreage Provided[1] |
|---|---|---|
| Fill of 8.17 acres of forested wetland and loss of associated wildlife habitat. | Provide in-kind replacement of forested wetland functions and increase overall wildlife habitat function by creating/restoring emergent wetlands to create native forested habitat. | 17.20 acres of forested wetland |
| | Enhance existing emergent wetlands to create native forested habitat. | 19.50 acres of enhanced forested wetland |
| Fill of 2.98 acre of shrub wetland and loss of associated wildlife habitat. | Provide in-kind replacement of shrub wetland functions and increase overall wildlife habitat function by enhancing and restoring emergent wetlands. | 6.00 acres of shrub wetland |
| Fill of 7.22 acres of emergent wetland and loss of associated wildlife habitat. | Provide functional replacement of emergent wetlands and increase wildlife habitat function by restoring emergent wetland. | 6.20 acres of emergent wetland |
| | Provide pockets of open-water habitat. | 0.60 acre of open-water wetland |
| Protect the wetland from potential off-site disturbance and provide enhanced upland wildlife habitat. | | |

[1] Approximately 15.90 acres of forested buffer protect the site from potential off-site disturbance and provide upland habitat.

Wetland mitigation immediately adjacent to the existing airport is constrained by the need to avoid creating wildlife hazards (i.e., waterfowl and flocking bird habitat) near the airfield (FAA 1997b). Therefore, the focus of the in-basin mitigation projects (Chapter 5) is to replace and enhance wetland functions, including hydrologic, water quality, aquatic habitat and riparian support functions, to the extent practicable, while reducing existing wildlife hazards and avoiding the creation of new wildlife hazards. As a consequence, in-basin projects will not create or enhance open-water or emergent wetland habitats that could attract waterfowl. Due to this constraint on-site mitigation, the Port therefore proposes to include significant additional restoration, creation, and enhancement of palustrine forest, shrub, emergent, and open-water habitats at the Auburn mitigation site to compensate for impacts to these habitats by the project.

Much of the emergent wetland habitat that will be impacted by the Master Plan Update projects is relatively low quality habitat that has been significantly altered and degraded by development. The Miller and Des Moines Creek basins historically supported forested or shrub wetlands dominated by a diverse native flora. The vegetation in existing emergent wetlands filled or disturbed by the project is generally maintained by on-going anthropogenic disturbance (i.e., mowing, golf course maintenance). In the absence of this disturbance, these wetlands would develop into forested or shrub wetlands. The emergent wetlands are also relatively low quality habitat for most wildlife species because of on-going disturbance, and a lack of vegetation diversity. Similarly, many of the existing shrub wetlands are dominated by non-native invasive species such as Himalayan blackberry, and in the absence of disturbance would develop into forested wetlands. Existing shrub wetlands also provide low quality habitat due to frequent disturbance and lack of habitat diversity.

For these reasons, the off-site mitigation has been designed to provide improved avian habitat conditions relative to the existing wetlands lost near STIA. Off-site mitigation emphasizes the development of forested wetlands, because over time, and in the absence of on-going human disturbance, most of the wetlands impacted by the Master Plan Update projects would develop into forested wetlands similar to those historically found in the area. Therefore, the wetland mitigation provided at Auburn (see Table 7.1.1) is not strictly in-kind mitigation of habitat types, and creates a greater amount of generally higher quality forested wetlands compared to the lower quality emergent and shrub wetlands found near STIA.

This chapter describes the off-site mitigation and monitoring plan. Overall goals and design criteria are described in Section 7.1. The mitigation site and site selection process are described in Section 7.2 and Section 7.3 contains a detailed description of the mitigation design, including a description of construction methods and implementation of the mitigation plan. Finally, Section 7.4 describes the implementation of the project at the mitigation site. Detailed plan sheets showing design elements are included in Appendix E.

## 7.1 GOALS, OBJECTIVES, AND DESIGN CRITERIA

Goals, objectives, and design criteria for the Auburn off-site wetland mitigation have been developed to guide the mitigation design and ensure that overall mitigation objectives are met (Table 7.1-2). The wetland mitigation goals and objectives identified below are designed to compensate for unavoidable wetland impacts, especially to wildlife habitat, by creating forested, shrub, emergent, and open-water replacement wetland habitat with a net gain in functional value and acreage.

**Table 7.1-2. Mitigation goals with associated design objectives and design criteria for the Auburn Mitigation Site.**

| Goals and Design Objectives | Design Criteria |
|---|---|
| **Goal 1: Achieve no net loss of wetland acreage by constructing replacement habitats of forest, shrub, and emergent wetland with a forested buffer** | |
| Provide seasonal to permanent wetland hydrology appropriate for each wetland vegetation cover type. | Use a perched water table to establish wetlands at the approximate final grades of: |
| | 41 ft to 38 ft in emergent wetlands |
| | 42 ft to 41 ft in shrub wetlands |
| | 45 ft to 42 ft in forested wetlands |
| | Below 38 ft in open-water wetland |
| | 42 ft to 44 ft in emergent wetlands |
| | 44 ft to 46 ft in shrub wetlands |
| | 46 ft to 49 ft in forested wetlands |
| | Below 42 ft in open-water wetland |
| Provide in-kind replacement for impacts to 8.17 acres of native forested wetland. | Plant five forested wetland plant associations that are similar in composition to naturally occurring plant associations. Use native deciduous and evergreen species such as black cottonwood, Oregon ash, red alder, western redcedar, and Sitka spruce. |
| | Forested communities will have a native shrub understory with species such as salmonberry, twinberry, red-osier dogwood, red elderberry, willows, and vine maple. |
| | Plant native tree species at densities greater than 280 trees per acre. |
| | Plant native shrub species in forested communities at densities greater than 1,800 plants per acre. |
| Provide in-kind replacement for impacts to 2.98 acres of native shrub wetland. | Plant an association of native shrub wetland species that is similar in composition to naturally occurring shrub wetlands, including species such as Pacific willow, Hooker's willow, Sitka willow, red-osier dogwood, and twinberry. |
| | Plant native shrub species at densities greater than 2,100 plants per acre. |
| Provide replacement for impacts to 7.22 acres of native emergent wetland. | Plant an association of native emergent wetland species similar in composition to native emergent wetlands. Use native species that are suited to seasonally and/or permanently flooded conditions, such as water parsley, hardstem bulrush, and common spike rush. |
| | Plant native emergent species in approximately 0.05-acre monotypic patches at densities greater than 10,000 plants per acre (approximately 24 inches on-center). |
| Provide a forested buffer around the mitigation site to enhance functions and protect of the wetland mitigation | Establish a 100-ft-wide forested buffer around the perimeter of the mitigation site |
| **Goal 2: Provide wildlife habitat replacement outside the 10,000-ft safety radius for aircraft operations.** | |
| Provide flooded emergent wetland habitat suitable for waterfowl feeding and resting during the winter and spring months. | Emergent wetlands will satisfy the design criteria for Wetland Mitigation Goal 1. Additional design criteria for waterfowl habitat include: |

**Table 7.1-2. Mitigation goals with associated design objectives, design criteria, and final performance standards for the Auburn Mitigation Site (continued).**

| Goals and Design Objectives | Design Criteria |
|---|---|
| | Provide year-round shallow water with patches of emergent vegetation as feeding habitat for dabbling duck species. |
| | Provide ponded water areas for resting habitat. |
| Provide emergent, shrub, and forested wetland habitat with feeding and breeding for songbirds. | Forested, shrub, and emergent wetlands will satisfy the design criteria for Wetland Mitigation Goal 1. Additional design criteria for songbird habitat include: |
| | Plant forested wetland adjacent to shrub, emergent, and open-water habitats |
| | Plant portions of the forested wetland with shrub understory species to provide a multiple-layered canopy adjacent to the shrub portion of the wetland. |
| Provide forested, shrub, and emergent wetland feeding and breeding habitat for small mammals. | Forested, shrub, and emergent wetlands will satisfy the design criteria identified for Wetland Mitigation Goal 1. Additional design criteria for small mammal habitat include: |
| | LWD (stumps and logs of native species) placed throughout the forested wetland to provide year-round cover for small mammals. |
| | Low hummocks constructed in the shrub wetland areas to provide non-saturated soils for burrowing small mammals. |
| Provide breeding habitat for amphibians. | Forested, shrub, and emergent wetlands will satisfy the design criteria for Wetland Mitigation Goal 1. Additional design criteria for amphibian habitat include: |
| | Provide attachment substrate for breeding amphibian species in areas of ponded water. |
| **Goal 3: Provide replacement wildlife habitat that increases overall habitat functions** | |
| Consolidate mitigation for impacts to many small, discontinuous wetlands into a single, larger wetland to provide a more diverse aggregate of habitat types. | Construct a contiguous wetland system with forested, shrub, and emergent wetland types and wildlife habitat features that provide in-kind and out-of-kind habitat replacement. |
| Assure long-term protection of the mitigation site(s). | Screen the wetland from off-site areas and install fencing around the perimeter. |
| | No public trails will be permitted on the mitigation site. |
| **Goal 4: Enhance the existing 19.5-acre emergent wetland at the Auburn site.** | |
| Enhance functions of approximately 19.5 acres of degraded emergent wetland. | Plant existing wetland with native trees and shrubs at densities greater than 2,100 individual plants per acre for shrubs and greater than 280 stems per acre for native trees. |

### 7.1.1 Goals and Objectives

The general mitigation goals for the Auburn site are as follows:

- Achieve an overall increase in wetland acreage and functional replacement at a mitigation ratio of at least 2:1.
- Mitigate lost habitat functions of the Master Plan Update improvements outside of the 10,000-ft aircraft operations safety radius of STIA to protect public safety and reduce wildlife hazards to aircraft.
- Create diverse wetland habitats (including forested, shrub, open water, and emergent) as well as upland forested habitat on a large site adjacent to existing habitat corridors along the Green River.
- Enhance wetland functions in the existing degraded wetlands, which are dominated by non-native species, by converting them to diverse, native forested, shrub, and emergent wetlands.
- Provide long-term protection for the mitigation site by providing a 100-ft forested buffer around the perimeter of the site.

## 7.2 WETLAND MITIGATION SITE

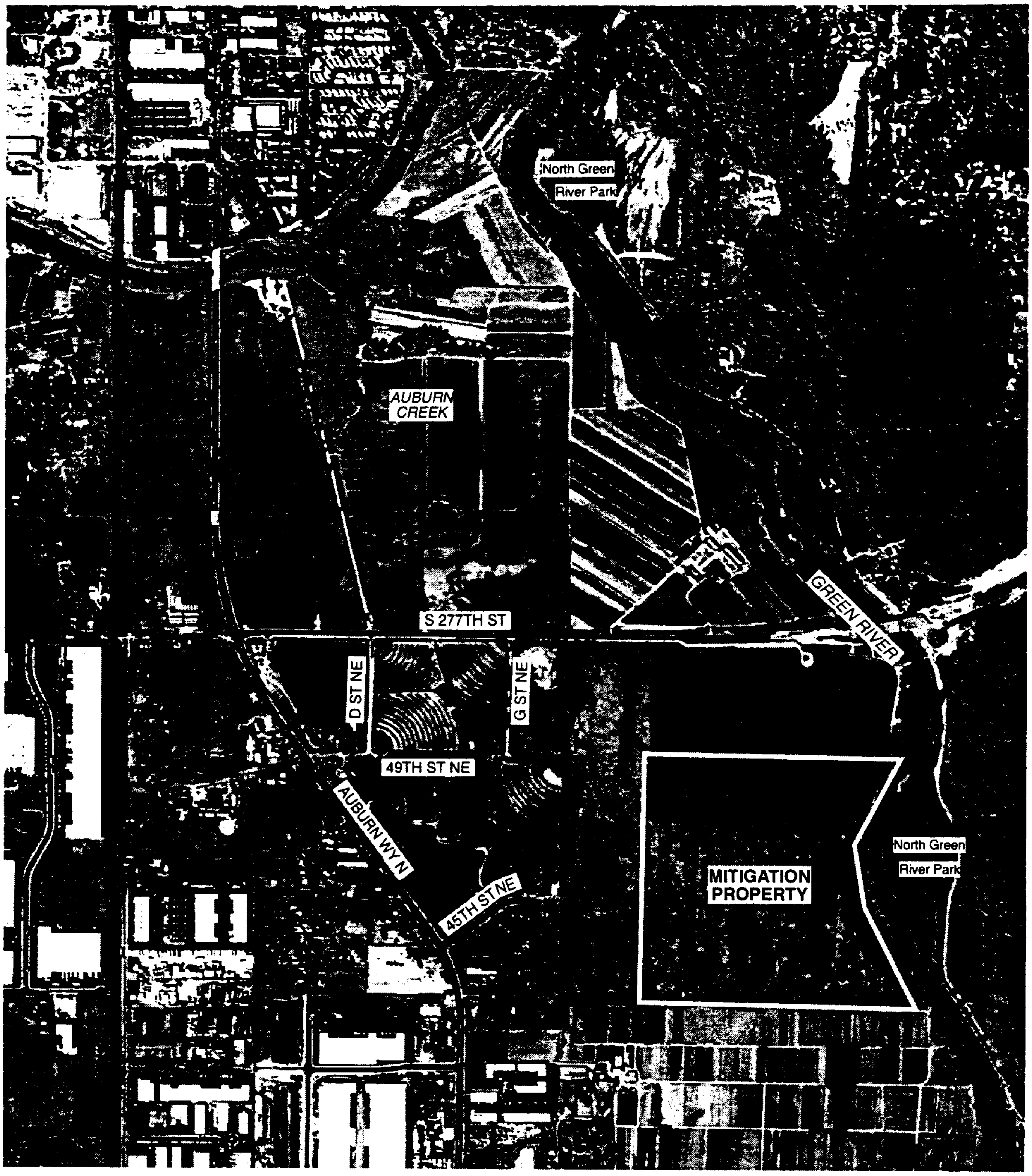
The mitigation site chosen for off-site compensatory mitigation for the Master Plan Update improvements is described in the following sections.

### 7.2.1 Site Description

The mitigation area is part of a 67-acre parcel located within the City of Auburn immediately west of the Green River (Figure 7.2-1). The site is nearly level but gradually slopes from the eastern (approximately 52 ft in elevation) and southeastern boundaries to approximately 45 ft in elevation in the northwest corner. The undeveloped parcel has been farmed in the recent past, and currently supports a mix of upland and wetland pasture grasses and forbs that are common on abandoned agricultural land in the Puget Sound basin. The mitigation site is located between 100 and 150 ft west of the OHWM of the adjacent Green River.[19]

The site is bounded by a variety of land uses including active agriculture fields to the north and south; undeveloped land, multi-family housing, and a drive-in theater to the west; and the Green River, patches of riparian forest, and undeveloped, forested slopes to the east. The site was previously zoned single-family residential (R2) by the City of Auburn, and the 1995 Comprehensive Plan designation is single-family (Auburn 1995). In 1998, a new section was added to the City's zoning ordinance that allows wetland mitigation to occur in R2 zoning. The mitigation site is located within the Draft Mill Creek Special Areas Management Plan (SAMP) (ACOE 1997). The relationship of this project to the Draft SAMP is discussed in Section 7.2.3.

[19] Approximately 1.62-acres along the eastern boundary of the 67-acre is set aside for potential development as part of a regional trail that may be built by King County.





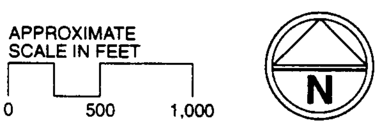




**Figure 7.2-1**
**Aerial Photograph of the Auburn Wetland Mitigation Site (1999)**

Three jurisdictional wetlands were delineated on the mitigation site. Wetland 1 extends from the northwest corner to the south-central portion of the site (Figure 7.2-2) and covers 18.89 acres of the site. The wetland also extends east, off-site to the east, through the access easement for the site. Wetland 2 is adjacent to Wetland 1 in the south-central portion of the site, and is about 0.60 acres in size. Wetland 3 is located in the north-central portion of the site and is about 0.01 acre in size (Parametrix 2000c). Descriptions of site hydrology, soils, and vegetation of the wetland and upland portions of the site are included in the following sections.

### 7.2.2 Ownership

The Port owns the entire 67-acre site and has a permanent access easement on the western side of the property (Appendix E, Sheet C2). Construction of the mitigation project requires temporary construction access easements, and a temporary drainage and construction easement that will allow the Port to modify an existing drainage ditch for drainage related to construction of the wetlands. A permanent easement allows monitoring and maintenance following construction. The Port has obtained these easements.

#### 7.2.2.1 Construction Access

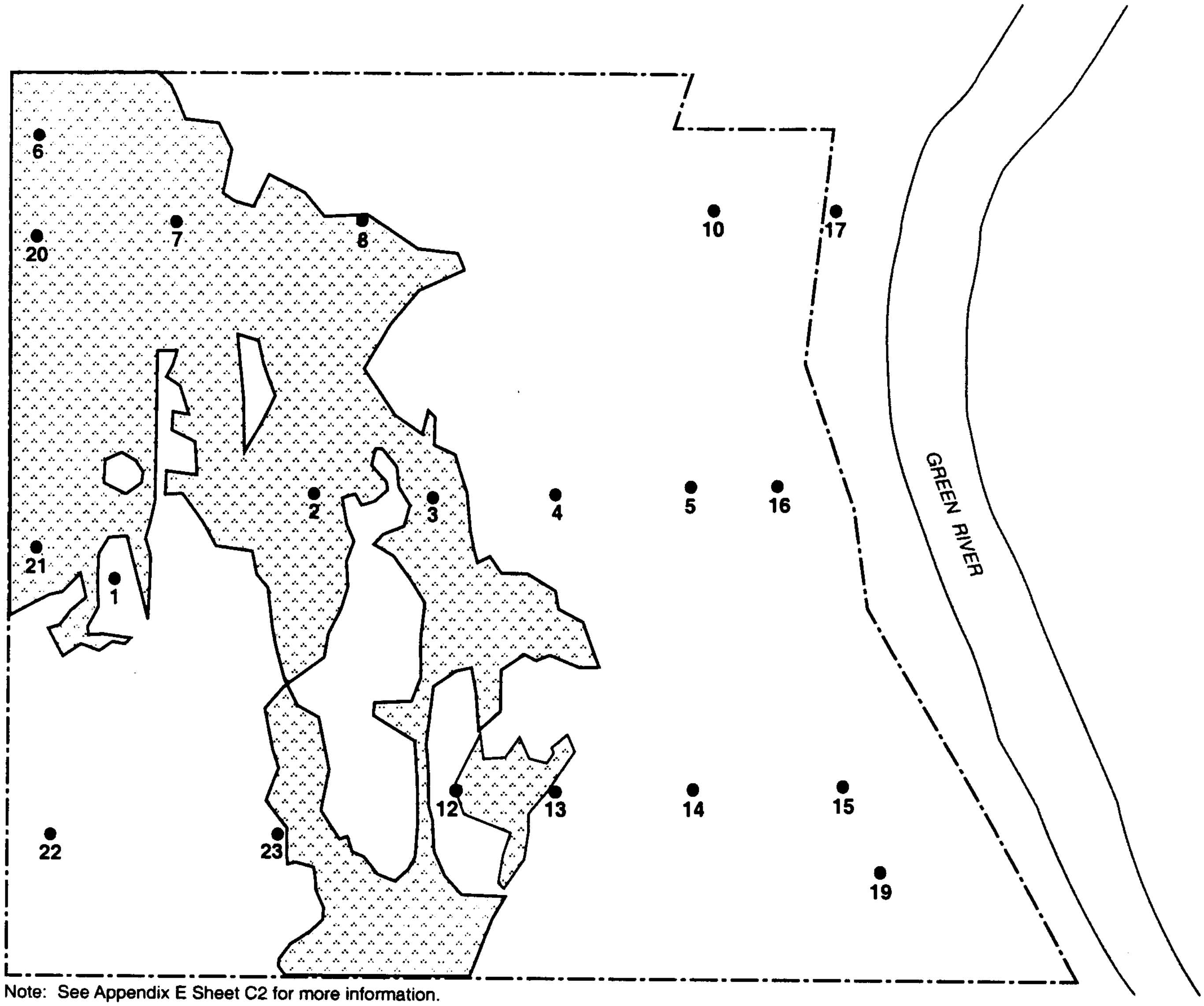
The Port has procured temporary construction and access easements from property owners to the west of the site for construction access to the mitigation project. As of December 2000, the Port had completed easement agreements from two property owners and was in the process of completing negotiations with three other owners.

#### 7.2.2.2 Drainage Easement

The Port has also procured a temporary drainage and construction easement across the property north of the mitigation site (Appendix E, Sheet C2). The purpose of this easement is to grant the Port the right to modify an existing channel for drainage purposes related to construction of the mitigation project. The easement grants the Port the right to use this channel for the temporary discharge of water from dewatering wells to be used during excavation and construction of the mitigation wetlands. During dewatering, drainage water from the Port's property will be temporarily channeled to the existing outfall into the Green River at South 277$^{th}$ Street. Other than during construction dewatering, drainage water from the mitigation site will flow north through existing drainage channels along and under 277$^{th}$ Street, and then north to the Green River. The temporary drainage and construction easement will remain in effect until a permanent flood channel is constructed across the property to the north.

#### 7.2.2.3 Permanent Flood Channel

Construction of a permanent flood channel is a condition of the Interlocal Agreement (ILA) between the Port and the City of Auburn. The ILA requires the Port to construct, or with the consent of the City, to pay the cost of constructing the floodway channel. The ILA requires that the flood channel be located in a mutually agreed upon location across the property to the north of the mitigation site (i.e., the Bristol property). The Port is currently working with the City of Auburn and Bristol on the design and location of the floodway channel. Although a final determination has




Note: See Appendix E Sheet C2 for more information.



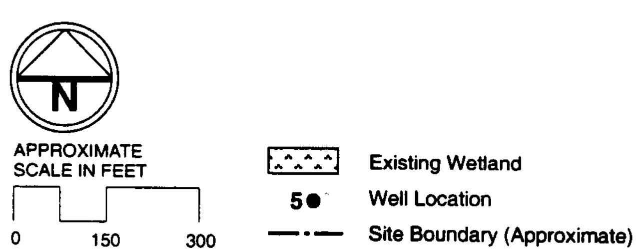



**Figure 7.2-2**
**Wetlands and Groundwater Monitoring Well Locations on the Wetland Mitigation Site, Auburn, Washington**

not been made as of December 2000, the existing channel is the most probable location of the permanent floodway channel (Appendix E, Sheet C2). Widening and deepening the existing drainage channel to construct the permanent floodway will result in impacts to a maximum of 2.2 acres of Waters of the U.S., and these impacts have been included in the project's CWA 404 permit application.

### 7.2.3 Rationale for Selection

Mitigation site selection began with a review of the established goals as outlined in Section 7.1.1. The general site criteria required to meet these goals are similar to those listed by Castelle et al. (1992) and are listed below:

- A large non-wetland site, greater than 50 acres in size, with evidence of a seasonally high water table
- A non-forested site (to allow for significant net habitat improvements) adjacent to a higher quality habitat area (i.e. the Green River Riparian Corridor)
- A site with relatively flat topography
- A vacant or substantially vacant site
- A site available for purchase by the Port
- A site at least 10,000 ft from proposed or existing runways as recommended by the FAA (FAA 1997b)

As described in Chapter 4, the recommended preference for selecting wetland mitigation sites in the State of Washington is as follows: (1) on-site and in-kind; (2) off-site, within the watershed, and in-kind; (3) off-site, out of the watershed, and in-kind; and (4) off-site, out of the watershed, and out-of-kind (Ecology 1990). The Port's mitigation for wetland impacts follows these recommendations and the majority of mitigation for most wetland functions is located on-site, but outside of the STIA operations area to avoid hazards to aircraft. However, creating new wetland habitat within the STIA operations area was eliminated from consideration because the site criteria listed above could not be met. Additional on-site mitigation near STIA was not considered because it could be subject to degradation from wildlife control for safety reasons. Therefore, consideration of off-site mitigation was necessary.

#### 7.2.3.1 Wetland Mitigation and Aircraft Safety

Bird-aircraft collisions (bird strikes) are a significant concern to the Port, the FAA, and the aviation community in general. Bird strikes threaten passenger safety, result in costly aircraft repair, cause passenger delays, and decrease revenue for commercial air carriers (Soloman 1973; Seubert 1977). In the United States, annual costs due to bird strikes have been estimated to be $112 million to military aircraft (Conover et al. 1996). Conover et al. (1996) estimate that for civilian aviation, about 33 percent of bird strikes are unreported, and that the annual rate for civilian aircraft is 6,240 strikes (the cost of these strikes was not estimated). Annual loss of life associated with bird strikes is less than three fatalities for all branches of the military, and 3.7 fatalities for civilian/commercial aviation (Conover et al. 1996). For these reasons, bird control in and around airports has become an important component of airport management.

The reported bird strikes at the STIA are summarized in Table 7.2-1. STIA is required by the FAA (as part of the Part 139 Airport Certification Program) to maintain and implement a wildlife hazard management plan (Port of Seattle 1992) to minimize bird strike hazards. Because of certification requirements and the Port's desire to maintain safe aircraft operations, it is compelled (where feasible) to eliminate bird hazards as part of the management plan. These hazards can be eliminated or reduced by hazing (scaring) birds from problem areas, killing wildlife (per permits issued by the U.S. Fish and Wildlife Service), or modifying habitat so it is no longer suitable for wildlife creating the hazards (Port of Seattle 1992).

**Table 7.2-1. Summary of reported bird strikes at Seattle-Tacoma International Airport (1979-1999).**

| Year | Number of Strikes |
|---|---|
| 1979 | 5 |
| 1980 | 8 |
| 1981 | 15 |
| 1982 | 4 |
| 1983 | 8 |
| 1984 | 3 |
| 1985 | 11 |
| 1986 | 12 |
| 1987 | 11 |
| 1989 | 7 |
| 1990 | 35 |
| 1991 | 13 |
| 1992 | 13 |
| 1993 | 14 |
| 1994 | 22 |
| 1995 | 21 |
| 1996 | 22 |
| 1997 | 27 [1] |
| 1998 | 13 [1] |
| 1999 | 21 |
| **Average** | **13.5** |

[1] These numbers include carcasses found near the airfield.

FAA policy regarding wildlife attractants near airports includes the position that any activity or land use on or near an airport that threatens aircraft safety by attracting or sustaining hazardous wildlife is not a compatible land use (FAA 1997b). The FAA recommends all new wildlife attractants be 10,000 ft from turbine aircraft movement areas, and 5 miles from an airport where wildlife could be attracted to or across the airport's approach or departure airspace. The FAA and the Port believe that wetland mitigation created as habitat for wildlife is a land use that should not occur near STIA.

There are compelling reasons to support decisions to mitigate for wildlife habitat mitigation greater than 10,000 ft from active runways. *Port of Seattle Position Paper re: Off-Airport Mitigation of Wetland Wildlife Habitat Function* (Port of Seattle 1998b) provides detailed explanation of off-airport mitigation needs. The reasons for off-airport mitigation discussed in that paper are summarized as follows:

- Creation of wetland wildlife habitat near the airport would increase the hazards to passenger safety. In the United States, more than 1,700 bird strikes occur each year. Worldwide since 1995, 74 people have been killed as a result of bird strikes and four large aircraft have been destroyed. For these reasons, FAA Advisory Circular 150/5200-33 recommends locating replacement wetlands more than 10,000 ft from runways serving turbine-engine airplanes. The FAA and the Department of Agriculture Animal Damage Control Division believe strongly that wetland wildlife habitat should not be created near STIA.
- If the Port were to create wetland wildlife habitat near the airport, it would be required to manage the wetland to prevent its attraction to birds. These management activities could be directly contrary to the key purpose of creating the habitat.
- The FAA has required, as a condition of its approval of the STIA improvements and as a condition of federal funding, that the Port comply with the FAA Advisory Circular and locate the replacement wetlands in Auburn. If the Port did not follow this requirement, it would likely lose essential federal funding for the airport projects.
- Constructing a replacement wetland in proximity to the airport raises liability concerns for the Port. Federal courts have found airport operators liable for failing to mitigate and warn pilots of wildlife hazards.

Considering the Port's and the FAA's mandate to provide a safe environment for aircraft operations, the construction of wetland mitigation to provide wildlife habitat is not feasible near (within 10,000 ft) an existing or proposed runway. A wetland mitigation project designed to provide forest and shrub wetland habitat (to discourage waterfowl use and replace functions in-kind) could attract additional numbers of birds known to be a strike hazard at the airport. These include flocking birds (starlings, blackbirds, and pigeons), raptors (owls and hawks), and other common passerine (perching) birds. These increased numbers could require management actions by the Port and FAA (such as modification of the mitigation site to discourage wildlife use) that would be contrary to federal and state wetland regulations and policies.

The Port is attempting to decrease the aircraft/bird strike hazard at STIA as described in the WHMP (USDA 2000). The addition of new wildlife habitat near airport runways could undermine the ongoing effort to maintain and enhance airport safety and would not meet the goals of the Master Plan Update in which landing and takeoff safety is a major consideration.

#### 7.2.3.2 In-basin Sites

A Geographic Information System (GIS) database (Puget Sound Regional Council 1994) was used to locate potential mitigation sites within the Miller Creek and Des Moines Creek watersheds. The GIS program identified all undeveloped, non-forested, non-wetland sites with average slopes less than 5 percent. It was assumed that, if available for purchase, these were the minimum criteria necessary for a suitable mitigation site. Based on these criteria, 19 potential mitigation sites were identified (Figure 7.2-3). The suitability of the sites (although all are within the 10,000-ft radius of concern for wildlife hazards to aircraft [FAA 1997b]) for wetland mitigation was evaluated during site visits on August 28, 1996 (Table 7.2-2).

The site selection criteria were altered because undeveloped sites greater than 50 acres were lacking in the two watersheds. For this level of analysis, it was assumed that drainage conditions on each site identified by the GIS program could be modified to retain adequate water to support wetlands, so evidence of high water tables was not considered. For this project, a mitigation site in excess of 50 acres is preferred because it would allow a mitigation ratio of at least 2:1 and allow protection of the site with adequate wetland buffers. In addition, sites greater than 50 acres would combine the functions of several small, isolated wetlands in a single large wetland mitigation project, enhancing the probability of achieving mitigation goals, ensuring long-term protection, and ultimately providing wetland functions to compensate for project impacts (Federal Register 1995; U.S. EPA and ACOE 1993). However, all sites greater than 10 acres were evaluated because there were few large undeveloped sites on suitable terrain in either watershed.

#### 7.2.3.3 Out-of-basin Sites

The search for off-site mitigation areas began by reviewing over 100 parcels for their suitability as wetland mitigation. The review focused on sites larger than 50 acres because of the acreage needed to mitigate impacts and the ecological and logistical advantages of developing mitigation on a single site. Other constraints identified for off-site areas included:

- Site selected should be in proximity to impact site and not conflict with other planned wetland mitigation projects in the Duwamish watershed
- Land not constrained by development restrictions (such as King County's Farmland Preservation Program)
- Land that is economically feasible for purchase and construction of desired mitigation
- Sites greater than 10,000 ft from proposed or existing STIA runways
- Sites greater than 5,000 ft from general aviation runways (for airports located within the Cities of Auburn and Kent)

In addition to the above constraints, a preference was given to suitably sized, non-wetland areas that were close to surface water or other riparian habitat areas. The mitigation site would then provide ecological functions to off-site areas.

Of eleven sites larger than 50 acres, five sites were rejected as unsuitable due to the large amount of wetlands present or because they offered minimal opportunity for habitat improvement. Of the six remaining sites, two were not available for purchase, the development rights of two were owned by King County for farmland preservation, and one site had been recently purchased by the City of Kent for its own mitigation purposes.

Off-Site Mitigation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- Road
- Major Highway
- Watershed boundary
- Present Runways
- Proposed 3rd Runway, Runway Safety Areas, and Runway Extentions.
- Borrow, Warehouse/ Parking or SASA area
- Slope less than or equal to 5%
- Non–developed/non–forested
- Slope <= 5% and non–developed/non–forested
- 8 Potential wetland mitigation
- 10,000-Foot Radius From Proposed Runways
- City Boundary

N

**Figure 7.2-3**
**Potential Mitigation Sites Evaluated in the Miller Creek and Des Moines Creek Watersheds**

0 3000 6000 9000

*Scale in Feet*

**Table 7.2-2. Summary of potential mitigation sites analyzed within the Miller Creek and Des Moines Creek watersheds (see Figure 7.2-3).**

| Site | Watershed | Acres | Existing Conditions | Mitigation Limitations |
|---|---|---|---|---|
| 1 | Miller Creek | 55 | The site is within the direct flight path to the airport. It is within a vacated residential area and has been identified for development as the North SeaTac Park (which includes play fields, a picnic shelter, restrooms, a playground, parking, and trails), pursuant to an agreement between the Port and the City of SeaTac. | Use of the site for wetland mitigation would eliminate use of much of the site as a community park.<br>The site is approximately 6,400 ft north of the existing runways. Enhancement of wildlife habitat in this area would increase wildlife hazards to aircraft. |
| 2 | Miller Creek | 14 | The area is within the direct flight path to the airport. It is in an abandoned residential area with scattered deciduous trees, blackberries, grasses, and weeds. The site drains from east to west into Tub Lake. | Some slopes on the site are steeper than mapped in the GIS database, and only approximately 5 acres of the site are suitable for wetland creation. Therefore, this site is not large enough.<br>The site is 4,500 ft north of the existing runways, and enhancement of wildlife habitat in this area would increase hazards to aircraft. |
| 3 | Miller Creek | 33 | The area is in a vacated residential area in the direct flight path to the airport. Vegetation is largely comprised of blackberries, ornamental trees, grasses, and weeds. The smaller, northern portion of the site connects to the Tub Lake wetland on one side, with an approximate rise in elevation of 30 to 50 ft on other sides. The southern portion of the site is also topographically higher than the Tub Lake wetland. | The site is fragmented by three streets, which could be detrimental to wildlife.<br>The site is approximately 2,600 ft north of the nearest existing runway. Creation of wetland habitat at this site would increase wildlife hazards to aircraft. |
| 4 | Miller Creek | 17 | The area is at a topographic high point in the direct flight path of the airport. There are patches of mixed deciduous and ornamental trees. A large water tower is in the northern portion of the site. | The area is not large enough to mitigate wetland impacts at one site, and there is no wildlife corridor to the other potential sites or other habitat areas. The site is within the fenced airport security area, which would preclude use of the wetland by some forms of wildlife, including deer, coyote, and fox.<br>The site is within the area of proposed Master Plan Update improvements where warehouse and parking is proposed.<br>This site is approximately 2,300 ft north of the nearest runway. Wetland creation would not be feasible due to the proximity of low-flying aircraft and increased wildlife hazards |

**Table 7.2-2. Summary of potential mitigation sites analyzed within the Miller Creek and Des Moines Creek watersheds (see Figure 7.2-3) (continued).**

| Site | Watershed | Acres | Existing Conditions | Mitigation Limitations |
|---|---|---|---|---|
| 5 | Miller Creek | 11 | The site is on a slope within the fenced airport security area. Patches of deciduous and ornamental trees are scattered throughout the site. | Most of the site would be developed as part of the Master Plan Update improvements. Only about 1 or 2 acres would remain after construction.<br><br>The proximity to existing airport operations (approximately 2,000 ft from existing runways and 1,000 ft from the proposed runway) would result in increased wildlife hazards to aircraft. |
| 6 and 7 | Miller Creek | 45 | These sites are grassy areas between the existing runways and taxiways within the airport operation area. | Locating wetland habitat within the airport operation area is not feasible for safety reasons. |
| 8 | Miller Creek | 23 | This site consists of landscaped yards in a semi-rural residential area west of the airport. Miller Creek flows through portions of the relatively flat site. | The eastern portion of this site is within the fill footprint for the proposed runway. The remaining portion of the site is not large enough to mitigate for the wetland impacts.<br><br>The mitigation area would be isolated from other habitat areas by South 154th Street, the airport, and SR 509, which would not be conducive to optimal wildlife habitat.<br><br>The mitigation area would be 3,100 ft southwest of the end of the nearest existing runway and 2,100 ft southwest of the end of the proposed runway. The site is approximately 1,000 ft directly west of the edge of the proposed runway. The proximity of airport operations increases the wildlife hazard to low-flying aircraft. |
| 9 | Des Moines Creek | 24 | The site is a cemetery. | It is not reasonable to locate wetland mitigation in a cemetery.<br><br>The proximity of the site (3,600 ft southeast of the end of the nearest runway and 2,600 ft east of the edge of the nearest runway) to runways presents a wildlife hazard to aircraft. |
| 10, 11, 13, and 14 | Miller Creek (sites 10 and 13) and Des Moines Creek (sites 11 and 14) | 100 | These sites are located between and adjacent to the existing runways and taxiways. They are grassy areas mowed and maintained for airport safety reasons. | Locating wetland habitat within the airport operations area is not feasible due to safety reasons. |

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**Table 7.2-2. Summary of potential mitigation sites analyzed within the Miller Creek and Des Moines Creek watersheds (see Figure 7.2-3) (continued).**

| Site | Watershed | Acres | Existing Conditions | Mitigation Limitations |
|---|---|---|---|---|
| 12 | Miller Creek | 16 | This relatively flat area consists of large expanses of lawn bordered by roads, houses, and a large scrub/shrub wetland. | Wetland mitigation at this site would require displacement of additional residents.<br>The site is not large enough to mitigate all of the wetland impacts at one location.<br>The area is bordered by major roadways (SR 509 and Des Moines Way S) on two of the three sides, which would not be conducive to optimal wildlife habitat.<br>Mitigation would be about 1,800 ft west of the proposed runway and approximately 4,500 ft from either end of the proposed runway. The proximity of the proposed runway to mitigation would increase the hazard to aircraft. |
| 15 | Des Moines Creek | 11 | Site 15 is a horse pasture surrounded on three sides by steep slopes. A scrub/shrub wetland, which connects to Bow Lake, lies on the western side of the pasture. Single-family homes, a trailer park, and a hotel overlook the site. | Less than half of the site would be available for wetland mitigation due to the surrounding topography and the presence of existing wetland. The proximity of a trailer park, hotel, and single-family homes, and the small size of available upland area make this site undesirable for wetland habitat mitigation.<br>The site is roughly 5,200 ft east of the ends of the existing runways, and 4,700 ft east of the edge of the nearest runway. |
| 16 | Des Moines Creek | - 35 | Site 16 is located in the direct flight path and consists of the northern portion of Tyee Valley Golf Course. Currently, a safety area for Runway 34R, which encroaches on the golf course, is under construction. | Much of the area is included in the Master Plan Update improvement area (including the safety area currently under construction and the SASA). If the preferred alternative for the airport expansion is implemented, there would not be enough suitable land remaining for wetland creation.<br>Mitigation at this site may not be protected in perpetuity due to the proximity of airport operations. It is approximately 1,500 ft south of Runway 34R, which would increase wildlife hazards to aircraft. |

**Table 7.2-2. Summary of potential mitigation sites analyzed within the Miller Creek and Des Moines Creek watersheds (see Figure 7.2-3) (continued).**

| Site | Watershed | Acres | Existing Conditions | Mitigation Limitations |
|---|---|---|---|---|
| 17 | Des Moines Creek | 23 | This site is the southern portion of Tyee Valley Golf Course. It is bordered by a mixed forest to the west and south, residential and recreational uses to the east, and the northern portion of the golf course to the north. Des Moines Creek divides the northern and southern portions of the golf course. | The site would be confined by ongoing disturbances or developments including the airport, the SASA area, and borrow areas for construction of the proposed runway, which is not conducive for wildlife habitat replacement.<br>It is 2,100 ft directly south of the end of Runway 34R, which would result in increased wildlife hazards to aircraft.<br>There is not enough land to mitigate wetland impacts on one site that could be protected in perpetuity. |
| 18 | Des Moines Creek | 16 | This site consists of grass pastures and landscaped yards adjacent to a forested area on the west side, and residential areas to the north, east, and south. Most of the site is on a topographically high area. | The necessary acreage required for compensatory mitigation could not be attained at this site. It is fragmented by homes and active roads, and residents would have to be displaced for mitigation.<br>The site is approximately 4,900 ft south of the existing runways and would increase wildlife hazards to aircraft. |
| 19 | Des Moines Creek | 12 | Site 19 consists of landscaped yards and some pasture area with a large forested area to the north. Most of the site is topographically high. | The necessary acreage required for compensatory mitigation could not be attained at this site. It is fragmented by homes and active roads, and residents would have to be displaced for mitigation.<br>Site 19 is approximately 5,200 ft south of the existing runways, and would increase wildlife hazards to aircraft. |

Note: Data compiled by Parametrix.

The remaining site, analyzed in this plan, has several attributes that make it favorable for wetland mitigation. It is large enough to accommodate the entire wetland mitigation project and has physical features that could successfully support the proposed mitigation approach. These features include proximity to the Green River and a seasonally high water table.

The mitigation site is within the boundary of the Mill Creek SAMP (ACOE 1997). This mitigation project enhances existing wetlands and creates wetlands from upland areas, enhances the aquatic resources of the basin, and is consistent with the goals and objectives of the SAMP. The Draft SAMP identifies specific wetland areas on which development would be permitted by a Regional General Permit, and other areas where protection and enhancement of wetlands will be required. The overall goal of the Draft SAMP is to provide for aquatic resource protection and economic development in the Mill Creek basin while assuring no net loss of aquatic resource functions and values of the basin.

### 7.2.4 Constraints

No construction or implementation constraints have been identified that would affect the success of the wetland mitigation at the Auburn site.

### 7.2.5 Ecological Assessment of the Mitigation Site

The ecological conditions of the upland and wetland areas of the proposed mitigation site are discussed in this section. The existing wetlands are described in more detail in Appendix A of the *Wetland Delineation Report* (Parametrix 2000c).

#### 7.2.5.1 Existing Site Conditions

**Vegetation**

The mitigation site consists primarily of abandoned agricultural land. Vegetation is a mix of native and non-native herbaceous species, including meadow foxtail (*Alopecurus pratensis*), Canada thistle (*cirsium arvense*), quackgrass (*Agropyron repens*), timothy (*Phleum pratense*), orchardgrass (*Dactylis glomerata*), colonial bentgrass (*Agrostis tenuis*), and patches of reed canarygrass (Table 7.2-3). Other non-native species scattered throughout the area include cocklebur (*Xanthium strumarium*), common dandelion (*Taraxacum officinale*), and climbing nightshade (*Solanum dulcamara*).

Three emergent wetlands are present at the Auburn site (totalling about 19.5 acres (see Figure 7.2-2) The wetlands are dominated by non-native pasture grasses that include meadow foxtail, redtop, colonial bentgrass, quackgrass, tall fescue, common velvetgrass, and patches of reed canarygrass. Other herbaceous species in the wetlands include soft rush and creeping buttercup. Along the western edge of the site are scattered black cottonwood and red alder trees.

A variety of shrubs and trees are scattered along a fence line at the southern boundary of the site. Shrubs found along the fenceline include Himalayan blackberry, vine maple, roses (*Rosa* sp.), snowberry (*Symphoricarpos albus*), and red-osier dogwood (*Cornus stolonifera*). Tree species

Table 7.2-3 **Plant species observed on the mitigation site and adjacent riparian areas during delineation site visits in October 1995 and 2000.**

| Scientific Name | | Common Name | WIS [a] |
|---|---|---|---|
| Trees | *Alnus rubra* | Red alder | FAC |
| | *Crataegus douglasii* | Douglas hawthorn | FAC |
| | *Fraxinus latifolia* | Oregon ash | FACW |
| | *Populus trichocarpa* | Black cottonwood | FAC |
| | *Prunus emarginata* | Bitter cherry | FACU |
| Shrubs | *Acer circinatum* | Vine maple | FACU |
| | *Cornus stolonifera* | Red-osier dogwood | FACW |
| | *Corylus cornuta* | Beaked hazelnut | FACU |
| | *Cytisus scoparius* | Scots broom | NI |
| | *Populus trichocarpa* (saplings) | Black cottonwood | FAC |
| | *Rosa nutkana* | Nootka rose | FAC |
| | *Rosa pisocarpa* | Clustered wild rose | FAC |
| | *Rosa* sp. | Rose | |
| | *Rubus discolor* | Himalayan blackberry | FACU |
| | *Rubus laciniatus* | Evergreen blackberry | FACU |
| | *Rubus ursinus* | Pacific blackberry | FACU |
| | *Salix* spp. | Willow | FACW |
| | *Salix scouleriana* | Scouler willow | FAC |
| | *Symphoricarpos albus* | Snowberry | FACU |
| Herbs | *Agropyron repens** | Quackgrass | FAC |
| | *Agrostis alba* | Redtop | FACW |
| | *Agrostis tenuis** | Colonial bentgrass | FAC |
| | *Alopecurus geniculatus* | Water foxtail | OBL |
| | *Alopecurus pratensis** | Meadow foxtail | FACW |
| | *Cirsium arvense** | Canada thistle | FACU |
| | *Cirsium vulgare** | Bull thistle | FACU |
| | *Dactylis glomerata** | Orchardgrass | FACU |
| | *Dipsacus sylvestris* | Teasel | FAC |
| | *Eleocharis palustris* | Creeping spikerush | OBL |
| | *Epilobium ciliatum* | Willow-herb | FACW |
| | *Equisetum arvense* | Field horsetail | FAC |
| | *Festuca arundinacea** | Tall fescue | FAC |
| | *Festuca rubra* | Red fescue | FAC+ |
| | *Geranium* spp. | Crane's-bill | FACU |
| | *Holcus lanatus** | Common velvetgrass | FAC |
| | *Juncus effusus* | Soft rush | FACW |
| | *Juncus* spp. | Rush | FACW |
| | *Lolium perenne* | Perennial rye grass | FACU |
| | *Lotus corniculatus* | Birds foot trefoil | FAC |
| | *Phalaris arundinacea** | Reed canarygrass | FACW |

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**Table 7.2-3. Plant species observed on the mitigation site and adjacent riparian areas during delineation site visits in October 1995 and 2000 (continued).**

| Scientific Name | Common Name | WIS [a] |
|---|---|---|
| *Phleum pratense** | Timothy | FAC |
| *Phragmites communis* | Common reed | FACW |
| *Plantago lanceolata* | English plantain | FAC |
| *Poa pratensis** | Kentucky bluegrass | FAC |
| *Polystichum munitum* | Sword fern | FACU |
| *Ranunculus repens* | Creeping buttercup | FACW |
| *Rumex crispus* | Curly dock | FAC |
| *Scirpus acutus* | Hard-stem bulrush | OBL |
| *Solanum dulcamara** | Climbing nightshade | FAC |
| *Symphoricarpos albus* | Snowberry | FACU |
| *Tanacetum vulgare** | Common tansy | UPL |
| *Taraxacum officinale* | Common dandelion | FACU |
| *Trifolium pratense* | Red clover | FACU |
| *Typha latifolia* | Common cattail | OBL |
| *Xanthium strumarium* | Cocklebur | FAC |

* Dominant species on portions of the site.

a Wetland Indicator Status (Table 7.2-4).

**Table 7.2-4. Wetland indicator status.**

| Category | Symbol | Definition |
|---|---|---|
| Obligate Wetland Plants | OBL | Obligate wetland plants occur almost always (estimated probability >99%) in wetlands under natural conditions, but may also occur rarely (estimated probability <1%) in non-wetlands. |
| Facultative Wetland Plants | FACW | Facultative wetland plants usually occur (estimated probability 67% to 99%) in wetlands, but may also occur (estimated probability 1% to 33%) in non-wetlands. |
| Facultative Plants | FAC | Facultative plants with a similar likelihood (estimated probability 33% to 67%) of occurring in wetlands or non-wetlands. |
| Facultative Upland Plants | FACU | Facultative upland plants usually occur (estimated probability 67% to 99%) in non-wetlands, but also occur (estimated probability 1% to 33%) in wetlands. |
| Obligate Upland Plants | UPL | Upland plants occur almost always (estimated probability >99%) in non-wetlands under natural conditions. |
| | + | Used in conjunction with a category to indicate a somewhat greater probability to occur in wetlands. |
| | - | Used in conjunction with a category to indicate a somewhat lower probability to occur in wetlands. |

Source: Environmental Laboratory (1987)

AR 009923

present in this area are Douglas hawthorn (*Crataegus douglasii*), Oregon ash (*Fraxinus latifolia*), and black cottonwood. The herbaceous community in this area is dominated by reed canarygrass.

In the summer of 1998, the northern one-fourth of the property was plowed and disced by a farmer leasing the land to the north.[20] This portion of the site is currently dominated by pasture grasses such as tall fescue (*Festuca arundinacea*) and perennial ryegrass (*Lolium perenne*), and weedy forbs such as bull thistle (*Cirsium vulgare*) and willowherb (*Epilobium ciliatum*).

**Hydrology**

There are no natural surface water features on the mitigation site. Two streams, the Green River and Auburn Creek, are located near the mitigation site. The Green River flows from south to north about 100 to 150 ft east of the mitigation site. At this location, the river base elevation is about 12 to 15 ft below the site elevation. The river channel consists of a steep bank, largely vegetated with red alder and black cottonwood saplings. North of the mitigation site and north of South 277th Street, King County sensitive areas maps (King County 1990) shows an intermittent stream, Auburn Creek (see Figure 7.2-1). This stream drains pasture and farmland and flows into the Green River about 1 mile north of the mitigation site. At the confluence of Auburn Creek and the Green River, a small dike, culvert, and flap gate provide flood control.

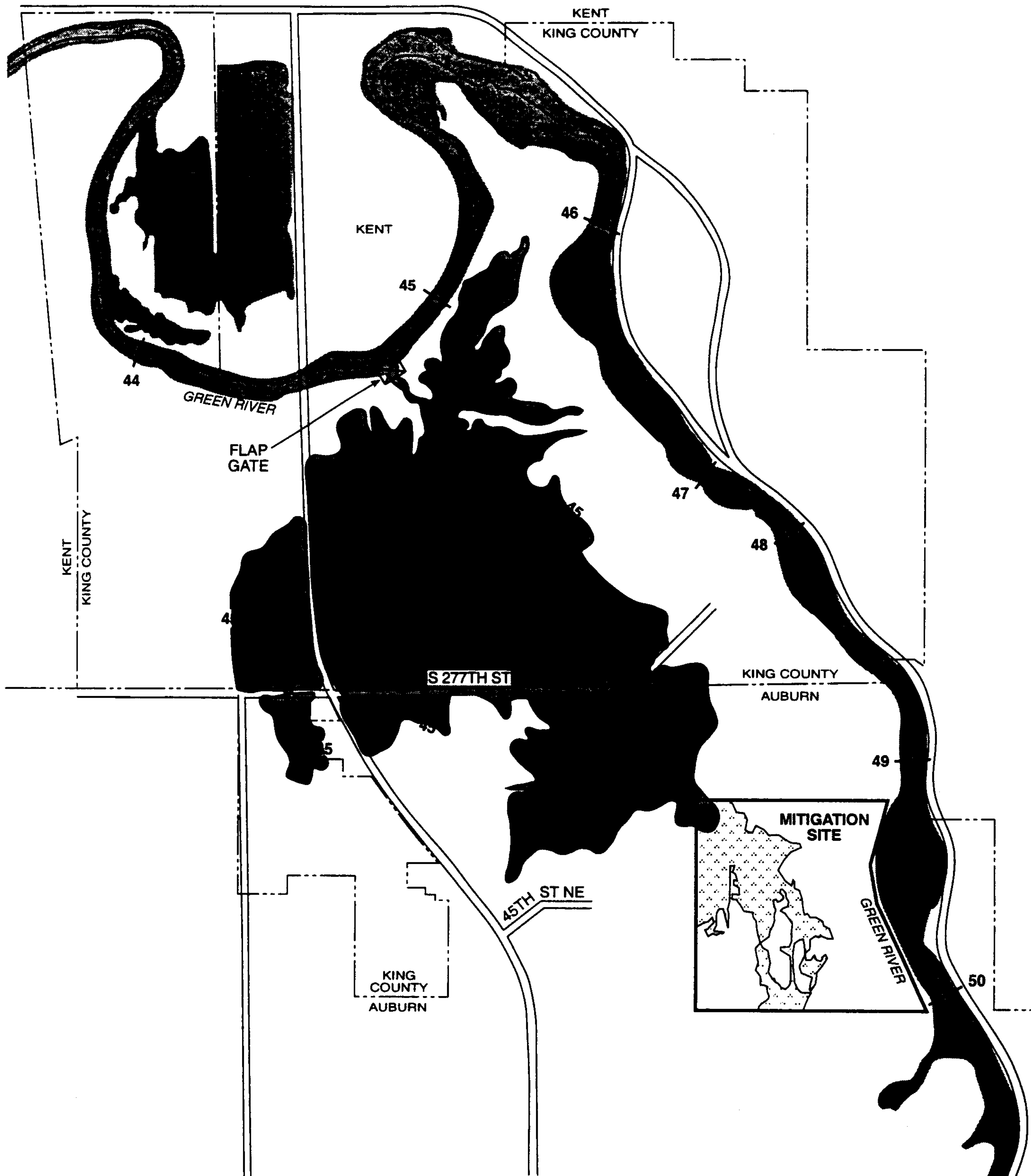
Overland flow enters the site through a wetland drainageway, or shallow swale, that crosses the middle of the site. For short periods following heavy rainfall, this shallow swale contains surface flows that convey water from south to north across the site. This shallow drainage swale is connected to the 100-year floodplain of the Green River at the very northwest corner of the site (Figure 7.2-4). The eastern portion of the mitigation site is not within the 100-year floodplain of the Green River because the eastern edge of the site is several feet higher than the 100-year flood elevation of the river (See Figure 7.2-4). A drainage ditch on the mitigation site conveys stormwater and surface water runoff from the northwestern portion of the site to other ditches along South 277th Street. This water eventually flows into the Green River via Auburn Creek.

Since September 1995, the groundwater hydrology of the site has been monitored using shallow groundwater monitoring wells. Three representative wells are presented in Figures 7.2-5 through 7.2-7. The well data indicate groundwater levels that are within 18 inches of the surface at a number of locations, and generally within 36 to 24 inches of the soil surface for extended periods of time during the late fall, winter and early spring months. Wetlands on the mitigation site appear to be largely supported by this seasonally high groundwater table. In addition, wetland hydrology is supported by on-site precipitation that perches in the low permeability soils, resulting in saturated soils and extensive areas of shallow surface water ponding during the rainy season (See Figures 7.2-5 through 7.2-7).

At all well sites, groundwater elevations were lowest in late summer and early fall. Groundwater elevations were highest during and immediately after winter and early spring rains. Groundwater monitoring data show that following early fall precipitation (October, November) and subsequent soil saturation, groundwater elevations on the mitigation site rise by approximately 5 to 8 ft (see Figures 7.2-5 through 7.2-7). Groundwater elevations fall slowly during periods of low precipitation. The changes in groundwater elevation in response to precipitation are largely independent of variations in surface water elevation in the Green River, because the river elevation is typically below the groundwater levels observed on the site (Figure 7.2-8).

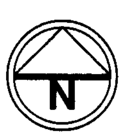
AR 009924

[20] The Port did not authorize this activity and the Port's property was not planted.




Source: FEMA 1989



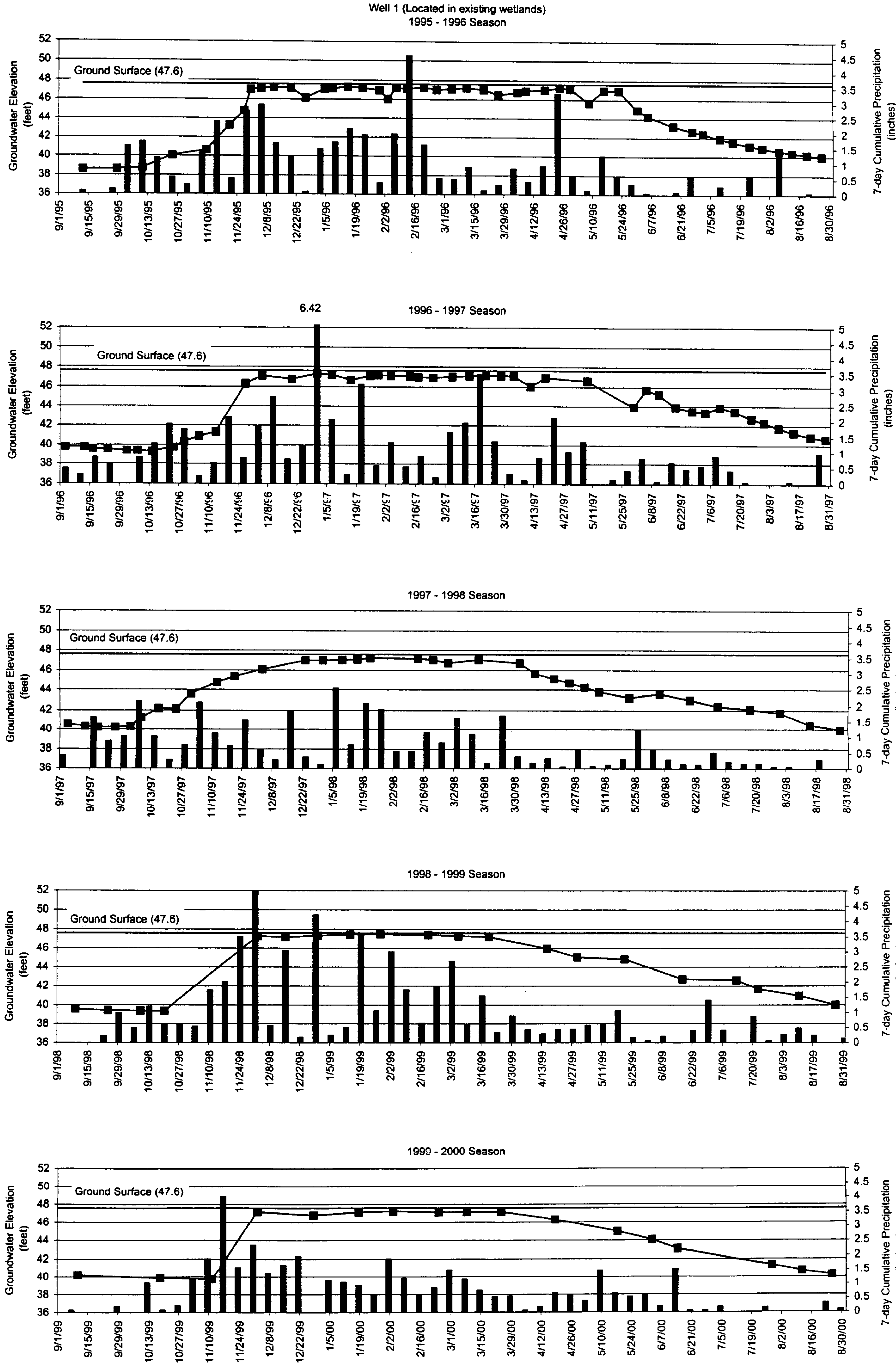



Existing Wetland

100 Year Floodplain

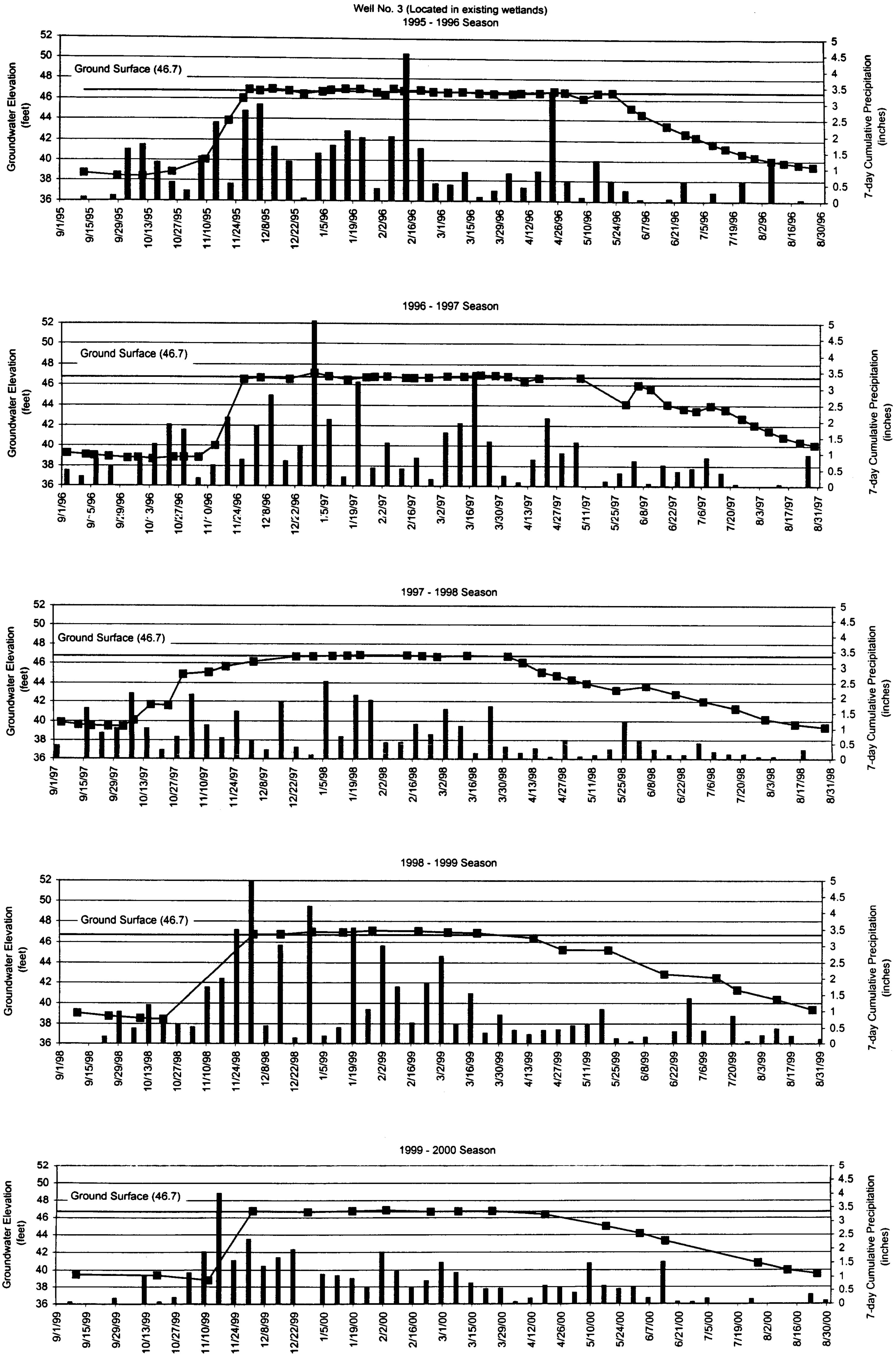
50 —— Flood Elevations

**Figure 7.2-4**
**100-Year Floodplains On and Near the Proposed Wetland Mitigation Site**




AR 009926

**Figure 7.2-5**
**Variations in Groundwater (Monitoring Well 1) and Daily Precipitation**




AR 009927

**Figure 7.2-6**
**Variations in Groundwater (Monitoring Well 3) and Daily Precipitation**

charts for NRMP.xls

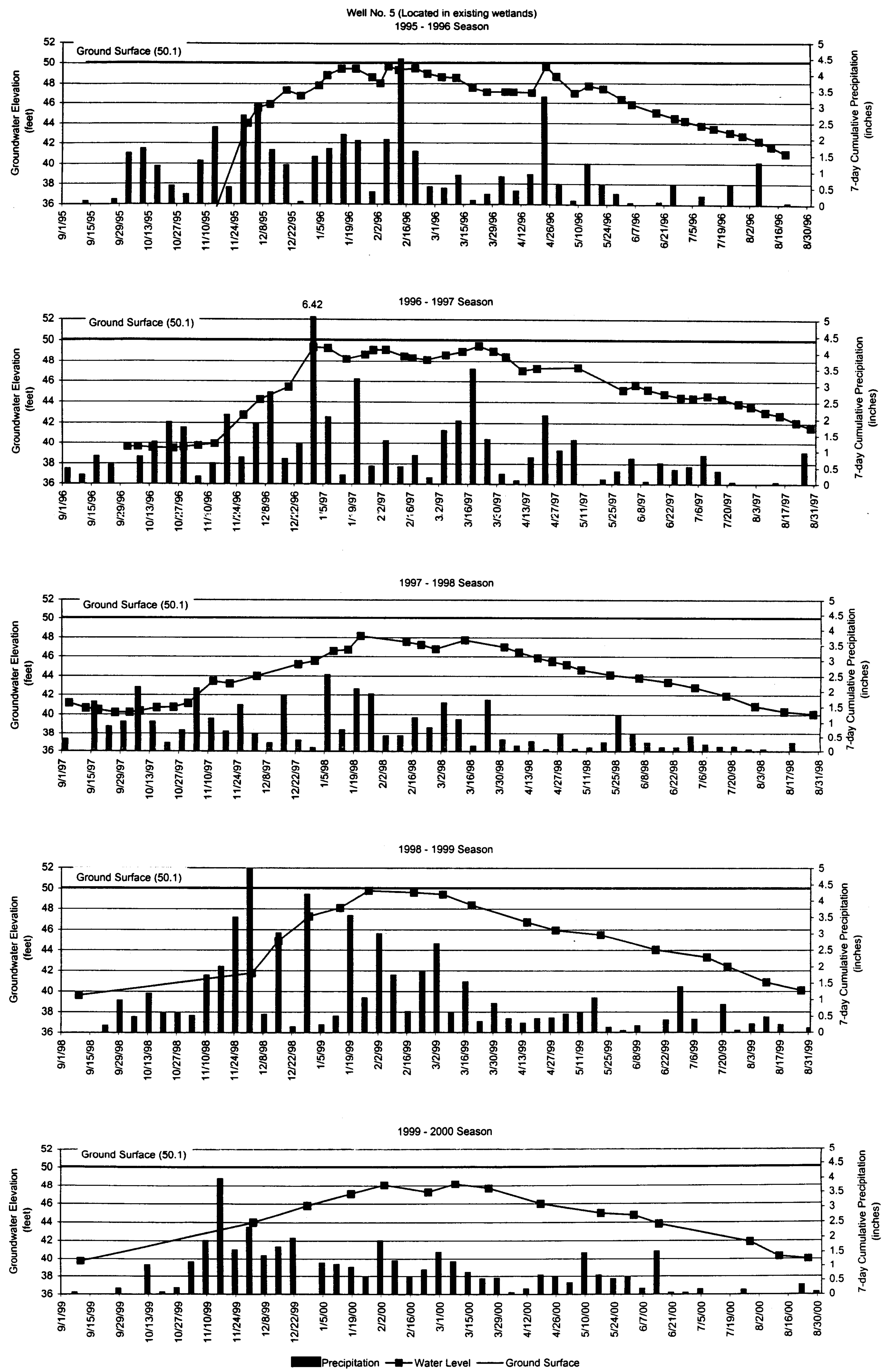
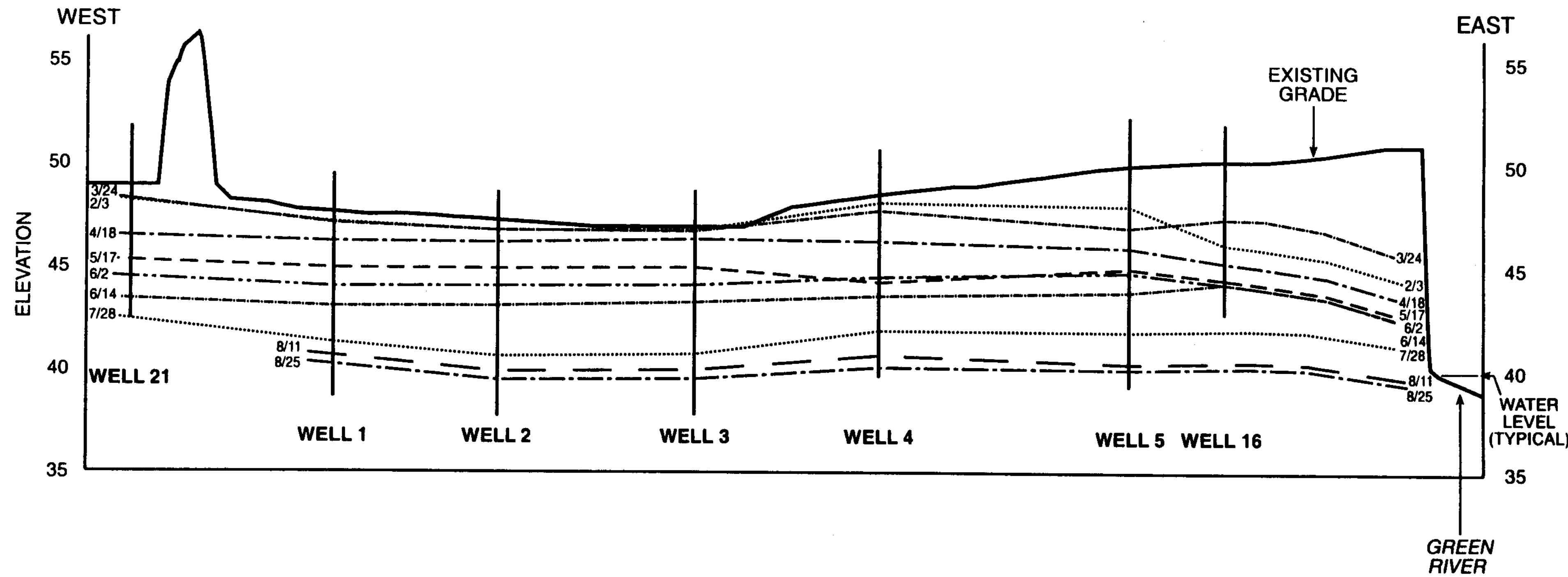



**Figure 7.2-7**
**Variations in Groundwater (Monitoring Well 5) and Daily Precipitation**

AR 009928

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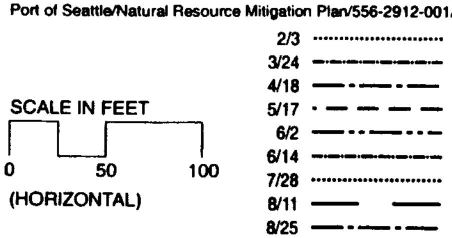



**Figure 7.2-8**
**Cross Section of Groundwater Elevations (February-August 2000) at the Wetland Mitigation Site**

Well data indicate that groundwater in the mitigation area is perched over low permeability clay layer and generally flows northwesterly in the same direction as surface water (Figure 7.2-9 through 7.2-11). A groundwater divide occurs approximately 700 ft west of the Green River (see Figure 7.2-9). East of this divide, groundwater flows eastward towards the river. West of the divide water flows to the northwest.

## Soils

The soils on the mitigation site are alluvial in origin, developed from material deposited on the site by the Green River. The surficial layers of these soils are a complex of silty mineral soils, frequently with lenses of fine sand intermixed. Plowing has mixed the surficial layers of soil, typically to a depth of 9 to 10 inches.

The King County Soil Survey (Snyder et al. 1973) maps soils on the site as the poorly drained Briscot, and Oridia silt loams, and the somewhat poorly drained Renton silt loam (Figure 7.2-12; Table 7.2.5). Briscot, Oridia, and Renton silt loams are designated as hydric soils on the King County, Washington Hydric Soil List (NRCS 2000).[21]

**Table 7.2-5. Drainage characteristics of soils occurring on the mitigation site.**

| | | High Water Table | | | Flooding | | |
|---|---|---|---|---|---|---|---|
| Soil Series [1] | Drainage Class | Permeability (in/hr) [2] | Depth (ft) | Months | Frequency | Duration | Months |
| Briscot | Poorly | 0.63-2.0 | 1 to -1 | Nov-Apr | Occasional | Brief | Dec to Feb |
| Oridia | Poorly | 0.20-2.0 | 1 to 3 | Nov-Apr | Occasional | Brief | Nov to Apr |
| Renton | Somewhat poorly | 2.0-6.3 | 1 to 1.5 | Nov-Apr | Common | Brief | Nov to Apr |

Source: U.S. Department of Agriculture (1973).

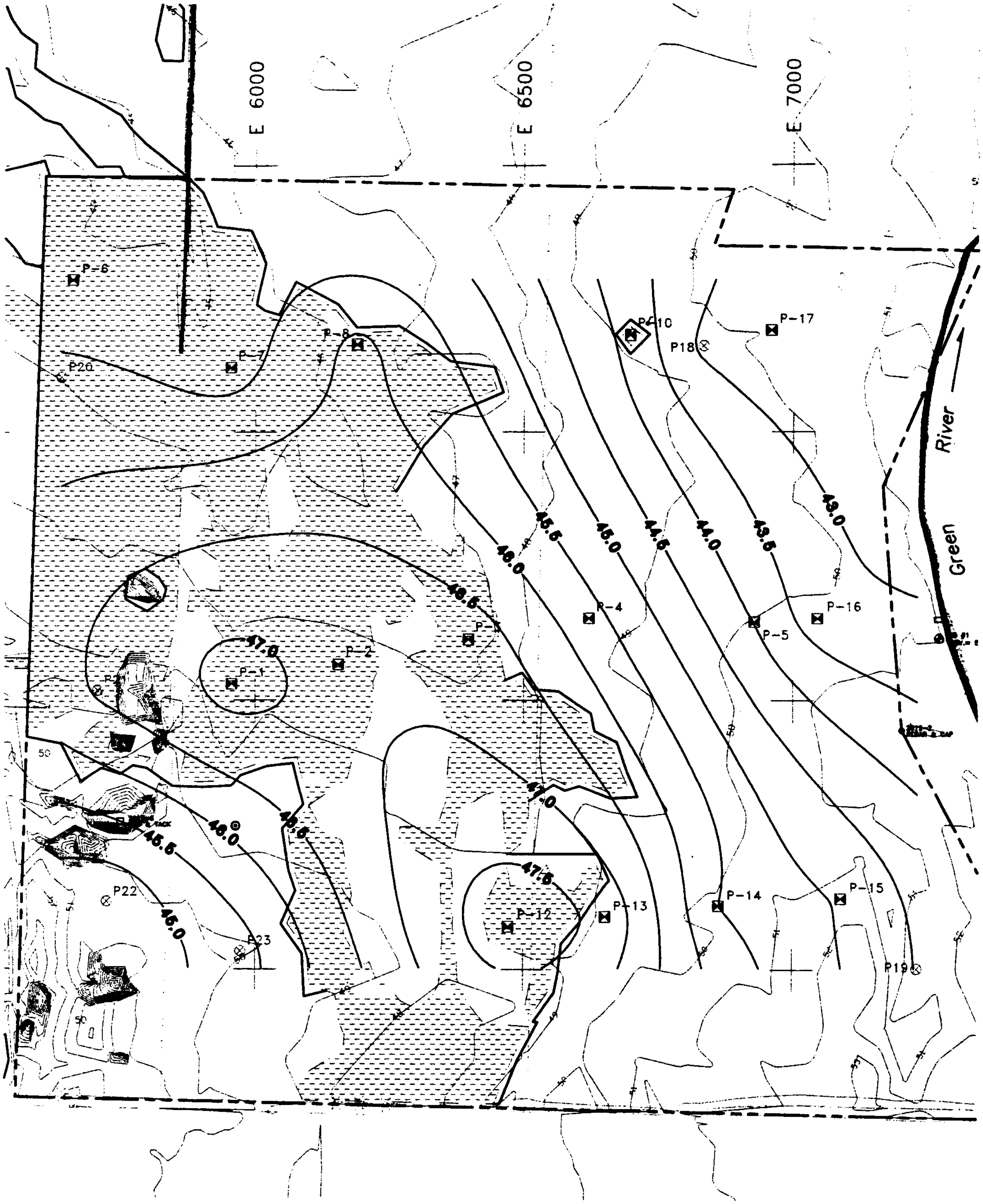
[1] All soils are classified as hydric (wetland); however, evaluation of on-site conditions indicate non-hydric soil inclusions occur throughout the site.

[2] Within the top 20 inches of soil.

The published soil descriptions are generally consistent with the results of the laboratory and field analysis of soil performed by Parametrix in October 1995 and soil data collected in the fall of 2000 (Parametrix 2000c). Field observations, and analytical test results indicate that two general soil profiles occur on the proposed mitigation site: a wetland soil profile and an upland soil profile (Figure 7.2-13).

The wetland soil profile generally consists of a 6-inch organic layer that covers a 72-inch layer of clayey silt (see Figure 7.2-13). The first 24 inches of the clayey silt are uniform, with mottles dispersed throughout. This uniformity is likely a result of past plowing. Below the uniformly mixed silt, the soil is stratified to layers of gray silt and sandy silt that grades to a sandy silt layer at a depth of about 72 inches. Below the sandy silt are 12 to 16 inches of very compact clayey silt. Below the clayey silt layer, the soil grades to a uniformly fine sand layer. The permeability of the clay silt varies between 0.001 to 0.003 inches/hour (determined at two locations). Because of the thickness of the clayey silt layer and the absence of an underlying fine sand (as found in the adjacent upland soils described below), these soils drain slowly, allowing hydric soil characteristics to develop.

[21] Because the soils on the site are mapped as hydric, and farming activities including ditching have occurred, mitigation on the site could be considered restoration. Because the Port's mitigation establishes some wetland classed that probably did not historically occur on the site, the term "creation" is used for mitigation in upland portions of the site.




FILE: 29121404a
DATE: 12/14/00

LEGEND:

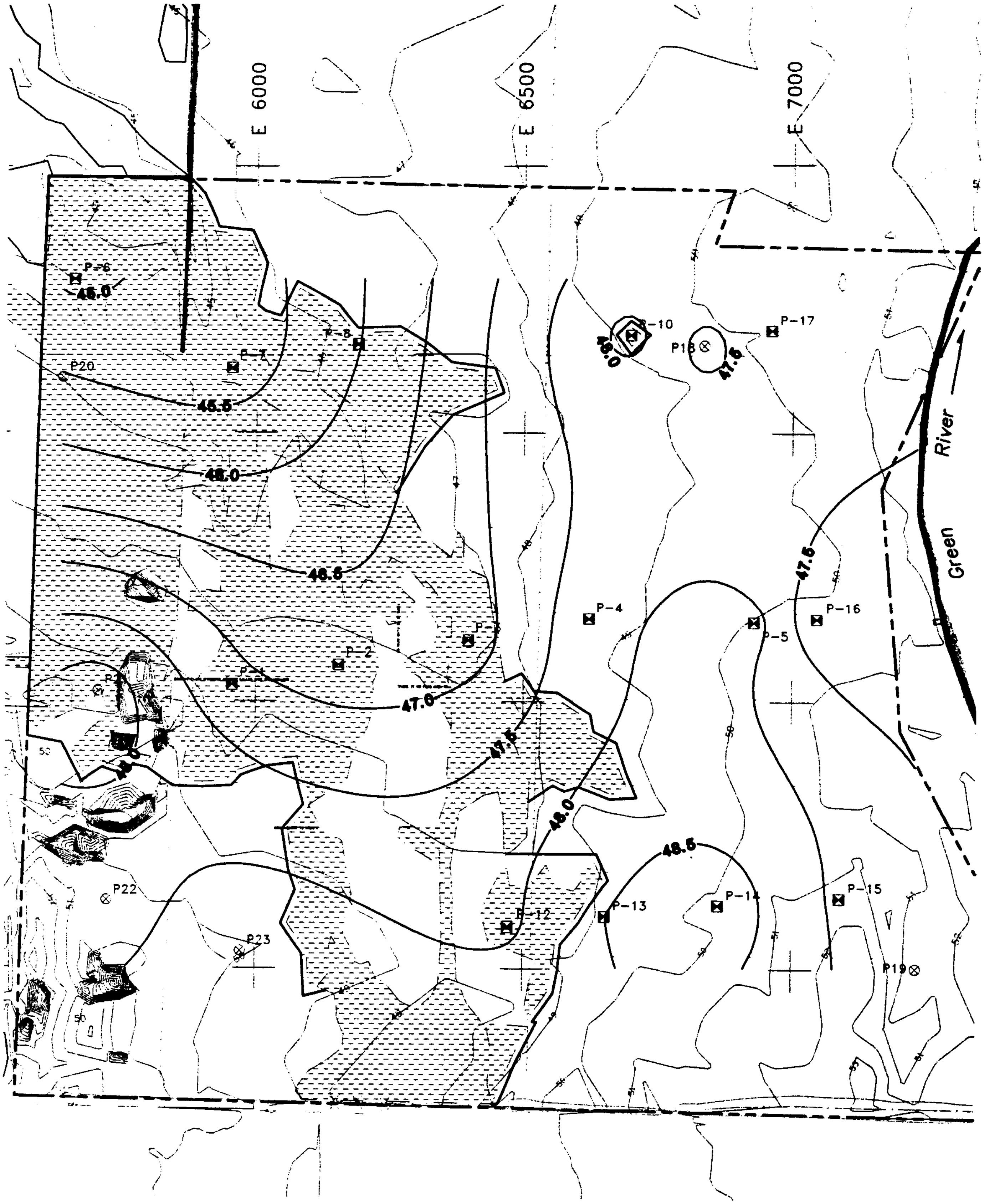
46.0 — *Groundwater Contour and Elevation*

*Existing Wetland*

P20 — *Piezometer Locations and Number*

45 — *Existing Ground Surface Contour and Elevation*

**Figure 7.2-9**
**Groundwater Elevations on the Auburn Wetland Mitigation Site (December 2, 1999)**




FILE: 29121404b
DATE: 12/14/00

LEGEND:

— 46.5 — Groundwater Contour and Elevation

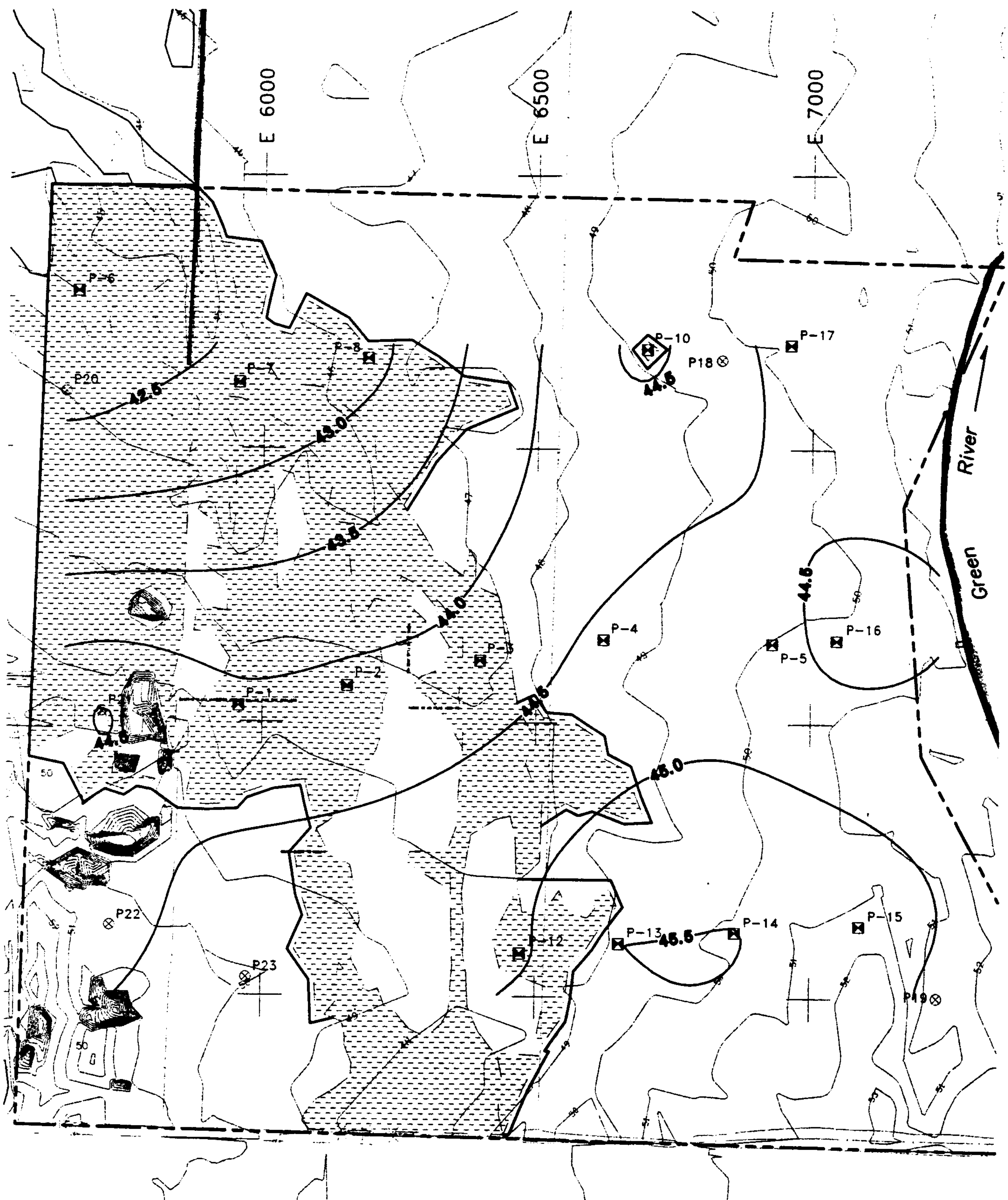
Existing Wetland

P20 Piezometer Locations and Number

— 45 — Existing Ground Surface Contour and Elevation

N

**Figure 7.2-10**
**Groundwater Elevations on the Auburn Wetland Mitigation Site (March 8, 2000)**




FILE: 29121404c
DATE: 12/14/00

LEGEND:

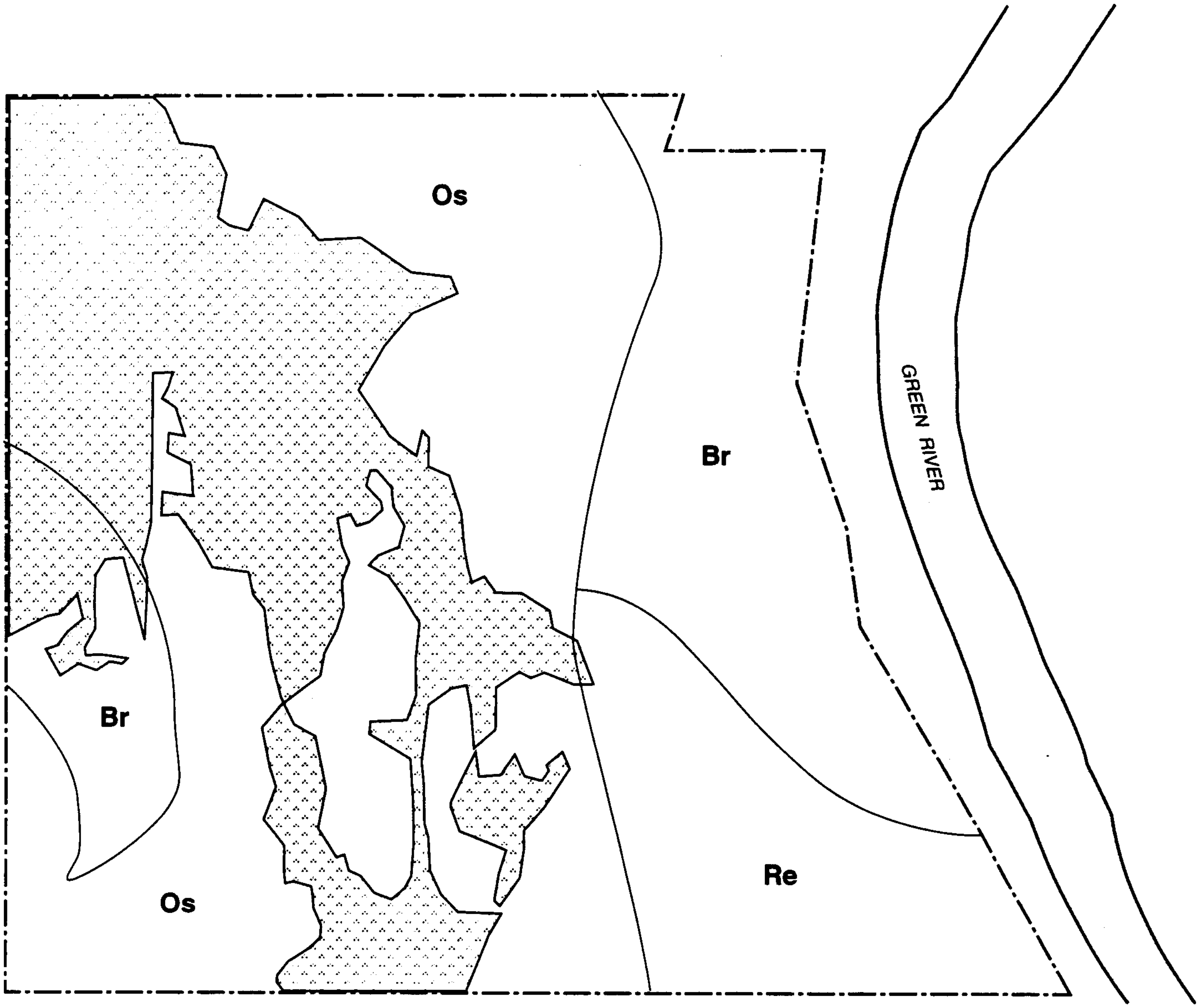
44.5 — Groundwater Contour and Elevation

Existing Wetland

P20 — Piezometer Locations and Number

45 — Existing Ground Surface Contour and Elevation

**Figure 7.2-11**
**Groundwater Elevations on the Auburn Wetland Mitigation Site (June 2, 2000)**




Source: USDA 1973

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N

APPROXIMATE SCALE IN FEET

0 150 300

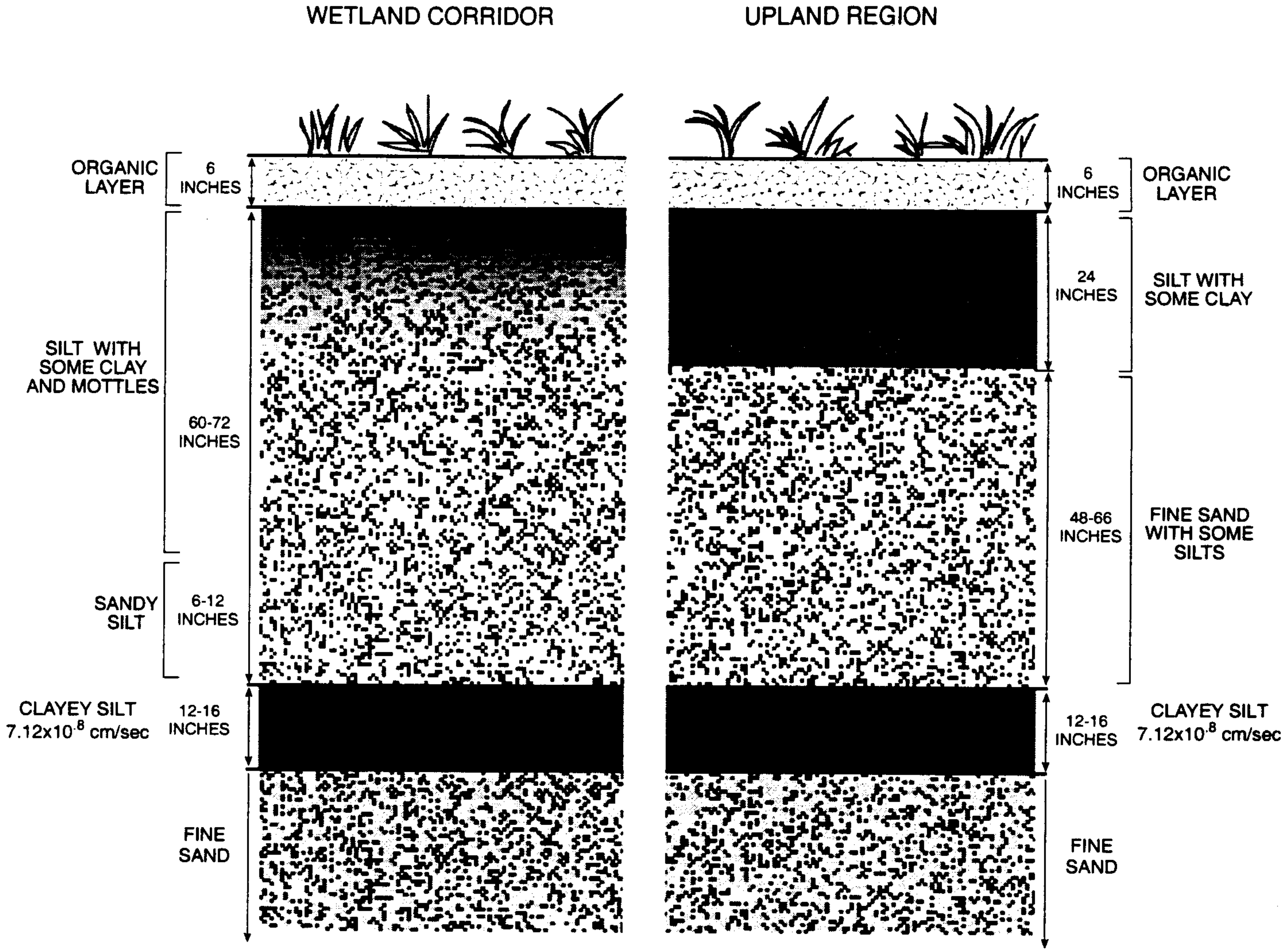
**Re** Renton Silt Loam
**Os** Oridia Silt Loam
**Br** Briscot Silt Loam

Existing Wetland

Site Boundary (Approximate)

**Figure 7.2-12**
**Soil Types on the Proposed Wetland Mitigation Site**

**AR 009934**




POS Natural Resource Mitigation/556-2912-001/01(03) 12/00

Data Compiled by Parametrix

**Figure 7.2-13**
**Typical Soil Profiles at the Wetland Mitigation Site**

In the upland portion of the site, including the areas outside the existing wetlands that would be graded under the proposed mitigation design, the upper 30 inches of soil is similar to the wetland soils described above (see Figure 7.2-13). A 6-inch topsoil layer is present over a 24-inch, uniformly mixed layer of clayey silt with dispersed mottles. Below 30 inches a 36- to 66-inch layer of uniform gray, fine sand (with some silt) is found. A 6- to 8-inch-thick clayey silt layer was encountered between the 72- and 96-inch depth. Below this clayey silt, the soil returns to a uniform fine sand. The sand layer located near the soil surface and a relatively thin clay silt layer in these soils allow them to drain more rapidly than the wetland soils.

#### 7.2.5.2 Environmental Site Assessment

A Phase I Site Assessment of the mitigation property was conducted in December 1995 (Parametrix 1995). The report was prepared according to guidelines described in *American Society for Testing and Materials (ASTM) Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process* (ASTM E 1527). The assessment indicates no environmental conditions of concern associated with past or current use of the site and adjacent properties.

#### 7.2.5.3 Wildlife Habitat

The mitigation site consists of abandoned agricultural land that is dominated by grasses and forbs. The properties immediately adjacent to the site to the north and south are actively farmed. West of the site, wildlife habitat has been largely eliminated by residential development. No permanent aquatic habitat is found on the site, although the Green River provides aquatic habitat near the eastern site boundary. Forested slopes along the east bank of the Green River provide habitat connectivity to riparian and other wetland systems, and forested areas. The WDFW Priority Habitats and Species database identifies the palustrine emergent wetland that bisects the site as a priority habitat (all wetlands are considered priority habitat by WDFW).

Habitat quality of the existing wetlands and the adjacent grassy uplands is relatively low due to a number of factors. The relatively uniform pasture grass vegetation is dominated by non-native plant species, lacks structural diversity, has a low plant species diversity, and lacks habitat complexity. Small mammals use the area for feeding and breeding. The site may provide foraging habitat for raptors, such as Northern harriers and red-tailed hawks. Apart from the tall pasture grasses there is a general lack of cover from predators, and a lack of habitat complexity (e.g., pits and mounds, large woody debris) that provides for breeding, resting, and/or thermal cover for small mammals. For most passerine bird species, the site lacks habitat structure for nesting, protection from predators, thermal cover, or perching. A narrow band of shrub vegetation along the southern boundary provides limited forage and perching habitat. Amphibian habitat on the site is currently limited by a lack of seasonally inundated pools, forest cover, and large woody debris.

Tracks or scat of coyote, mink, deer, and raccoon were observed on or near the mitigation site during the site assessment. Species observed on the site include kingfisher, short-eared owl, barn owl, common snipe, red-tailed hawk, common yellowthroat, and mallard duck. Most of these species appeared to be most abundant in the eastern portion of the site next to the Green River.

### 7.2.5.4 Functional Changes Anticipated at the Auburn Mitigation Site

The off-site wetland mitigation site is designed to wetland habitat functions affected by implementation of the proposed Master Plan Update improvements. The proposed design of the mitigation site would also provide additional mitigation for species using wetland buffer areas and other upland habitats at the airport.

**Wildlife Habitat**

Construction of the forested, shrub, and emergent wetlands would create conditions that provide habitat for a variety of wildlife species (Table 7.2-6). Habitat structure and availability would change as vegetation matures over the next several decades, and the wildlife species using the site are expected to change over time (Table 7.2-7). Plant species proposed for the wetland mitigation area and their values to various forms of wildlife are presented in Table 7.2-8.

Post-construction habitat structure in proposed forested wetlands would be similar to a regenerating forest, and would develop mature forest habitat attributes after several decades (Figure 7.2-14). The shrub understory would enhance the development of habitat structure. Songbird use in early stages of habitat development would include foliage and bark-gleaning species (kinglet, chickadee, bushtit, vireo) that forage in the area. In later years, Oregon ash, vine maple, willows, redcedar, and western hemlock seed production would be used by additional songbird species. Small mammals would likely forage on the forest floor for seeds and invertebrates, even though optimal habitat conditions would not occur for one or more decades. As a tree canopy begins to develop, it would provide nesting habitat and cover for predator avoidance.

Post-construction habitat structure in shrub wetlands would generally be similar to that of forested systems during the first several years of development (see Figure 7.2-14). However, since shrub communities would periodically be flooded, ground-dwelling animals would be less common. The shrub community would reach functional maturity in 15 to 25 years following planting (see Figure 7.2-14).

Emergent communities would provide resting and foraging habitat for shore and water birds within 1 year of planting. After 2 to 3 years, most of the intended wildlife functions should be present, and in the following 5 to 10 years, relatively mature communities should be present.

Tree-nesting songbirds (such as thrushes, vireos, and warblers) are expected to use horizontal branches for nesting when the canopy closes enough to provide cover. Leaf litter and forest detritus would begin to accumulate, providing habitat for the invertebrates (Pennak 1989) that amphibians (such as ensatina), small mammals, and ground-foraging birds feed on. Small mammals, in turn, are likely to become food for predators, such as barred owls. Over several decades, disease or competition for light would result in mortality. Dead and decaying trees would provide woody debris and snag habitat for flickers, woodpeckers, and small cavity-nesting birds.

**Table 7.2-6. Wildlife species expected to occur in the Auburn wetland mitigation site after construction.**

| Common Name | Habitat Type: Permanently Flooded Emergent Wetland | Seasonally Flooded Emergent Wetland | Shrub Wetland | Forested Wetland | Riparian Forest | Abandoned Agricultural Land |
|---|---|---|---|---|---|---|
| **Amphibians** | | | | | | |
| Northwestern salamander | X | X | | X | X | |
| Long-toed salamander | | X | X | X | X | |
| Pacific giant salamander | X | | | X | X | |
| Rough-skinned newt | X | X | | | X | |
| Ensatina | | | | | X | |
| Western toad | X | X | | | | |
| Pacific chorus frog | X | X | X | X | X | |
| Red-legged frog | X | X | X | X | X | |
| Bullfrog [1] | X | | | | | |
| **Reptiles** | | | | | | |
| Common garter snake | X | X | X | X | X | |
| **Birds** | | | | | | |
| Great blue heron | X | X | X | X | | |
| Canada goose | X | X | | | | X |
| Green-winged teal | X | X | | | | X |
| Mallard | X | X | X | | | X |
| Northern pintail | X | X | | | | X |
| American pigeon | X | X | | | | X |
| Osprey | | | | | X | |
| Bald eagle | | | | | X | |
| Northern harrier | X | X | | | | X |
| Red-tailed hawk | | | | X | X | X |
| Killdeer | X | X | | | | X |
| Common snipe | X | X | | | | |
| Herring gull | X | | | | | X |
| Rock dove [1] | | | | | | X |
| Western screech-owl | | | | X | X | |
| Rufous hummingbird | | | | | X | X |
| Belted kingfisher | X | | | | | |
| Downy woodpecker | | | | X | X | |
| Northern flicker | | | | X | X | |
| Pileated woodpecker | | | | X | | |
| Willow flycatcher | | | | X | X | |
| American/northwestern crow | X | X | | X | X | X |
| Black-capped chickadee | | | | X | X | |
| Bushtit | | | | X | X | |

Table 7.2-6. **Wildlife species expected to occur in the Auburn wetland mitigation site after construction (continued).**

| Common Name | Permanently Flooded Emergent Wetland | Seasonally Flooded Emergent Wetland | Shrub Wetland | Forested Wetland | Riparian Forest | Abandoned Agricultural Land |
|---|---|---|---|---|---|---|
| | **Habitat Type** | | | | | |
| Bewick's wren | | | X | X | X | |
| Winter wren | | | | | X | |
| Marsh wren | X | | X | | | |
| Golden-crowned kinglet | | | | | X | |
| Ruby-crowned kinglet | | | | X | X | |
| American robin | | X | | X | X | X |
| Varied thrush | | | | X | X | |
| European starling [1] | | | | X | X | X |
| Yellow warbler | | | | X | X | |
| Yellow-rumped warbler | | | | X | X | |
| MacGillivray's warbler | | | X | X | X | |
| Common yellowthroat | X | | X | | | |
| Wilson's warbler | | | | X | X | |
| Rufous-sided towhee | | | | X | X | |
| Fox sparrow | | | | X | X | |
| Song sparrow | X | X | X | X | X | X |
| Dark-eyed junco | | | | X | X | |
| Red-winged blackbird | X | X | X | | | X |
| Brown-headed cowbird | X | X | X | X | X | X |
| American goldfinch | | | | X | X | |
| House sparrow [1] | | | | | | X |
| **Mammals** | | | | | | |
| Vagrant shrew | | X | X | X | X | |
| Pacific water shrew | X | X | | | | |
| Shrew-mole | | | | | X | |
| Pacific mole | | | | | | X |
| Pacific jumping mouse | | | | X | X | |
| Raccoon | X | X | X | X | X | |
| Mink | X | X | X | X | X | |
| Striped skunk | | | | | X | X |
| Coyote | | | X | X | X | |
| Red fox | | | X | X | X | |

1 Introduced species.

**Table 7.2-7. Potential wildlife use of constructed wetland habitats.**

| | Years After Planting | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Emergent Wetland | | | | Shrub Wetland | | | | Forested Wetland | | | |
| **Wildlife Types** | **0 to 2** | **2 to 5** | **5 to 15** | **>15** | **0 to 2** | **2 to 5** | **5 to 15** | **>15** | **0 to 2** | **2 to 10** | **10 to 25** | **>25** |
| **Mammals** | | | | | | | | | | | | |
| Shrews and mice | | F | F | F | F | B/F | B/F | B/F | F | B/F | B/F | B/F |
| Squirrels | | | | | | F | F | F | F | F | B/F | B/F |
| Raccoons and mink | | F | F | F | | F | F | F | | F | B/F | F/M |
| Fox and coyote | | F | F | F | | F | F | F | | F | F | F |
| Bats | F | F | F | F | F | F | F | | | | | |
| Deer | F | F | F | F | F | F | F | F | F | F | F | F |
| **Birds** | | | | | | | | | | | | |
| Shrub-nesting songbirds | | F | F/M | F/M | F/M | F/M | B/F/M | B/F/M | F/M | B/F/M | B/F/M | B/F/M |
| Swallows and swifts | F | F | F | F | F | | | | | | | B/F |
| Forest-dwelling songbirds | | | | | | F/M | F/M | F/M | F/M | F/M | B/F/M | B/F/M |
| Cavity-nesting birds | | | | | | F | F | F | | F | F | B/F |
| Marsh-nesting songbirds | F | F | B/F | B/F | F | F | B/F | B/F | F | F | | |
| Raptors | F | F | F | F | F | F | F | F | F | F | F | B/F |
| Wading birds | | F/M | F/M | F/M | F/M | F/M | | | | | | |
| Dabbling waterfowl | | F/M | F/M | F/M | F/M | F/M | | | | | | |
| Diving waterfowl | | F/M | F/M | F/M | | | | | | | | |
| **Herpetofauna** | | | | | | | | | | | | |
| Reptiles | | F | F | F | F | B/F | B/F | B/F | F | B/F | B/F | F |
| Terrestrial-breeding amphibians | | F | F | F | F | F | F | F | F | B/F | B/F | B/F |
| Aquatic-breeding amphibians | | F | B/F | B/F | F | B/F | B/F | B/F | F | F | F | F |
| **Macroinvertebrates** | | | | | | | | | | | | |
| Aquatic insects | B/F | B/F | B/F | B/F | B/F | B/F | B/F | B/F | B/F | B/F | B/F | B/F |
| Gastropods | | | B/F | B/F | | B/F | B/F | B/F | | B/F | B/F | B/F |

B = Breeding
F = Foraging
M = Migration

**Table 7.2-8. Plant species to be planted at the Auburn wetland mitigation site.**

| Plant Species | | | |
|---|---|---|---|
| Scientific Name | Common Name | Wildlife Function | Description |
| **Deciduous Trees** | | | |
| *Acer macrophyllum*<br>*Alnus rubra*<br>*Populus trichocarpa*<br>*Rhamnus purshiana*<br>*Fraxinus latifolia*<br>*Malus fusca*<br>*Salix lasiandra* | Big-leaf maple<br>Red alder<br>Black cottonwood<br>Cascara<br>Oregon ash<br>Pacific crabapple<br>Pacific willow | Forage | The seeds of big-leaf maple and Oregon ash are eaten by small mammals, songbirds, and game birds.[1] Cascara and western crabapple fruit are persistent and offer good winter forage for pileated woodpeckers, thrushes, band-tailed pigeons, and other songbirds. The female catkins of alder, cottonwoods, and willows are used by foraging songbirds. New growth provides browse for medium and large mammals. Deciduous trees provide foraging habitat for hawking and foliage-gleaning insectivores. The leaf litter provides food for detritivores (which in turn are consumed by small mammals, amphibians, reptiles, and birds). |
| | | Habitat | Deciduous trees provide nesting habitat for birds, small mammals, and invertebrates; perching and roosting habitat for birds; and escape cover for prey species. Mature Oregon ash are vulnerable to heart rot and subsequent insect invasion, providing cavity nesting and roosting habitat. Leaf litter from deciduous trees is used as cover by amphibians and small mammals. |
| **Coniferous Trees** | | | |
| *Picea sitchensis*<br>*Thuja plicata*<br>*Abies grandis* | Sitka spruce<br>Western redcedar<br>Grand fir | Forage | These coniferous trees provide seed forage for songbirds, game birds, mice, squirrels, voles, and shrews, as well as foraging habitat for hawking and foliage-gleaning insectivores. Deer, rabbit, and mountain beaver browse on new growth and young bark. |
| | | Habitat | Evergreen vegetation provide breeding and roosting habitat for birds and small mammals. Coniferous heartwood often decays readily when attacked by fungi, resulting in hollow living trees which provide habitat for cavity-nesting and roosting species. The foliage provides year-round escape cover and thermal protection when deciduous foliage is lacking. |
| **Shrubs** | | | |
| *Salix sitchensis*<br>*Salix hookeriana*<br>*Salix scouleriana*<br>*Acer circinatum* | Sitka willow<br>Hooker's willow<br>Scouler's willow<br>Vine maple | Forage | Willow shrubs may be used as browse by deer and some small mammals. The female catkins provide forage for songbirds. Vine maple seeds are eaten by small birds and mammals. |

**Table 7.2-8. Plant species proposed for the Auburn wetland mitigation area (continued).**

| Plant Species | | Wildlife | |
|---|---|---|---|
| Scientific Name | Common Name | Function | Description |
| | | Habitat | These shrubs provide dense multi-stem nesting habitat and escape cover for songbirds and small mammals. The leaf litter provides habitat for amphibians and detritivores. |
| *Cornus stolonifera* | Red-osier dogwood | Forage | Hazelnut provides a mast crop and winter forage for game birds, deer, and small mammals. Twinberry, red elderberry, snowberry, and Indian plum fruit are an excellent food source for birds and mammals. Rose hips are a food source for songbirds, game birds, deer, small mammals, and rodents. The fruits are persistent and provide forage in the winter months. Salmonberries are eaten by songbirds, game birds, small mammals, deer, and some omnivores (fox, raccoon, etc.). Deer browse on the leaves, twigs, and fruit of all of these shrubs. |
| *Lonicera involucrata* | Twinberry | | |
| *Oemleria cerasiformis* | Indian plum | | |
| *Physocarpus capitatus* | Pacific ninebark | | |
| *Rubus spectabilis* | Salmonberry | | |
| *Rosa nutkana* | Nootka rose | | |
| | | Habitat | The shrub structure provides nesting and escape cover for birds, mammals, and other prey species. |
| **Herbaceous Species** | | | |
| *Carex rostrata* | Beaked sedge | Forage | The seeds of sedges and fruits of rushes are eaten by songbirds, game birds, and waterfowl, especially mallard and ring-necked ducks. The foliage is browsed upon by deer and small mammals. Bur-reed fruit and the young shoots of most emergent plants are forage for waterfowl and muskrat. |
| *Eleocharis palustris* | Common spike-rush | | |
| *Scirpus microcarpus* | Small-fruited bulrush | | |
| *Scirpus acutus* | Bulrush | | |
| *Scirpus lacustris* | Hardstem bulrush | | |
| *Sparganium emersum* | Narrow-leaf bur-reed | | |
| | | Habitat | These species provide nesting materials and cover for songbirds, waterfowl, and small mammals. Shrews, mice, and voles use the ground cover for thermal protection and predator avoidance. In late winter and spring floods, the stems are used for breeding substrate by amphibians and invertebrates. |
| *Oenanthe sarmentosa* | Water parsley | Forage | Some herbivores may browse on water parsley and smartweed. Water smartweed fruit are eaten by songbirds, game birds, deer, and rabbit. Dabbling and diving ducks feed on the foliage. |
| *Polygonum amphibium* | Water smartweed | | |

**Table 7.2-8. Plant species proposed for the Auburn wetland mitigation area (continued).**

| Plant Species | | Wildlife | |
|---|---|---|---|
| Scientific Name | Common Name | Function | Description |
| **Grasses** | | | |
| *Agrostis alba* | Redtop | Forage | Songbirds and rodents feed on all these grass seeds, while mannagrass and red fescue are grazed by waterfowl. |
| *Festuca rubra* | Red fescue | | |
| *Glyceria* sp. | Mannagrass | | |
| | | Habitat | Grasses provide breeding and escape cover for small mammals. Grasses are used by many species for nest construction and lining. |

Sources: Martin et al. (1951); Brown (1961); Payne and Bryant (1992)

[1] Seed production by trees varies with maturity. Red alder and black cottonwood produce seeds at 4 to 10 years of age. Big-leaf maple, Douglas fir, and western redcedar produce seeds after 10 to 12 years of age. Oregon ash, Sitka spruce, and western hemlock produce large seed crops after about 20 years of growth.

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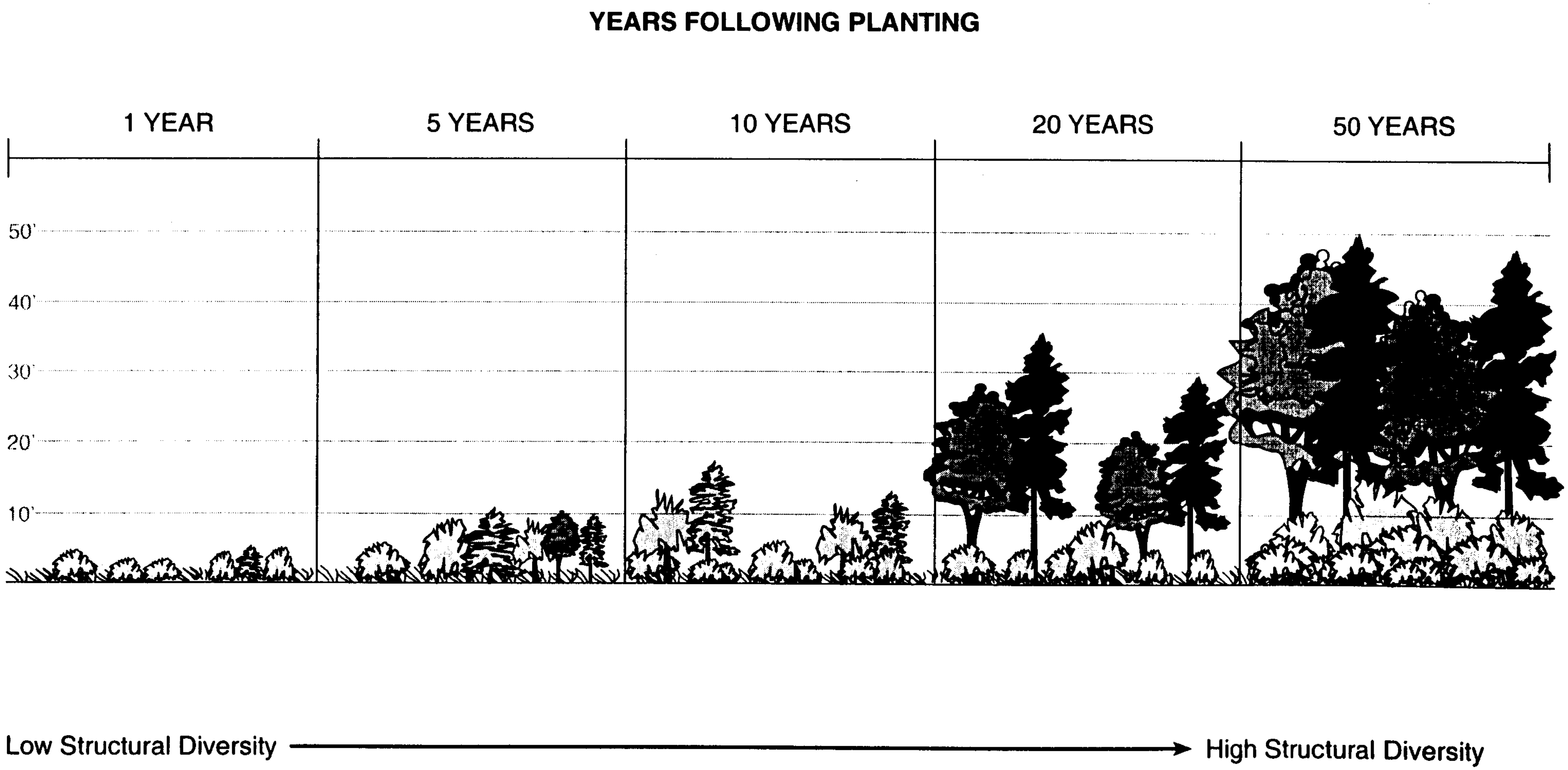




**Figure 7.2-14**
**Typical Successional Changes in Forested Wetland Vegetation Following Planting**

The shrub and emergent wetlands should achieve stable habitat conditions earlier than the forested wetland community. Shrub wetland communities should produce forage and nesting opportunities within 2 to 10 years. Swainson's thrush and Wilson's warblers use moist shrub habitats for nesting and foraging. Berries produced by salmonberry, red elderberry, and red-osier dogwood are used by several insectivorous songbird species to supplement fall and winter diets (Ehrlich et al. 1988). Mink, shrews, and other small mammals would exploit these insect and aquatic invertebrate food sources. Wading birds, such as great blue herons and bitterns, can feed on small mammals and amphibians.

Amphibian use, however, would likely be limited by immigration rates because of the lack of existing amphibian habitat in the area. Some species, such as Pacific giant salamander, northwestern salamander, and rough-skinned newt, commonly migrate through terrestrial habitats and could use the mitigation site.

Although flooded emergent wetlands can provide substantial forage opportunities for ducks, habitat use would vary with proximity to upland predator cover. Waterfowl, which are wary of dense shrubs that allow predators to approach undetected, prefer interspersion of flooded emergent vegetation and open water. Slough sedge (*Carex obnupta*), spike-rush (*Eleocharus palustris*), and horsetail are all species preferred by dabbling ducks and geese during migration (Payne and Bryant 1992). Narrow-leaf bur-reed (*Sparganium emersum*) is preferred by dabblers and migrating wood ducks. As decaying vegetation builds up in flooded areas, shovelers, pintails, and other diving species could forage on growing populations of plankton, algae, aquatic insects, and snails.

Over time, portions of properties adjacent to or near the mitigation site may be developed for commercial and/or residential uses. Depending on the nature of any development and its proximity to the mitigation site, some changes to the wildlife habitat functions provided by the mitigation site may occur. The 65-acre mitigation site is a large enough habitat area to provide key habitat functions for target wildlife species. The proximity of the mitigation site to riparian habitat corridors along the Green River will ensure that the project is connected to other terestrial and aquatic habitats.

If significant areas of farmland near the mitigation site are developed, use of the mitigation area by non-water dependent wildlife (i.e., mammals such as deer, coyote, and red fox) may decrease because these species may be eliminated from adjacent areas. Development of nearby land with residential uses may increase use of the site by dogs and cats. Dogs and cats could affect some wildlife populations on the mitigation site (i.e., ground-nesting birds and small mammals could be subject to increased predation or cats could become a food resource for coyote). Depending on the exact proximity of development to the wetland buffer and the intensity of human use, wildlife use of the buffer could be reduced. Alternatively, wetland protection and restoration on nearby parcels that contain wetlands (likely required by existing regulations) could result in increased habitat for wildlife and enhanced wildlife function of the mitigation site.

## Hydrology

Hydrologic conditions and functions at the wetland mitigation site are anticipated to be stable over the long term, even if future development occurs nearby. Hydrologic monitoring on the wetland mitigation site has been ongoing since September of 1995. The monitoring indicates that favorable sub-surface hydrology necessary for creating wetlands exists, and the probability of successful wetland mitigation is high. Further, in planning the mitigation project, contingency actions have been identified that will be implemented if post construction monitoring indicates the required performance standards for the wetland are not achieved.

Monitoring results indicate that seasonally high groundwater levels on the site are maintained by precipitation. This conclusion is based on observations of rapid increases in groundwater during mid to late fall, often within several days of heavy rainfall. The rates of water level increase are more rapid than one would expect if the high water table were dependent on groundwater movement from off-site areas. Because the site hydrology is largely precipitation driven, off-site development that may occur near the mitigation would have minimal effect on the hydrology in the mitigation wetlands.

Finally, stormwater management (water quality and discharge) standards and/or wetland protection and restoration requirements for development on nearby parcels will protect the hydrology of the site. These standards are likely to prioritize infiltration, require water quality BMPs, and detention to prevent high flow discharges. Wetland protection requirements (required by existing regulations) could result in wetland restoration and further protect hydrologic conditions on the Port's mitigation site.

## 7.3 MITIGATION SITE DESIGN

The mitigation design is based on design objectives and criteria explained in this section. This section also explains the basis for specific design elements, including the rationale for establishing the wetland mitigation hydrologic water regime, grading plan, and planting plan.

The mitigation design for the wetland mitigation site consists of the following elements: (1) excavating two new wetland basins; (2) establishing native forested, shrub, emergent, and open-water wetland habitats in these basins; (3) enhancing the existing emergent wetlands by replacing the non-native plant communities with native forest and shrub communities; (4) establishing a forested buffer around the perimeter of the site; and (5) post-construction monitoring and maintenance.

### 7.3.1 Water Regime

An adequate water regime is the most critical factor in establishing the desired forest, shrub, and emergent wetland vegetation on the mitigation site. The duration and amount of standing water and soil saturation control the wetland classes and plant community types suitable for the site. Evaluation of the hydrology requirements of natural Puget Sound wetland communities (Ecology 1994a; Kunze 1994) and examination of over 5 years of groundwater monitoring data (see Figures 7.2-5, 7.2-6, and 7.2-7) indicate that it is feasible to create the hydrologic conditions necessary to sustain the diverse wetland habitats and plant communities designed for this site.

Appropriate hydrologic conditions will be attained by excavating the two basins on the mitigation site to intercept the seasonally high or permanent groundwater table. Excavating the new basins to approximately 1 to 8 ft below the current ground surface will provide a range of soil saturation conditions, and support the variety of planned wetland plant communities. Following grading, ground surface elevations on the site will range from approximately 37 to 50 ft, with most of the graded site below approximately 43 ft. Excavation in some limited areas will be a maximum of 12 ft deep to create open-water habitat. The approximate elevations, hydrologic regime, and wetland vegetation classes proposed for the mitigation are presented in Table 7.3-1. The relationship of the proposed wetland vegetation zones to anticipated water levels and site topography of the east basin is shown in Figure 7.3-1.

**Table 7.3-1. Proposed wetland classes, elevation ranges, and hydrologic regimes.**

| Proposed Wetland Class | Proposed Elevation Range (ft) | Anticipated Hydrologic Regime |
|---|---|---|
| Forested Wetland | East Basin: 42 to 46<br>West Basin: 46 to 49 | Seasonally saturated soil during years of typical rainfall. During a 10-year flood,[1] flooding of up to 3 ft for up to 9 consecutive days would occur. Soil would be unsaturated to at least 18 inches below the ground surface during most summer and fall periods. |
| Shrub Wetland | East Basin: 41 to 42<br>West Basin: 44 to 46 | Seasonally saturated or flooded with up to 1 ft of water during years of average rainfall. During a 10-year flood, water could be up to 4 ft deep for 9 consecutive days. Soil would generally be saturated within 12 inches of the ground surface during most of the summer and early fall. |
| Persistent Emergent | East Basin: 38 to 41<br>West Basin: 42 to 44 | Seasonally flooded with up to 4 ft of water during years of average rainfall. The water table would be at or within 6 inches of the ground surface during late summer and early fall. |
| Open-water/Unvegetated | East Basin: Below 38<br>West Basin: Below 42 | Permanently to semi-permanently flooded during years of average rainfall. Surface water would generally be 6 to 24 inches deep during late summer and early fall, but may not be present during years of extremely low rainfall. |

[1] Because of flood control management of the Green River, the peak flow for 10-year and 100-year flood events are equivalent.

The new wetland areas would be connected to the 100-year floodplain of Green River (see Figure 7.2-4) (FEMA 1989) by constructing a vegetated swale from existing ditches located along South 277th Street to the northwest corner of the wetland. The bottom elevation of this ditch would be at 41 ft. Existing and restored wetlands on the mitigation site would become inundated during 100-year flood events, as backwater flooding from the Green River reaches the site (see Figure 7.2-4).

During the 100-year flood event, water levels would increase in the wetland by up to 3 ft. The frequency of inundation due to Green River flooding is low (Figure 7.3-2), with the greatest probability occurring during late fall through mid-winter. All plants proposed for the wetland area are adapted to a fluctuating water table and periodic inundation, which is common during winter months in floodplain wetlands of western Washington. Therefore, vegetation "die-back" as a result of flooding should not occur.

To provide additional flexibility in the control of site hydrology over the first few years of monitoring, a fixed-weir outlet control structure will be constructed near the northwest portion of the site to regulate water levels in the wetland. The weir can be adjusted by raising or lowering the gate and thereby raise or lower water levels. Such adjustments will allow flexibility in the control of site water levels over the first few seasons following planting. However, the weir will be permanently fixed once the desired level is determined (Appendix E, Sheets C3, C5, and C8).

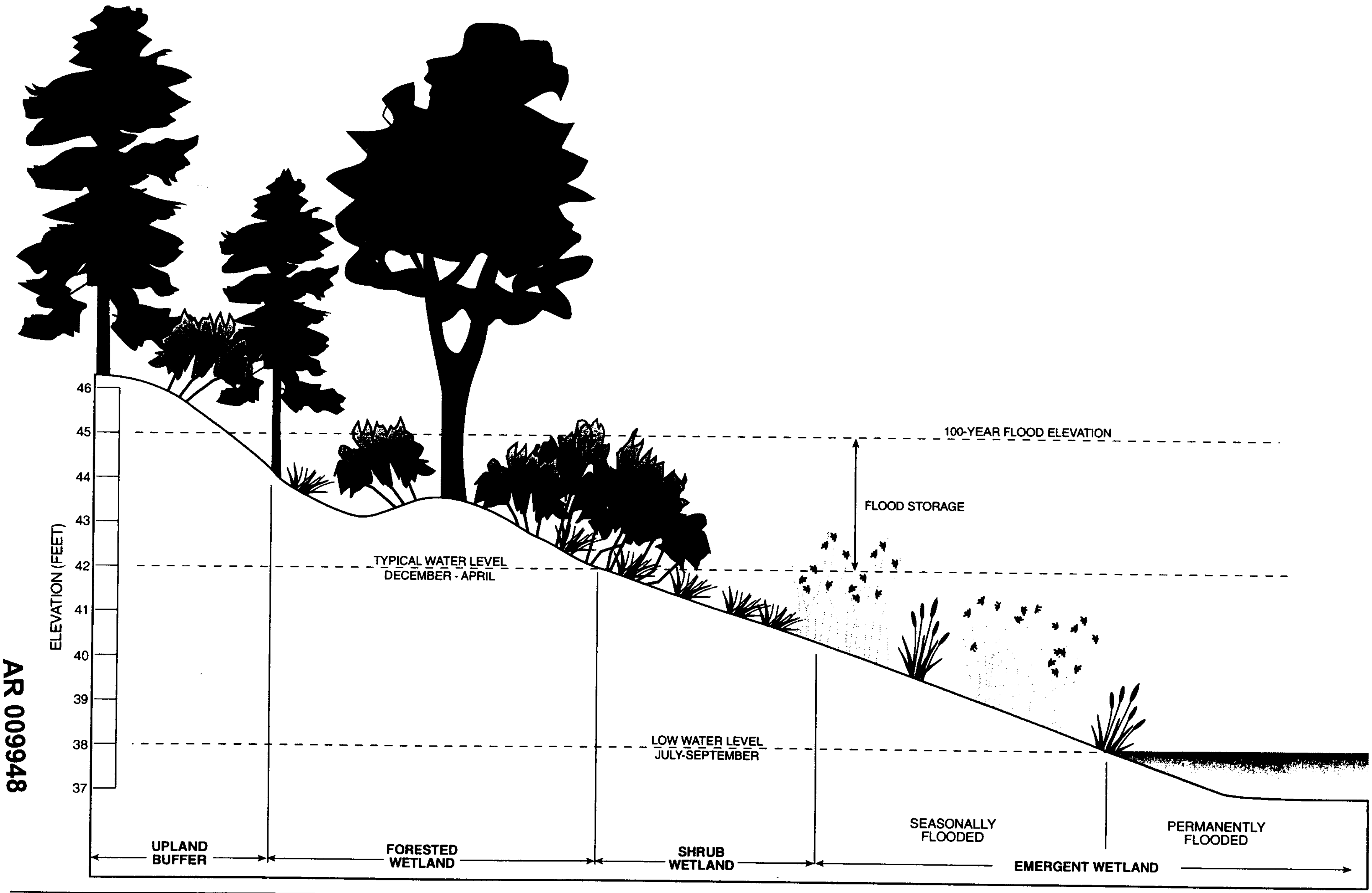


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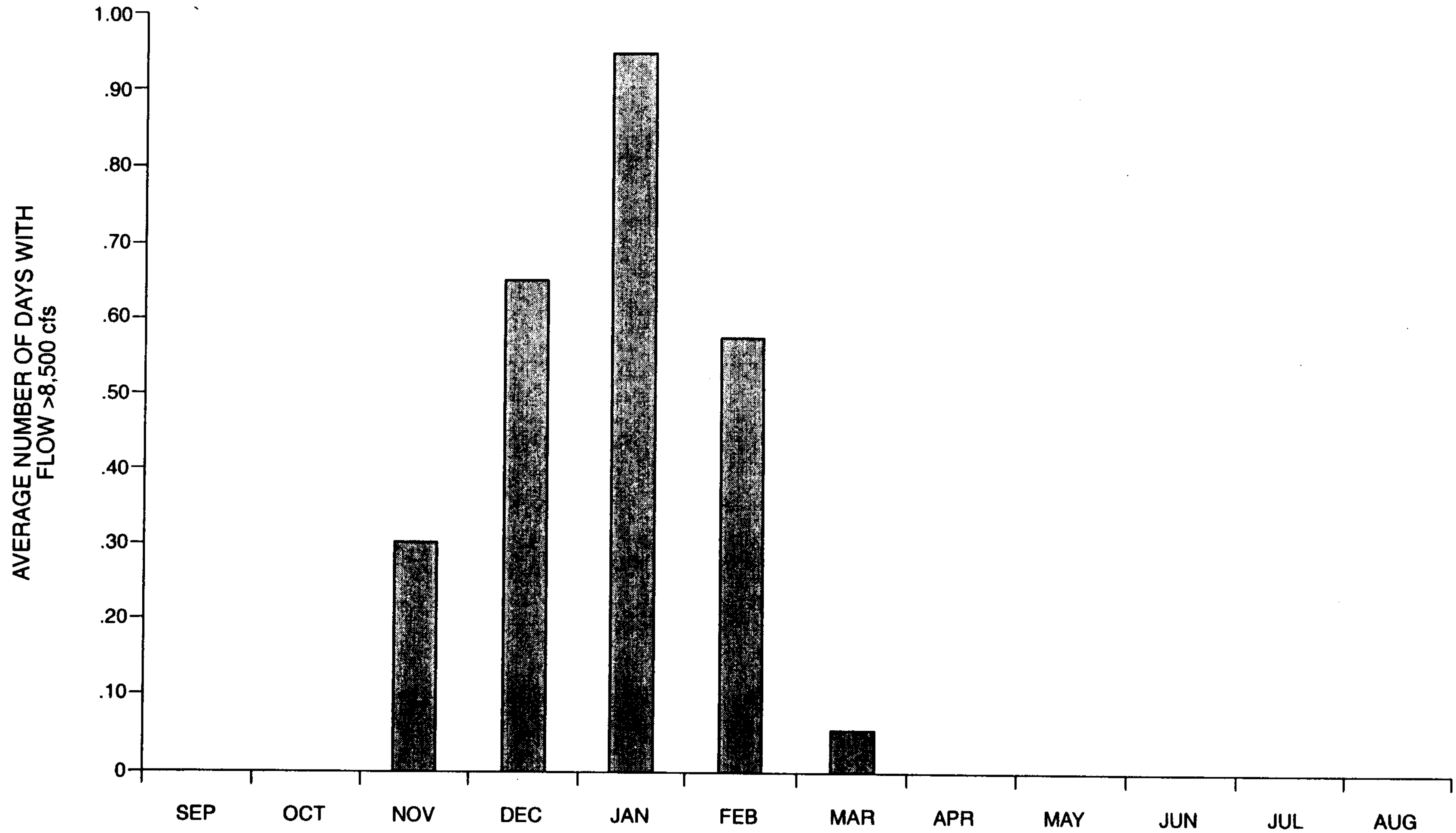
**Figure 7.3-1**
**Relationship of Seasonal Water Level Variations and Soil Surface Elevations to Proposed Wetland Vegetation Classes**

Data Compiled by Parametrix




USGS 1996



**Figure 7.3-2**
**Green River Flood Frequency by Month**
**(Based on 1960-1996 Data for Auburn)**

During the initial plant establishment phase, some control of water levels may be required to optimize establishment and survival of the planted stock. Any necessary adjustments to water regime are anticipated to be minor and short-term, and should not be necessary after plants become established. The Port will monitor site hydrology and plant survival carefully during the first few growing seasons and any adjustments to site water levels will be based on these monitoring results. Adjustments to the weir will be made by the Port's wetland scientist, and adjustments will be fully documented in monitoring reports. Following this initial plant establishment period, and based on any water level adjustments made during the first few years, the weir will be set at a fixed elevation appropriate for the site. No long-term adjustments to the weirs or site water levels are anticipated.

### 7.3.2 Grading

One basin will be excavated to the east, and another basin to the southwest of the existing wetlands to create two new wetland areas (Figures 7.3-3 and 7.3-4; Appendix E, Sheets C2 through C7). Excavation will generally be to depths between 1 and 5 ft below the existing ground surface to intercept the seasonally high or permanent groundwater table. Excavation depths will be slightly less in the western basin due to higher groundwater elevations, as well as to avoid impacts to the existing wetlands to the east of this basin. Due to site constraints, an area north of the west wetland creation basin will be used as a temporary staging area during construction. This area will be restored and enhanced after construction is complete (see Section 7.4-4).

Due to the high water table, the site will be dewatered prior to and during grading. Grading and site work other than planting will take place during the dry season (e.g., June through September). Site grading may take place in phases, if necessary, to ensure that all grading and site stabilization (e.g., hydroseed) can take place in one construction season. If construction of both basins cannot be completed in the same season (i.e., excavation, final grading, site stabilization), then the east basin will be constructed first and the west basin the following year. Construction is currently anticipated to begin during the 2001 dry season. Major construction activities will be limited to the period from October 31 to March 31 to avoid any disturbance to wintering bald eagles that may be in the vicinity of the Green River.

The proposed grading would affect about 11.9 acres of the existing emergent wetland described in Section 7.2.5.1 (see Table 3.1-4). In addition, a maximum of 2.2 acres of low quality emergent wetland and existing wetland drainage ditches (located north of the site) will be widened to connect with the 100-year floodplain and existing ditch systems, which will provide floodwater storage and conveyance functions. Approximately 0.12 acre of existing wetland will be permanently impacted by access roads. However, no net loss of wetland area will result due to the restoration and wetland creation actions planned for the site.

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**Figure 7.3-3**
**Wetland Mitigation Grading Plan**

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Parametrix, Inc.

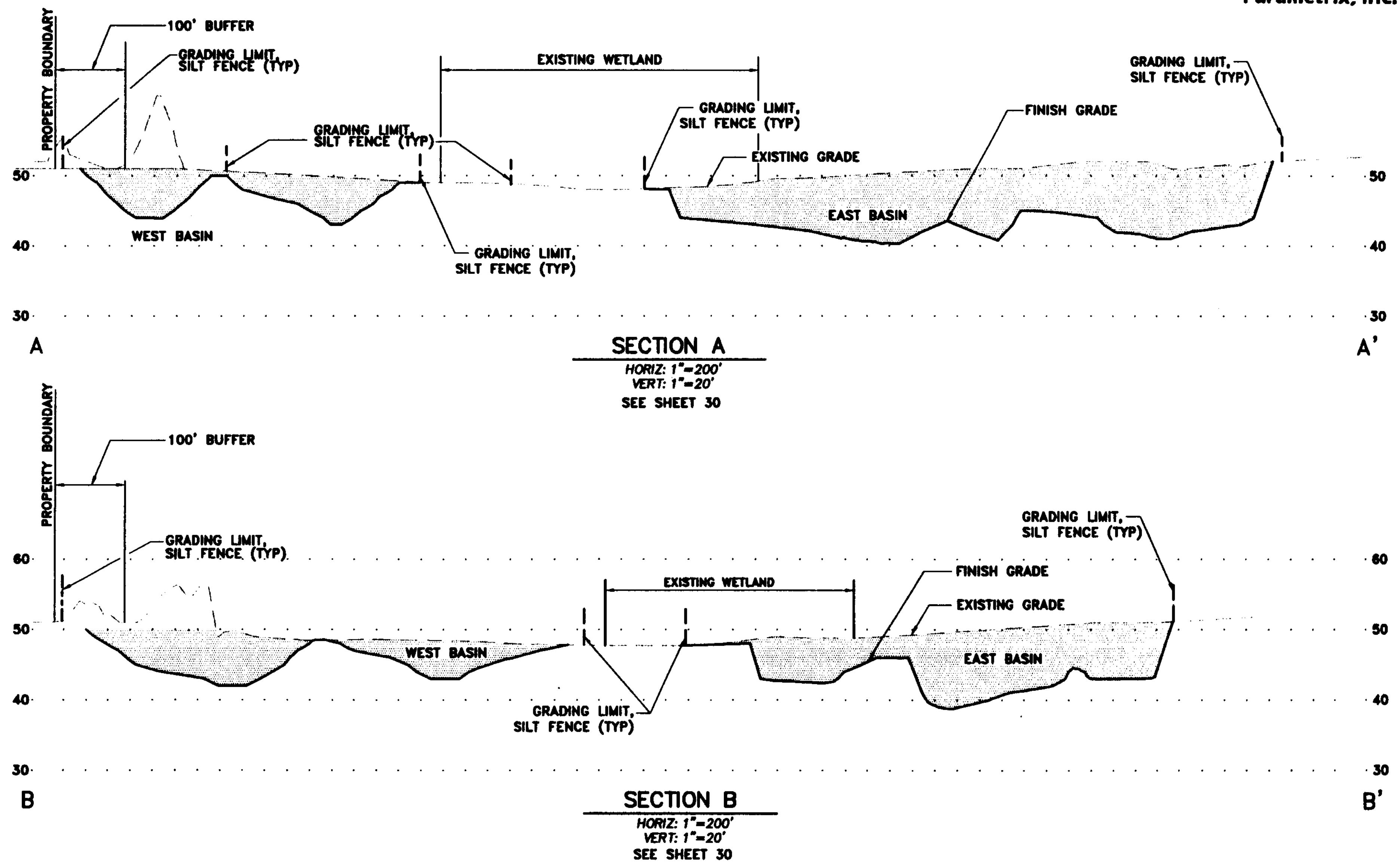


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**Figure 7.3-4**
**Grading Cross Section for Off-site Wetland Mitigation**

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Maintenance roads will be constructed around each wetland basin to provide access to the site during planting, maintenance, and monitoring. These roads will be removed and these areas will be restored and enhanced with native vegetation after construction is complete.

#### 7.3.2.1 Surface Soil Removal

The first grading step will be to strip off the top 12 inches of soil, which will be disposed of in an approved, upland location off site. Removal of this soil will remove rhizomes, roots, and seeds of the existing vegetation, and minimize re-colonization by non-native plants after native plants are installed. Suitable subsoil material removed during excavation will be stockpiled, amended with composted organic material that is free of weeds, spread to a depth of 12 inches, and disced into the subsoil prior to installing plants. Approximately one-third of the excavated soil will be stockpiled for use as topsoil in the new basins. Soils that become compacted during grading will be ripped and/or disced to break up the soil and provide a suitable rooting medium for plants.

#### 7.3.2.2 Basin Excavation and Dewatering

Approximately 440,000 cy of soil will be excavated to create the two wetland basins, with excavation depths ranging between 1 and 8 ft. Due to seasonally high groundwater levels on this site, dewatering will likely be necessary to allow excavation of the new wetland basins and site grading. Water from the site dewatering will be conveyed through a series of sediment/settling ponds and straw bale filters to existing ditches that drain the site at the northwest corner.

**Dewatering Plan**

All dewatering will be performed according to conditions of the HPA obtained for the project. The Port estimates that the current groundwater table should be lowered approximately 5 ft below the subgrade to facilitate grading. The dewatering plan would use approximately 45 to 50 wells that extend into the shallow groundwater table. To lower the water table sufficiently to allow grading, water will be pumped off-site via these wells. Groundwater will be conveyed to the existing ditch that drains the site. It is estimated that dewatering on the project site could discharge up to 4,600 gallons per minute of groundwater while the excavation is occurring. The highest discharge rates are anticipated to occur early in the construction season (May or June) with little discharge occurring in August or September.

Two retention ponds will be constructed to capture runoff from the Phase 1 construction staging area located on the northwest portion of the site. Based on the design criteria and runoff modeling, the minimum total storage volume required is 3.65 acre-feet. This volume will contain the 25-year summer storm event, with a 1.5 factor of safety. A smaller pond, able to retain at least 0.77 acre-feet of runoff, will serve the northern section of the staging area. A larger pond, with a minimum storage capacity of 3.65 acre-feet, will collect runoff from the remaining portion of the site as well as the pumped discharge from the smaller pond.

Sediment in the pond water will be removed by an on-site alum treatment facility. The treatment facility will consist of three coagulation tanks and one settling tank. Additional coagulation tanks will be utilized, if necessary. While treated water from the facility will be discharged off-site; any treatment plant bypass water will be discharged on-site. In addition, sediment from the facility will be redeposited on-site. Surface water that accumulates during the excavation will also be treated prior to being discharged from the site. All water discharged from the site must meet turbidity standards for water quality. These standards are less than 5 NTUs above background when background levels are less than 50 NTUs, and no more than 10 percent above background when background levels are more than 50 NTUs.

**Drainage Easements for Dewatering**

The Port has procured a temporary drainage and construction easement across the property north of the mitigation site that allows use of an existing channel for drainage purposes. The easement also grants the Port the right to use this channel for the temporary discharge of water from dewatering wells to be used during construction of the Port's wetlands. During the dewatering process, water will be temporarily channeled to the existing outfall into the Green River at South 277th Street. Other than during the dewatering process, drainage water from the Port's property will flow north through existing drainage channels along and under South 277th Street, and discharge to the Green River north of South 277th Street. The newly constructed wetland basins will generally drain to the northwest at elevations of 42 ft in the east and 43 ft in the west. The temporary drainage and construction easement remains in effect until a permanent flood channel is constructed.

The location of the temporary drainage channel is shown on Appendix E, Sheet C3. A cross-section schematic of the temporary drainage channel (i.e., wetland outlet ditch) is shown on Appendix E, Sheet C8,.

**Effects of Dewatering on Existing Wetlands**

Dewatering activities on the Auburn site are not likely to affect the hydrology or habitat conditions in existing wetlands located on or near the mitigation site. Dewatering of the site will occur from approximately May through September, over one or two seasons. The purpose of dewatering is to accelerate the rate at which the water table falls during the summer and early fall. During this time, the water table in the wetlands normally falls a total of 6 to 8 ft over a period of 4 to 5 months (see Figures 7.2-5, 7.2-6, 7.2-7). In May, at the time dewatering starts, the water level in the wetlands is typically 24 inches below the ground surface, and thus below the rooting zone of wetland plants. By late May it is as much as 36 inches below the surface. Because the timing of dewatering is such that it will occur after water levels in the wetlands have already dropped below the surface root zone, wetland vegetation will not be impacted by dewatering. Dewatering will not lower the water table below the elevation it normally reaches by late summer, and thus, dewatering will not increase the amount of time it takes the water table to rise again in the fall. Since it is not present, dewatering will not remove surface water that could provide special habitat types to wildlife.

### 7.3.2.3 Topsoil Replacement and Finish Grading

Native subsoils at the Auburn site are a mix of silts and fine sands, and will be used to construct an amended topsoil for the site. Approximately one-third of the excavated material will be selectively stockpiled either at on-site staging areas, or off site, for use as backfill and to construct topsoil for the excavated areas.

Two types of soil amendments will be used to provide a suitable substrate for wetland plant establishment on the site. The first soil type (Wetland Soil 1) will be a 3:1 mix of suitable native

Two types of soil amendments will be used to provide a suitable substrate for wetland plant establishment on the site. The first soil type (Wetland Soil 1) will be a 3:1 mix of suitable native subsoils with organic compost that is free of weed seeds or other unsuitable material. This soil will be used above 42 ft elevation in the east basin and throughout the excavated area of the west basin (Appendix E, Sheet C9). The second soil type (Wetland Soil 2) will be used below 42 ft in elevation in the east basin to provide soil for the emergent planting zone (Appendix E, Sheet C9). Native subsoils on the site are a mix of sands, silts, and clays, and naturally form layers that are relatively impervious. To ensure that subsoils used in the emergent planting zones maintain this relative impermeability, Wetland Soil 2 will be native subsoil amended with 4 percent bentonite.

Final grades will establish elevation and hydrologic gradients, which will allow the planting of the desired native plant community types (see Figure 7.3-4). Fine grading and habitat log placement will also establish a complex microtopography on the site, which will enhance water storage and microhabitat diversity (Appendix E, Sheet 8.2). Habitat log placement and installation of snags will enhance wildlife functions on the site. Placement of logs, snags, and fine grading will be accomplished under field direction by the landscape architect and/or wetland scientist. Microtopography will be established by constructing a series of 'pit and mound' features in the forested and shrub wetland areas. Pit and mound features are designed to simulate the microtopography created by windthrow of large trees. Pit and mound features will be constructed at a density of approximately 4 per acre. Habitat logs will be placed predominantly in forested and shrub wetland classes, with a density of approximately 15 per acre (Appendix E, Sheet C9).

#### 7.3.2.4 Hydroseed/Mulch

Following completion of fine grading and topsoil placement, the soil surface will be stabilized with a hydroseed/mulch mix consistent with federal and state permit conditions and the City of Auburn grading permit.

Hydroseed mixes have been designed to accomplish several objectives. Hydroseeding is part of the TESC measures and will provide short-term stabilization of the soil surface and erosion control following grading. Hydroseeding will also provide for the rapid establishment of ground cover and serve as a weed barrier to reduce colonization of the open site by invasive species. In addition, native herbaceous understory species for the forest, shrub, and emergent communities will be provided by hydroseeding prior to planting the overstory vegetation in these zones.

Hydroseeding will use one of three seed mixes, with the mix selected for each zone matched to the site moisture conditions in that zone (Table 7.3-2). A wet zone seed mix consisting of OBL and FACW species will be used below 43 ft in the east basin and below 46 ft in the west basin (see Figure 7.3-4). A transition zone seed mix consisting of FACW, FAC+, and FAC rated species will be used from 43 to 45 ft in the east basin and from 46 to 49 ft in the west basin. A native buffer seed mix consisting of FAC, FAC+, FAC- and FACU rated species will be used in the forested buffer areas above 45 ft in the east basin and above 49 ft in the west basin. In addition, a low-grow seed mix will be used to revegetate temporary construction access roads and staging areas that are located outside the mitigation area.

**Table 7.3-2. Hydroseed mixtures.**

| Common name | Scientific Name | % by weight |
|---|---|---|
| **For use in areas designated as emergent wetland** | | |
| Tall mannagrass | *Glyceria elata* | 15 |
| Water foxtail | *Alopecurus geniculatus* | 10 |
| Water parsley | *Oenanthe sarmentosa* | 10 |
| Slough sedge | *Carex obnupta* | 10 |
| Beaked sedge | *Carex rostrata* | 15 |
| Small-fruited bulrush | *Scirpus microcarpus* | 15 |
| Woolgrass | *Scirpus cyperinus* | 10 |
| Dagger leaf rush | *Juncus ensifolius* | 5 |
| Taper tip rush | *Juncus acuminatus* | 5 |
| Slough grass | *Beckmania syzigachne* | 5 |
| **For use in areas designated as forested or shrub wetland and wet buffers** | | |
| Blue wildrye | *Elymus glaucus* | 25 |
| Western mannagrass | *Glyceria occidentalis* | 8 |
| Tall mannagras | *Glyceria elata* | 10 |
| Tufted hairgrass | *Deschampsia cespitosa* | 10 |
| Annual ryegrass | *Lolium multiflorum* | 15 |
| Chewings red fescue | *Festuca rubra* | 10 |
| Meadow foxtail | *Alopecurus pratensis* | 10 |
| Bentgrass | *Agrostis tenuis* | 10 |
| Alsike clover | *Trifolium hybridum* | 2 |
| **For use in upland buffer areas** | | |
| Barkley's perennial ryegrass | *Lolium perenne* | 30 |
| Red fescue | *Festuca rubra* | 35 |
| Aurora hard fescue | *Festuca longifolia* | 35 |

Hydroseed mixes will be comprised predominantly of native grass, sedge and rush species. However, some non-native grasses may be included to provide rapid germination and growth for erosion and weed control. Use of non-natives will be restricted to species that are not invasive, and will not persist once the planted stock becomes established and canopies become closed. The buffer zone hydroseed mix is designed to establish a low-growing ground cover of grasses that will protect the soil, and reduce erosion while minimizing competition with the planted stock. The wetland and transition seed mixes are designed to supplement the container stock by increasing ground cover and plant density.

### 7.3.2.5 Temporary Irrigation

An irrigation system will be installed on the mitigation site (Appendix E, Sheets L1 through L3). Irrigation with municipal water purchased by the Port will be used during the initial stages of the restoration to optimize conditions for plant establishment. Irrigation will be used to provide flexibility in the timing of plant installation, to increase survival rates, and to enhance growth rates of the planted stock. Enhancing plant growth during the first few years will lead to a more rapid establishment of canopy cover and shade on the site, and reduce re-invasion of the site by non-natives.

The irrigation system will be installed, tested, and fully operational before plants are installed. Irrigation in the existing wetland will be installed above ground to minimize disturbance during installation. Irrigation in the areas to be excavated and graded will be installed below ground.

The irrigation system will be sufficiently durable to provide irrigation to the site throughout the monitoring period; however, it is likely that the system will be used longer than the first few growing seasons. Irrigation will be used for the first few years following planting. In subsequent years, the Port will evaluate the need for continued irrigation based on need for replanting, observed plant survival, and other factors. Once the system is no longer needed, the above-ground portions (e.g., risers, sprinkler heads, valves, or control boxes) will be removed. The below-ground portions of the system will be abandoned in place to minimize disturbance to the created and enhanced wetlands.

### 7.3.3 Landscape Plan

Native species will be planted to establish forested wetland, shrub wetland, and emergent wetland plant communities, as well as a forested upland buffer around the edges of the site (Figure 7.3-5; Appendix E, Sheets L5 through L10). These general community types would include six wetland plant associations (or planting zones) typical of freshwater wetlands and forested uplands in the northern Puget Sound basin (Figure 7.3-6). Choice of plant species, planting densities, and community composition is based primarily on composition and densities of common western Washington wetland plant communities (Kunze 1994). In addition, plant species were chosen for their value as food sources or habitat elements for wildlife. For example, the design includes shrubs and emergent plants that are particularly valuable as wildlife food sources (e.g., hazelnut, Indian plum, sedges, and bulrushes).

Forested wetland plant communities include black cottonwood/Pacific willow, red alder/salmonberry, Oregon ash/Pacific willow, and western redcedar plant communities. A dogwood/willow shrub community and a beaked sedge/water parsley emergent community will be planted in wetter portions of the site, surrounding small areas of open water in the centers of the basins. The existing emergent wetland will be enhanced by planting black cottonwood, Oregon ash, and red alder forested communities to increase plant diversity and enhance wildlife habitat (Appendix E, Sheets L5 through L10). The upland buffer will be planted with a mix of native trees and shrubs such as Douglas fir, big-leaf maple, vine maple, hawthorn, and Indian plum (Appendix E, Sheet L10). Along the boundaries of the site, the upland buffers will be planted densely adjacent to the perimeter fence with species likely to discourage intrusion into the site (e.g., tall Oregon grape, hawthorn, rose). Planting may occur in phases, with an initial planting of rapidly growing plants tolerant of full sun followed by a second planting of species that are more shade tolerant.

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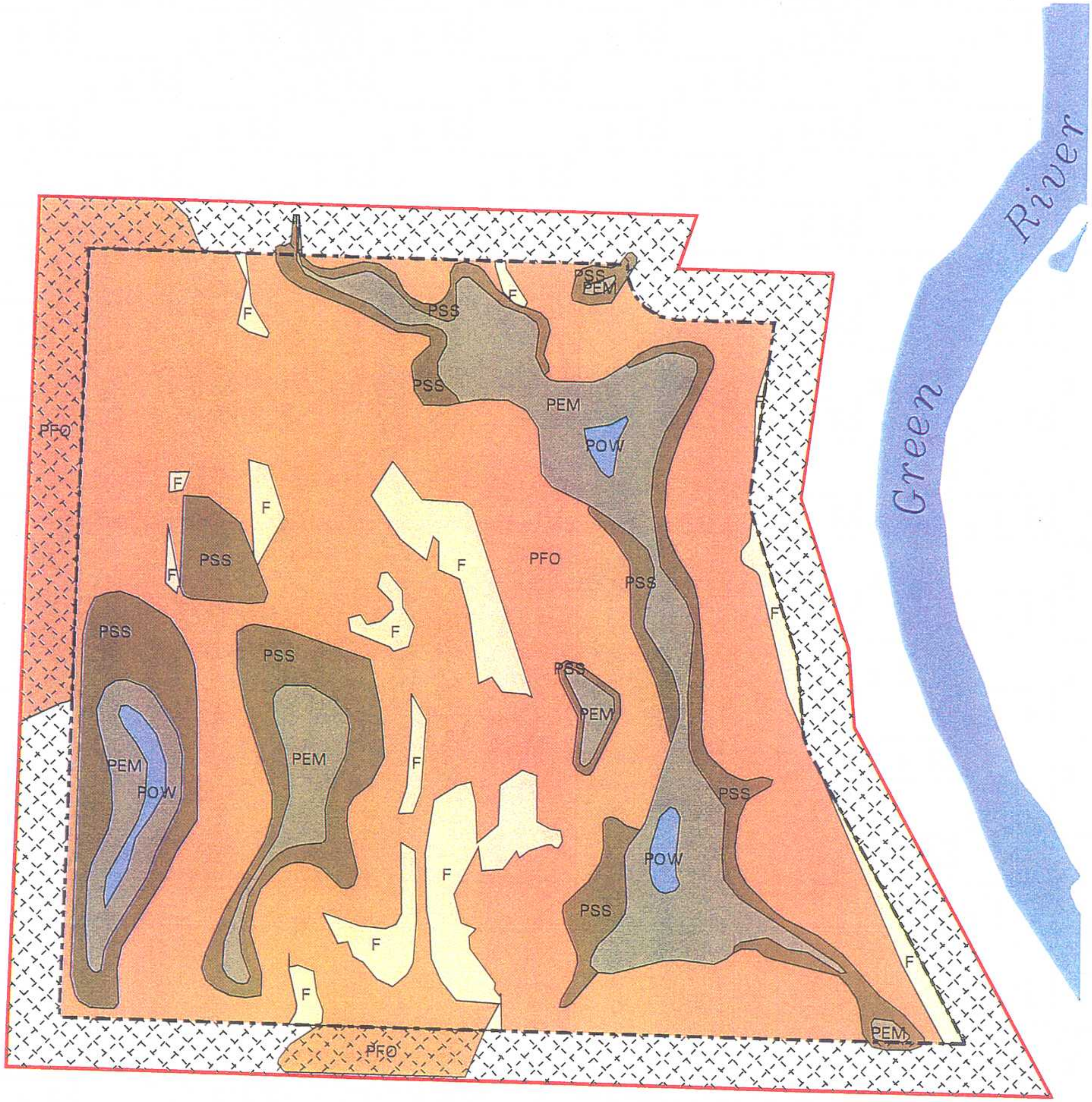


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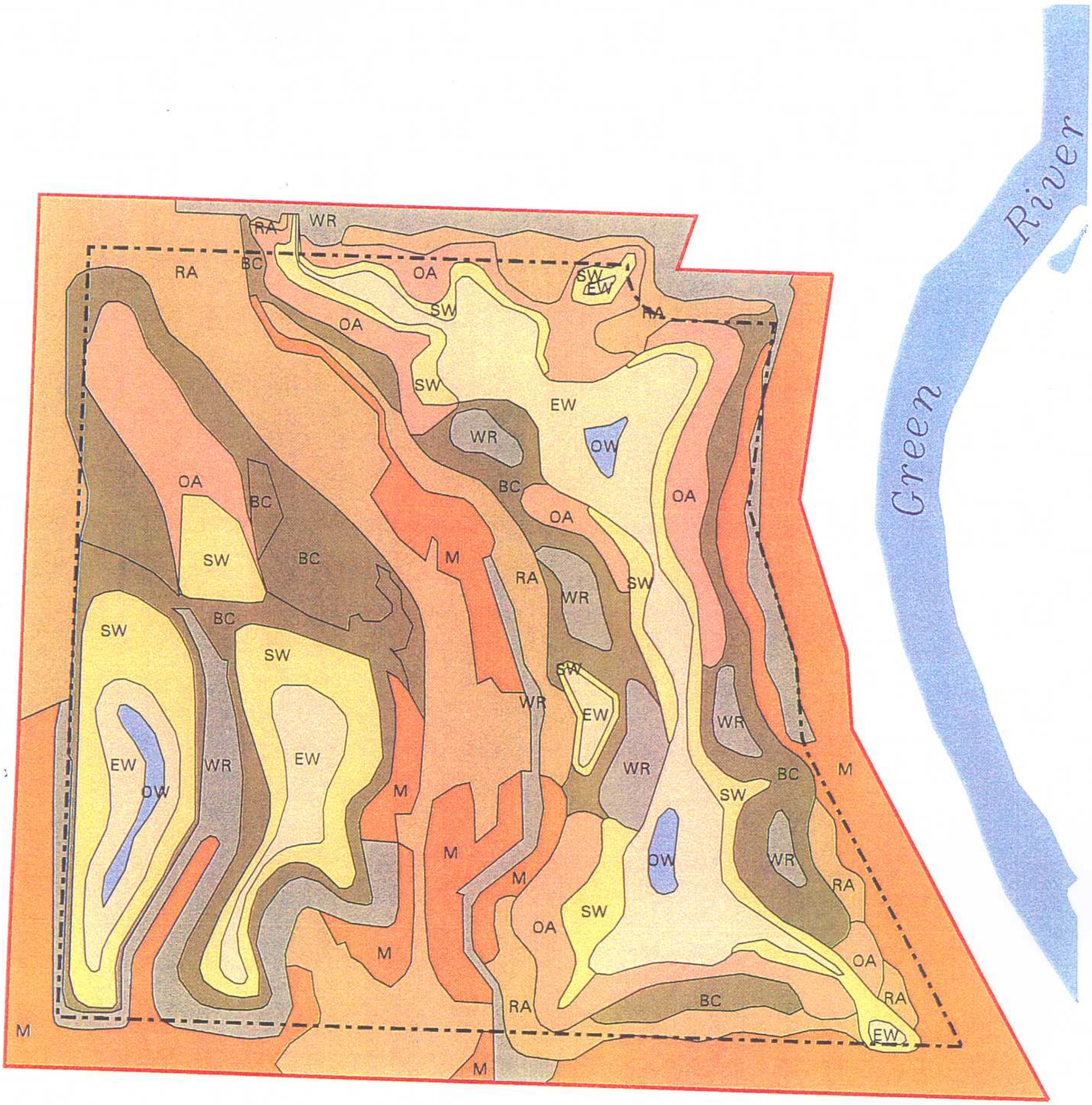
(PFO) Palustrine Forested
(PSS) Palustrine Scrub-Scrub
(PEM) Palustrine Emergent
(POW) Palustrine Open Water
(F) Forested Upland
Forested Buffer
Property Boundary
100 Foot Buffer

**Figure 7.3-5 Wetland Vegetation Classes for the Wetland Mitigation Site**

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- Black Cottonwood (BC)
- Red Alder (RA)
- Oregon Ash (OA)
- Mixed Forest (M)
- Western Redcedar (WR)
- Shrub Wetland (SW)
- Emergent Wetland (EW)
- Open Water Non-vegetated (OW)
- Property Boundary
- 100 Foot Buffer

**Figure 7.3-6 Plant Associations for the Wetland Mitigation Site**

The sections below describe the general planting approach for each planting zone. The sections identify the types of plant species, the condition of material planted (container, bareroot, live stakes, seed, or plugs), and the planting approach (density, pattern, and area of coverage). At the time of planting, minor variations in the plantings may occur to account for site-specific factors and the planting season. For example, if an area is planted in late spring or summer, container-grown versus live-stake material would be used. Similarly, during late fall, winter, or early spring plantings, a greater amount of bareroot and live-stake versus container-grown material would be planted. Figure 7.2-14 depicts the expected growth pattern of the plantings as time progresses. It is anticipated that a mature forested wetland system will develop within 50 years.

Plant material used in the mitigation will be obtained from commercial nurseries. Nurseries will be required to certify that the plant material is legally procured and from the appropriate geographic sources. The appropriate geographic sources for plant material used in the mitigation is the area that is bounded on the north by the Fraser River Valley of British Columbia, on the east by the 1,000-foot elevation of the Cascades, on the west by the 1,000-foot elevation in the Olympic or Coast ranges, and on the south by the Willamette Valley.

#### 7.3.3.1 Weed Control

Invasive non-native species such as reed canarygrass and Himalayan blackberry can reduce successful establishment of desirable native plant species. A variety of weed control strategies are available to treat non-native species prior to and during the native plant installation period. These control strategies are incorporated into the planting design, or will be implemented during the monitoring period to control invasive species. Weed control methods are:

- Dense plantings of target species that competitively exclude non-native species
- Applications of EPA-approved herbicides by licensed applicators
- Application of sterile straw or other biodegradable mulch as a weed barrier
- Installation of biodegradable weed barrier fabric
- Mechanical removal using mowers or line trimmers, or hand removal

Several methods for controlling reed canarygrass are currently proposed. An integrated approach, relying on a suite of control strategies (listed above) and adaptive management will be used to control reed canarygrass at the Auburn site.

Topsoil containing weed seed, roots, and rhizomes will be removed in order to establish appropriate wetland hydrology over much of this site. Existing vegetation, including reed canarygrass, may also be removed from the site by application of approved herbicides, plowing, cultivating, and allowing the site to lie fallow. The project has been designed to anticipate some colonization of reed canarygrass by targeting the establishment of forested wetlands that ultimately will shade out the reed canarygrass. Competitive exclusion will be used early in the planting period by seeding areas with a fast-germinating cover crop (see Table 7.3-2). Competitive grass species such as tufted hairgrass (*Deschampsia cespitosa*), sloughgrass (*Beckmannia syzigachne*), bentgrass, or red fescue can be effective in establishing cover and reducing invasion by reed canarygrass. Contingency actions could include repeated applications of herbicides, mowing, or use of weed barriers.

#### 7.3.3.2 Plant Protection from Animals

To deter plant damage by rodents (i.e. herbivory), plants may be installed with protective devices such as plastic stem collars. Depending on the type of community and level of herbivory, deterrence measures may range from plastic collars around individual stems to wire mesh around groups of plants. After plants are installed, a 4- to 6-inch-deep covering of mulch will be placed in a 6-ft radius around the base of each plant to conserve water, provide organic material, and serve as a weed barrier.

#### 7.3.3.3 Perimeter Fencing

A fence will be installed around the perimeter of the site to clearly mark the mitigation boundary and to protect the mitigation site from intrusion and damage from people or domestic animals. Based on discussions with ACOE, the Port has designed a fence that will be post and rail or equivalent. In addition to the fence, signs will be posted along the boundary of the mitigation site, designating the site as a wetland mitigation area.

### 7.3.4 Native Plant Communities

The planting plan will result in establishing five forested communities, one shrub community, and one emergent community on the site. Four of the forested communities, as well as the shrub and emergent communities, are wetlands. An upland forested community will be planted in buffer zones.

#### 7.3.4.1 Forested Communities

**Black Cottonwood/Willow Association**

The black cottonwood/willow association is characteristic of many floodplain forested wetlands in western Washington, including the Green River Valley. The plants within this association (Table 7.3-3 and Figure 7.3-7) are adapted to large fluctuations in the water table and are tolerant of seasonally dry soils. This zone would be planted above elevation 42 ft on the east side and above elevation 46 ft on the west side.

**Red Alder/Salmonberry Association**

The red alder/salmonberry association (Table 7.3-4, see Figure 7.3-7) commonly occurs on wet valley floors in seasonally flooded areas (Kunze 1994). This association would be planted above the 42-ft elevation on the east side and above the 46-ft elevation on the west side, where year-round soil saturation would not occur.

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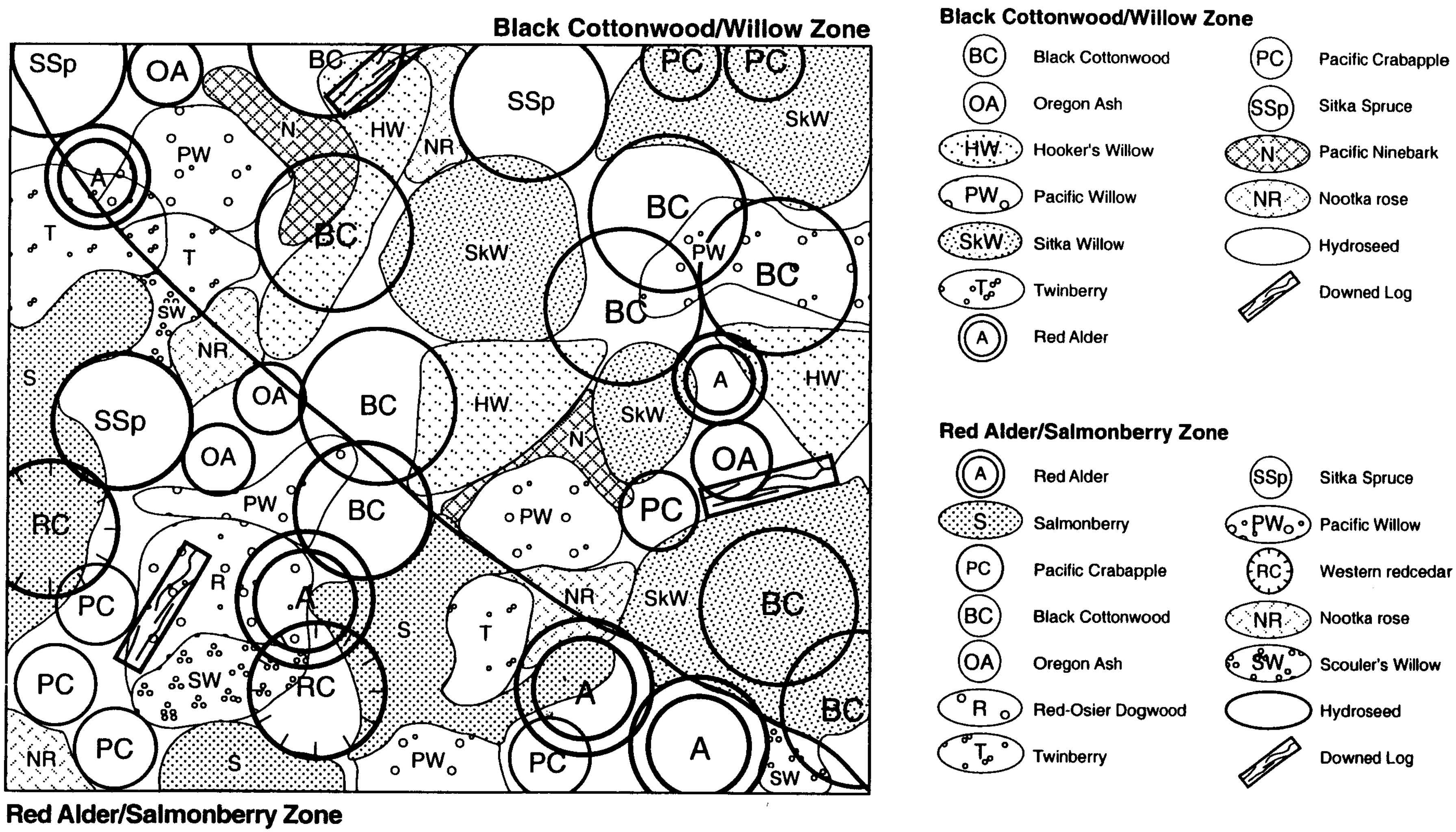


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Note: See Appendix E Sheets L5 - L10 for more details



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**Figure 7.3-7**
**Typical Planting Plan Example for the Black Cottonwood and Red Alder Planting Zones**

**Table 7.3-3. Proposed plant species for the black cottonwood/willow association.**

| Scientific Name | Common Name | Indicator Status[1] | Condition |
|---|---|---|---|
| **Trees** | | | |
| *Alnus rubra* | Red alder | FAC | container |
| *Fraxinus latifolia* | Oregon ash | FACW | container |
| *Malus fusca* | Pacific crabapple | FACW | container |
| *Picea sitchensis* | Sitka spruce | FAC | container/bareroot |
| *Populus trichocarpa* | Black cottonwood | FAC | container/ live stake |
| *Salix lasiandra* | Pacific willow | FACW+ | container/ live stake |
| **Shrubs** | | | |
| *Lonicera involucrata* | Twinberry | FAC+ | container |
| *Physocarpus capitatus* | Pacific ninebark | FACW- | container |
| *Rosa nutkana* | Nootka rose | FAC | container |
| *Salix hookeriana* | Hooker's willow | FACW | container/ live stake |
| *Salix sitchensis* | Sitka willow | FACW | container/ live stake |

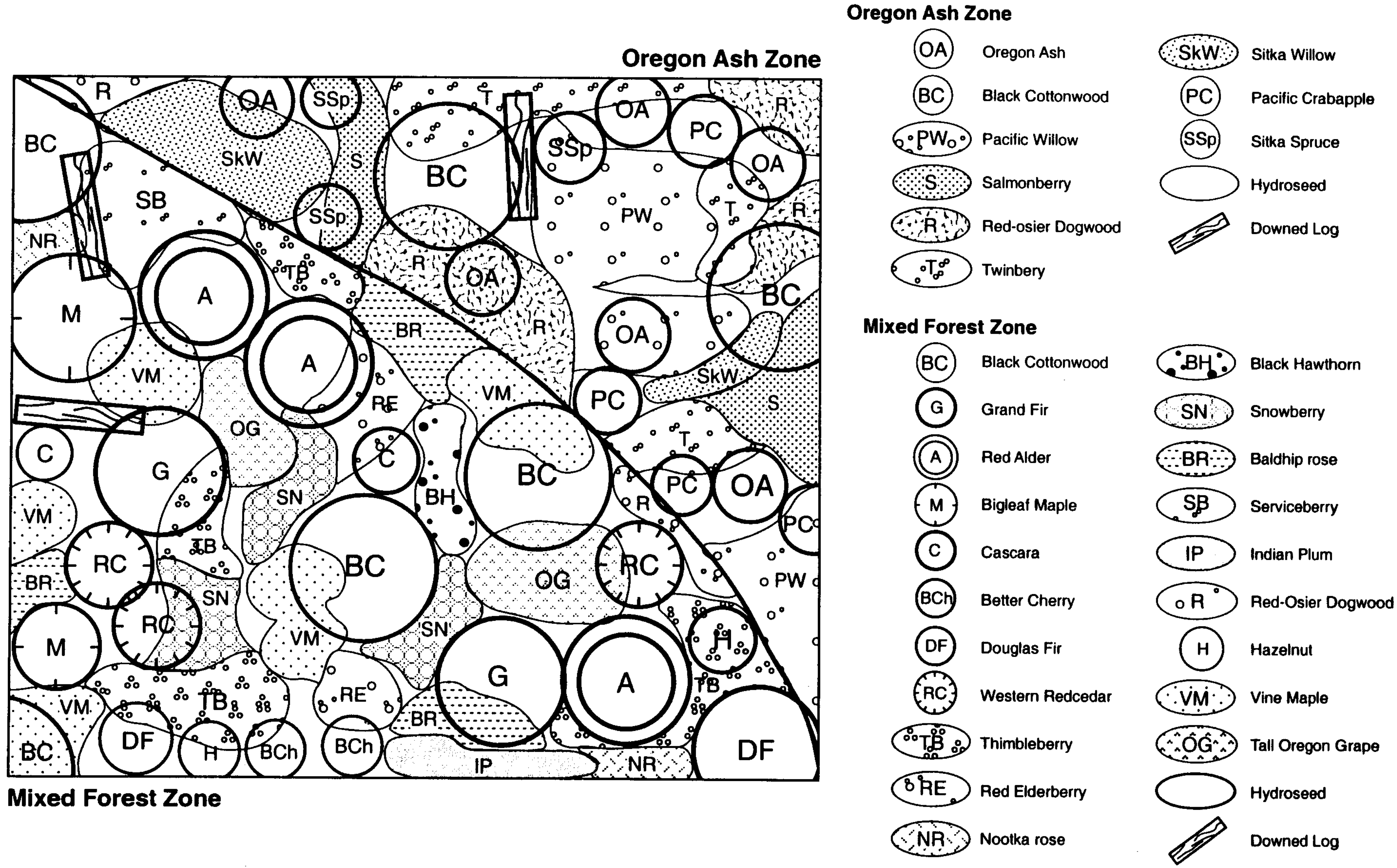
1 See Table 7.2-4 for indicator status definitions

**Table 7.3-4. Proposed plant species list for the red alder/salmonberry association.**

| Scientific Name | Common Name | Indicator Status | Condition |
|---|---|---|---|
| **Trees** | | | |
| *Alnus rubra* | Red alder | FAC | container |
| *Fraxinus latifolia* | Oregon ash | FACW | container |
| *Malus fusca* | Western crabapple | FACW | container |
| *Picea sitchensis* | Sitka spruce | FAC | container |
| *Populus trichocarpa* | Black cottonwood | FAC | container/live stake |
| *Salix lasiandra* | Pacific willow | FACW+ | container/live stake |
| *Thuja plicata* | Western redcedar | FAC | container/ bareroot |
| **Shrubs** | | | |
| *Cornus stolonifera* | Red-osier dogwood | FACW | container/ live stake |
| *Lonicera involucrata* | Twinberry | FAC+ | container |
| *Rosa nutkana* | Nootka rose | FAC | container |
| *Rubus spectabilis* | Salmonberry | FAC+ | container |
| *Salix scouleriana* | Scouler's willow | FAC | container/ live stake |

## Oregon Ash Association

The Oregon ash association is most commonly found in floodplains or associated with streams and backwater sloughs (Kunze 1994). This community would be planted in the wetter portions of the forest zone, since most of the associated species are tolerant of soil saturation and inundation well into the spring. Oregon ash will comprise most of the canopy cover, with salmonberry and willow in the shrub layer (Table 7.3-5; Figure 7.3-8).




Note: See Appendix E Sheets L5 - L10 for more details





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**Figure 7.3-8**
**Typical Planting Plan for the Oregon Ash and the Mixed Forest Planting Zone**

Table 7.3-5. Proposed plant species list for the Oregon ash association.

| Scientific Name | Common Name | Indicator Status | Condition |
|---|---|---|---|
| **Trees** | | | |
| *Fraxinus latifolia* | Oregon ash | FACW | container |
| *Malus fusca* | Western crabapple | FACW | container |
| *Picea sitchensis* | Sitka spruce | FAC | container/bareroot |
| *Populus trichocarpa* | Black cottonwood | FAC | container/ live stake |
| *Salix lasiandra* | Pacific willow | FACW+ | container/ live stake |
| **Shrubs** | | | |
| *Cornus stolonifera* | Red osier dogwood | FACW | container/live stake |
| *Lonicera involucrata* | Twinberry | FAC+ | container |
| *Rubus spectabilis* | Salmonberry | FAC+ | container |
| *Salix stichensis* | Sitka willow | FACW | container/live stake |

## Mixed Forest Association

The mixed forest association includes several coniferous and deciduous tree species as well as an understory shrub component. Some of the tree species in this association are not tolerant of prolonged saturation. Therefore, this association would be planted in the upper zone between wetland and upland, as well as in the upland buffers (Table 7.3-6; see Figure 7.3-8).

Table 7.3-6. Proposed plant species list for the mixed forest association.

| Scientific Name | Common Name | Indicator Status | Condition |
|---|---|---|---|
| **Trees** | | | |
| *Abies grandis* | Grand fir | FACU- | container |
| *Acer macrophyllum* | Big-leaf maple | FACU | container |
| *Alnus rubra* | Red alder | FAC | container |
| *Crataegus douglasii* | Black hawthorn | FAC | container |
| *Populus trichocarpa* | Black cottonwood | FAC | container/ bare root |
| *Prunus emarginata* | Bitter cherry | FACU | Container |
| *Psuedotsuga menziesii* | Douglas fir | FACU | container |
| *Rhamnus purshiana* | Cascara | FAC- | container |
| *Thuja plicata* | Western redcedar | FAC | container |
| **Shrubs** | | | |
| *Acer circinatum* | Vine maple | FAC- | container |
| *Amelanchier alnifolia* | Serviceberry | FACU | container |
| *Berberis aquilifolium* | Tall Oregon grape | FACU | container |
| *Corylus cornuta* | Hazelnut | FACU | container |
| *Oemleria cerasiformis* | Indian plum | FACU | container |
| *Rosa gymnocarpa* | Bald-hip rose | FACU | container |
| *Rosa nutkana* | Nootka rose | FAC | container |
| *Rubus parviflorus* | Thimbleberry | FAC- | container |
| *Sambucus racemosa* | Red elderberry | FACU | container |
| *Symphoricarpos albus* | Snowberry | FACU | container |

## Western Redcedar Association

The western redcedar association includes deciduous as well as coniferous tree species, with an understory of FAC and FACW shrub species (Table 7.3-7; Figure 7.3-9). Tree species such as western redcedar and big-leaf maple are not tolerant of prolonged soil saturation. Therefore, this association will be planted in the upper portions of the wetland zone, or above approximately 47 ft in the west and about 44 ft in the eastern basin.

**Table 7.3-7. Proposed plant species list for the western redcedar association.**

| Scientific Name | Common Name | Indicator Status | Condition |
|---|---|---|---|
| **Trees** | | | |
| *Abies grandis* | Grand fir | FACU- | container/ bareroot |
| *Acer macrophyllum* | Big-leaf maple | FACU | container |
| *Alnus rubra* | Red alder | FAC | container |
| *Populus trichocarpa* | Black cottonwood | FAC | container/ bareroot |
| *Rhamnus purshiana* | Cascara | FAC- | container |
| *Thuja plicata* | Western redcedar | FAC | container |
| **Shrubs** | | | |
| *Acer circinatum* | Vine maple | FAC- | container |
| *Oemleria cerasiformis* | Indian plum | FACU | container |
| *Physocarpus capitatus* | Pacific ninebark | FACW- | container |
| *Salix scouleriana* | Scouler's willow | FAC | container/ live stake |

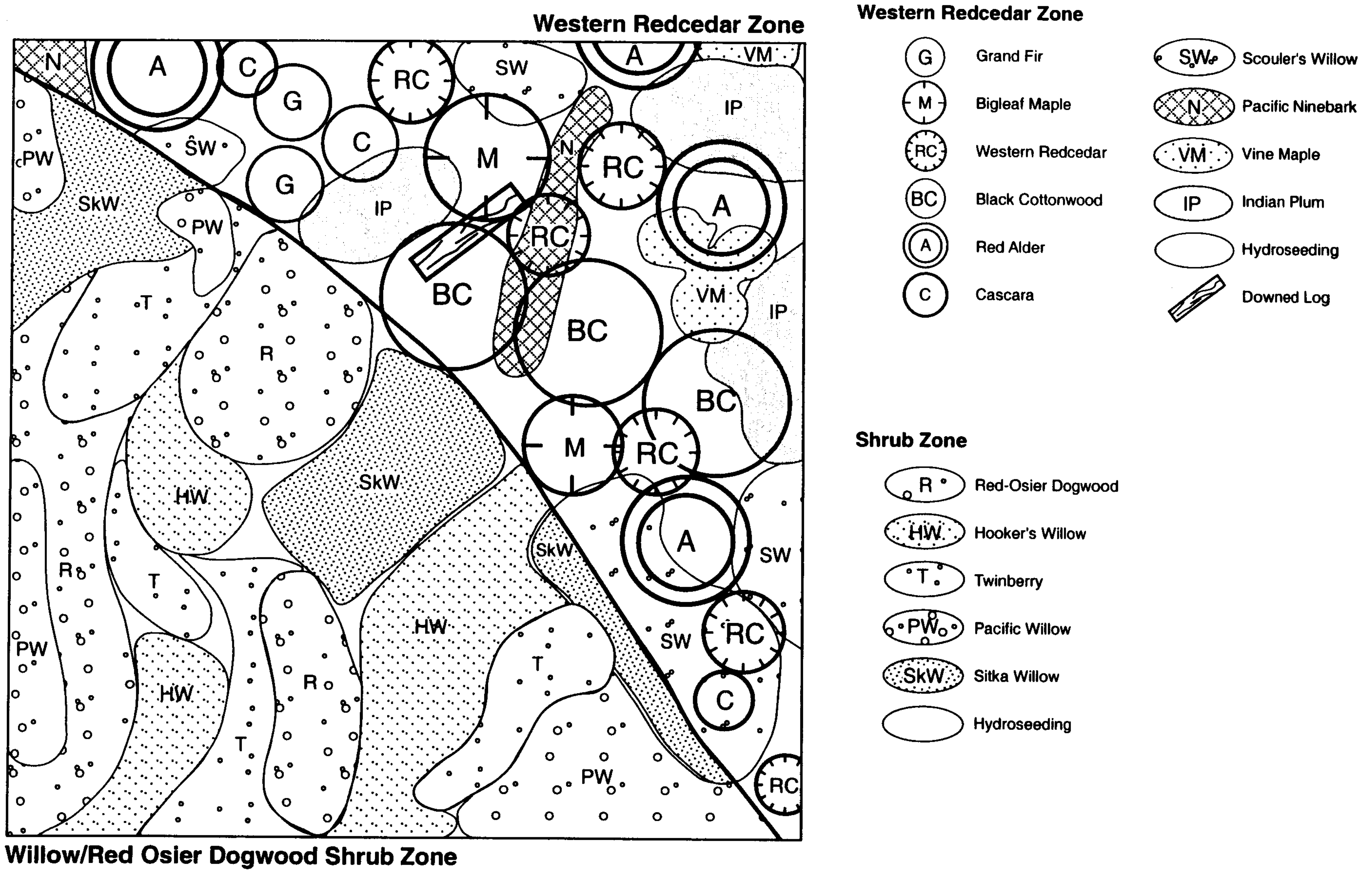
## Existing Wetland Enhancement

The existing emergent wetlands will be enhanced by planting them with various forested and shrub communities, including black cottonwood/willow, red alder/salmonberry, and Oregon ash, and willow/red osier dogwood plant associations (see Tables 7.3-3 through 7.3-5 and 7.3-8). Trees and shrubs included in these associations will be infill-planted into the existing wetland vegetation. Wetland enhancement communities will be planted at the existing ground elevations, between elevations 45 and 49 ft.

## Forested Buffers

The mitigation site will be protected by 100-ft forested buffers along its boundaries. In addition, upland forest between the existing wetland and the newly created wetlands will create an upland/wetland mosaic to increase habitat diversity (Appendix E, Sheets L5 through L10). Approximately 15.9 acres of forested buffer and upland will be established.

Buffer areas on the site range from moist upland areas to wetter transitional areas between uplands and wetlands. Transitional areas between uplands and wetlands will be planted with the western redcedar association (see Table 7.3-7), while upland areas will be planted with the mixed forest association (see Table 7.3-6).




Note: See Appendix E Sheets L9 and L10 for more details



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**Figure 7.3-9**
**Typical Planting Plan**
**for the Western Redcedar**
**and the Shrub Planting Zones**

Upland areas disturbed during wetland construction will be seeded using a mix of low-growing grass species (see Table 7.3-2) prior to planting. Trees and shrubs will be planted at densities sufficient to attain the stem density and canopy cover performance standards identified for forested wetland habitat (see Table 7.1-2).

#### 7.3.4.2 Shrub Wetland Community

**Willow/Red Osier Dogwood Association**

The shrub wetlands will be planted with a willow/red osier dogwood association (Table 7.3-8; see Figure 7.3-9). Shrubs will be planted approximately 4 to 6 ft on-center. This association will occupy wetter areas of the site that are inundated during the winter months and have saturated soils into the summer. Shrub wetlands will be planted between 44 and 47 ft in the western basin, and between 41 and 42 ft in the eastern basin (Appendix E, Sheets L5 through L10).

**Table 7.3-8. Proposed plant species list for the willow/red osier dogwood shrub zone.**

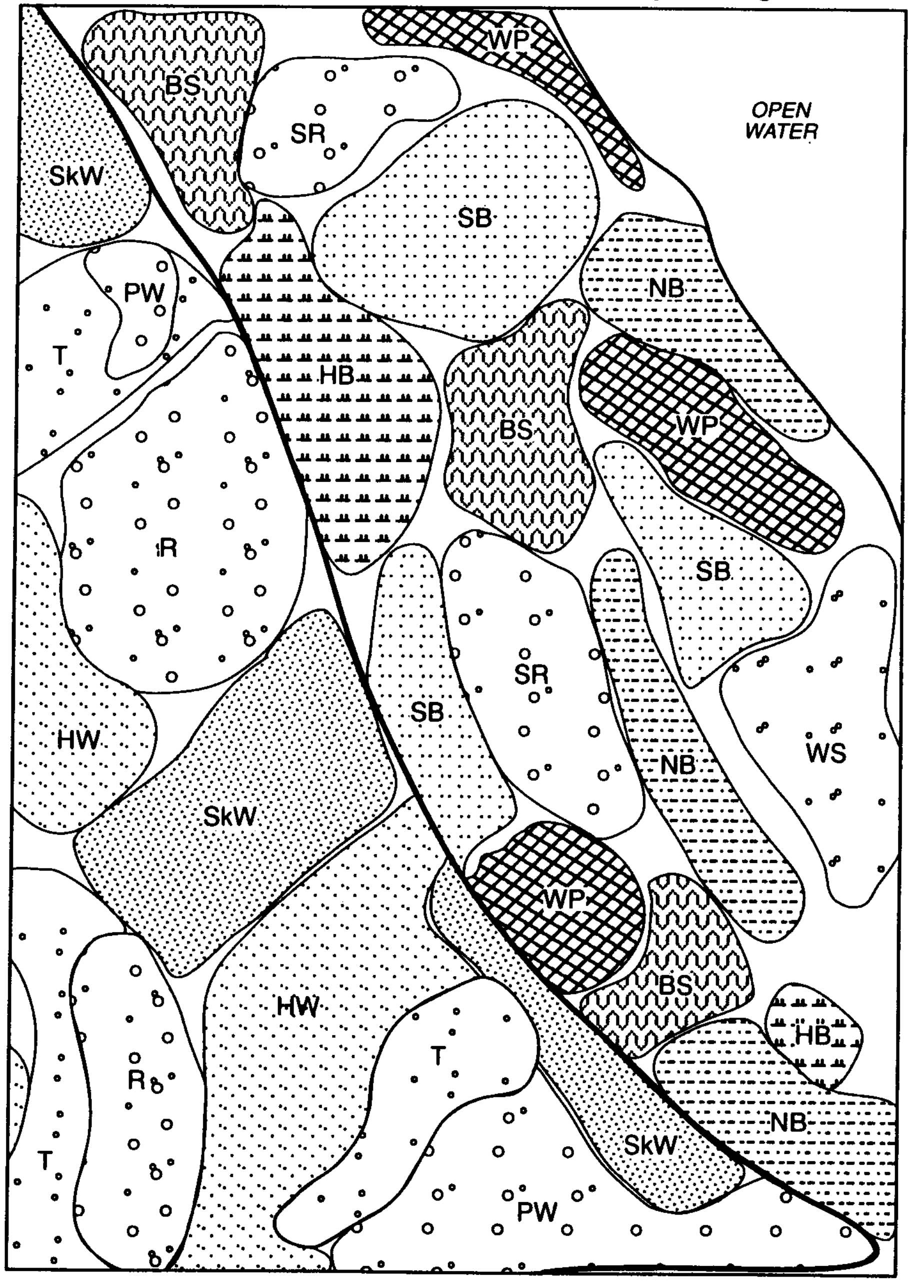
| Scientific Name | Common Name | Indicator Status | Condition | Comments |
|---|---|---|---|---|
| *Cornus stolonifera* | Red-osier dogwood | FACW | container/ live stake | Shrubs would be planted in approximately 85% to 90% of the shrub zone at spacings ranging from 5 to 8 ft on-center. |
| *Lonicera involucrata* | Twinberry | FAC+ | container | |
| *Salix hookeriana* | Hooker's willow | FACW- | container/ live stake | |
| *Salix lasiandra* | Pacific willow | FACW+ | container/ live stake | |
| *Salix sitchensis* | Sitka willow | FACW | container/ live stake | |

#### 7.3.4.3 Emergent Wetland Community

**Beaked Sedge/Water Parsley Association**

Emergent wetlands in the excavated basins will be planted with native emergent species common in the Green River Valley and the northern Puget Sound region. Since wetland hydrology is designed to create both seasonally and permanently flooded areas, plants that are tolerant of extended flooding and soil saturation would be established in these areas. The emergent zones will be planted with an herbaceous community dominated by native sedge and rush species such as beaked sedge, slough sedge, water parsley, small-fruited bulrush, and narrow-leaved bur-reed (Table 7.3-9; Figure 7.3-10; Appendix E, Sheets L5 through L10). Emergent communities will be planted in the wettest portions of the site with year round soil saturation and some areas of permanent standing water. Emergent communities will be planted below approximately between 44 ft in the western basin and 41 ft in the eastern basin.

Beaked Sedge/Water Parsley Emergent Zone




Willow/Red Osier Dogwood Shrub Zone

**Emergent Zone**

- BS — Beaked Sedge
- WP — Water Parsley
- SR — Common Spike-Rush
- HB — Water Smartweed
- SB — Hardstem Bulrush
- NB — Small-fruited Bulrush
- Narrow-leaf Bur-reed
- Hydroseed Mix/ Natural Colonization

**Shrub Zone**

- R — Red-Osier Dogwood
- HW — Hooker's Willow
- T — Twinberry
- PW — Pacific Willow
- SkW — Sitka Willow
- Hydroseeding

Note: See Appendix E Sheets L9 and L10 for more details

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**Figure 7.3-10**
**Typical Planting Plan for the Emergent and Shrub Planting Zones**

Table 7.3-9. **Proposed species list for the beaked sedge/water parsley emergent zone.**

| Scientific Name | Common Name | Indicator Status | Condition |
|---|---|---|---|
| *Carex rostrata* | Beaked sedge | OBL | plug/container |
| *Eleocharis palustris* | Common spike-rush | OBL | plug/container |
| *Oenanthe sarmentosa* | Water parsley | OBL | container |
| *Polygonum amphibium* | Water smartweed | OBL | container |
| *Scirpus acutis* | Hardstem bulrush | OBL | plug/container |
| *Scirpus microcarpus* | Small-fruited bulrush | OBL | plug/container |
| *Sparganium emersum* | Narrow-leaf bur-reed | OBL | plug/container |

The typical growth pattern for emergent marsh plants is in monotypic patches with some interspersion in open, less densely vegetated areas, and proposed planting would mimic this pattern (See Figure 7.3-10). Planting shoots with rhizomes 18 inches on-center in monotypic stands of varying size, in combination with seeding a mix of emergent species (see Table 7.3-2) in the areas between patches should achieve that result. Because ponding in emergent areas is expected well into the early summer, planting of emergent species would occur during the fall months when soils are becoming saturated, but before water levels reach their winter maximum.

## 7.4 IMPLEMENTATION

The following sections describe the general implementation sequence for the Auburn site. Table 7.4-1 presents a proposed implementation timeline for Auburn mitigation projects.

### 7.4.1 Pre-construction Meeting

Oversight during construction of the wetland mitigation will be required to ensure that the contractors follow the plans and specifications. Prior to any site work, a pre-construction meeting will be held with the Port, general contractors, engineers, landscape contractors, landscape architects, and biologists to ensure that the work is constructed as designed, and that contractors understand and comply with all environmental permit conditions. Both a civil engineer and wetland ecologist will be available for on-site inspections and approvals of all work during construction.

### 7.4.2 Site Preparation and Planting

#### 7.4.2.1 Existing Wetlands

The majority of the existing wetlands will not be cleared of vegetation or graded during site grading and excavation (Appendix E, Sheets C3 through C6). Non-native vegetation in the existing

Table 7.4-1. Proposed Implementation Timeline for Auburn Wetland Mitigation Projects.

| Project/Activity | Year (Year One Starts with the First Construction Season After the Date Permits Are Issued[1]) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year 1 | | | | | | | | | | | | Year 2 | | | | | | | | | | | | Year 3 | | | | | | | | | | | |
| | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D |
| **Auburn Wetland Mitigation** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Preconstruction meeting | | | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| TESC, Site Preparation | | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Begin dewatering | | | | | | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Excavate and mass grade east basin | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Fine grade east basin, place wetland soil | | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mow and herbicide buffer | | | | | | | | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Construct water control structure and connection to east basin | | | | | | | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Install irrigation in east basin and buffer | | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Install groundwater monitoring wells and staff gages and begin hydrology monitoring | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Hydroseed graded portions of site | | | | | | | | | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Produce grading record drawings | | | | | | | | | ■ | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Install plants in east basin and buffer | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | | | | | | | | | |
| Produce planting plan record drawing | | | | | | | | | | | | | | | | | | | | | | ■ | | | | | | | | | | | | | | |
| Excavate and mass grade west basin | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | | |
| Fine grade west basin, place soils | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | | | | | | | | | | | | | | | |
| Mow existing wetland; mow, herbicide and disc buffer | | | | | | | | | | | | | | | | | | | | ■ | ■ | | | | | | | | | | | | | | | |
| Install irrigation in west basins, existing wetland and buffers | | | | | | | | | | | | | | | | | | | | ■ | ■ | | | | | | | | | | | | | | | |
| Construct water control structure | | | | | | | | | | | | | | | | | | | | ■ | ■ | | | | | | | | | | | | | | | |
| Install groundwater monitoring wells and begin compliance monitoring | | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Hydroseed open areas | | | | | | | | | | | | | | | | | | | | | ■ | | | | | | | | | | | | | | | |

Table 7.4-1. Proposed Implementation Timeline for Auburn Wetland Mitigation Projects (continued).

| Project/Activity | Year (Year One Starts with the First Construction Season After the Date Permits Are Issued[1]) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year 1 | | | | | | | | | | | | Year 2 | | | | | | | | | | | | Year 3 | | | | | | | | | | | |
| | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D |
| Produce grading and irrigation record drawings | | | | | | | | | | | | | | | | | | | | | ■ | ■ | | | | | | | | | | | | | | |
| Install plants in west basin, existing wetland and buffers | | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| Closeout of temporary access roads, staging areas | | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | | | | | | |
| Produce planting plan record drawings, conduct baseline monitoring for entire site | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ | ■ | ■ | | | |
| Begin compliance monitoring[2] | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | ■ | ■ | ■ |

[1] Plant procurement for all projects will be implemented six to twelve months prior to the anticipated planting date to ensure that plants in the specified quantities and species are available by the scheduled planting date. Implementing mitigation projects may vary from this proposed schedule depending upon coordination with other MPU projects and contract obligations.

[5] Compliance monitoring begins for all parameters except hydrology; monitoring continues for 10 years; hydrology monitoring begins once grading is complete.

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wetlands will be managed before installing native plants to reduce competition, and to control weeds. Management will include reducing cover and vigor of existing non-native vegetation. Plant installation will occur between March and October, and weed management should occur immediately prior to installing plants.

Prior to the scheduled plant installation in the existing wetlands, existing vegetation will be mowed and maintained at a maximum height of approximately 6 to 12 inches. Enhancement plantings will be installed per the planting schedule (Appendix E, Sheets L5 through L10). Native trees and shrubs will be installed in clumps of 5 to 10 individuals, with a weed barrier mulch applied around the base of each plant. Mowing may occur periodically to maintain the grasses at a height of 12 inches or less. Mowing between the planted areas may be necessary for the first 3 to 5 years of the monitoring period to minimize competition between the planted stock and existing pasture grasses or to control invasive plants.

This weed management strategy is expected to maximize the success of plant establishment. Over time, the areas in between the planted clumps will fill in with native wetland trees and shrubs through the increase in cover from the initial planted stock, as well as colonization of new areas.

#### 7.4.2.2 Protective Buffers

Buffers at the Auburn site will be established in a 100-ft-wide zone around the perimeter of the mitigation site, as well as in the areas between the existing wetlands and newly created wetlands (Appendix E, Sheets C3 through C6). The existing upland areas, including the buffer around the wetlands, are currently dominated by non-native pasture grasses and forbs. To reduce competition from existing vegetation and to control weeds prior to planting, the cover of existing vegetation will be reduced, and soils will be disced to prepare a substrate for the hydroseed mix and the planted stock. During early to mid summer, existing vegetation will be mowed to a maximum height of approximately 6 to 12 inches. The vegetation will be allowed to grow for about 2 weeks to produce new shoots and leaves, and then herbicide will be applied per the specifications. Approximately 2 weeks after the herbicide application, the area will be thoroughly disced to mix the upper soil profile, irrigation will be installed, and a hydroseed/mulch mix applied. The following spring and summer, plants will be installed in the buffer planting zones.

Depending on the timing of mitigation construction, it may not be possible to prepare the buffer area, install irrigation, and apply hydroseed in time for the hydroseed to become established before the winter season. Therefore, there will be two options for preparing the upland and existing wetland buffers. Option one is to complete the entire sequence outlined above, if all the steps can be completed by mid-September or earlier. This will allow the hydroseed time to establish cover and stabilize the soil before the winter rainy season. If the entire sequence cannot be completed by mid-September, then the existing vegetation should be left in place to stabilize the soil and prevent erosion during the winter. The discing and hydroseed steps will be omitted and the irrigation system and planted stock will be installed into the existing vegetation. If the existing vegetation is left in place in the buffer areas, planting will proceed as described above for the existing wetland areas.

### 7.4.3 Excavation and Grading

Prior to excavation and grading, the extent of all grading activities will be surveyed by a professional surveyor and staked in the field. The contractor will establish vertical and horizontal site controls and maintain them throughout the construction period. The limits of work will be identified and flagged in the field, wetlands and surface water features will be identified with orange barrier fencing, and the TESC measures will be installed.

Approximately 440,000 cy of soil will be excavated to form the new wetlands basins to the east and west of the existing wetlands. The top 12 inches of soil will be stripped and removed from the site. This surface material, as well as the majority of the excavated material, will be transported off-site and disposed of at an approved upland location. A portion of the excavated subsoils, which are composed of silts, clays, and fine sands, will be blended with composted organic matter and used as topsoil, to be placed after the new site grades are established. The topsoil blending operation will require temporary stockpiling and processing at either an on-site or off-site location.

The existing drainage channel, located north of the site, will be widened to connect the mitigation site with the 100-year floodplain and an existing ditch system near 277$^{th}$ Avenue South (see Appendix E, Sheet C8 Section 5).

Final grading and habitat log placement will be performed under the direction of the wetland scientist or landscape architect. If subsoils have become compacted during preliminary grading, the soil surface will be ripped and/or disced prior to spreading the amended top soil mix. The top soil mix will be placed to a depth of at least 12 inches.

### 7.4.4 Construction Access Roads, Staging Areas, and Maintenance Roads

In addition to any temporary access and/or haul roads, temporary construction and maintenance roads will be required on the mitigation site. Temporary maintenance roads will be constructed around each wetland basin to provide vehicular access during planting, and for the early site maintenance and monitoring period. Temporary gravel paths will provide foot and small vehicle access to the interior of the site during the planting period.

#### 7.4.4.1 Staging Areas, Temporary Haul, and Access Roads

On completion of earthwork and planting phases, temporary staging areas, access, and haul roads will be removed, prepared for planting, and planted. Staging areas and/or access roads that are not within the mitigation site boundaries will be cleared of construction equipment and debris and soils will then be ripped or disced to break up compacted layers and prepare a suitable substrate for planting. Except for where these areas cross wetland, they will be hydroseeded with the low-grow erosion control seed mix specified for the upland buffers (see Table 7.3-2). Where they cross wetlands, the wetland hydroseed mix will be used.

Temporary staging areas or access roads within the mitigation site will be removed and planted. These areas will be cleared of construction equipment and debris, road materials will be removed, and soil surfaces will be prepared for planting and planted according to the planting plan. For example, where a temporary haul road occurs in an area designated as western redcedar on the planting plans (Appendix E, Sheets L1 through L5), the area will be planted with the western redcedar association once the road is removed. Preparation of these areas for planting may include deep ripping or discing, depending on the degree of soil compaction, and the addition of organic mulch (as specified for the rest of the site).

#### 7.4.4.2 Gravel Paths and Maintenance Roads

Temporary gravel paths in the mitigation area provide access for planting, initial maintenance, and monitoring. The gravel paths will be decommissioned after five complete growing seasons following completion of planting, if the areas have met plant cover and survival performance standards for 2 consecutive years. If the areas are not meeting cover performance standards at the end of 5 years, the gravel paths will be decommissioned when basins have met plant cover and survival performance standards. Decommissioning will include removing path materials, preparing the soil surface for planting (e.g., ripping and/or tilling), and planting according to the planting plan.

The temporary maintenance roads will be removed after five growing seasons if the areas they serve meet cover performance standards for 3 consecutive years. The road materials will be removed and soil surfaces treated to provide a suitable medium for plant growth (i.e., ripping and/or discing). The road area will be planted with fast-growing species from the mixed forest plant schedule (i.e., Douglas fir, red alder, black cottonwood, bald-hip rose).

Maintenance roads along the west, north, and south sides of the site, may be retained throughout the 10-year monitoring period for maintenance and security for the site (i.e., to manage weed control, any necessary replanting, prevent dumping, etc.). At the end of the 10-year monitoring period, the Port will consult with regulatory agencies to determine if the maintenance roads should be decommissioned, or if they should be retained to allow for on-going maintenance, or security needs. If it is determined the maintenance roads should be removed, they will be planted as described above for the construction haul and access roads.

### 7.4.5 Erosion Control

Prior to any site preparation and grading, sediment and erosion control measures will be implemented to protect on- and off-site aquatic systems from sedimentation. Generally, construction of the wetland basins will not be prone to off-site migration of sediments due to the level topography of the site and the lack of surface water features in or adjacent to the site. In areas where fine sediments could potentially occur in surface waters, adjacent properties, or existing wetlands due to construction activities, a variety of erosion control measures will be employed. Staging areas and existing wetlands will be protected with silt fencing. Stockpiled soil left in place for more than 3 weeks will be stabilized with an approved native hydroseed mixture, tarp, or appropriate BMP. In addition, a native erosion control grass seed mixture will be used to stabilize the soil in the graded portions of the site until native vegetation can be installed.

To reduce tracking of mud onto paved roads, the site entrance roads will be stabilized using a pad constructed of quarry spalls. Vehicles and/or their tires will be washed or brushed prior to leaving the site during periods when track-out of mind could occur.

### 7.4.6 Irrigation

After all grading activities have been completed, a temporary irrigation system will be installed throughout the site. Installation of the irrigation system will be coordinated with grading and planting steps to ensure that irrigation is installed prior to plant installation. Installation of the irrigation system will be below ground in all areas that will be cleared and graded; however, the system will be installed above ground in the existing wetlands. The irrigation system will remain in place until the plants become established, which is anticipated to take 2 to 5 years. The temporary systems will then be decommissioned and above-ground parts of the system will be removed.

### 7.4.7 Establish Native Wetland and Upland Buffer Vegetation

All planting zone boundaries will be surveyed by a professional surveyor, and staked and flagged in the field according to the planting plan. A landscape architect or wetland scientist will observe plant installation to ensure that plants are installed properly and according to the plans and specifications. The contractor will be responsible for ensuring that plants are not damaged during transport, staging, or installation, and will be responsible for plant survival and health during the first year following planting.

Due to the large number of plants required to cover the entire buffer, planting may occur in phases. An initial planting of rapidly growing plants tolerant of full sun will be followed by a second planting of more slowly growing species that tolerate or require shade. Planting activities will most likely occur during the spring and fall months to avoid potential disturbance to wintering bald eagles in the vicinity of the Green River.

To provide additional protection to the site from people and pets, the fence line will be densely planted with species from the mixed forest community type to provide a physical and visual screen. Dense planting along the fence line will include Douglas fir, black hawthorn, tall Oregon grape, bald-hip rose, and big-leaf maple (Appendix E, Sheet L10, Detail 6)

### 7.4.8 Record Drawings Report and Monitoring

On completion of earthwork, site topographs will be surveyed and a report containing record drawings for the earthwork phase will be prepared and submitted to regulatory agencies. The planting plan will be reviewed and adjusted if necessary to match constructed grades and site conditions. Adjustments may include moving the boundaries of planting zones or adjusting species compositions to ensure successful establishment of the plant communities. Any necessary adjustments to the planting plan will be submitted to regulatory agencies with the earthwork record drawings and report.

Upon completion of planting (i.e., completion of all planting phases), a complete set of record drawings (including both earthwork and planting as-builts) documenting the constructed mitigation site will be developed and submitted to regulatory agencies. Baseline monitoring (year 0 monitoring) will be conducted on completion of planting to document baseline ecological conditions on the site. Compliance monitoring consistent with the monitoring plan outlined in Chapter 4 of this document will begin during the first growing season after submittal of the complete set of record drawings (i.e., monitoring year 1). Monitoring reports will be submitted to the regulatory agencies consistent with the schedule described in Chapter 4 of this document.

### 7.4.9 Construction Steps

The following sections provide a general outline of the construction and post-construction steps necessary to implement the Mitigation Plan.

#### 7.4.9.1 General Conditions

- All site work will be consistent with permit conditions and City of Auburn grading permit.
- Pre-construction meeting will be held with contractor, architect/engineer, and wetland scientist to review submittals, work plan, schedules, and permit conditions.
- The contractor will be responsible for ensuring that the work is performed in accordance with all permit conditions and shall maintain a copy of permits on-site.
- During construction, hydroseed or mulch will be applied to all open areas after grading consistent with City of Auburn grading permit.
- All areas of exposed soil will be hydroseeded or mulched by September 15$^{th}$ to stabilize the site prior to the start of the rainy season.
- Plant procurement must be coordinated with the construction schedule to ensure that specified plant quantities and species are available when they are needed.

#### 7.4.9.2 Site Preparation

- Vertical and horizontal site controls will be established and maintained throughout the construction period.
- Identify and flag limits of work for the mitigation site.
- Install fencing (orange barrier) around existing wetlands and outlet ditches.
- Implement TESC plan.
- Maintain security of the site through construction; install security fence around site.
- Establish temporary site access roads and wetland crossings.
- Establish staging and stockpile areas.
- Implement a spill control plan and identify fueling areas.
- Install site dewatering system (pumping wells, manifold piping, and discharge structure).
- Install temporary utilities (e.g., electric power and irrigation mains).

#### 7.4.9.3 Outlet Channel and Weir Construction

- Install temporary sediment and erosion control measures.

- Recontour ditch at the north end of site (as needed), construct water control structure and channel connecting to the east wetland basin.
- Install erosion control matting and hydroseed open areas.
- Install control weir.

#### 7.4.9.4 East Wetland Basin and Buffer

- Clear site of brush and fence, etc.
- Strip top 12 inches of soil material and dispose off site in an approved upland disposal area.
- Start dewatering.
- Excavate east side of wetland basin.
- Mix subsoils with organic compost and stockpile; stabilize consistent with grading permit requirements.
- Complete fine grading of east side of wetland basin.
- Disc soils where compacted after grading.
- Place amended soils 12 inches deep over entire east side basin and disc into subsoils.
- Mow existing vegetation in upland buffer areas.
- Install habitat logs and snags.
- Install irrigation system in east basin; restore disturbed grades as needed.
- Install irrigation in upland buffer.
- Test irrigation system.
- Install erosion control matting as needed.
- Remove haul roads, access roads, dewatering ponds/pipes, staging areas, etc., not needed for planting of the existing wetland or west basins, return staging areas/access roads, etc. to grade.
- Apply hydroseed/mulch to east basin (wet and transition seed mixes) and upland buffer (low-grow mix) per specifications.
- Winterize irrigation system.
- Produce grading record drawings.
- After grading is complete, install plants in east basin; phase planting if necessary.
- Install plants in upland buffer and in the area between the maintenance roads and the fencing.
- Place mulch or other materials 4 to 6 inches deep around plants as a weed barrier.

#### 7.4.9.5 Preparation and Enhancement Planting of Existing Wetland and Buffer

- Mow existing vegetation in wetland and buffer.
- Disc and install irrigation in the buffer.
- Hydroseed buffer with transition seed mix.
- Install above-ground irrigation in existing wetland.
- Install additional plants in the existing wetland and surrounding buffer areas.
- Place sterile organic mulch (e.g., wood fiber) 4 to 6 inches deep between plants as a weed barrier.
- Perform maintenance mowing in areas between enhancement plantings in the existing wetland.

#### 7.4.9.6 West Wetland Basin

- Clearing (site of brush, fence, etc.)
- Strip top 12 inches of soil material and dispose off-site in an approved upland disposal area.
- Start dewatering.
- Excavate west side wetland basin.
- Mix subsoils with organic compost and stockpile; stabilize consistent with grading permit requirements.
- Complete fine grading of west side basin.
- Disc soils that are compacted by grading.
- Place amended soils 12 to 24 inches deep over entire west side basin.
- Mow existing vegetation in upland buffer areas.
- Install irrigation system and restore disturbed grades as needed.
- Test irrigation system.
- Install habitat logs.
- Install erosion control matting as needed.
- Apply hydroseed or mulch to west basin (wet and transition seed mixes) and upland buffer (low-grow seed mix) per specifications.
- Winterize irrigation system.
- Produce grading record drawing (as-built).
- After grading is complete, install plants.
- Place organic mulch (e.g., wood fiber) 4 to 6 inches deep between plants as a weed barrier.



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#### 7.4.9.7 Closeout

- Remove temporary haul/access roads.
- Remove construction equipment and debris.
- Hydroseed and/or install plants in temporary staging areas or access roads within the mitigation site boundaries.
- Hydroseed erosion control mix in temporary staging areas/access roads outside the mitigation boundaries.

#### 7.4.9.8 Record Drawings, Monitoring, and Maintenance

- Produce irrigation and plant installation record drawings (i.e., 'as-builts').
- Conduct baseline monitoring and complete baseline report including record drawings, results of baseline monitoring, and final monitoring plan (e.g., locations of monitoring plots, baseline conditions).
- Begin compliance monitoring after grading is complete; submit annual monitoring reports for 10-year monitoring period.
- Conduct maintenance (e.g., weed management) and implement any necessary contingency measures to meet performance standards.

## 7.5 MONITORING AND PERFORMACE STANDARDS

The mitigation site will be monitored for a 10-year period, with monitoring focusing on collecting the physical and biological data necessary to determine if the performance standards, and ultimately the ecological benefits of the mitigation are met (see Table 7.1-2). Monitoring reports will summarize the ecological condition of the site and document compliance with performance standards. If necessary, specific contingency actions and schedules for implementing contingency measures will be recommended. The first phase of monitoring will be to complete record drawings and a baseline monitoring report, as described below in Section 7.5.1. Section 7.5.2 describes specific monitoring activities and schedules for the mitigation site.

### 7.5.1 Record Drawings and Baseline Monitoring Report

Conditions on the mitigation site following completion of construction will be documented with record drawings and a baseline monitoring report. This report will verify that the mitigation has been constructed as designed, or to document any deviations from the plan. Any significant deviations from the mitigation design will be noted, and submitted to ACOE for approval. The baseline report will also include documentation of all sampling locations for future monitoring activity. A detailed map of the site will be prepared from field surveys, and will include the following information:

- Site topography at 1-ft contour intervals and selected spot elevations.
- Locations of major plant community boundaries.

- Locations of surface water and control structures.
- Locations of vegetation transects, photograph points, groundwater wells, staff gages, and other sampling points.

Baseline monitoring data will be collected to provide the basis for evaluating future changes on the mitigation site, consistent with the approach and methods outlined for all Port mitigation projects in Chapter 4 of this document. Results of the baseline monitoring will be compared to the established design criteria and performance standards for the mitigation site (see Table 7.1-2).

### 7.5.2 10-Year Monitoring Plan

Monitoring activities during the 10-year monitoring period will focus on the collection of vegetation, hydrology, and wildlife data to determine wetland function and performance, and compliance of the mitigation site with the performance standards. The monitoring schedule and methods for the mitigation site are summarized in Table 7.5-1.

#### 7.5.2.1 Vegetation Monitoring

Vegetation monitoring will measure establishment of native plant communities on the site. The development of native plant communities will be a key indicator of how well wetland and upland functions are being restored and enhanced by the mitigation. Vegetation is also an indicator of wildlife habitat, as well as having a significant influence on hydrologic and water quality functions.

Data describing plant species composition, density, and cover will be collected along permanent vegetation transects or within permanent plots. Walk-through surveys will be made to estimate annual shoot growth, survival rates, and vertical and horizontal vegetation structure. Photographs can provide qualitative documentation of plant community development over time by evaluating variables such as cover, species composition, height, and vertical structure. Therefore, photographs will be taken along transects and at appropriate viewpoints to document the extent and nature of plant cover. Results of the vegetation monitoring will be used to determine if performance standards for plant survival, cover, density, and species composition are met in each monitoring year.

#### 7.5.2.2 Hydrology

Data on site hydrology will be collected to evaluate the duration and extent of flooding and/or soil saturation in each wetland type on the mitigation site. Both surface and groundwater hydrology will be monitored using staff gages or groundwater monitoring wells, and field observations. Surface water levels at staff gages will be recorded monthly for the first 3 years after construction is complete, and three times per year thereafter. Permanent groundwater monitoring wells will be installed throughout the site to measure groundwater depths. Wells will be placed within existing wetlands, and at representative sites in the newly constructed forested, shrub, and emergent plant communities. Depths to the water table will be recorded monthly for the first 3 years after construction is complete, and three times per year thereafter (see Table 7.5-1).

**Table 7.5-1. Auburn Wetland Mitigation Site monitoring methods and schedule.**

| Design Objective | Performance Standard | Method | Frequency | Wetland Vegetation Zone | Data Collection Year (calculated as years after construction is complete) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Forested Wetland Vegetation | In-kind replacement ratio | Aerial photographic or ground-based mapping | May | All | X | X | X | X | | X | | X | | X | X |
| | Species composition | Walk-through surveys and vegetation sampling (plots, transects, or plotless techniques) to document all plant species present | July | All | X | X | X | X | | X | | X | | X | X |
| | Plant Survival | Vegetation sampling | July | All | | X | X | X | | | | | | | |
| | Tree and shrub density | Measure by plot sampling method along transects | July | PFO, PSS, Buffer | | | | X | | X | | X | | | X |
| | Plant growth | Walk-through surveys to estimate annual shoot growth and survival rates | July | All | X | X | X | X | | X | | X | | | X |
| | Vegetation structure | Describe from walk-through surveys, incorporating data from above analysis as available | July | All | X | X | X | X | | X | | X | | | X |
| Shrub Wetland Vegetation | In-kind replacement ratio | Aerial photographic or ground-based mapping | May | PSS | X | X | | X | | X | | | | | X |
| | Species composition | Walk-through surveys to document all plant species present by vegetation sampling (plots, transects, or plotless technique) | July | PSS | X | X | X | X | | X | | X | | | X |
| | Plant Survival | Vegetation sampling | July | All | | X | X | X | | | | | | | |
| | Shrub density | Measure by line-intercept method along transects | July | PSS | | | | X | | X | | | | | X |
| | Plant growth | Walk-through surveys to estimate annual shoot growth and survival rates | July | PSS | X | X | X | X | | X | | | | | |

**Table 7.5-1. Auburn Wetland Mitigation Site Monitoring Methods and Schedule (continued).**

| Design Objective | Performance Standard | Method | Frequency | Wetland Vegetation Zone | Data Collection Year (calculated as years after construction is complete) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | Vegetation structure | Describe from walk-through surveys, incorporating data from above analysis as available | July | PSS | X | X | X | X | | X | | X | | | X |
| Emergent Wetland Vegetation | In-kind replacement ratio | Aerial photographic or ground-based mapping | May | PEM | X | X | | X | | X | | X | | | X |
| | Species composition | Walk-through surveys to document all plant species present | July | PEM | X | X | X | X | | X | | X | | | X |
| | Herbaceous plant coverage | Measure by plot sampling method along transects | July | PEM | X | X | | X | | X | | X | | | X |
| | Plant growth | Walk-through surveys to estimate annual shoot growth and survival rates | July | PEM | X | X | X | X | | X | | | | | |
| | Vegetation structure | Describe from walk-through surveys, incorporating data from above analysis, as available | July | PEM | X | X | X | X | | X | | X | | | X |
| Wetland Hydrology | Soil saturation | Depth from the soil surface to groundwater measured at permanent sampling stations in forested, shrub, and emergent wetland zones | Monthly<br>February, June, September | PFO, PSS, PEM | X | X | X | X | X | X | X | X | X | X | X |
| | Surface water depth | Water depths measured at permanent sampling stations in shrub and emergent wetland zones | Monthly<br>February, June, September | PFO, PSS, PEM | X | X | X | X | X | X | X | X | X | X | X |
| Wildlife | Habitat structure | Analysis of hydrologic and vegetation data from forested, shrub, and emergent wetlands | February, June | PFO, PSS, PEM | X | X | X | X | | X | | X | | | X |

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Table 7.5-1. Auburn Wetland Mitigation Site Monitoring Methods and Schedule (continued).

| Design Objective | Performance Standard | Method | Frequency | Wetland Vegetation Zone | Data Collection Year (calculated as years after construction is complete) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | Description of habitat structure from walk-through surveys | February, June | PFO, PSS, PEM | X | X | X | X | | X | | X | | | X |
| | Wildlife usage | Report wildlife species and activities on-site. | January, April, June, November | All | X | X | X | X | X | X | X | X | X | X | X |
| Long-term Protection | Buffers, adjacent land uses | Description of buffer vegetation and adjacent land uses, including proximity and screening. | June | All | X | X | | | | X | | | | | X |
| | | Description of adjacent vegetation and land uses. | June | All | X | | | | | X | | | | | X |

### 7.5.2.3 Wildlife Habitat

Habitat structure (i.e. vegetation types, flooding, etc.) of the mitigation site will be monitored to evaluate whether performance standards are being met. These data will be supplemented with observations of wildlife using the site. Wildlife surveys will be conducted four times per year to record wildlife species and activities on site.[22] A variety of techniques will be used to evaluate wildlife use and wildlife habitat attributes on the site. Techniques described in Ralph and Scott (1981), Ramsey and Scott (1979), and Reynolds et al. (1980) may be used to monitor bird numbers. Techniques described in Olson et al. (1997) may be used to sample pond-breeding amphibians and Corn and Bury (1990) for terrestrial amphibians.

## 7.6 SITE PROTECTION

The Port will execute and file restrictive covenants on the Auburn wetland mitigation site to provide permanent protection for the site. Copies of the restrictive covenants are provided in Appendix F. Language and conditions of these restrictive covenants have been revised to reflect discussions between the Port and ACOE, Ecology, FAA, and USDA-WSD.

The mitigation site will be marked with permanent signs and protected by fencing. Signs will clearly mark the area as a protected wetland mitigation site. The Port will inspect and maintain the signs and fencing on a regular basis.

## 7.7 MAINTENANCE AND CONTINGENCY PLANS

### 7.7.1 Routine Maintenance

Routine maintenance tasks (e.g., maintaining irrigation system, removing trash) and adaptive management/contingency measures (e.g., weed management, replacing plants) will occur during the monitoring period. Routine weed control does not include contingency measures that may be needed to keep invasive species cover below the 10 percent cover standard. These are discussed below under contingency measures.

The mitigation site has been designed to achieve final performance standards without significant ongoing maintenance. The need for maintenance is anticipated to decline during the monitoring period, as the mitigation has been designed to be self-sustaining in the long term. Some maintenance will continue for at least as long as the 10-year monitoring period.

Typical maintenance activities will include replacing dead plants, and weed control measures. For the first year following planting, the landscape contractor will be responsible for ensuring the health of planted material and for replacing dead or severely stressed plant material. After the first year, the Port will be responsible for maintaining plants and will replace plants as needed based on

[22] Note that performance standards do not require wildlife surveys. Wildlife surveys well be conducted to provide additional information about the wetland that may be useful in making adaptive management decisions or implementing contingency measures.

performance standards and consistent with specified contingency measures. To achieve relatively rapid overstory development and structural diversity, trees will be planted closer together than would occur in natural, mature stands and may be fertilized. At the end of the 10-year monitoring period to allow better development of some trees, other trees may be cut or girdled (these would then be left as woody debris for wildlife habitat). This management activity will allow the remaining trees adequate space to reach full size, while providing additional microhabitat for animals in the downed or standing woody debris.

### 7.7.2 <u>Contingency Measures</u>

Contingency measures will be implemented consistent with the adaptive management approach if monitoring results show that specific performance standards are not being met. Specific performance standards and contingency measures for the mitigation site are given in Table 7.7-1. If conditions arise that have not been identified in this table, they will be evaluated on a case-by-case basis, and discussed with ACOE and Ecology. Based on these discussions, appropriate contingency measures will be developed and implemented.

#### 7.7.2.1 Weed Management

If needed, a variety of weed control strategies are available to manage non-native invasive species, and these weed control strategies may be used as appropriate throughout the project. Specific control measures will be determined on a case-by-case basis, depending on the extent of the invasive species problem, the invasive species of concern, and the site condition. Steps in weed control may include (listed in order of preference), any of the following:

- Dense plantings of desired species that competitively exclude non-native species
- Use of mulch in the form of sterile straw or other biodegradable mulch
- Installation of biodegradable weed barrier cloth
- Mechanical removal of weeds by using weed whackers, hoeing, or hand-removal
- Applications of EPA-approved herbicides, as necessary

Reed canarygrass is present in wetland areas on and adjacent to the mitigation site, and this undesirable species could spread into mitigation wetlands via seed dispersal. To control the spread of reed canarygrass and to ensure the success of native plant establishment, contingency measures as well as routine maintenance actions may be required. Potential control measures include periodic mowing, reseeding with native wetland grasses, and/or treatment with an EPA-approved herbicide.

Because of the planting approach taken (hydroseeding, densely planting fast growing species, and very wet emergent areas), the need for long-term control of reed canarygrass on the site is not anticipated. The dense planting of forested vegetation, including a significant conifer component, will provide dense shade over much of the site. Shade from the forest canopy will greatly reduce the likelihood that reed canarygrass can persist on the site over the long term. The emergent wetlands are designed to be too wet for this species, and it is unlikely to out-compete native wetland plants once they are established in the emergent zone. Hydroseeding at the time of construction should also limit the ability of reed canarygrass to become established.

Table 7.7-1. Final performance standards, evaluation approach, and contingency measures for the Auburn wetland mitigation project.

| Design Criteria | Performance Standard[1] | Evaluation Approach | Contingency Measures |
|---|---|---|---|
| Use a perched water table to establish wetlands at the approximate final grades of:<br>**West Basin:**<br>41 ft to 38 ft in emergent wetlands<br>42 ft to 41 ft in shrub wetlands<br>45 ft to 42 ft in forested wetlands<br>Below 38 ft in open-water wetland<br>**East Basin:**<br>42 ft to 44 ft in emergent wetlands<br>44 ft to 46 ft in shrub wetlands<br>46 ft to 49 ft in forested wetlands<br>Below 42 ft in open-water wetland | Wetland areas will meet the following hydrology criteria:<br>In forested areas, soils will be saturated within the upper 12 inches for a minimum of 2 weeks during the growing season.<br>In shrub areas, soils will be saturated within the upper 6 inches for a minimum of 2 weeks during the growing season.<br>In emergent zones, soils will be saturated to the soil surface for 6 months. | Measure hydrology using ground water monitoring wells and staff gages. | Minor regrading if necessary<br>Modify surface drainage features or control elevations of drainage channels. |
| Plant five forested wetland plant associations that are similar in composition to naturally occurring plant associations. Use native deciduous and evergreen species such as black cottonwood, Oregon ash, red alder, western redcedar, and Sitka spruce.<br>Forested communities will have a native shrub understory with species such as salmonberry, twinberry, red-osier dogwood, red elderberry, willows, and vine maple. | Forested wetlands will achieve cover at least 36 acres of the mitigation site.<br>Native upland forest habitat will be established on approximately 16 acres of the mitigation site.<br>Native tree and shrub species in the forested wetlands will be in a healthy, vigorous growing condition. | Measured using record surveys, vegetation monitoring, and mapping.<br>Verify areas available for vegetation zones on completion of grading and prior to planting. | Replant as necessary to achieve desired vegetation<br>Make minor adjustments to planting areas to match as-built grades and planned vegetation zones. |

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**Table 7.7-1. Final performance standards, evaluation approach, and contingency measures for the Auburn wetland mitigation project (continued).**

| Design Criteria | Performance Standard[1] | Evaluation Approach | Contingency Measures |
|---|---|---|---|
| Plant native tree species at densities greater than 280 trees per acre). Plant native shrub species in forested communities at densities greater than 1,800 plants per acre. | Forested wetlands will have at least 80% cover of native species by monitoring year 10.<br>Forested wetlands will have no more than 10% cover of non-native invasive species by monitoring year 10.<br>Average survival of planted stock will be at least 80% in the first 3 monitoring years. At this time tree species density will be at least 280 trees per acre in forested wetland areas and shrub density will be at least 1,800 individual plants per acre in areas of the forested wetland that are planted with shrubs. By the end of year 3, plant diversity in each stratum will not decrease by more than 10% from the number and type of plants installed at baseline. | Verify using record surveys and vegetation monitoring<br>Vegetation sampling (plots, transects, or plotless techniques) to determine plant mortality, density, cover, and presence of invasive species. | Replant as necessary to meet required density.<br>If standards are not met:<br>• Select species that are better adapted to existing hydrologic conditions.<br>• Install additional plant material.<br>• Install protective collars to reduce herbivore damage.<br>• Control/reduce non-native invasive species.<br>• Implement integrated weed management plan, which may include test plots to evaluate potential control methods, use of mechanical removal, manual controls (i.e., chopping, digging) mowing, mulching, biological control, and/or herbicides. |
| Plant an association of native shrub wetland species that is similar in composition to naturally occurring shrub wetlands, including species such as Pacific willow, Hooker's willow, Sitka willow, red-osier dogwood, and twinberry. | Shrub wetlands will cover at least 6.0 acres of the mitigation site. | See above. | See above. |
| Plant native shrub species at densities greater than 2,100 plants per acre. | Species composition in the shrub wetland will include at least a 5% component of each native species planted.<br>Native shrub species will be in a healthy, vigorous growing condition. | See above. | See above. |

Table 7.7-1. Final performance standards, evaluation approach, and contingency measures for the Auburn wetland mitigation project (continued).

| Design Criteria | Performance Standard[1] | Evaluation Approach | Contingency Measures |
|---|---|---|---|
| | Average survival of planted stock will be at least 80% in the first 3 monitoring years. At this time shrub density will be at least 2,100 individual plants per acre in shrub wetland areas.<br>Canopy cover of native species will be at least 80% by monitoring year 10.<br>Shrub areas will have no more than 10% cover of non-native invasive species by monitoring year 10. By the end of year 3, plant diversity in each stratum will not decrease by more than 10% from the number and type of plants installed at baseline. | | |
| Plant an association of native emergent wetland species similar in composition to naturally occurring emergent wetlands. Use native species that are suited to seasonally and/or permanently flooded conditions, such as water parsley, hardstem bulrush, and common spike rush. | Emergent wetlands and open-water habitat will cover at least 6.8 acres of the mitigation site.<br>Native emergent wetland species will contribute at least 90% of plant cover in areas planted with emergent species by monitoring year 10. | See above. | See above. |
| Plant native emergent species in approximately 0.05-acre monotypic patches at densities greater than 10,000 plants per acre (approximately 24 inches on-center). | Species composition (stem density or percent composition) in the emergent wetland will include at least a 5% component of each native species planted.<br>Cover of native species will be at least 80% by monitoring year 10.<br>Emergent areas will have no more than 10% cover of non-native invasive | See above. | See above. |

**Table 7.7-1. Final performance standards, evaluation approach, and contingency measures for the Auburn wetland mitigation project (continued).**

| Design Criteria | Performance Standard[1] | Evaluation Approach | Contingency Measures |
|---|---|---|---|
| | species by monitoring year 10. By the end of year 3, plant diversity in each stratum will not decrease by more than 10% from the number and type of plants installed at baseline. | | |
| Establish an approximately 100-ft-wide forested buffer around the perimeter of the mitigation site | An approximately 100-ft-wide buffer will extend around the perimeter of the site.<br>The buffer will be densely planted with native trees and shrubs to provide site protection and discourage access to the site by people or domestic animals.<br>Average survival of planted stock in the buffer will be at least 80% in the first 3 monitoring years.<br>Canopy cover of native species in the buffer will be at least 80% by monitoring year 10.<br>Canopy cover of non-native invasive species will be no more than 10% by monitoring year 10. | See above. | See above. |
| Provide year-round shallow water with patches of emergent vegetation as feeding habitat for dabbling duck species. | Permanently flooded emergent wetlands will have shallow-water habitat (<12 inches deep) near the edges, with emergent vegetation and bottom detritus interspersed throughout. | Hydrologic monitoring and vegetation surveys. | Replant or minor regrading as necessary. |
| Provide ponded water areas for water resting habitat. | Ponded water at least 26 inches deep will occur in open areas of at least 1 acre from December through May. | Hydrologic monitoring. | Minor regrading as necessary. |

Table 7.7-1. **Final performance standards, evaluation approach, and contingency measures for the Auburn wetland mitigation project (continued).**

| Design Criteria | Performance Standard[1] | Evaluation Approach | Contingency Measures |
|---|---|---|---|
| Plant forested wetland adjacent to shrub, emergent, and open-water habitats. | Perch sites in the forested canopy will overhang emergent wetland areas. | Vegetation monitoring, site mapping. | Replant as necessary. |
| Plant portions of the forested wetland with shrub understory species to provide a multiple-layered canopy adjacent to the shrub portion of the wetland. | Forested wetlands will have a shrub understory of approximately 1,800 individual plants per acre over 25% to 50% of the area, depending on the planting zone. | | |
| | Evidence of songbird nesting (nest, breeding territories, or observations of breeding behavior) will be present. | Seasonal surveys for wildlife. | |
| LWD (stumps and logs of native species) placed throughout the forested wetland to provide year-round cover for small mammals. | LWD placed at densities of 50 pieces per acre (approximately 25 ft on-center). | As-built surveys for wood placement and topography. | Supplement with more wood as necessary. |
| Low hummocks constructed in the shrub wetland areas to provide non-saturated soils for burrowing small mammals. | Shrub hummocks (with a minimum area of 150 $ft^2$ at elevation 43 ft) at least 4 per acre in the shrub zone. | | |
| | Leaf litter and vegetative debris will be present to provide habitat for invertebrates. | Vegetation surveys. | |
| | Evidence of small mammal use (nests, feeding signs, observations) will be present. | Wildlife surveys. | |
| Provide attachment substrate for breeding amphibian species in areas of ponded water. | At least 50% of live and dead stems in ponded emergent wetland areas will be species with stem diameters less than 0.25 inch. | Vegetation surveys. | Replant as necessary. |
| | Evidence of amphibian breeding (egg masses, larval stages) will be present. | Amphibian surveys during the breeding season. | |

**Table 7.7-1. Final performance standards, evaluation approach, and contingency measures for the Auburn wetland mitigation project (continued).**

| Design Criteria | Performance Standard[1] | Evaluation Approach | Contingency Measures |
|---|---|---|---|
| Screen the wetland from off-site areas. | Forest and shrub buffers (100-ft-wide) screen the site. | Vegetation surveys. | Replant as necessary. |
| Enhance habitat functions of existing wetland. | Plant sections of the existing wetland with native trees and shrubs at densities of at least 2,100 individual plants per acre for shrubs and at least 280 stems per acre for native tree | Vegetation sampling (plots, transects, or plotless techniques) to determine plant mortality, density, cover, and presence of invasive species. | If standards are not met:<br>• Select species that are better adapted to existing hydrologic conditions.<br>• Install additional plant material.<br>• Install protective collars to reduce herbivore damage.<br>• Control/reduce non-native invasive species.<br>• Implement integrated weed management plan, which may include test plots to evaluate potential control methods, use of mechanical removal, manual controls (i.e., chopping, digging) mowing, mulching, biological control, and/or herbicides |

[1] All hydrologic criteria (water depths, soil saturation, etc.) must be met during years of normal rainfall, which is considered to be years when rainfall amounts are statistically similar to the long term average 9p>0.10).

#### 7.7.2.2 Reducing Herbivore Damage

Vegetation at newly planted mitigation sites can be vulnerable to browse by Canada geese, deer, voles, beaver, and other wildlife species. In order to avoid significant loss of planted species, a number of contingency measures may be necessary. Stem collars may be installed around the base of woody species or netting may be placed over some plantings. A combination of cayenne pepper and pruning wax applied to woody stems has been an effective deterrent to herbivory at the Auburn Race Track mitigation site and may be used here. These and other contingency measures may be employed on a case-by-case basis.

### 7.7.3 Performance Standards

In addition to overall goals and objectives, specific design criteria and performance standards (see Table 7.1-2) were developed to achieve the established wetland mitigation goals. Performance standards are measurable criteria that can be evaluated to demonstrate when a mitigation element has been successfully implemented. Performance standards were developed for each design objective (see Table 7.1-2). During the monitoring period, these performance standards will be evaluated to determine the need for contingency or adaptive management actions. At the end of the monitoring period, performance standards will be used to determine if the project has successfully met design objectives and goals.

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Appendices

APPENDICES A THROUGH E

DESIGN DRAWINGS
(UNDER SEPARATE COVER)

# APPENDIX F

# RESTRICTIVE COVENANTS

**DRAFT**
10/30/00

RECORDED AT THE REQUEST OF
AND AFTER RECORDING RETURN TO:

________________________________
________________________________
________________________________
________________________________

# DECLARATION OF RESTRICTIVE COVENANTS
## (Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area)

Grantor: Port of Seattle, a Washington municipal corporation

Grantees: Port of Seattle, a Washington municipal corporation

Legal Description: ________________________________________
Official legal description attached on Exhibit A.

Assessor's Tax Parcel ID#: ________________________

Reference # (If applicable): N/A

This Declaration of Restrictive Covenants (this "Declaration") is made as of this _________ day of _________________________, ____, by the Port of Seattle, a Washington municipal corporation (the "Port") as required by the Washington State Department of Ecology ("Ecology") Order number _______________ and the Seattle District Office of the U.S. Army Corps of Engineers ("Corps") Section 404 Permit Number _____________, each more particularly described in Recital C, below.

## RECITALS

A. The Port is the owner of those certain real properties located in King County, Washington and described as follows: (i) the real property adjacent to or near Miller Creek (the "Miller Creek Mitigation Area"); (ii) the real property adjacent to or near Miller Creek, Lora Lake, and the former Vacca Farm (the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area"); (iii) the real property adjacent to or near the Tyee Valley Golf Course property (the "Tyee Valley Golf Course Mitigation Area"); (iv) the real property comprising approximately 67-acres located in the City of Auburn (the "Auburn Wetland Mitigation Area"); (v) the real property adjacent to or near Des Moines Creek (the "Des Moines Creek Mitigation Area"); and (vi) the real property at and adjacent to the Tyee Detention Pond (the "Tyee Detention Pond Area") (collectively, the "Miller Creek Mitigation Area," the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area," the "Tyee Valley Golf Course Mitigation Area," the "Des Moines Creek Mitigation Area," the "Tyee Detention Pond Area," and the "Auburn Wetland Mitigation Area" are referred to herein as the "Mitigation Sites"). This Declaration relates to the Miller Creek/Lora Lake/Vacca Farm Mitigation Area, which is legally described in Exhibit A attached hereto and by this reference incorporated herein.

B. In connection with the construction of a third runway and other improvements at Seattle-Tacoma International Airport, the Port proposed certain mitigation activities for the Mitigation Sites that include: stream riparian/buffer enhancements, stream baseflow augmentation, floodplain and wetland enhancement, and construction of replacement wetlands.

C. In order to comply with Ecology's Order #_____________ ("Ecology's Order"), and the Corps Section 404 Permit # _______________ ("Corps Permit"), for the Port's mitigation activities at the Mitigation Sites, the Port has executed this Declaration regarding the Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area, and has executed similar Declarations for the other Mitigation Sites, to submit the Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area to the covenants, conditions, and restrictions herein.

NOW, THEREFORE:

1. Declaration. The Port hereby declares that the Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area (hereinafter, the "Mitigation Area") shall be subject to the covenants, conditions, and restrictions stated herein which shall be binding on all parties having any right, title, or interest in the Mitigation Area or any part thereof and shall inure to the benefit of each subsequent owner thereof.

2. Purpose. The purpose of this Declaration is to meet the requirements of the federal Clean Water Act and state water quality standards as set forth in Ecology's Order and the Corps Permit, and to restrict development and construction activities within the Mitigation Area.

3. Restrictive Covenants. The Mitigation Area shall be used as a floodplain, wetlands, flood storage areas, and/or riparian corridors, and no development activity including clearing, grading, filling, or the construction of any building, structure, or other improvement shall occur in the Mitigation Area, except for the following:

a. Activities authorized in the Corps/Ecology-approved Natural Resource Mitigation Plan to construct and establish the mitigation. Existing uses in the Mitigation Area may continue until the uses are removed or halted during construction of the mitigation.

b. Wildlife management control actions pursuant to and governed by the current Wildlife Hazard Management Plan or any subsequent version of the Plan adopted by the Port in cooperation with the U.S. Department of Agriculture's Wildlife Services Program and the Federal Aviation Administration pursuant to Title 14 of the Code of Federal Regulations (Section 139.337). Prior to the adoption of any subsequent version of the Plan, the Plan shall be submitted to the Corps and Ecology for review and comment regarding potential impacts on the Mitigation Area. If during review and comment, the Corps or Ecology identifies any impacts to the functions and values of the Mitigation Area, the Port shall within 60 days submit to the Corps and Ecology a conceptual plan that compensates for the identified impacts and, within 90 days following Corps and Ecology approval of the conceptual plan, submit for approval a final compensation plan.

c. Monitoring, maintenance, and contingency actions pursuant to Ecology's Order and the Corps Permit, including but not limited to removal of exotic, non-native, invasive vegetation to satisfy the mitigation performance standards.

d. Construction of stormwater drainage channels as authorized in writing by the Corps and Ecology, and maintenance of those channels.

e. Installation of guy-wires and anchors (to support navigation light towers outside the Mitigation Area) and maintenance of the guy-wires and anchors.

f. Continuation, including maintenance and reconstruction, of the existing underground sanitary sewer trunk line, owned and operated by the Southwest Suburban Sewer District or its successor; and partial relocation of this line as authorized in writing by the Corps and Ecology.

g. Installation of water and air quality monitoring equipment as authorized in writing by the Corps and Ecology, and maintenance of the equipment.

h. Continuation, including maintenance and reconstruction, of the existing electrical power line owned and operated by Seattle City Light or its successor.

i. Vegetation height control to maintain FAA required approach slopes and radar coverage.

j. Removal of trees that a certified arborist has recommended be removed to prevent a hazard to persons or property. The Port shall replant areas where trees are removed, as necessary to maintain consistency with the Corps/Ecology-approved Natural Resources Mitigation Plan.

k. Other activities authorized in writing by the Corps and Ecology.

Following any activity in the Mitigation Area, as authorized above, the Port shall restore the Mitigation Area to the condition contemplated in the Corps/Ecology-approved Natural Resource Mitigation Plan (except for any authorized structure or use that will remain in the Mitigation Area).

4. Default; Remedies. Any violation of a covenant or condition in this Declaration shall be considered a violation of Ecology's Order and the Corps Permit, and this Declaration may be enforced pursuant to the terms of Ecology's Order and the Corps Permit.

5. Binding Effect. The Declaration shall run with the land and be binding upon the Port and its successors and assigns.

6. Captions. The captions and paragraph headings contained in this Declaration are for convenience and reference only and in no way define, describe, extend, or limit the scope or intent of this Declaration, nor the intent of any provision hereof.

7. Recording. This Declaration shall be recorded in the real property records of King County.

8. No Third Party Rights. Nothing in this Declaration, express or implied, is intended to confer upon any person, other than the Port and its successors and assigns any rights or remedies under or by reason of this Declaration; provided that this Declaration may be enforced by the Corps or Ecology as described herein.

9. Governing Law. This Declaration shall be governed by and construed in accordance with the laws of the state of Washington.

EXECUTED AND EFFECTIVE as of the date first written above.

PORT OF SEATTLE, a Washington municipal corporation

By: ______________________________
Name: ______________________________
Its: ______________________________

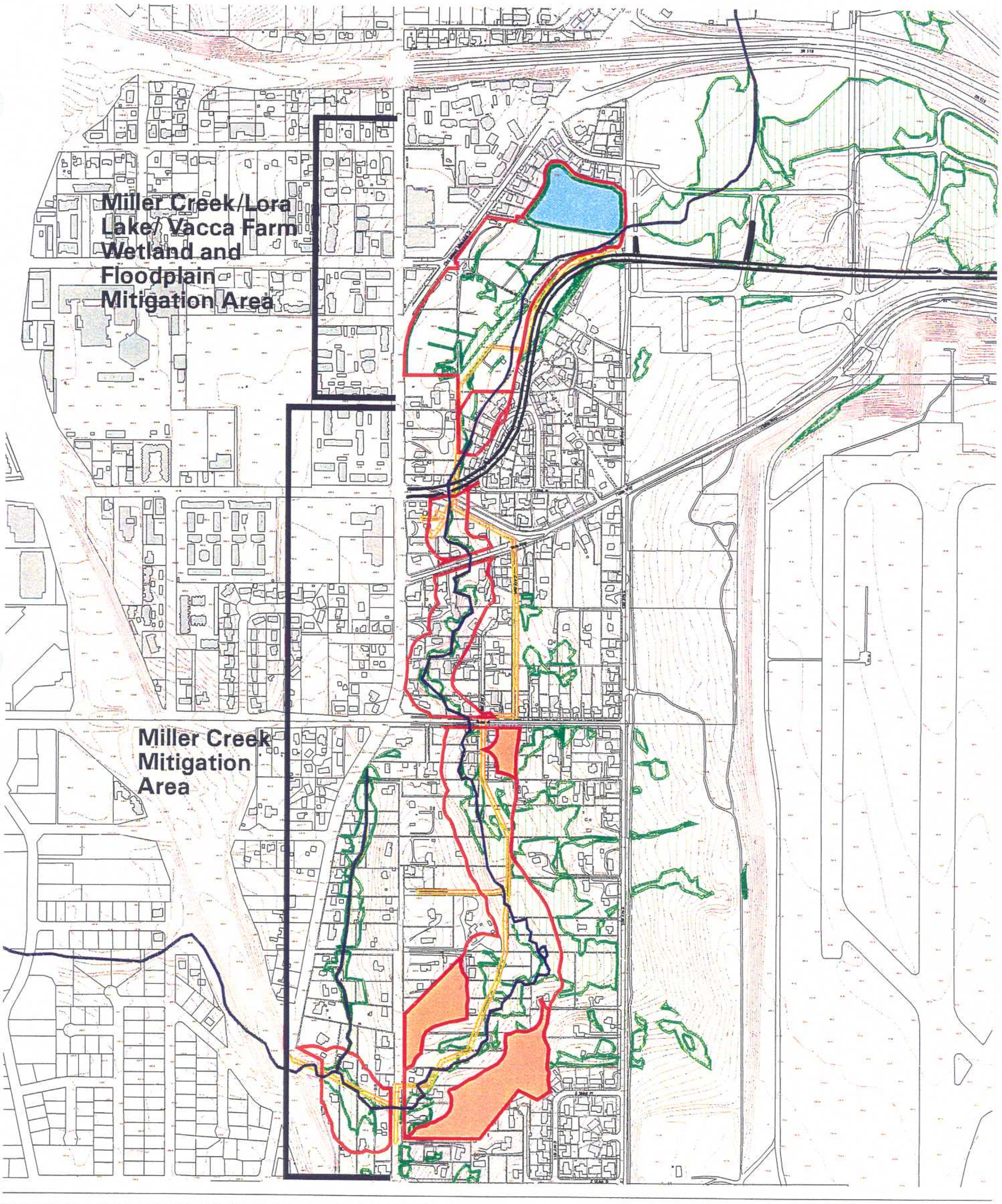
STATE OF WASHINGTON )
) ss.
COUNTY OF _______________ )

I certify that I know or have satisfactory evidence that ________________________ signed this instrument, on oath stated that he was authorized to execute the instrument and acknowledged it as the ______________________ of the Port of Seattle, a Washington municipal corporation, to be the free and voluntary act of such municipal corporation for the uses and purposes mentioned in the instrument.

Dated this ________ day of _________________________, _____.

______________________________________
(Signature of Notary)

______________________________________
(Legibly Print or Stamp Name of Notary)
Notary public in and for the state of
Washington, residing at __________________
My appointment expires: __________________

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Surveyed wetland boundary
Restrictive Covenant Area
Buffer Averaging Area
Miller Creek
20' Sewer Line Easement
Contour Lines

**Location of Miller Creek / Lora Lake / Vacca Farm Wetland and Floodplain Mitigation Area Restrictive Covenants**

**AR 010016**

**DRAFT**
10/30/00

RECORDED AT THE REQUEST OF
AND AFTER RECORDING RETURN TO:

________________________________________
________________________________________
________________________________________
________________________________________

# DECLARATION OF RESTRICTIVE COVENANTS
## (Miller Creek Mitigation Area)

Grantor: Port of Seattle, a Washington municipal corporation

Grantees: Port of Seattle, a Washington municipal corporation

Legal Description: ________________________________________
Official legal description attached on Exhibit A.

Assessor's Tax Parcel ID#: __________________________

Reference # (If applicable): N/A

This Declaration of Restrictive Covenants (this "Declaration") is made as of this _________ day of _________________________, ____, by the Port of Seattle, a Washington municipal corporation (the "Port") as required by the Washington State Department of Ecology ("Ecology") Order number ______________ and the Seattle District Office of the U.S. Army Corps of Engineers ("Corps") Section 404 Permit Number __________, each as more particularly described in Recital C, below.

## RECITALS

A. The Port is the owner of those certain real properties located in King County, Washington and described as follows: (i) the real property adjacent to or near Miller Creek (the "Miller Creek Mitigation Area"); (ii) the real property adjacent to or near Miller Creek, Lora Lake, and the former Vacca Farm (the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area"); (iii) the real property adjacent to or near the Tyee Valley Golf Course property (the "Tyee Valley Golf Course Mitigation Area"); (iv) the real property comprising approximately 67-acres located in the City of Auburn (the "Auburn Wetland Mitigation Area"); (v) the real property adjacent to or near Des Moines Creek (the "Des Moines Creek Mitigation Area"); and (vi) the real property at and adjacent to the Tyee Detention Pond (the "Tyee Detention Pond Area") (collectively, the "Miller Creek Mitigation Area," the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area," the "Tyee Valley Golf Course Mitigation Area," the "Des Moines Creek Mitigation Area," the "Tyee Detention Pond Area," and the "Auburn Wetland Mitigation Area" are referred to herein as the "Mitigation Sites"). This Declaration relates to the Miller Creek Mitigation Area, which is legally described in <u>Exhibit A</u> attached hereto and by this reference incorporated herein.

B. In connection with the construction of a third runway and other improvements at Seattle-Tacoma International Airport, the Port proposed certain mitigation activities for the Mitigation Sites that include: stream riparian/buffer enhancements, stream baseflow augmentation, floodplain and wetland enhancement, and construction of replacement wetlands.

C. In order to comply with Ecology's Order #____________ ("Ecology's Order"), and the Corps Section 404 Permit # ___________ ("Corps Permit"), for the Port's mitigation activities at the Mitigation Sites, the Port has executed this Declaration regarding the Miller Creek Mitigation Area, and has executed similar Declarations for the other Mitigation Sites, to submit the Miller Creek Mitigation Area to the covenants, conditions, and restrictions herein.

NOW, THEREFORE:

1. <u>Declaration</u>. The Port hereby declares that the Miller Creek Mitigation Area (hereinafter, the "Mitigation Area") shall be subject to the covenants, conditions, and restrictions stated herein which shall be binding on all parties having any right, title, or interest in the Mitigation Area or any part thereof and shall inure to the benefit of each subsequent owner thereof.

2. Purpose. The purpose of this Declaration is to meet the requirements of the federal Clean Water Act and state water quality standards as set forth in Ecology's Order and the Corps Permit, and to restrict development and construction activities within the Mitigation Area.

3. Restrictive Covenants. The Mitigation Area shall be used as a natural vegetative buffer, and no development activity including clearing, grading, filling, or the construction of any building, structure, or other improvement shall occur in the Mitigation Area, except for the following:

   a. Activities authorized in the Corps/Ecology-approved Natural Resource Mitigation Plan to construct and establish the mitigation. Existing uses in the Mitigation Area may continue until the uses are removed or halted during construction of the mitigation.

   b. Wildlife management control actions pursuant to and governed by the current Wildlife Hazard Management Plan or any subsequent version of the Plan adopted by the Port in cooperation with the U.S. Department of Agriculture's Wildlife Services Program and the Federal Aviation Administration pursuant to Title 14 of the Code of Federal Regulations (Section 139.337). Prior to the adoption of any subsequent version of the Plan, the Plan shall be submitted to the Corps and Ecology for review and comment regarding potential impacts on the Mitigation Area. If during review and comment, the Corps or Ecology identifies any impacts to the functions and values of the Mitigation Area, the Port shall within 60 days submit to the Corps and Ecology a conceptual plan that compensates for the identified impacts and, within 90 days following Corps and Ecology approval of the conceptual plan, submit for approval a final compensation plan.

   c. Monitoring, maintenance, and contingency actions pursuant to Ecology's Order and the Corps Permit, including but not limited to removal of exotic, non-native, invasive vegetation to satisfy the mitigation performance standards.

   d. Construction of stormwater drainage channels as authorized in writing by the Corps and Ecology, and maintenance of those channels.

   e. Continuation, including maintenance and reconstruction, of the existing underground sanitary sewer trunk line, owned and operated by the Southwest Suburban Sewer District or its successor; and partial relocation of this line as authorized in writing by the Corps and Ecology.

f. Installation of water and air quality monitoring equipment as authorized in writing by the Corps and Ecology, and maintenance of the equipment.

g. Vegetation height control to maintain FAA required approach slopes and radar coverage.

h. Removal of trees that a certified arborist has recommended be removed to prevent a hazard to persons or property. The Port shall replant areas where trees are removed, as necessary to maintain consistency with the Corps/Ecology-approved Natural Resources Mitigation Plan.

i. Other activities authorized in writing by the Corps and Ecology.

Following any activity in the Mitigation Area, as authorized above, the Port shall restore the Mitigation Area to the condition contemplated in the Corps/Ecology-approved Natural Resource Mitigation Plan (except for any authorized structure or use that will remain in the Mitigation Area).

4. Default; Remedies. Any violation of a covenant or condition in this Declaration shall be considered a violation of Ecology's Order and the Corps Permit, and this Declaration may be enforced pursuant to the terms of Ecology's Order and the Corps Permit.

5. Binding Effect. The Declaration shall run with the land and be binding upon the Port and its successors and assigns.

6. Captions. The captions and paragraph headings contained in this Declaration are for convenience and reference only and in no way define, describe, extend, or limit the scope or intent of this Declaration, nor the intent of any provision hereof.

7. Recording. This Declaration shall be recorded in the real property records of King County.

8. No Third Party Rights. Nothing in this Declaration, express or implied, is intended to confer upon any person, other than the Port and its successors and assigns any rights or remedies under or by reason of this Declaration; provided that this Declaration may be enforced by the Corps or Ecology as described herein.

9. Governing Law. This Declaration shall be governed by and construed in accordance with the laws of the state of Washington.

EXECUTED AND EFFECTIVE as of the date first written above.

PORT OF SEATTLE, a Washington municipal corporation

By: ______________________________
Name: ______________________________
Its: ______________________________

STATE OF WASHINGTON )
) ss.
COUNTY OF ______________ )

I certify that I know or have satisfactory evidence that ______________________ signed this instrument, on oath stated that he was authorized to execute the instrument and acknowledged it as the ______________________ of the Port of Seattle, a Washington municipal corporation, to be the free and voluntary act of such municipal corporation for the uses and purposes mentioned in the instrument.

Dated this ________ day of ________________________, ____.

______________________________
(Signature of Notary)

______________________________
(Legibly Print or Stamp Name of Notary)
Notary public in and for the state of
Washington, residing at ______________
My appointment expires: ______________

**DRAFT**
10/30/00

RECORDED AT THE REQUEST OF
AND AFTER RECORDING RETURN TO:

______________________________
______________________________
______________________________
______________________________

**DECLARATION OF RESTRICTIVE COVENANTS**
**(Tyee Valley Golf Course Mitigation Area)**

| | |
|---|---|
| Grantor: | Port of Seattle, a Washington municipal corporation |
| Grantees: | Port of Seattle, a Washington municipal corporation |
| Legal Description: | ______________________________<br>Official legal description attached on Exhibit A. |
| Assessor's Tax Parcel ID#: | ____________________ |
| Reference # (If applicable): | N/A |

This Declaration of Restrictive Covenants (this "Declaration") is made as of this ________ day of ______________________, _____, by the Port of Seattle, a Washington municipal corporation (the "Port") as required by the Washington State Department of Ecology ("Ecology") Order number _____________ and the Seattle District Office of the U.S. Army Corps of Engineers ("Corps) Section 404 Permit Number _________, each as more particularly described in Recital C, below.

## RECITALS

A. The Port is the owner of those certain real properties located in King County, Washington and described as follows: (i) the real property adjacent to or near Miller Creek (the "Miller Creek Mitigation Area"); (ii) the real property adjacent to or near Miller Creek, Lora Lake, and the former Vacca Farm (the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area"); (iii) the real property adjacent to or near the Tyee Valley Golf Course property (the "Tyee Valley Golf Course Mitigation Area"); (iv) the real property comprising approximately 67-acres located in the City of Auburn (the "Auburn Wetland Mitigation Area"); (v) the real property adjacent to or near Des Moines Creek (the "Des Moines Creek Mitigation Area"); and (vi) the real property at and adjacent to the Tyee Detention Pond (the "Tyee Detention Pond Area") (collectively, the "Miller Creek Mitigation Area," the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area," the "Tyee Valley Golf Course Mitigation Area," the "Des Moines Creek Mitigation Area," the "Tyee Detention Pond Area," and the "Auburn Wetland Mitigation Area" are referred to herein as the "Mitigation Sites"). This Declaration relates to the Tyee Valley Golf Course Mitigation Area, which is legally described in Exhibit A attached hereto and by this reference incorporated herein.

B. In connection with the construction of a third runway and other improvements at Seattle-Tacoma International Airport, the Port proposed certain mitigation activities for the Mitigation Sites that include: stream riparian/buffer enhancements, stream baseflow augmentation, floodplain and wetland enhancement, and construction of replacement wetlands.

C. In order to comply with Ecology's Order #_____________ ("Ecology's Order"), and the Corps Section 404 Permit # _________________ ("Corps Permit"), for the Port's mitigation activities at the Mitigation Sites, the Port has executed this Declaration regarding the Tyee Valley Golf Course Mitigation Area, and has executed similar Declarations for the other Mitigation Sites, to submit the Tyee Valley Golf Course Mitigation Area to the covenants, conditions, and restrictions herein.

NOW, THEREFORE:

1. Declaration. The Port hereby declares that the Tyee Valley Golf Course Mitigation Area (hereinafter, the "Mitigation Area") shall be subject to the covenants, conditions, and restrictions stated herein which shall be binding on all parties having any right, title, or interest in the Mitigation Area or any part thereof and shall inure to the benefit of each subsequent owner thereof.

2. Purpose. The purpose of this Declaration is to meet the requirements of the federal Clean Water Act and state water quality standards as set forth in Ecology's Order and the Corps Permit, and to restrict development and construction activities within the Mitigation Area.

3. Restrictive Covenants. The Mitigation Area shall be used as a natural wetland area, and no development activity including clearing, grading, filling, or the construction of any building, structure, or other improvement shall occur in the Mitigation Area, except for the following:

a. Activities authorized in the Corps/Ecology-approved Natural Resource Mitigation Plan to construct and establish the mitigation. Existing uses in the Mitigation Area may continue until the uses are removed or halted during construction of the mitigation.

b. Wildlife management control actions pursuant to and governed by the current Wildlife Hazard Management Plan or any subsequent version of the Plan adopted by the Port in cooperation with the U.S. Department of Agriculture's Wildlife Services Program and the Federal Aviation Administration pursuant to Title 14 of the Code of Federal Regulations (Section 139.337). Prior to the adoption of any subsequent version of the Plan, the Plan shall be submitted to the Corps and Ecology for review and comment regarding potential impacts on the Mitigation Area. If during review and comment, the Corps or Ecology identifies any impacts to the functions and values of the Mitigation Area, the Port shall within 60 days submit to the Corps and Ecology a conceptual plan that compensates for the identified impacts and, within 90 days following Corps and Ecology approval of the conceptual plan, submit for approval a final compensation plan.

c. Monitoring, maintenance, and contingency actions pursuant to Ecology's Order and the Corps Permit, including but not limited to removal of exotic, non-native, invasive vegetation to satisfy the mitigation performance standards.

d. Construction of stormwater drainage channels as authorized in writing by the Corps and Ecology and maintenance of those channels.

e. Installation of water and air quality monitoring equipment as authorized in writing by the Corps and Ecology, and maintenance of the equipment.

f. Vegetation height control to maintain FAA required approach slopes and radar coverage.

g. Removal of trees that a certified arborist has recommended be removed to prevent a hazard to persons or property. The Port shall replant areas where trees are removed, as necessary to maintain consistency with the Corps/Ecology-approved Natural Resources Mitigation Plan.

h. Other activities authorized in writing by the Corps and Ecology.

Following any activity in the Mitigation Area, as authorized above, the Port shall restore the Mitigation Area to the condition contemplated in the Corps/Ecology-approved Natural Resource Mitigation Plan (except for any authorized structure or use that will remain in the Mitigation Area).

4. Default; Remedies. Any violation of a covenant or condition in this Declaration shall be considered a violation of Ecology's Order and the Corps Permit, and this Declaration may be enforced pursuant to the terms of Ecology's Order and the Corps Permit.

5. Binding Effect. The Declaration shall run with the land and be binding upon the Port and its successors and assigns.

6. Captions. The captions and paragraph headings contained in this Declaration are for convenience and reference only and in no way define, describe, extend, or limit the scope or intent of this Declaration, nor the intent of any provision hereof.

7. Recording. This Declaration shall be recorded in the real property records of King County.

8. No Third Party Rights. Nothing in this Declaration, express or implied, is intended to confer upon any person, other than the Port and its successors and assigns any rights or remedies under or by reason of this Declaration; provided that this Declaration may be enforced by the Corps or Ecology as described herein.

9. Governing Law. This Declaration shall be governed by and construed in accordance with the laws of the state of Washington.

EXECUTED AND EFFECTIVE as of the date first written above.

PORT OF SEATTLE, a Washington municipal corporation

By: ______________________________
Name: ______________________________
Its: ______________________________

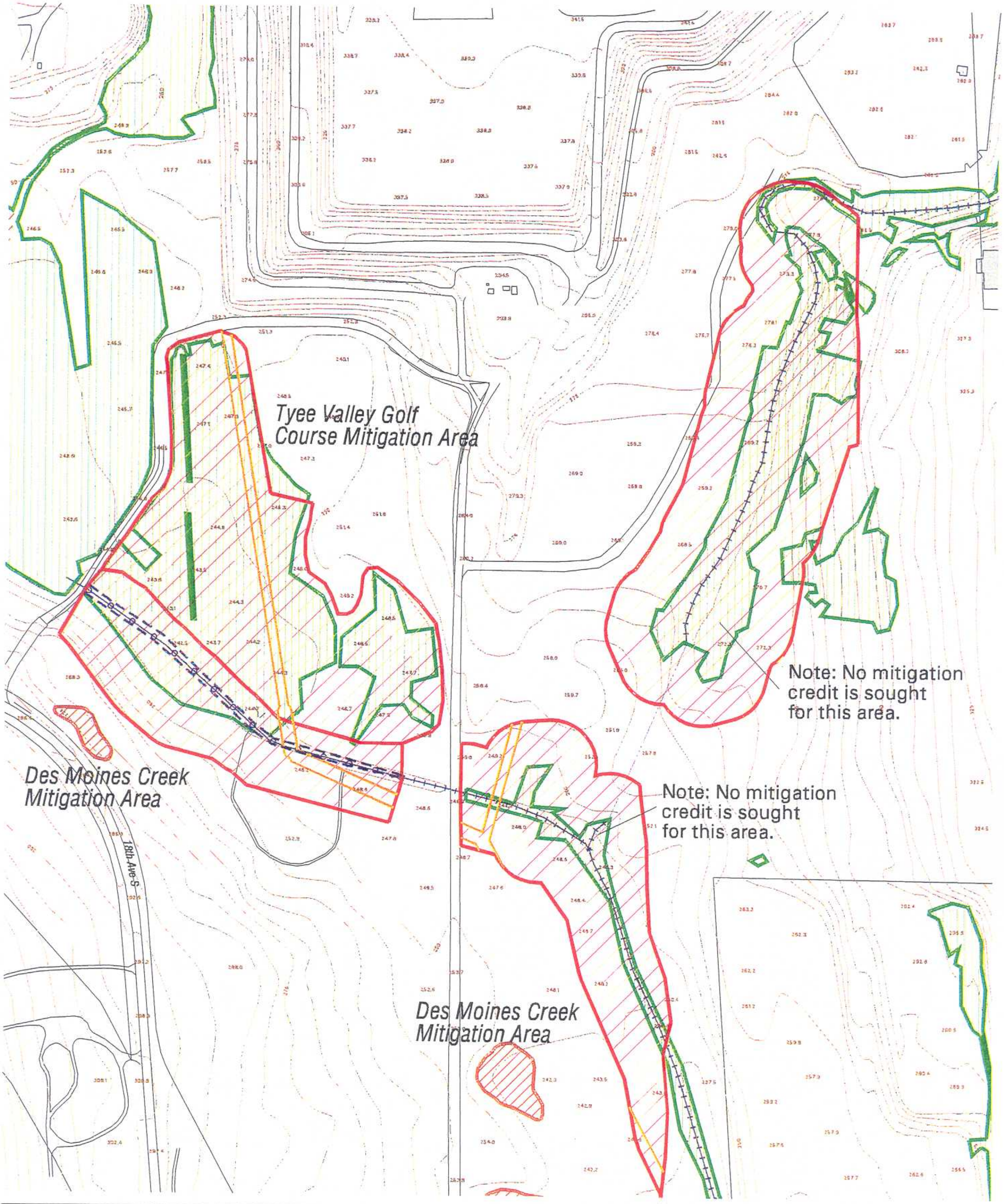
STATE OF WASHINGTON )
) ss.
COUNTY OF ______________ )

I certify that I know or have satisfactory evidence that ______________________ signed this instrument, on oath stated that he was authorized to execute the instrument and acknowledged it as the ____________________ of the Port of Seattle, a Washington municipal corporation, to be the free and voluntary act of such municipal corporation for the uses and purposes mentioned in the instrument.

Dated this ________ day of ______________________, ______.

__________________________________
(Signature of Notary)

__________________________________
(Legibly Print or Stamp Name of Notary)
Notary public in and for the state of Washington, residing at ______________
My appointment expires: ______________




Prepared by Parametrix, Inc. File: seatac2/p_8x11tyee_site.aml creating p8x11tyee_site.gra Date: December 11, 2000

N

FEET 0 200 400

Scale 1:3500

Covenant Boundary
Sewer Line Easement
Des Moines Creek (svy.)
Des Moines Creek (culvert)
Surveyed OHWM Des Moines Creek
Des Moines Creek (est.)
Surveyed Wetland Boundary
Other Wetlands Outside Project Area.

**Restrictive Covenant at the Tyee Golf Course Mitigation Area**

**DRAFT**
10/30/00

RECORDED AT THE REQUEST OF
AND AFTER RECORDING RETURN TO:

____________________________________
____________________________________
____________________________________
____________________________________

# DECLARATION OF RESTRICTIVE COVENANTS
## (Des Moines Creek Mitigation Area)

| | |
|---|---|
| Grantor: | Port of Seattle, a Washington municipal corporation |
| Grantees: | Port of Seattle, a Washington municipal corporation |
| Legal Description: | ____________________________________<br>Official legal description attached on Exhibit A. |
| Assessor's Tax Parcel ID#: | ________________________ |
| Reference # (If applicable): | N/A |

This Declaration of Restrictive Covenants (this "Declaration") is made as of this _________ day of ________________________, ____, by the Port of Seattle, a Washington municipal corporation (the "Port") as required by the Washington State Department of Ecology ("Ecology") Order number ___________________ and the Seattle District Office of the U.S. Army Corps of Engineers ("Corps") Section 404 Permit Number ___________________, each as more particularly described in Recital C, below

## RECITALS

A. The Port is the owner of those certain real properties located in King County, Washington and described as follows: (i) the real property adjacent to or near Miller Creek (the "Miller Creek Mitigation Area"); (ii) the real property adjacent to or near Miller Creek, Lora Lake, and the former Vacca Farm (the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area"); (iii) the real property adjacent to or near the Tyee Valley Golf Course property (the "Tyee Valley Golf Course Mitigation Area"); (iv) the real property comprising approximately 67-acres located in the City of Auburn (the "Auburn Wetland Mitigation Area"); (v) the real property adjacent to or near Des Moines Creek (the "Des Moines Creek Mitigation Area"); and (vi) the real property at and adjacent to the Tyee Detention Pond (the "Tyee Detention Pond Area") (collectively, the "Miller Creek Mitigation Area," the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area," the "Tyee Valley Golf Course Mitigation Area," the "Des Moines Creek Mitigation Area," the "Tyee Detention Pond Area," and the "Auburn Wetland Mitigation Area" are referred to herein as the "Mitigation Sites"). This Declaration relates to the Des Moines Creek Mitigation Area, which is legally described in <u>Exhibit A</u> attached hereto and by this reference incorporated herein.

B. In connection with the construction of a third runway and other improvements at Seattle-Tacoma International Airport, the Port proposed certain mitigation activities for the Mitigation Sites that include: stream riparian/buffer enhancements, stream baseflow augmentation, floodplain and wetland enhancement, and construction of replacement wetlands.

C. In order to comply with Ecology's Order #____________ ("Ecology's Order"), and the Corps Section 404 Permit # ____________ ("Corps Permit"), for the Port's mitigation activities at the Mitigation Sites, the Port has executed this Declaration regarding the Des Moines Creek Mitigation Area, and has executed similar Declarations for the other Mitigation Sites, to submit the Des Moines Creek Mitigation Area to the covenants, conditions, and restrictions herein.

NOW, THEREFORE:

1. <u>Declaration</u>. The Port hereby declares that the Des Moines Creek Mitigation Area (hereinafter the "Mitigation Area") shall be subject to the covenants, conditions, and restrictions stated herein which shall be binding on all parties having any right, title, or interest in the Mitigation Area or any part thereof and shall inure to the benefit of each subsequent owner thereof.

2. Purpose. The purpose of this Declaration is to meet the requirements of the federal Clean Water Act and state water quality standards as set forth in Ecology's Order and the Corps Permit, and to restrict development and construction activities within the Mitigation Area.

3. Restrictive Covenants. The Mitigation Area shall be a setback area adjacent to the creek, and no development activity including clearing, grading, filling, or the construction of any building, structure, or other improvement shall occur in the Mitigation Area, except for the following:

a. Activities authorized in the Corps/Ecology-approved Natural Resource Mitigation Plan.

b. Wildlife management control actions pursuant to and governed by the current Wildlife Hazard Management Plan or any subsequent version of the Plan adopted by the Port in cooperation with the U.S. Department of Agriculture's Wildlife Services Program and the Federal Aviation Administration pursuant to Title 14 of the Code of Federal Regulations (Section 139.337). Prior to the adoption of any subsequent version of the Plan, the Plan shall be submitted to the Corps and Ecology for review and comment regarding potential impacts on the Mitigation Area. If during review and comment, the Corps or Ecology identifies any impacts to the functions and values of the Mitigation Area, the Port shall within 60 days submit to the Corps and Ecology a conceptual plan that compensates for the identified impacts and, within 90 days following Corps and Ecology approval of the conceptual plan, submit for approval a final compensation plan.

c. Monitoring, maintenance, and contingency actions pursuant to Ecology's Order and the Corps Permit.

d. Construction of stormwater drainage channels as authorized in writing by the Corps and Ecology, and maintenance of those channels.

e. Installation of water and air quality monitoring equipment as authorized in writing by the Corps and Ecology, and maintenance of the equipment.

f. Vegetation height control to maintain FAA required approach slopes and radar coverage.

g. Removal of trees that a certified arborist has recommended be removed to prevent a hazard to persons or property. The Port shall replant areas where trees are removed, as necessary to maintain consistency with the Corps/Ecology-approved Natural Resources Mitigation Plan.

h. Continuation, including maintenance and reconstruction, of the existing underground sewer line owned and operated by the Port.

i. Construction of a water supply pipeline and associated facilities for Des Moines Creek flow augmentation as authorized in writing by the Corps and Ecology, and maintenance of the pipeline and facilities.

j. Activities to implement the Des Moines Creek Basin Plan as authorized in writing by the Corps and Ecology.

k. Construction of a new roadway to the airport (known as "South Access") as authorized in writing by the Corps and Ecology, and maintenance of the roadway.

l. Other activities authorized in writing by the Corps and Ecology.

Following any activity in the Mitigation Area, as authorized above, the Port shall restore the Mitigation Area to the condition contemplated in the Corps/Ecology-approved Natural Resource Mitigation Plan (except for any authorized structure or use that will remain in the Mitigation Area).

4. Default; Remedies. Any violation of a covenant or condition in this Declaration shall be considered a violation of Ecology's Order and the Corps Permit, and this Declaration may be enforced pursuant to the terms of Ecology's Order and the Corps Permit.

5. Binding Effect. The Declaration shall run with the land and be binding upon the Port and its successors and assigns.

6. Captions. The captions and paragraph headings contained in this Declaration are for convenience and reference only and in no way define, describe, extend, or limit the scope or intent of this Declaration, nor the intent of any provision hereof.

7. Recording. This Declaration shall be recorded in the real property records of King County.

8. No Third Party Rights. Nothing in this Declaration, express or implied, is intended to confer upon any person, other than the Port and its successors and assigns any rights or remedies under or by reason of this Declaration; provided that this Declaration may be enforced by the Corps or Ecology as described herein.

9. Governing Law. This Declaration shall be governed by and construed in accordance with the laws of the state of Washington.

EXECUTED AND EFFECTIVE as of the date first written above.

PORT OF SEATTLE, a Washington municipal corporation

By: ______________________________
Name: ______________________________
Its: ______________________________

STATE OF WASHINGTON )
) ss.
COUNTY OF ________________ )

I certify that I know or have satisfactory evidence that ________________________ signed this instrument, on oath stated that he was authorized to execute the instrument and acknowledged it as the ______________________ of the Port of Seattle, a Washington municipal corporation, to be the free and voluntary act of such municipal corporation for the uses and purposes mentioned in the instrument.

Dated this ________ day of _________________________, ____.

_____________________________________
(Signature of Notary)

_____________________________________
(Legibly Print or Stamp Name of Notary)
Notary public in and for the state of Washington, residing at ________________
My appointment expires:________________

**DRAFT**
10/30/00

RECORDED AT THE REQUEST OF
AND AFTER RECORDING RETURN TO:

______________________________
______________________________
______________________________
______________________________

# DECLARATION OF RESTRICTIVE COVENANTS
## (Tyee Detention Pond Area)

Grantor: Port of Seattle, a Washington municipal corporation

Grantees: Port of Seattle, a Washington municipal corporation

Legal Description: ____________________________________
Official legal description attached on Exhibit A.

Assessor's Tax Parcel ID#: ____________________

Reference # (If applicable): N/A

This Declaration of Restrictive Covenants (this "Declaration") is made as of this ________ day of _______________________, ____, by the Port of Seattle, a Washington municipal corporation (the "Port") as required by the Washington State Department of Ecology ("Ecology") Order Number __________________ and the Seattle District Office of the U.S. Army Corps of Engineers ("Corps") Section 404 Permit Number __________________, each as more particularly described in Recital C, below

## RECITALS

A. The Port is the owner of those certain real properties located in King County, Washington and described as follows: (i) the real property adjacent to or near Miller Creek (the "Miller Creek Mitigation Area"); (ii) the real property adjacent to or near Miller Creek, Lora Lake, and the former Vacca Farm (the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area"); (iii) the real property adjacent to or near the Tyee Valley Golf Course property (the "Tyee Valley Golf Course Mitigation Area"); (iv) the real property comprising approximately 67-acres located in the City of Auburn (the "Auburn Wetland Mitigation Area"); (v) the real property adjacent to or near Des Moines Creek (the "Des Moines Creek Mitigation Area"); and (vi) the real property at and adjacent to the Tyee Detention Pond (the "Tyee Detention Pond Area") (collectively, the "Miller Creek Mitigation Area," the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area," the "Tyee Valley Golf Course Mitigation Area," the "Des Moines Creek Mitigation Area," the "Tyee Detention Pond Area," and the "Auburn Wetland Mitigation Area" are referred to herein as the "Mitigation Sites"). This Declaration relates to the Tyee Detention Pond Area, which is legally described in Exhibit A attached hereto and by this reference incorporated herein.

B. In connection with the construction of a third runway and other improvements at Seattle-Tacoma International Airport, the Port proposed certain mitigation activities for the Mitigation Sites that include: stream riparian/buffer enhancements, stream baseflow augmentation, floodplain and wetland enhancement, and construction of replacement wetlands.

C. In order to comply with Ecology's Order #____________ ("Ecology's Order"), and the Corps Section 404 Permit # ____________ ("Corps Permit"), for the Port's mitigation activities at the Mitigation Sites, the Port has executed this Declaration regarding the Tyee Detention Pond Area, and has executed similar Declarations for the other Mitigation Sites, to submit the Tyee Detention Pond Area to the covenants, conditions, and restrictions herein.

NOW, THEREFORE:

1. Declaration. The Port hereby declares that the Tyee Detention Pond Area shall be subject to the covenants, conditions, and restrictions stated herein which shall be binding on all parties having any right, title, or interest in the Tyee Detention Pond Area or any part thereof and shall inure to the benefit of each subsequent owner thereof.

2. Purpose. The purpose of this Declaration is to meet the requirements of the federal Clean Water Act and state water quality standards as set forth in Ecology's Order

and the Corps Permit, and to restrict development and construction activities within the Tyee Detention Pond Area.

3. Restrictive Covenants. The Tyee Detention Pond Area shall be a stormwater detention pond, spill control facility, and adjacent buffer. No development activity including clearing, grading, filling, or the construction of any building, structure, or other improvement shall occur in the Tyee Detention Pond Area, except for the following:

a. Activities authorized in the Corps/Ecology-approved Natural Resource Mitigation Plan.

b. Wildlife management control actions pursuant to and governed by the current Wildlife Hazard Management Plan or any subsequent version of the Plan adopted by the Port in cooperation with the U.S. Department of Agriculture's Wildlife Services Program and the Federal Aviation Administration pursuant to Title 14 of the Code of Federal Regulations (Section 139.337). Prior to the adoption of any subsequent version of the Plan, the Plan shall be submitted to the Corps and Ecology for review and comment regarding potential impacts on the Tyee Detention Pond Area. If during review and comment, the Corps or Ecology identifies any impacts to the functions and values of the Tyee Detention Pond Area, the Port shall within 60 days submit to the Corps and Ecology a conceptual plan that compensates for the identified impacts and, within 90 days following Corps and Ecology approval of the conceptual plan, submit for approval a final compensation plan.

c. Monitoring, maintenance, and contingency actions pursuant to Ecology's Order and the Corps Permit.

d. Construction of stormwater drainage channels as authorized in writing by the Corps and Ecology, and maintenance of those channels.

e. Installation of water and air quality monitoring equipment as authorized in writing by the Corps and Ecology, and maintenance of the equipment.

f. Vegetation height control to maintain FAA required approach slopes and radar coverage.

g. Removal of trees that a certified arborist has recommended be removed to prevent a hazard to persons or property. The Port shall replant areas where trees are removed, as necessary to maintain consistency with the Corps/Ecology-approved Natural Resources Mitigation Plan.

h. Construction of a water supply pipeline and associated facilities for Des Moines Creek flow augmentation as authorized in writing by the Corps and Ecology, and maintenance of the pipeline and facilities.

i. Activities to implement the Des Moines Creek Basin Plan as authorized in writing by the Corps and Ecology.

j. Activities related to the operation, maintenance, and periodic reconstruction/replacement of a stormwater detention pond and hazardous material spill control facility, including but not limited to mowing, vegetation clearing, animal control, maintenance of equipment such as sensors and outlet controls, and soil remediation.

k. Construction of a new roadway to the airport (known as "South Access") as authorized in writing by the Corps and Ecology, and maintenance of the roadway.

l. Other activities authorized in writing by the Corps and Ecology.

Following any activity in the Tyee Detention Pond Area, as authorized above, the Port shall restore the Tyee Detention Pond Area to the condition contemplated in the Corps/Ecology-approved Natural Resource Mitigation Plan (except for any authorized structure or use that will remain in the Tyee Detention Pond Area).

4. Default; Remedies. Any violation of a covenant or condition in this Declaration shall be considered a violation of Ecology's Order and the Corps Permit, and this Declaration may be enforced pursuant to the terms of Ecology's Order and the Corps Permit.

5. Binding Effect. The Declaration shall run with the land and be binding upon the Port and its successors and assigns.

6. Captions. The captions and paragraph headings contained in this Declaration are for convenience and reference only and in no way define, describe, extend, or limit the scope or intent of this Declaration, nor the intent of any provision hereof.

7. Recording. This Declaration shall be recorded in the real property records of King County.

8. No Third Party Rights. Nothing in this Declaration, express or implied, is intended to confer upon any person, other than the Port and its successors and assigns any rights or remedies under or by reason of this Declaration; provided that this Declaration may be enforced by the Corps or Ecology as described herein.

9. Governing Law. This Declaration shall be governed by and construed in accordance with the laws of the state of Washington.

EXECUTED AND EFFECTIVE as of the date first written above.

PORT OF SEATTLE, a Washington municipal corporation

By: ______________________________
Name: ______________________________
Its: ______________________________

STATE OF WASHINGTON )
) ss.
COUNTY OF ______________ )

I certify that I know or have satisfactory evidence that ______________________ signed this instrument, on oath stated that he was authorized to execute the instrument and acknowledged it as the ______________________ of the Port of Seattle, a Washington municipal corporation, to be the free and voluntary act of such municipal corporation for the uses and purposes mentioned in the instrument.

Dated this ________ day of _________________________, ____.

______________________________
(Signature of Notary)

______________________________
(Legibly Print or Stamp Name of Notary)
Notary public in and for the state of
Washington, residing at ______________
My appointment expires:______________



50210850.02
Tyee Detention Pond Area

AR 010041

**DRAFT**
10/30/00

RECORDED AT THE REQUEST OF
AND AFTER RECORDING RETURN TO:

____________________________________
____________________________________
____________________________________
____________________________________

**DECLARATION OF RESTRICTIVE COVENANTS**
**(Auburn Wetland Mitigation Area)**

Grantor: Port of Seattle, a Washington municipal corporation

Grantees: Port of Seattle, a Washington municipal corporation

Legal Description: ____________________________________
Official legal description attached on Exhibit A.

Assessor's Tax Parcel ID#: ________________________

Reference # (If applicable): N/A

This Declaration of Restrictive Covenants (this "Declaration") is made as of this _________ day of ________________________, _____, by the Port of Seattle, a Washington municipal corporation (the "Port") as required by the Washington State Department of Ecology ("Ecology") Order number _______________ and the Seattle District Office of the U.S. Army Corps of Engineers ("Corps") Section 404 Permit Number ______________, each as more particularly described in Recital C, below.

## RECITALS

A. The Port is the owner of those certain real properties located in King County, Washington and described as follows: (i) the real property adjacent to or near Miller Creek (the "Miller Creek Mitigation Area"); (ii) the real property adjacent to or near Miller Creek, Lora Lake, and the former Vacca Farm (the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area"); (iii) the real property adjacent to or near the Tyee Valley Golf Course property (the "Tyee Valley Golf Course Mitigation Area"); (iv) the real property comprising approximately 67-acres located in the City of Auburn (the "Auburn Wetland Mitigation Area"); (v) the real property adjacent to or near Des Moines Creek (the "Des Moines Creek Mitigation Area"); and (vi) the real property at and adjacent to the Tyee Detention Pond (the "Tyee Detention Pond Area") (collectively, the "Miller Creek Mitigation Area," the "Miller Creek/Lora Lake/Vacca Farm Wetland and Floodplain Mitigation Area," the "Tyee Valley Golf Course Mitigation Area," the "Des Moines Creek Mitigation Area," the "Tyee Detention Pond Area," and the "Auburn Wetland Mitigation Area" are referred to herein as the "Mitigation Sites"). This Declaration relates to the Auburn Wetland Mitigation Area, which is legally described in Exhibit A attached hereto and by this reference incorporated herein.

B. In connection with the construction of a third runway and other improvements at Seattle-Tacoma International Airport, the Port proposed certain mitigation activities for the Mitigation Sites that include: stream riparian/buffer enhancements, stream baseflow augmentation, floodplain and wetland enhancement, and construction of replacement wetlands.

C. In order to comply with Ecology's Order #______________ ("Ecology's Order"), and the Corps Section 404 Permit # ____________________ ("Corps Permit"), for the Port's mitigation activities at the Mitigation Sites, the Port has executed this Declaration regarding the Auburn Wetland Mitigation Area, and has executed similar Declarations for the other Mitigation Sites, to submit the Auburn Wetland Mitigation Area to the covenants, conditions, and restrictions herein.

NOW, THEREFORE:

1. Declaration. The Port hereby declares that the Auburn Wetland Mitigation Area shall be subject to the covenants, conditions, and restrictions stated herein which shall be binding on all parties having any right, title, or interest in the Auburn Wetland Mitigation Area (hereinafter the "Mitigation Area") or any part thereof and shall inure to the benefit of each subsequent owner thereof.

2. Purpose. The purpose of this Declaration is to meet the requirements of the federal Clean Water Act and state water quality standards as set forth in Ecology's Order and the Corps Permit, and to restrict development and construction activities within the Mitigation Area.

3. Restrictive Covenants. The Mitigation Area shall be used for wetland mitigation. The Mitigation Area shall also be used for floodwater storage in flood events, but it shall not be used for stormwater management for developed areas (i.e., stormwater detention and water quality treatment). No development activity including clearing, grading, filling, or the construction of any building, structure, or other improvement shall occur in the Mitigation Area, except for the following:

a. Activities authorized in the Corps/Ecology-approved Natural Resource Mitigation Plan to construct and establish the mitigation. Existing uses in the Mitigation Area may continue until the uses are removed or halted during construction of the mitigation.

b. Activities necessary for the maintenance and effective functioning of the wetlands and buffers, including but not limited to: (i) monitoring, maintenance, and contingency actions pursuant to Ecology's Order and the Corps Permit; (ii) the removal of exotic, non-native, invasive vegetation; and (iii) maintenance of drainage channels.

c. Removal of trees that a certified arborist has recommended be removed to prevent a hazard to persons or property. The Port shall replant areas where trees are removed, as necessary to maintain consistency with the Corps/Ecology-approved Natural Resources Mitigation Plan.

d. Other activities authorized in writing by the Corps and Ecology.

Following any activity in the Mitigation Area, as authorized above, the Port shall restore the Mitigation Area to the condition contemplated in the Corps/Ecology-approved Natural Resource Mitigation Plan (except for any authorized structure or use that will remain in the Mitigation Area).

4. Default; Remedies. Any violation of a covenant or condition in this Declaration shall be considered a violation of Ecology's Order and the Corps Permit, and

this Declaration may be enforced pursuant to the terms of Ecology's Order and the Corps Permit.

5. Binding Effect. The Declaration shall run with the land and be binding upon the Port and its successors and assigns.

6. Captions. The captions and paragraph headings contained in this Declaration are for convenience and reference only and in no way define, describe, extend, or limit the scope or intent of this Declaration, nor the intent of any provision hereof.

7. Recording. This Declaration shall be recorded in the real property records of King County.

8. No Third Party Rights. Nothing in this Declaration, express or implied, is intended to confer upon any person, other than the Port and its successors and assigns, any rights or remedies under or by reason of this Declaration; provided that this Declaration may be enforced by the Corps or Ecology as described herein.

9. Governing Law. This Declaration shall be governed by and construed in accordance with the laws of the state of Washington.

EXECUTED AND EFFECTIVE as of the date first written above.

PORT OF SEATTLE, a Washington municipal corporation

By: ______________________________
Name: ______________________________
Its: ______________________________

STATE OF WASHINGTON )
) ss.
COUNTY OF ________________ )

I certify that I know or have satisfactory evidence that ________________________ signed this instrument, on oath stated that he was authorized to execute the instrument and acknowledged it as the ______________________ of the Port of Seattle, a Washington municipal corporation, to be the free and voluntary act of such municipal corporation for the uses and purposes mentioned in the instrument.

Dated this _________ day of ___________________________, _____.

______________________________________
(Signature of Notary)

______________________________________
(Legibly Print or Stamp Name of Notary)
Notary public in and for the state of
Washington, residing at _________________
My appointment expires: __________________


Prepared by Parametrix, Inc. File: seatac1/11x17auburn_restcov.aml creating p11x17auburn_restcov.gra Date: December 13, 2000

- Mitigation Area in Restrictive Covenant
- Permanent Access Route
- Contour Lines (1 ft. interval)
- Roads

N

FEET 0 250 500 750

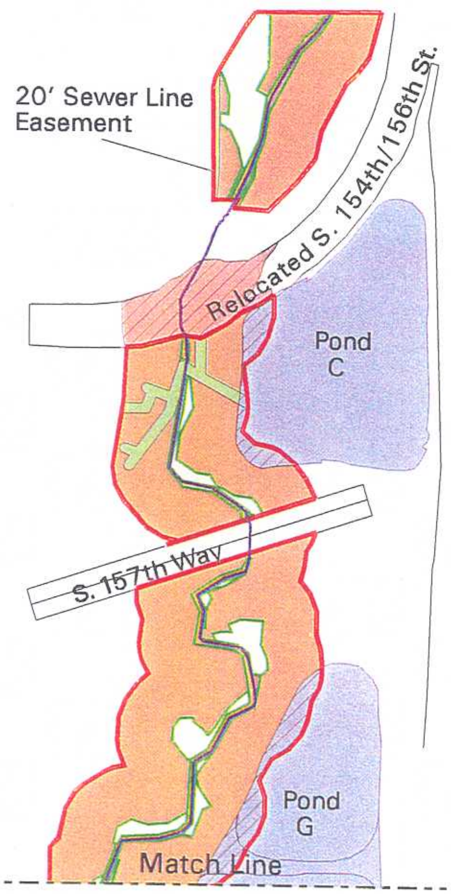
Scale 1:3000

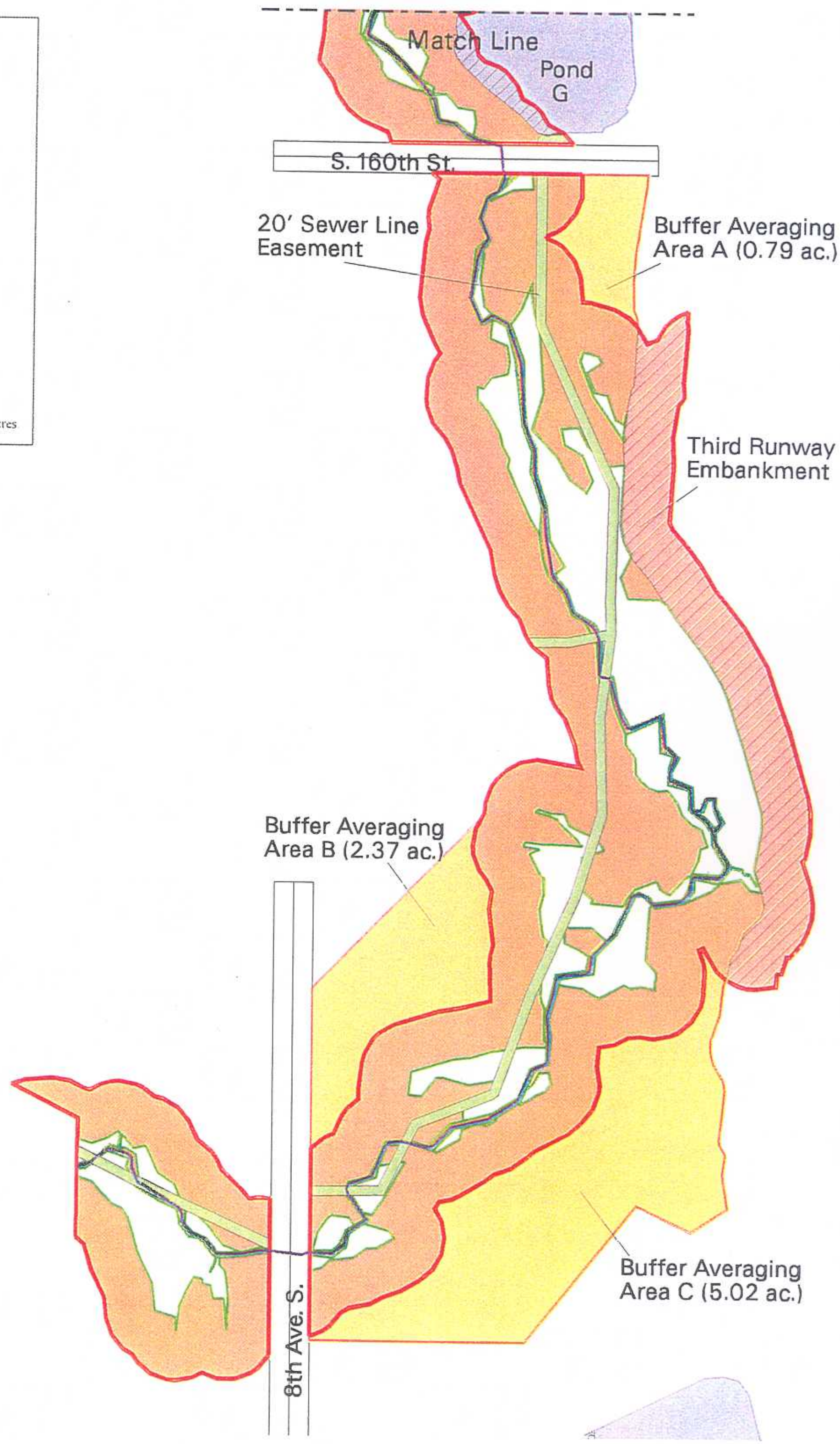
**Restrictive Covenant at the Port of Seattle Auburn Property Site**

AR 010047

| Encroachments Within the Wetland and Riparian Buffer[1] | Area (acres) |
|---|---|
| Sewer line and 20' easement | 1.71 |
| Permanent Stormwater Ponds (C and G) | 0.84 |
| Third Runway and Relocated South 154 St./ South 156th St. | 3.95 |
| **Total Buffer Encroachment** | **6.50** |
| **Buffer Averaging Area** | **Area (acres)** |
| Area A | 0.79 |
| Area B | 2.37 |
| Area C | 5.02 |
| **Total Buffer Averaging Area** | **8.18** |

[1] Total area in Miller Creek buffer and Buffer Averaging Area is approximately 40 acres




seatac2/plotamls/p_bufavg1_8x11_0922.aml creating bufavg1.gra Date: December 13, 2000

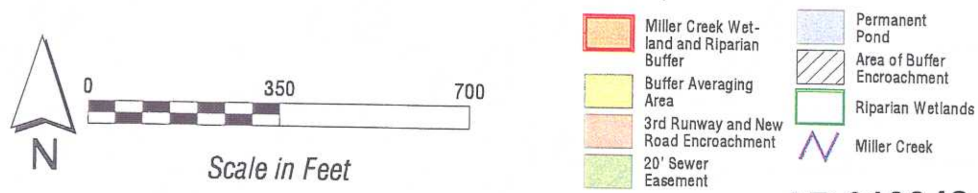



**Figure 5.2-3 Buffer Averaging Analyses For Miller Creek Wetland and Riparian Buffer**

## APPENDIX G

## SEA-TAC THRID RUNWAY – BORROW AREA 3 PRESERVATION OF WETLANDS

# MEMORANDUM

**DATE:** October 20, 2000

**TO:** Jim Thomson, HNTB

**FROM:** Michael A.P. Kenrick, P.E., and Michael J. Bailey, P.E., Hart Crowser

**RE:** **Sea-Tac Third Runway - Borrow Area 3**
**Preservation of Wetlands**
J-4978-06

---

As requested by the Port of Seattle, this memo and the attached figures provide conceptual design and supporting information for the proposed drainage swale to protect wetlands in Borrow Area 3. We also provide a brief explanation of the hydrology that supports the wetlands, including why excavation of Borrow Area 3 will not drain these wetlands. Figure 1 shows the location of Borrow Area 3 to the south of Sea-Tac Airport.

## REVIEW OF BORROW AREA 3 WETLAND HYDROLOGY

The first section of this memo provides a review and explanation of the hydrology that currently supports and sustains wetlands in Borrow Area 3. Understanding these hydrologic factors is important in ensuring the long-term preservation of the wetlands during and after excavation of the fill materials contained in Borrow Area 3.

### *Factors Promoting Preservation of the Wetlands*

Existing wetlands and current topography in Borrow Area 3 are shown on Figure 2; the proposed area of mining and resulting contours for final excavation are shown on Figure 3.

The series of wetlands mapped in Borrow Area 3 follow a line of shallow depressions in the southcentral part of the site, extending to the southeast from Wetland 29 through Wetlands B9, 30, B7, B6, and B5. These wetlands exist in an area of relatively permeable subsoils where the main groundwater table is at a depth of 10 to 15 feet below the wetlands. Depth of the water table indicates the wetlands are supported by other sources of water. The sources of water appear to include surficial runoff and shallow interflow, as well as

Anchorage
Boston
Chicago
Denver
Fairbanks
Jersey City
Juneau
Long Beach
Portland
Seattle

1910 Fairview Avenue East
Seattle, Washington 98102-3699
Fax 206.328.5581
Tel 206.324.9530

groundwater seepage occurring from a perched zone above the main water table that discharges in the area of Wetland 29. Observation wells in the area indicate the perched zone does not contribute flow directly to the other wetlands but, by extension, flow from Wetland 29 appears to pass along the line of wetlands, to each wetland in turn.

The key factors for sustaining wetland hydrology in Borrow Area 3 are (1) ensuring the continued supply of water and (2) preventing the undue loss of water from the wetlands. Wetland hydrology is typically sustained by a combination of hydrologic processes, as shown schematically on Figure 4. The processes supporting wetland hydrology include precipitation (P), groundwater flow (GW) and spring seepage (Sp), runoff (RO), and interflow (IF). Other processes such as evapotranspiration (Et) and deep percolation (DP) lead to the potential loss of water from wetlands. Where wetlands exist, it can be assumed that the sources of water exceed the losses, for at least a large part of the year. Maintenance of the water sources, without increasing the losses, should ensure preservation of the wetlands in perpetuity.

One of the main constraints on wetland development in the area is the relatively high permeability of the surficial soils. In agricultural terms, the surficial soils are identified to be part of the Indianola series (USDA, 1973) and are characterized as being "excessively drained" with "rapid permeability." This is consistent with the predominant soil material in Borrow Area 3 being stratified glacial drift, which is primarily sand and gravel outwash with varying amounts of silt in a predominantly granular matrix.

The overall approach for maintaining wetlands in Borrow Area 3 focuses on preserving or enhancing the existing sources of water, and ensuring that no additional loss pathways are created.

***<u>Wetland 29</u>***

Wetland 29 is unique in that it occurs on a hillside (see Figure 3). Its existence is attributable primarily to a continuous supply of groundwater that seeps from the hillside at this point. Investigation of subsurface conditions at Borrow Area 3 links this area of seepage with a laterally continuous zone of perched groundwater that extends to the north and west, behind Wetland 29 (Hart Crowser, 1999, see reference list following the text of this memo). In hydrologic terms, the wetland occupies part of a surface seepage discharge area for groundwater flowing through the perched zone, as illustrated in the cross section on Figure 4. Part of the seepage from the perched zone flows into Wetland 29, the rest of the seepage from the perched layer does not appear elsewhere on the surface, so is assumed to percolate down into the shallow regional aquifer in the eastern part of the site where the perching layer has been removed by erosion.

The proposed borrow area excavation to the east of Wetland 29 (Figures 3 and 4) will not interfere with the perching layer behind or beneath the wetland and will, therefore, have no direct effect on the continued discharge of groundwater from the west. An analysis of groundwater flow potentially diverted from Wetland 29 (Hart Crowser, 2000) indicates that excavation could change the seepage gradient and result in a decrease in flow to Wetland 29. Mitigation to address this potential change is discussed below.

Although the base of the Borrow Area 3 excavation will be lower in elevation than most of Wetland 29, excavation will occur in predominantly permeable soils that are above the water table. These existing permeable soils already provide a drainage pathway for seepage losses from the wetlands. The persistence of the wetlands despite the presence of permeable soils and a relatively deep water table demonstrates that wetlands will not be drained by the adjacent excavations.

***<u>Other Wetlands</u>***

Water in Wetland 29 is primarily lost by percolation to the underlying aquifer and evapotranspiration. A portion of the water flowing through Wetland 29 is inferred to move downslope as interflow or shallow subsurface flow to feed successive wetlands that trend southeastward from Wetland 29, occupying a series of shallow depressions (see Figure 3 - note that this flow is out of the plane of the cross section on Figure 4). This inference is based on the topographic position of the adjacent wetlands and the absence of other sources of water. Flow appears to move from one wetland to the next, and some water is likely lost as deep percolation into the permeable subsurface soils that underlie most of the site, including the wetlands. Some additional water probably comes as surface runoff or interflow from the surface catchments feeding each wetland.

According to the Wetland Delineation Report (Parametrix, 1999) and supporting Field Data Sheets, the wetlands in Borrow Area 3 typically feature 10 to 12 inches of "black muck" - a fine-grained richly organic soil that appears to help the ponding of water in the wetland, and likely retains saturation of the root zone rather than allowing much of the water to percolate downward. The concept is illustrated on Figure 5, which is a cross section through Wetland 30.

Note that Wetlands 30, B7, B6, and B5 appear to exist beyond the main perching layer. It is possible that these wetlands formed on locally silty (less permeable) zones in the predominantly granular soil, promoting shallow perched conditions that sustain the wetland hydrology. As evidence of this, Wetland B7 is reported to have a seasonally high water table that would be 10 to 15 feet above the main groundwater table in the underlying relatively permeable shallow regional aquifer. As a result, excavation of the perching layer northeast of Wetland 29 would not have any direct impact on the other wetlands in Borrow Area 3 provided flow into Wetland 29 is maintained as described below.

### *Proximity of Excavations*

The Port proposes that excavations of Borrow Area 3 (see Figure 3) will leave at least a 50-foot buffer around the wetlands. Excavation to the east of the wetlands will proceed to approximate elevation 233 to 235 feet, whereas the wetlands themselves are at approximate elevations 236 feet (Wetland 30) and 235 to 238 feet (Wetlands B6 and B7), see Figures 5 and 6. The hydrology of these wetlands will not be adversely impacted by the excavations because:

- The wetlands already exist over permeable subsoils;
- The buffer will be retained, preventing any lateral "short circuit" flowpath that could divert water from the wetlands and into the borrow site excavation; and
- Base elevations of the proposed excavations are at most only a foot or two lower than the lowest point in these adjacent wetlands.

Wetland B5 is at about elevation 230 feet, well below the proposed excavation. Wetlands B9 and 29 are upslope of the proposed excavation and would be protected against any potential loss of water by the proposed mitigation discussed herein. Wetland B10 is upslope of the perched zone and, therefore, would not be impacted by changes in perched zone flow.

### ***Potential Loss of Surface Flows***

In some areas of the buffer zone between the wetlands and the proposed excavation, there may be localized low spots that provide a potential pathway for overland flow to occur from the wetland into the excavation at periods of exceptionally high water levels. If erosion occurs during periods of high water in the wetlands, formation of gullies could divert increased surface flows from the wetlands into the excavations. Erosion will be prevented by preserving existing vegetation in the wetland buffer areas and revegetating the excavated area in accordance with Washington Department of Natural Resources reclamation criteria. However, if erosion threatens the wetland floor, mitigation could easily be accomplished. The Port has proposed a period of wetland monitoring following excavation of the borrow site. If necessary during or after excavations, berms or other erosion protection will be constructed outside the wetland buffer and on the edge of the excavations to prevent overland flow occurring from the wetland depressions into the adjacent excavation. This element of the mine plan will depend on field surveying for elevation control of the land-surface profile along the buffer zone, reclamation of the site to a stable condition, and monitoring after reclamation, which the Port has already committed to.

## DRAINAGE SWALE DESIGN

The remainder of this memo addresses the design of a drainage swale that will provide additional water to Wetland 29 to replace the potential loss of seepage from the perched zone.

As described in Hart Crowser (2000), groundwater modeling suggests the possibility that mining will produce a small change in the groundwater flow regime within the perched zone that feeds Wetland 29. Modeling suggests increased drawdown in the perched zone due to excavation in the Borrow Area 3 (see Figure 3) could cause a shift in the seepage gradient. This change in gradient could reduce groundwater flow by a maximum of about 20 percent of the current flow to Wetland 29, or about 400 $ft^3$/day (roughly 2 gallons per minute). The Port proposes to mitigate this potential indirect impact by collecting groundwater seepage in a swale along the western slope face of the excavation (see Figure 3) and diverting this to Wetland 29.

### *Overall Concept for Drainage Swale*

The proposed drainage swale is designed to collect groundwater seepage from the excavated slope face on the north and west sides of Borrow Area 3, as depicted on Figure 3. The groundwater seepage represents natural flow from the perched zone that is forced to discharge at the cut slope face, as described in detail in Hart Crowser (2000). The flow will be collected and conducted southward in a swale that drains into Wetland 29. Grades along the swale are expected to be between about 1 and 2 percent. A schematic profile along the drainage swale is shown on Figure 7. Modeling shows there is about 2,400 $ft^3$/day of groundwater flow available compared to projected maximum loss to Wetland 29 of 400 $ft^3$/day (Hart Crowser, 2000). There is more than enough seepage flow available to make up any loss in the natural perched zone groundwater flow to Wetland 29.

## *Adaptive Design Approach*

The detailed design and construction of the drainage swale will be modified as needed to take account of field conditions revealed during the excavation of Borrow Area 3. For example, the swale could be lined with HDPE (see Figure 6) if needed to prevent loss of flow in the event soils encountered during construction are more permeable than indicated by the borings. Design, construction, operation, and maintenance issues are described under the following headings.

### ***Typical Cross Section***

The typical cross section for the proposed drainage swale is shown on Figure 6(a). This cross section presupposes that a sufficient thickness of natural low-permeability soils (the lateral extension of the perching layer) will be present in the upper part of the bench holding the swale.

### ***Prevention of Leakage***

To allow for potential variability in the surface elevation or thickness of the perching zone, the design assumes the invert of the swale may extend below the base of the perching horizon in places, in order to maintain the design slope of 1 to 2 percent. If the perching horizon is thin or even be eroded away in places, this will be revealed as excavation of Borrow Area 3 occurs and the intersection of the perching layer with the final cut slope becomes visible. In the event that field mapping during excavation shows insufficient low-permeability soil is present to form the required subgrade for the unlined drainage swale, the swale grade or alignment could be modified, and/or an impermeable lining (protected by gravel) would be used in the base of the swale to prevent seepage loss, as shown on Figure 6(b).

### ***Control of Excess Flows***

The position of the drainage swale at mid-slope around the northern and western sides of Borrow Area 3 will cause the swale to collect surface water runoff during high precipitation. Some precipitation upslope of the swale is likely to infiltrate but may appear as shallow interflow or perched water and contribute to seepage in the swale. Also, if constructed to its full length as shown on Figure 3, the swale is expected to collect more than enough groundwater seepage to make up for the projected maximum loss in flow from Wetland 29.

Two measures are available to deal with these anticipated excess flows:

1) A flow-control structure will be constructed in the course of the swale before it enters Wetland 29 (see Figure 9); and
2) The length of the swale can also be modified (at time of construction, or after some period of post-construction monitoring) to control the amount of seepage (and runoff) that is collected and diverted to Wetland 29.

The proposed flow control weir or diversion structure will be designed to provide a consistent low flow of seepage into Wetland 29 and enable diversion of excess flow in the drainage swale away from Wetland 29. The excess flow will be diverted along a channel and into the base of Borrow Area 3, where it will infiltrate and/or be handled by the stormwater facilities for managing runoff from the remainder of the borrow area.

The flow control structure will be constructed of reinforced concrete. As illustrated on Figure 9, it will include a narrow flow slot at the lower elevation to enable a continuous low flow from the drainage swale into Wetland 29. The second part of the flow control structure will include a broad overflow weir that will allow water to spill over into a diversion channel during periods of higher flow in the swale. Flow through both the narrow slot and the broad weir will be controlled with adjustable boards as shown on Figure 9. Flow to Wetland 29 will be fine-tuned during the initial maintenance period (following construction) by adjusting the height of the boards placed in each part of the structure. Final flow levels may then be fixed by replacing the boards with masonry at the end of the monitoring period.

***Construction***

Construction of the drainage swale will be integrated with the mining and reclamation plan for the excavation of Borrow Area 3. This will prevent over-mining of the perching layer in close proximity to the final slope contours for the excavation. Mining will progress from the highest area of the site in the northwest part of Borrow Area 3, working down the slope and reclaiming the upper part of the final cut slope as excavation proceeds. The perched zone will be encountered as wet areas at the base of the working slope. Mining will then step in approximately 20 feet to allow the bench for the drainage swale to be formed in the perching layer beneath the perched zone.

The next stage will be to excavate within the bench width to cut the swale into the perched zone and underlying perching layer. The bench will be cleaned off and graded to form the swale, which will be constructed per the typical cross section. This will provide the opportunity to determine from field surveying the elevation, profile, and thickness of the perching layer in the area of the final slope. The final design of the swale invert elevations and cross sections will then be adjusted as required to best match subsurface conditions and topography, facilitating final construction the swale at the required elevation on the bench. Mining will then proceed into the lower part of the slope below the drainage swale.

***Surface Protection and Reclamation***

Reclamation of the borrow area will be accomplished in accordance with Washington Department of Natural Resources criteria and the Port of Seattle landscape plans. Once final grades have been established, the drainage swale and adjacent slopes will be protected from erosion using the same techniques demonstrated to be effective by the embankment construction to date. The excavation slopes will be dressed and hydroseeded with a bonded fiber matrix. The swale will be protected with erosion control matting until grass is established as part of the post-excavation site reclamation.

***Operation and Maintenance***

Operation of the swale, and particularly the flow control structure, will require monitoring and recordkeeping for an initial period of about two to five years. During this period, the amount of seepage and operation of the flow control weir will be monitored. The weir height may be adjusted to ensure stable and appropriate flows to Wetland 29, which are consistent with plant and ecological requirements of the wetlands.

Long-term operation and maintenance of the swale will be restricted to periodic (annual) inspections of the facility to check the basic integrity of the swale and look for signs of erosion or blockage that could require remedial work by Port grounds maintenance staff.

F:\docs\jobs\497806\DraftWetlandPreservationSwale.doc

Attachments:
References
Figure 1 - Site Location Map
Figure 2 - Pre-Excavation Topography and Wetlands – Borrow Area 3 Perched Zone
Figure 3 - Post-Excavation Topography and Drainage Facilities - Borrow Area 3 Drainage Swale
Figure 4 - Cross Section A - A' through Wetland 29
Figure 5 - Cross Section B - B' through Wetland 30
Figure 6 - Cross Section C - C' through Wetland B6
Figure 7 - Drainage Swale – Profile D-D'
Figure 8 - Typical Cross Sections E-E' - Borrow Area 3 Drainage Swale
Figure 9 - Flow Control Structure Schematic - Borrow Area 3 Drainage Swale

## REFERENCES

Hart Crowser, Inc., 1999. Subsurface Conditions Data Report, Borrow Areas 1, 3, and 4, Sea-Tac Airport Third Runway. Prepared for HNTB and the Port of Seattle, September 24, 1999 (J-4978-02).

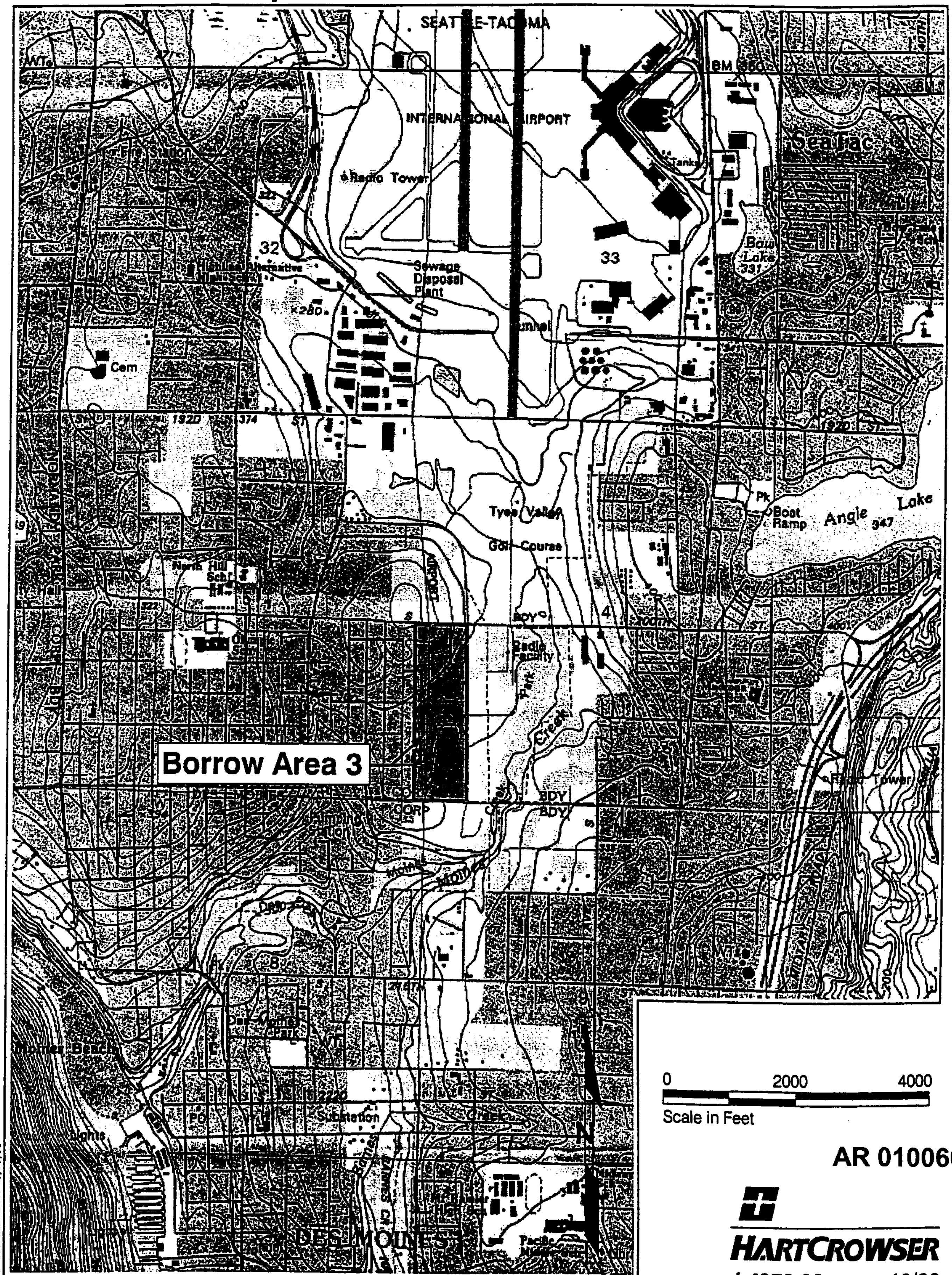
Hart Crowser, Inc., 2000. Evaluation of Perched Zone Interception and Possible Impacts to Wetland Hydrology, Borrow Areas 3, Sea-Tac Airport Third Runway. Prepared for HNTB and the Port of Seattle, September 12, 2000 (J-4978-13).

Parametrix, Inc., 1999. Wetland Delineation Report, Seattle-Tacoma International Airport, Master Plan Update Improvements. Prepared for Port of Seattle, August 1999.

USDA, 1973. Soil Survey, King County Area, Washington. United States Department of Agriculture, Soil Conservation Service, 100 pp. November 1973.

F:\docs\jobs\497806\DraftWetlandPreservationSwale.doc

# Site Location Map




0 2000 4000

Scale in Feet

AR 010060

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J-4978-06 10/00

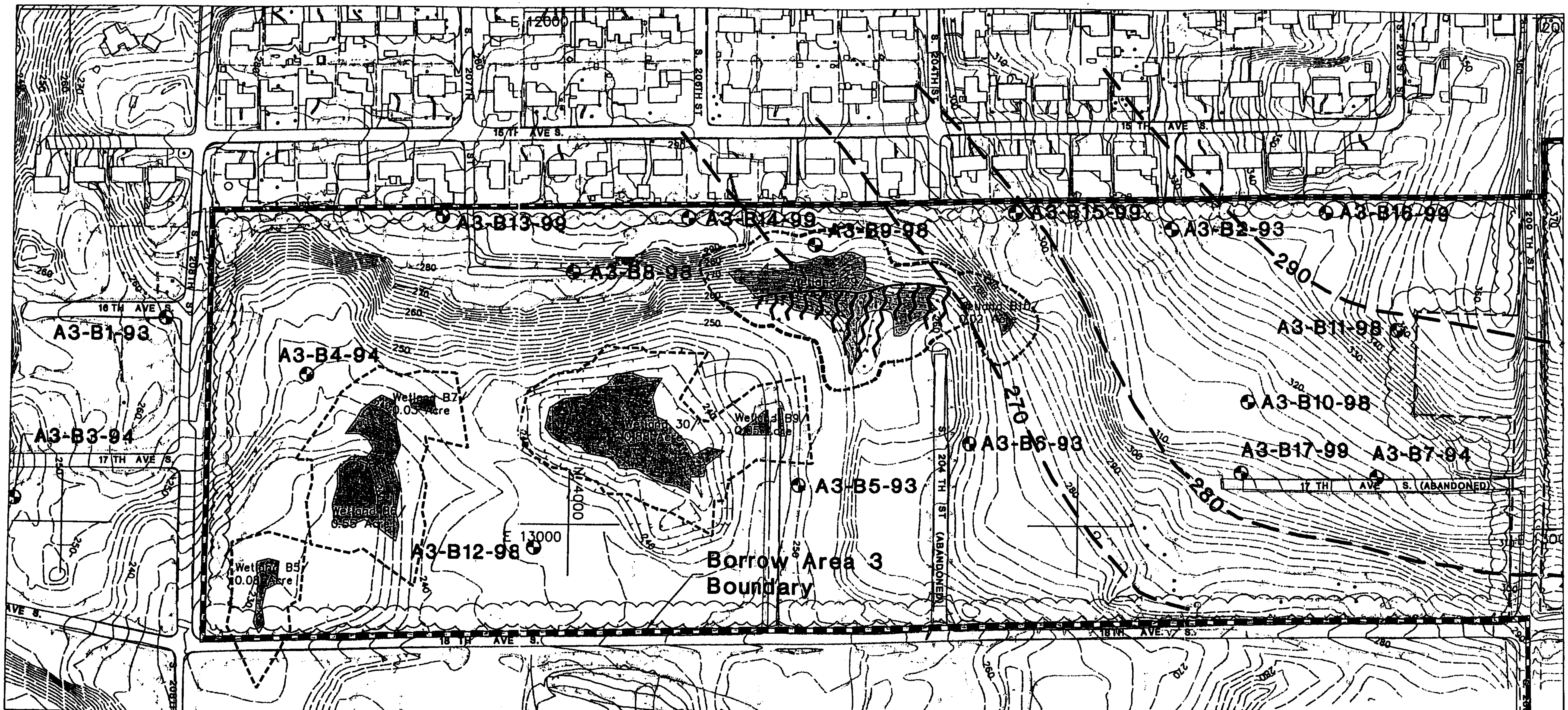
Figure 1

49786Acd DTN 10/17/00

Note: Base map prepared from USGS 7.5 minute quadrangle maps of Seattle South, Washington, revised 1995.

# Pre-Excavation Topography and Wetlands

## Borrow Area 3 Perched Zone




A3-B4-94 Exploration Boring with Monitoring Well

280 Perched Zone Groundwater Elevation Contour in Feet

Wetland Location, Designation, Acreage, and 50-foot Wetland Buffer (Based on Parametrix, 1999)

Inferred Seepage Face

N

0 200 400

Scale in Feet

HARTCROWSER

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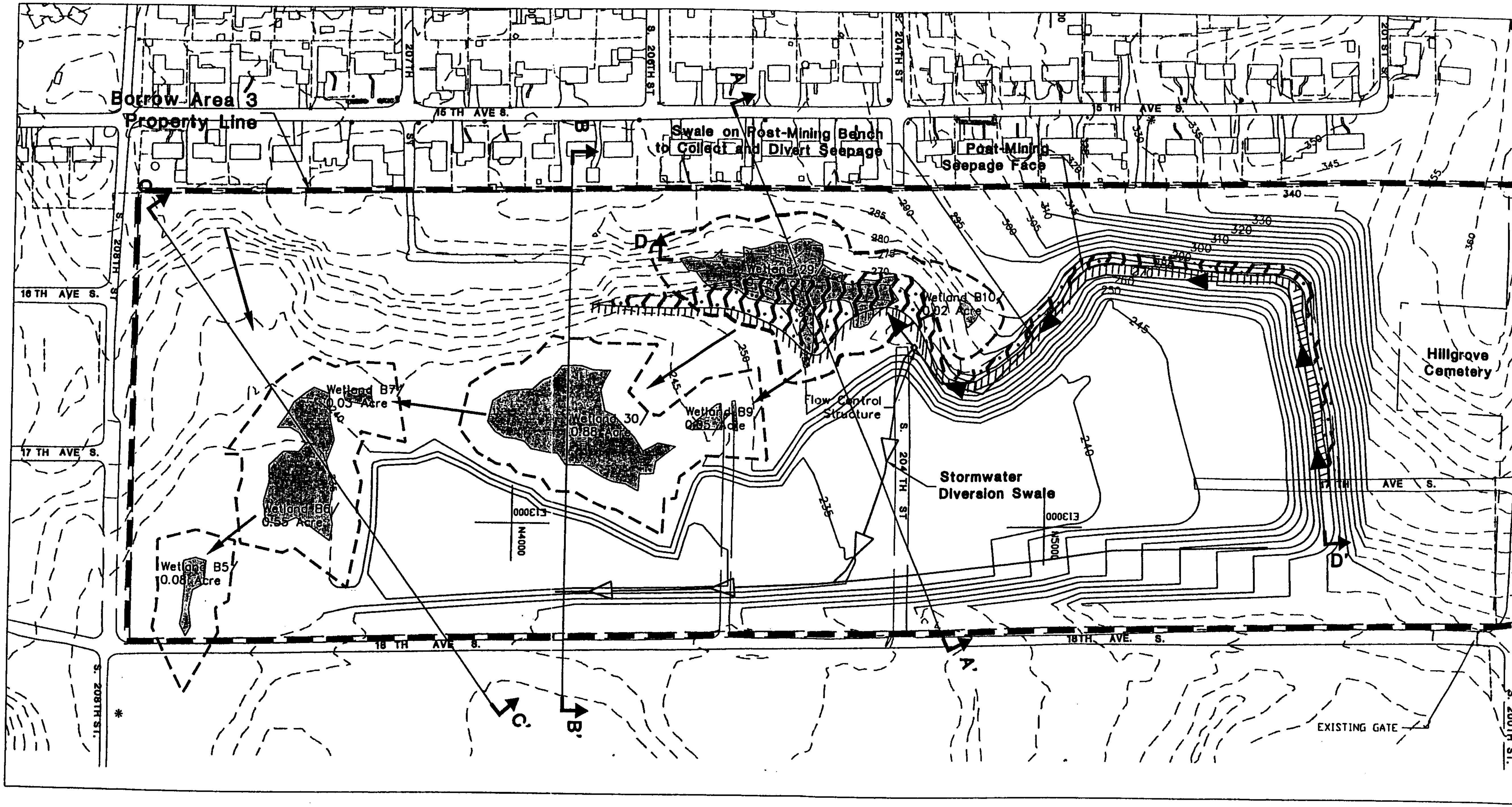
Figure 2

AR 010061

DTN 10/17/00 1=1 charlie.pc2 49780836

# Post-Excavation Topography and Drainage Facilities
## Borrow Area 3 Drainage Swale




———240——— Proposed Elevation Contour in Feet

– – – – – 50-Foot Wetland Buffer

Wetland B5 0.08 Acre — Wetland Location, Designation, and Acreage

←—— Direction of Surface/Shallow Subsurface Drainage

Inferred Seepage Face above Outcrop of Perching Layer

AA' — Cross Section/Profile Location and Designation

N

0 200 400
Scale in Feet

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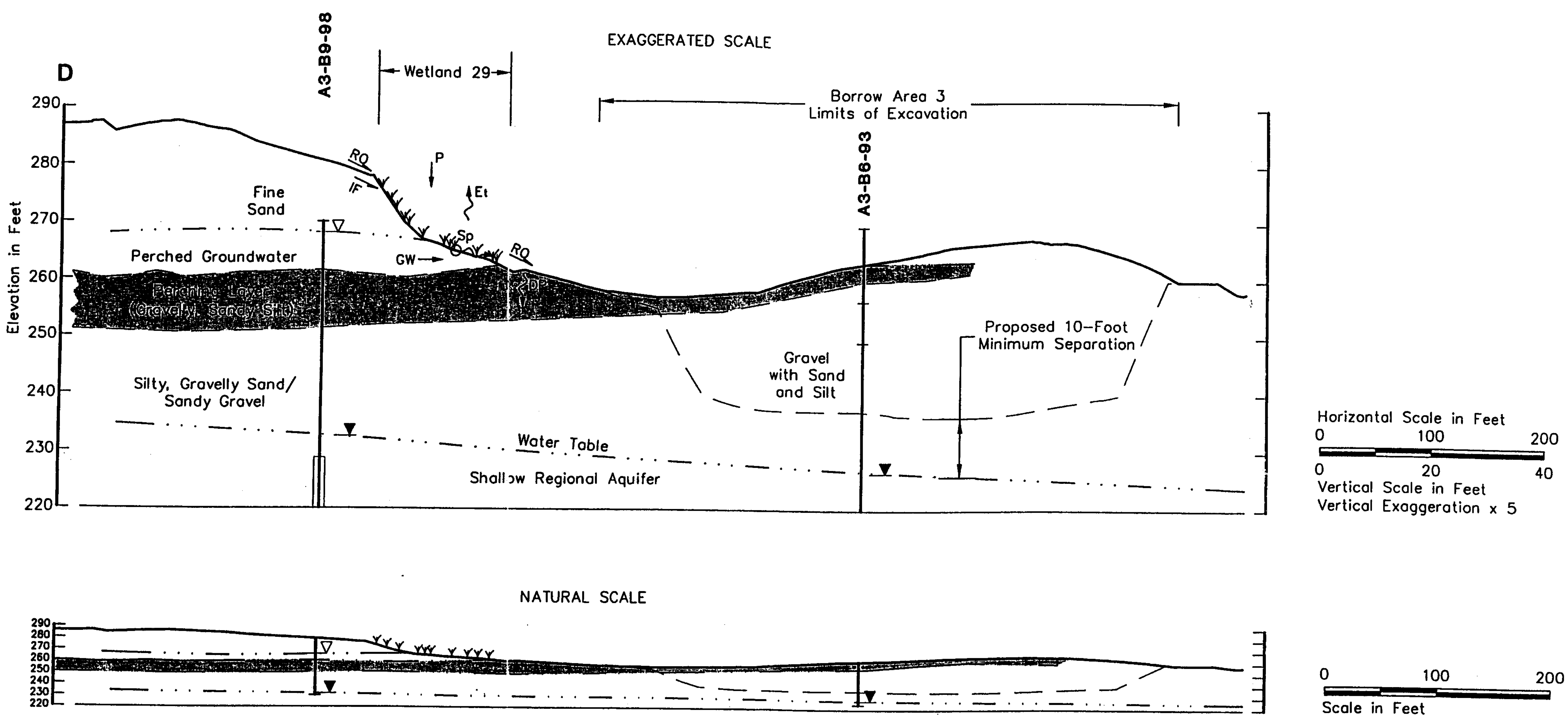
Figure 3

AR 010062

DJH 10/20/00 1=200 (xref)see drawing file/49780637.pc2
49780637

# Cross Section A-A' through Wetland 29

## Looking North




Note: Contacts between soil units are based upon interpolation between borings and represent our interpretation of subsurface conditions based on currently available data.

<u>Wetland Hydrology</u>

Inflows: P Precipitation
RO Runoff
IF Interflow
Sp Springs or Seeps
GW Groundwater

Outflows: Et Evapotranspiration
DP Deep Percolation

**A3-B8-98** Exploration Number

Exploration Location

Perched Water Level

Shallow Aquifer Water Level

Screened Interval

RC 10/17/99 1=100 Charlie.pc2
49780635

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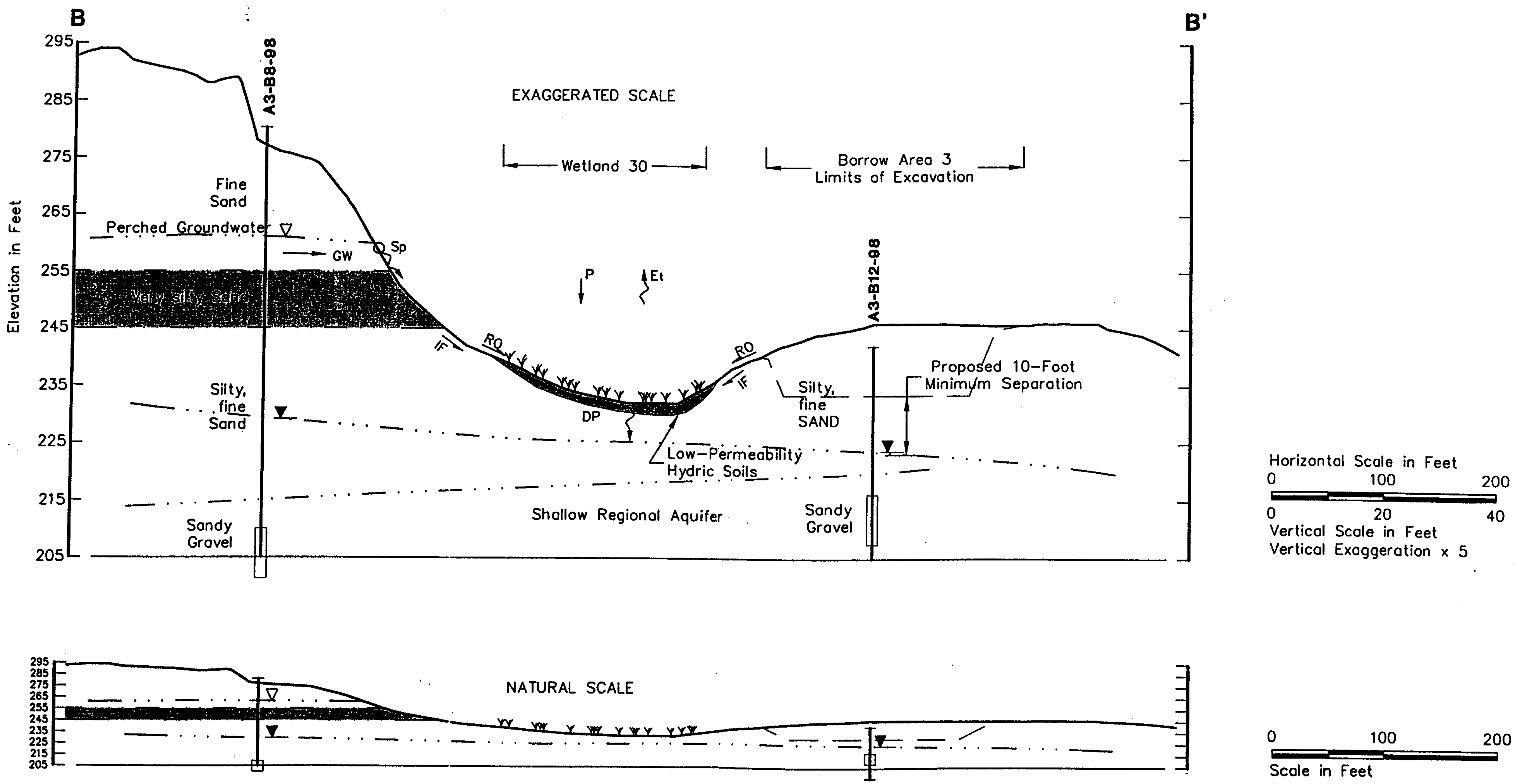
***J-4978-06 10/00***
***Figure 4***

**AR 010063**

# Cross Section B-B' through Wetland 30

*Looking North*




Note: Contacts between soil units are based upon interpolation between borings and represent our interpretation of subsurface conditions based on currently available data.

Wetland Hydrology

Inflows: P Precipitation
RO Runoff
IF Interflow
Sp Springs or Seeps
GW Groundwater

Outflows: Et Evapotranspiration
DP Deep Percolation

**A3-B8-98** Exploration Number

Exploration Location

Perched Water Level

Shallow Aquifer Water Level

Screened Interval

DTN 10/17/00 1=100 charlie.pc2
49780638

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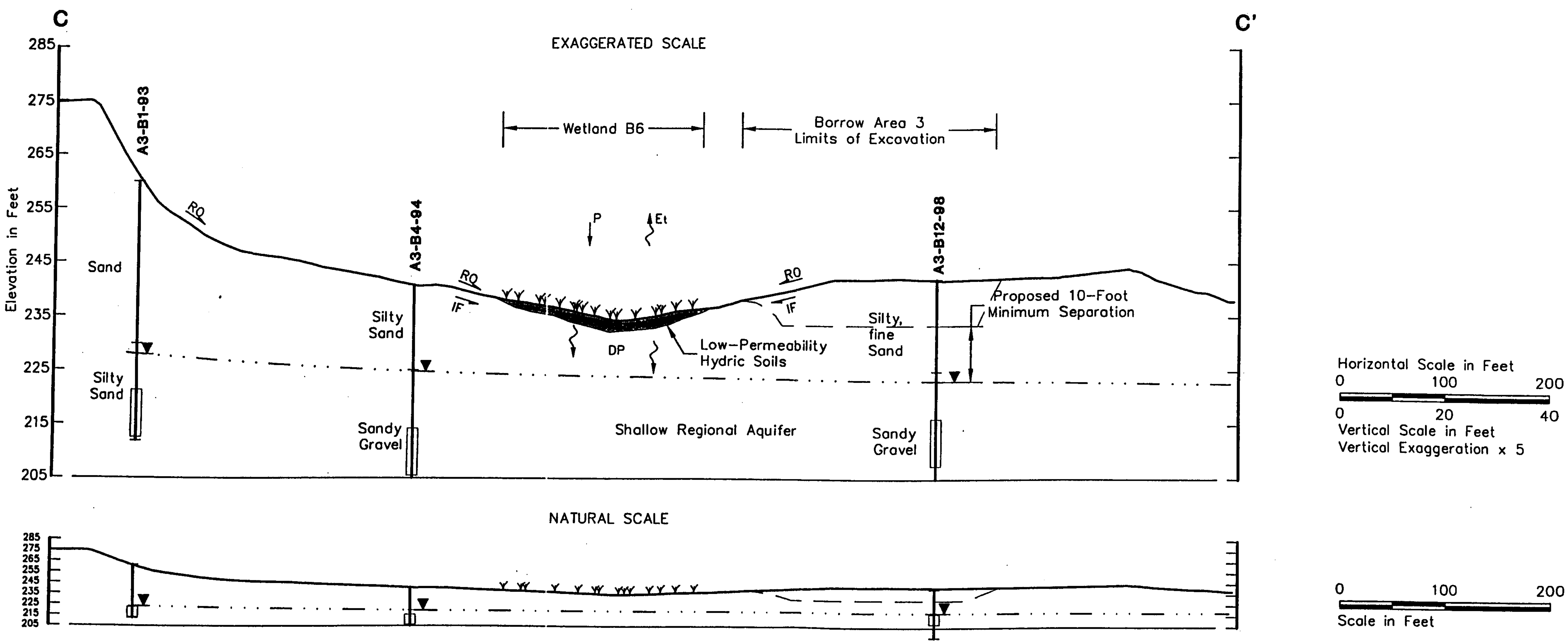
J-4978-06 10/00

Figure 5

AR 010064

# Cross Section C-C' through Wetland B6

## Looking North




Note: Contacts between soil units are based upon interpolation between borings and represent our interpretation of subsurface conditions based on currently available data.

**Wetland Hydrology**

Inflows:
- P Precipitation
- RO Runoff
- IF Interflow
- Sp Springs or Seeps
- GW Groundwater

Outflows:
- Et Evapotranspiration
- DP Deep Percolation

**A3-B8-98** Exploration Number

Exploration Location

Perched Water Level

Shallow Aquifer Water Level

Screened Interval

DTN 10/17/00 1=100 charlie.pc2
49780639

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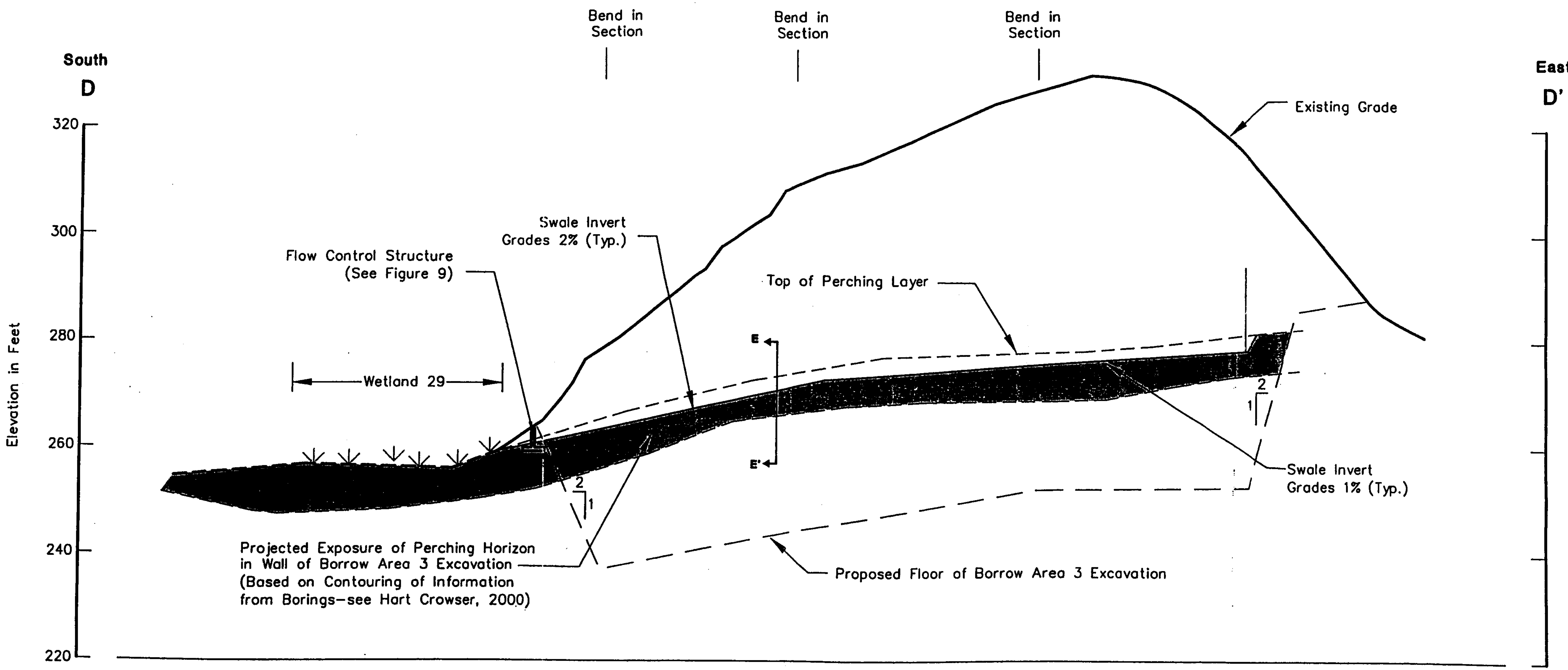
J-4978-06 10/00
Figure 6

AR 010065

## Drainage Swale - Profile D-D'
### Borrow Area 3




Note: Contacts between soil units are based upon interpolation between borings and represent our interpretation of subsurface conditions based on currently available data.

Horizontal Scale in Feet
0 200 400

0 20 40
Vertical Scale in Feet
Vertical Exaggeration x 10

DTN 10/18/00 1=200 charlie.pc2
49780640

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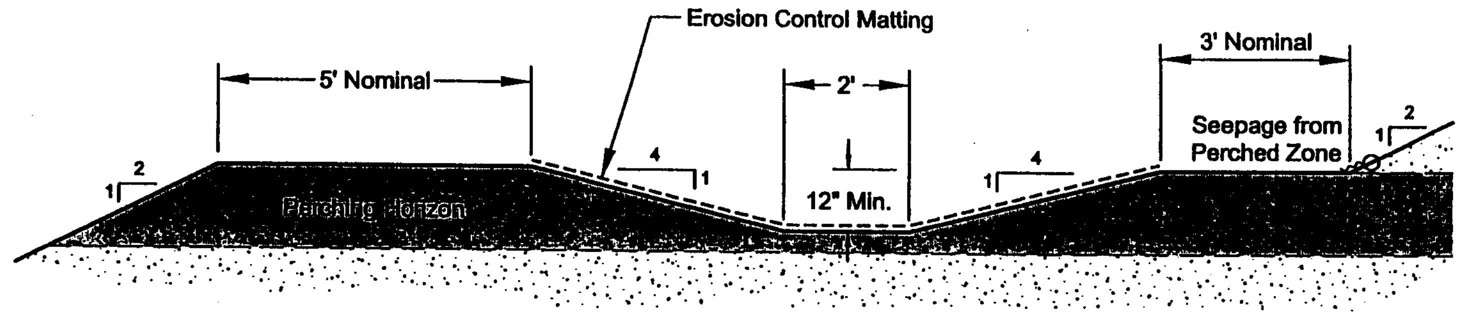
J-4978-06 10/00
Figure 7

AR 010066

DTN 10/18/00 1=1 charlie-8.pc2 49780641.dwg

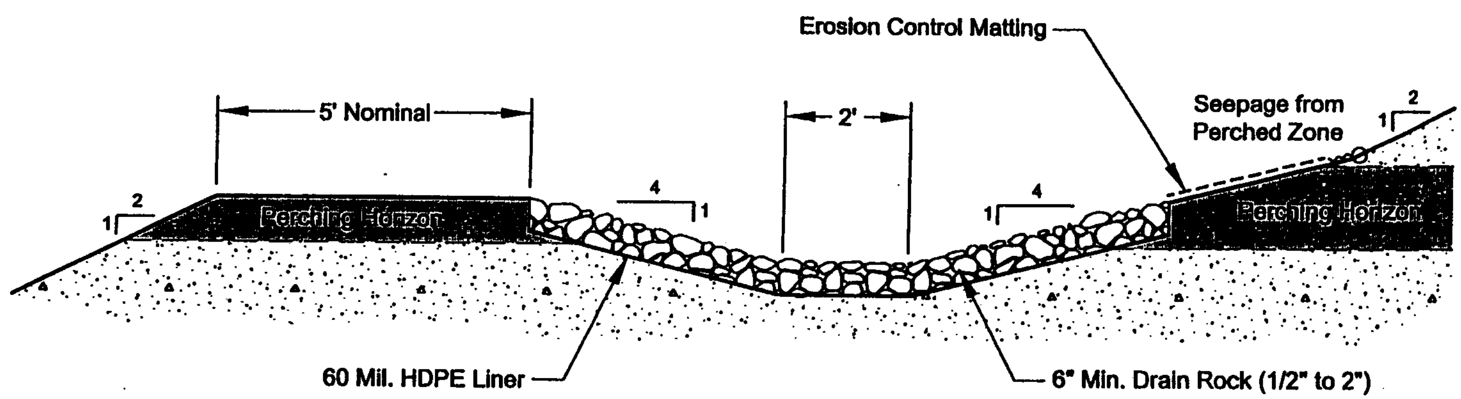
# Typical Cross Sections E-E'

## Borrow Area 3 Drainage Swale




**(a) DRAINAGE SWALE (TYPICAL)**

Not to Scale




**(b) LINED DRAINAGE SWALE (AS NEEDED)**

Not to Scale

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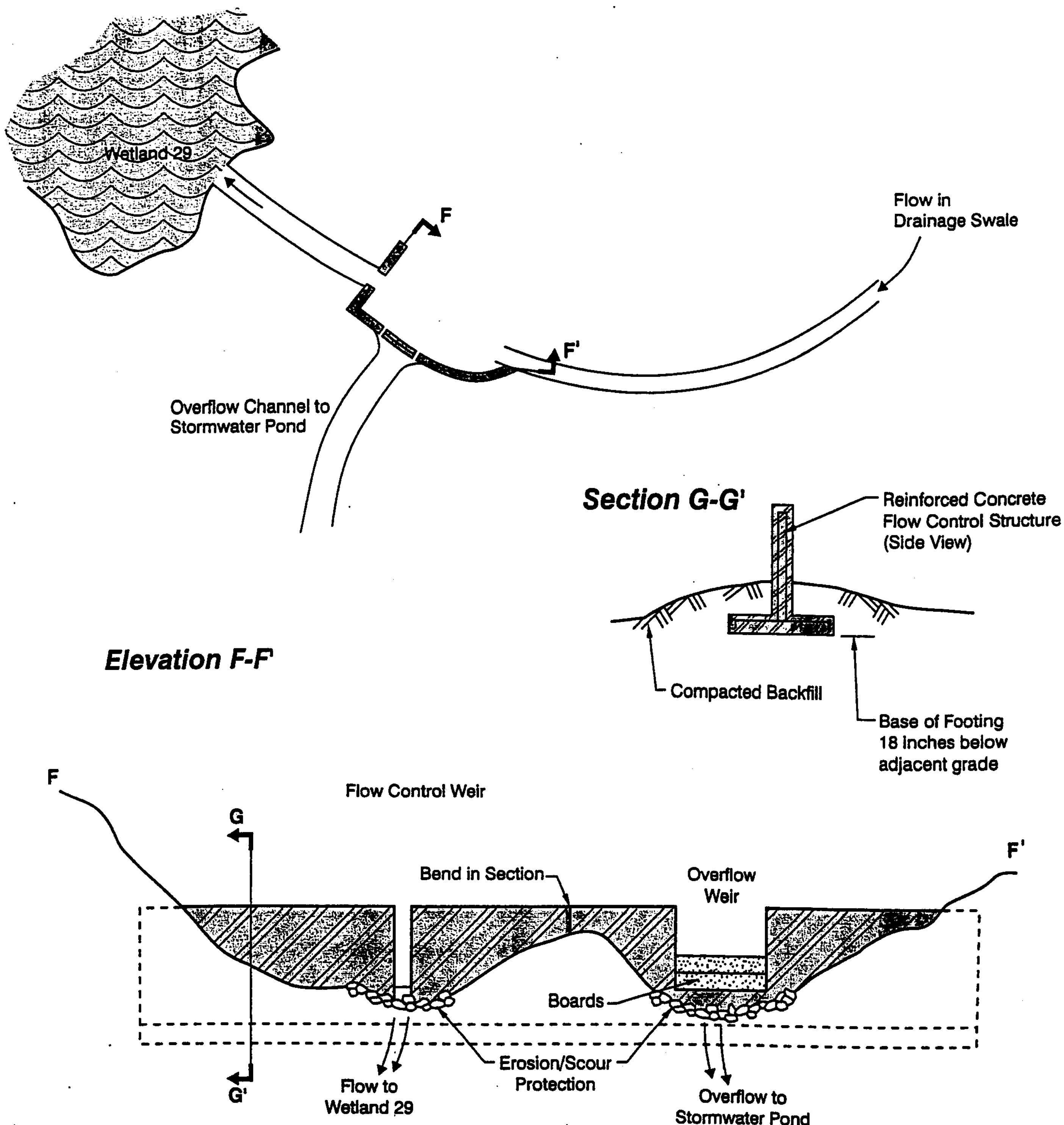
Figure 8

# Flow Control Structure Schematic

## Borrow Area 3 Drainage Swale




hel 10/18/00 4978068.cdr

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Figure 9

AR 010068

# APPENDIX H

# SAMPLE DATA SHEETS

**HYDROLOGIC MONITORING**
**SEATTLE-TACOMA INTERNATIONAL AIRPORT**
# WETLAND MITIGATION MONITORING
**SURFACE WATER DEPTHS – STAFF GAUGE DATA**

**Wetland:** ☐ Vacca Farm ☐ Tyee Golf Course ☐ Auburn
☐ Miller Creek Buffer ☐ Temporary Impacts ☐ Sampling Station: ________________

☐ Groundwater ☐ Surface Water

| Date | Time | Read By | Water Level[a] | Weather[b] | Notes[c] | Water Quality Notes[d] |
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[a] Indicate subsurface water levels with a negative sign preceding depth from soil surface to standing water.
[b] Record observations of present and preceding weather conditions.
[c] Record species, numbers, and locations.
[d] Record algae blooms or odors.

**HYDROLOGIC MONITORING – GROUNDWATER ELEVATIONS**
**SEATTLE-TACOMA INTERNATIONAL AIRPORT**
**WETLAND MITIGATION MONITORING**
**GROUNDWATER WELL DATA**

**Wetland:** ☐ Vacca Farm ☐ Tyee Golf Course ☐ Auburn
☐ Miller Creek Buffer ☐ Temporary Impacts ☐ Sampling Station: ____________________

☐ Groundwater ☐ Surface Water

| Date | Time | Read By | Water Level[a] | Weather[b] | Notes[c] |
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[a] Indicate subsurface water levels with a negative sign preceeding depth from soil surface to standing water.
[b] Record observations of present and preceeding weather conditions.
[c] Record algae blooms or odors.

**PHOTOGRAPHIC RECORD**
**SEATTLE-TACOMA INTERNATIONAL AIRPORT**
**WETLAND MITIGATION MONITORING**

**Wetland:** ☐ Vacca Farm ☐ Tyee Golf Course ☐ Auburn
☐ Miller Creek Buffer ☐ Temporary Impacts ☐ Sampling Station: ____________

☐ Groundwater ☐ Surface Water

Date:______________________________

Observer:___________________________

| Location | Photo Numbers | Description/Remarks/Wildlife Observations[a] |
|---|---|---|
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[a] Include species, location, and numbers

**HERBACEOUS VEGETATION COVER DATA**
**SEATTLE-TACOMA INTERNATIONAL AIRPORT**
**WETLAND MITIGATION MONITORING**

Date: ______________________ Plot: ______________________
Transect: ______________________ Observer: ______________________
Soil color (at 12-inch depth): ____________ Water table/Soil moisture: ____________

**Wetland:** ☐ Vacca Farm ☐ Tyee Golf Course ☐ Auburn
☐ Miller Creek Buffer ☐ Temporary Impacts ☐ Sampling Station: ____________

☐ Groundwater ☐ Surface Water

| Species | Estimated Cover | Cover Class | Remarks |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| 9. | | | |
| 10. | | | |
| 11. | | | |
| 12. | | | |
| 13. | | | |
| 14. | | | |
| 15. | | | |

**WOODY PLANT COVER**
**SEATTLE-TACOMA INTERNATIONAL AIRPORT**
**WETLAND MITIGATION MONITORING**

Date: ______________________ Observer: ______________________
Soil color (at 12-inch depth): __________ Water table/Soil moisture: __________

**Wetland:** ☐ Vacca Farm ☐ Tyee Golf Course ☐ Auburn
☐ Miller Creek Buffer ☐ Temporary Impacts ☐ Sampling Station: __________

☐ Groundwater ☐ Surface Water

Transect number: ______________ Length of transect (or interval) __________

| Species | Record Intercept Lengths by Species and Occurrences | Intercept Total |
|---|---|---|
| 1. | | |
| 2. | | |
| 3. | | |
| 4. | | |
| 5. | | |
| 6. | | |
| 7. | | |
| 8. | | |
| 9. | | |
| 10. | | |
| 11. | | |
| 12. | | |
| 13. | | |
| 14. | | |
| 15. | | |

# WETLAND PLANT CONDITION[A]
# SEATTLE-TACOMA INTERNATIONAL AIRPORT
# WETLAND MITIGATION MONITORING

**Wetland:** ☐ Vacca Farm ☐ Tyee Golf Course ☐ Auburn
☐ Miller Creek Buffer ☐ Temporary Impacts ☐ Sampling Station: ______________

☐ Groundwater ☐ Surface Water

Wetland Zone (circle one): Shrub Emergent Open Water Buffer Other: ________

Date: ______________________ Observer: ______________________

| Species | Leaves[b] | % | Shoots[c] | % | Stems[d] | % | Disease[e] | % |
|---|---|---|---|---|---|---|---|---|
| 1. | | | | | | | | |
| 2. | | | | | | | | |
| 3. | | | | | | | | |
| 4. | | | | | | | | |
| 5. | | | | | | | | |
| 6. | | | | | | | | |
| 7. | | | | | | | | |
| 8. | | | | | | | | |
| 9. | | | | | | | | |
| 10. | | | | | | | | |
| 11. | | | | | | | | |
| 12. | | | | | | | | |
| 13. | | | | | | | | |
| 14. | | | | | | | | |

[a] Attach site map of wetland to indicate specific areas examined and reported on this data sheet
[b] Note leaf color, size, and shape abnormalities
[c] Note typical shoot elongation for current season, and abnormalities (including die-back)
[d] Note stem die-back, if any
[e] Record diseases or pests (including insect or animal grazing)

N

Supplemental Information

# Cumulative Impacts to Wetlands and Streams

## Master Plan Update Improvements
## Seattle-Tacoma International Airport

Port of Seattle

Parametrix, Inc.

August 2001

AR 010077

# SUPPLEMENTAL INFORMATION

# CUMULATIVE IMPACTS TO WETLANDS AND STREAMS

# MASTER PLAN UPDATE IMPROVEMENTS
# SEATTLE-TACOMA INTERNATIONAL AIRPORT

Prepared for:

**PORT OF SEATTLE**
Seattle-Tacoma International Airport
Seattle, Washington 98158

Prepared by:

**PARAMETRIX, INC.**
5808 Lake Washington Blvd. NE, Suite 200
Kirkland, Washington 98033-7350

August 2001

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AR 010082

## EXECUTIVE SUMMARY

The Seattle-Tacoma International Airport (STIA) has updated its Master Plan to meet future aviation needs. This report has been prepared to provide information requested by the U.S. Army Corps of Engineers (ACOE) regarding cumulative effects to wetlands, streams, and habitat as a result of the STIA Master Plan Update. This information also responds to public concerns addressed to ACOE and the Washington Department of Ecology (Ecology) during the recent public comment period. This report analyzes cumulative impacts of past, present, and future actions to wetlands, streams, and the fish, aquatic, and wildlife habitat they provide. The report updates earlier cumulative impact analyses completed in support of the National Environmental Policy Act (NEPA)/State Environmental Policy Act (SEPA), Final Environmental Impact Statement (FEIS) (FAA 1996), and Final Supplemental Environmental Impact Statement (FSEIS) (FAA 1997) for the Master Plan.

Specific information requested by ACOE and addressed in this report relating to cumulative impacts is:

- *What has happened to the Miller Creek, Walker Creek, and Des Moines Creek watersheds in the past?*
- *Estimate the types of impacts that have occurred to the wetlands and streams in the past, from both airport-related construction as well as other development.*
- *How much of the watershed has been developed?*
- *How much impervious surface is in the watershed?*
- *How will the proposed project increase these impacts?*
- *How do any future proposed projects add to these impacts?*
- *What does all of this mean to the watershed?*
- *How does this cumulatively affect the avian populations in the area? [Of particular concern for the watershed is the need to eliminate avian habitat from within 10,000 ft of an active runway.]*

The watersheds of concern have undergone large ecological changes since pioneer settlement beginning in the 1870s. The most dramatic impacts to the natural history of the area would have occurred in the late 1800s and early 1900s, when forestland was clear-cut and much of the watersheds were developed as farmland. These actions would remove wildlife habitat, alter wetlands and streams, and eliminate some wildlife populations. Several larger wetlands were drained to improve soils for farming. Several other wetlands have been mined to extract horticulturally valuable peat.

As the watersheds urbanized, a continued loss of habitat occurred. Urbanization, including airport development and road building, resulted in the filling of some wetland area, as well as the loss of wildlife habitat. Most of this development occurred without environmental mitigation and has contributed to cumulative losses of wetland, stream, and habitat resources.

The development of Seattle-Tacoma International Airport has contributed to wetland, stream, and habitat impacts at levels that appear proportionate to other development that has occurred in the watersheds. While the large footprint associated with the development of airport facilities (constructed primarily between 1946 and 1972) resulted in wetland loss and stream modifications, such losses were also common to many of the private- and public-sector development projects that occurred prior to the establishment of environmental regulations. The need for large buffers as part of noise remedy programs near STIA has resulted in purchase of wetlands associated with agricultural and residential land uses by the Port of Seattle. The removal of these land uses has resulted in the revegetation and preservation of several wetland areas.

The historical impacts to wetlands, streams, and wildlife habitat are typical for urban areas in King County. Clearing of forestland to accommodate agricultural uses has occurred throughout the Puget Sound region. As has occurred in the Miller, Walker, and Des Moines Creek watersheds, the development of agriculture in the region routinely included the modification of wetlands, soil drainage, and stream channel conditions to improve land for crop production. Conversion of forest and agricultural lands to urban uses has occurred throughout the Seattle-Tacoma metropolitan areas. These conversions have included wetland filling, stream channel modifications, watershed hydrology modification, and wildlife habitat loss. In the Miller, Walker, and Des Moines Creek watersheds, these impacts have been similar to other localities. The impacts in these watersheds have been less severe than in many areas (i.e., wetland and tideland filling at the mouths of the Puyallup, Duwamish, and Snohomish Rivers, or wetland fill and stream channelization for commercial development in the lower Green River Valley).

Current and future development (including the STIA Master Plan Update actions) must comply with a variety of environmental regulations affecting wetlands, streams, and habitat. These regulations and substantial mitigation requirements reduce the potential that additional cumulative impacts would occur. For the Master Plan Update projects, wetland, stream, and hydrologic mitigation improves wetland and stream functions by enhancing wetlands and streams and by retrofitting previous development lacking stormwater quality and quantity controls to meet current standards. This mitigation should prevent losses of stream or wetland functions, and provide habitat for wildlife species.

AR 010084

# 1. INTRODUCTION

Implementation of the Seattle-Tacoma International Airport (STIA) Master Plan by the Port of Seattle (Port) will result in the filling of 18.37 acres of wetland and 980 ft of Miller Creek. This report provides information on cumulative impacts to wetlands and streams in the affected watershed to help the U.S. Army Corps of Engineers (ACOE) evaluate the Port Section 404 permit application (Port of Seattle 2000).

Cumulative impacts are defined by the Council on Environmental Quality (1997) and 40 CFR 1508.7 as:

> *...the impact on the environment which results from incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.*

This report has been prepared to provide information requested by ACOE regarding cumulative effects to wetlands, streams, and habitat as a result of the STIA Master Plan Update. This report analyzes information relative to cumulative impacts of past, present, and future actions to wetlands, streams, and the fish, aquatic, and wildlife habitat they provide, and follows guidance provided by the National Transportation Research Board (1998) and the Council on Environmental Quality (1997). This information also responds to public concerns made to ACOE and Washington Department of Ecology (Ecology) during the recent public comment period.

Specific information requested by ACOE (ACOE 2001) and addressed in this report relating to cumulative impacts is:

- *What has happened to the Miller Creek, Walker Creek, and Des Moines Creek watersheds in the past?*
- *Estimate the types of impacts that have occurred to the wetlands and streams in the past, from both airport-related construction as well as other development.*
- *How much of the watershed has been developed?*
- *How much impervious surface is in the watershed?*
- *How will the proposed project increase these impacts?*
- *How do any future proposed projects add to these impacts?*
- *What does all of this mean to the watershed?*
- *How does this cumulatively affect the avian populations in the area? [Of particular concern for the watershed is the need to eliminate avian habitat from within 10,000 ft of an active runway.]*

This report summarizes the existing available information needed to answer these questions. The report is organized in five chapters. Chapter 2 provides an analysis of historic and current land use and impervious area in the watersheds. Chapter 3 evaluates changes in wetland conditions in the watersheds in the project area. Chapter 4 evaluates information on historic and current stream and riparian habitat conditions. Finally, Chapter 5 evaluates past, current, and future impacts to wetland wildlife habitat. A summary of the cumulative effects analysis is provided in Chapter 6.

# 2. LAND USE CHANGES IN THE MILLER AND DES MOINES CREEK WATERSHEDS

The changes in land use near Seattle-Tacoma International Airport and within the Des Moines, Miller, and Walker Creek Watersheds (Figure 1) are presented in this section. The land use information presented in this chapter addresses questions regarding past and current development in the watershed. It also provides a basis for discussions in Chapters 3, 4, and 5 regarding changes and cumulative impacts to wetlands, streams, and habitat within the watersheds.

## 2.1 METHODS AND AVAILABLE DATA

Historical information of the early settlement of the Miller, Walker, and Des Moines Creek watersheds is found in Draper (1975), Eyler and Yeager (1972), Kennedy and Schmidt (1989), and USGS (1900). These documents provide general information on some of the early development that would affect watershed conditions (early roads, settlements, lumber mills, bridges, etc.). Due to the anecdotal nature of much of this information relative to the concerns of ACOE, it could not be used as a significant source of information.

More detailed land use changes were determined based on existing information from a variety of sources. The primary data sources used in this report documenting current and historical land use conditions in the watersheds are:

- *Sea-Tac Airport Vicinity Land Use Inventory Project* (prepared by Shapiro and Associates [1994] for the Port of Seattle Aviation Planning Division).
- *King County GIS Land Use Data Base (1995)* (available from King County).
- *1936 Aerial Photographs* (available from Walker and Associates).
- *Soil Survey, King County Washington* (USDA 1952).
- *Habitat Limiting Factors and Reconnaissance Assessment Report: Green Duwamish and Central Puget Sound Watersheds (Land Use Appendix).* King County and Washington State Conservation Commission (2000).
- *Comprehensive Stormwater Management Plan STIA Master Plan Update.* Parametrix (2000a).
- *Land Use Layer, King County Geographical Information System (GIS).* King County Washington.

Historical land use data from Shapiro and Associates (1994) provides analysis of land use changes from 1948 to 1992 (Table 1; Figures 2 through 6). These data were based on review of aerial photographs for an analysis area that includes much of the Miller, Walker, and Des Moines Creek watersheds. Land use categories used in this assessment were:

- **Airports.** STIA and King County International Airport (Boeing Field).
- **Commercial/industrial.** Includes railroad yards, landfills, and other commercial or industrial facilities.
- **Community and public facilities.** Schools, hospitals, cemeteries, park-and-ride lots, government buildings, and other government facilities.

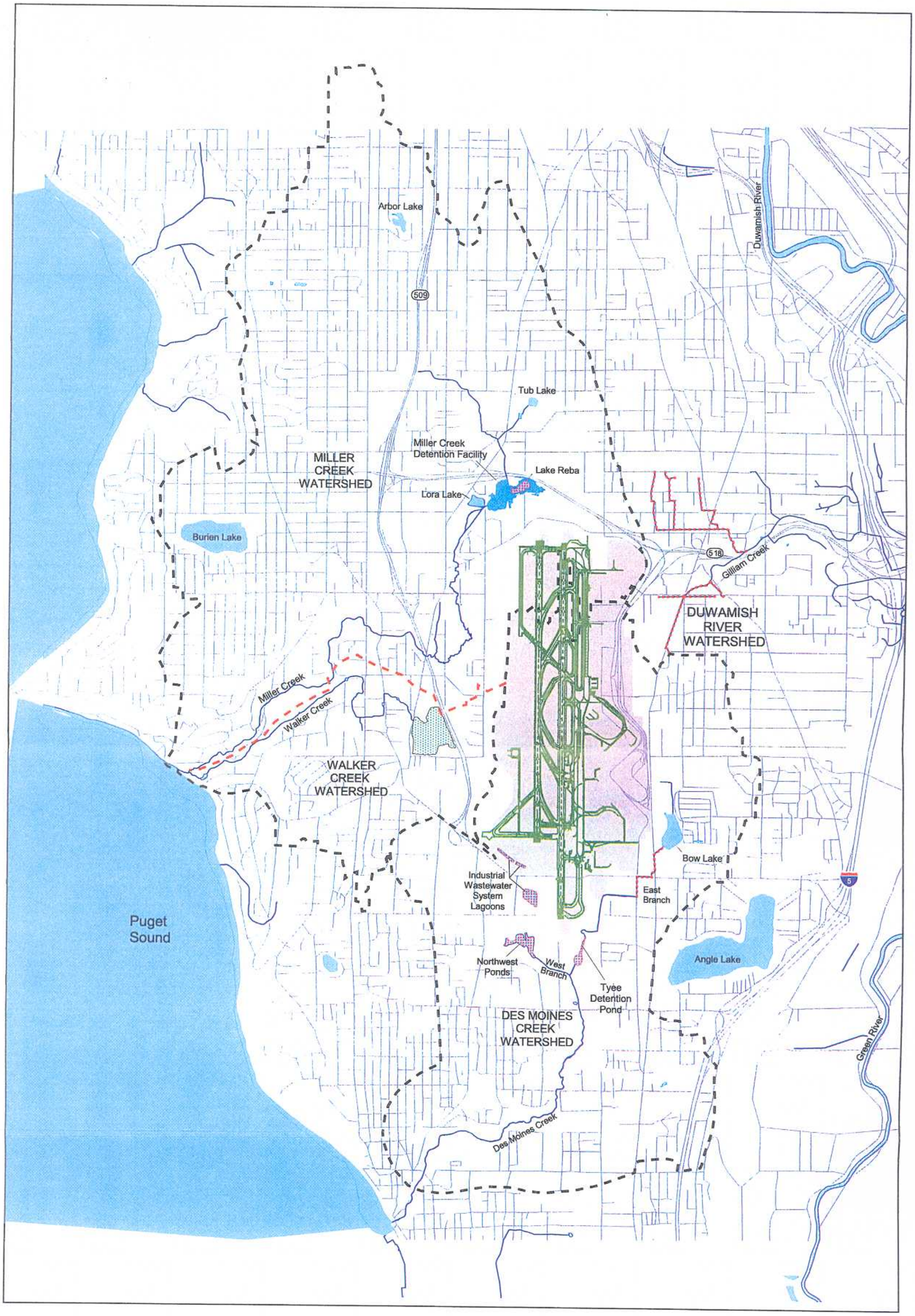
**Table 1. Historical land uses near Seattle-Tacoma International Airport from 1948 to 1992.**

| | Residential | | Undeveloped | | Commercial | | Public Facilities | | Other[b] | | Airports[c] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Acres | Percent[a] | Acres | Percent[a] | Acres | Percent[a] | Acres | Percent[a] | Acres | Percent[a] | Acres | Percent[a] |
| 1948 | 7,255 | 24.4 | 19,945 | 67.3 | 555 | 1.9 | 165 | 0.5 | 730 | 2.5 | 1,000 | 3.4 |
| 1961 | 11,770 | 39.7 | 11,510 | 38.8 | 1,980 | 6.7 | 655 | 2.2 | 2,075 | 7.0 | 1,660 | 5.6 |
| 1974 | 12,855 | 43.4 | 7,545 | 25.4 | 2,800 | 9.4 | 780 | 2.6 | 2,780 | 9.4 | 2,890 | 9.8 |
| 1982 | 13,490 | 45.5 | 5,360 | 18.1 | 3,500 | 11.8 | 780 | 2.6 | 3,310 | 11.2 | 3,210 | 10.8 |
| 1992 | 14,685 | 49.5 | 4,955 | 16.7 | 3,750 | 12.6 | 815 | 2.8 | 2,065 | 7.0 | 3,380 | 11.4 |

[a] Percent of a 29,650-acre study area, as summarized in Shapiro and Associates (1994).

[b] Includes other land uses, undetermined land uses, major road rights-of-way, and transmission line rights-of-way.

[c] Includes STIA and Boeing Field.



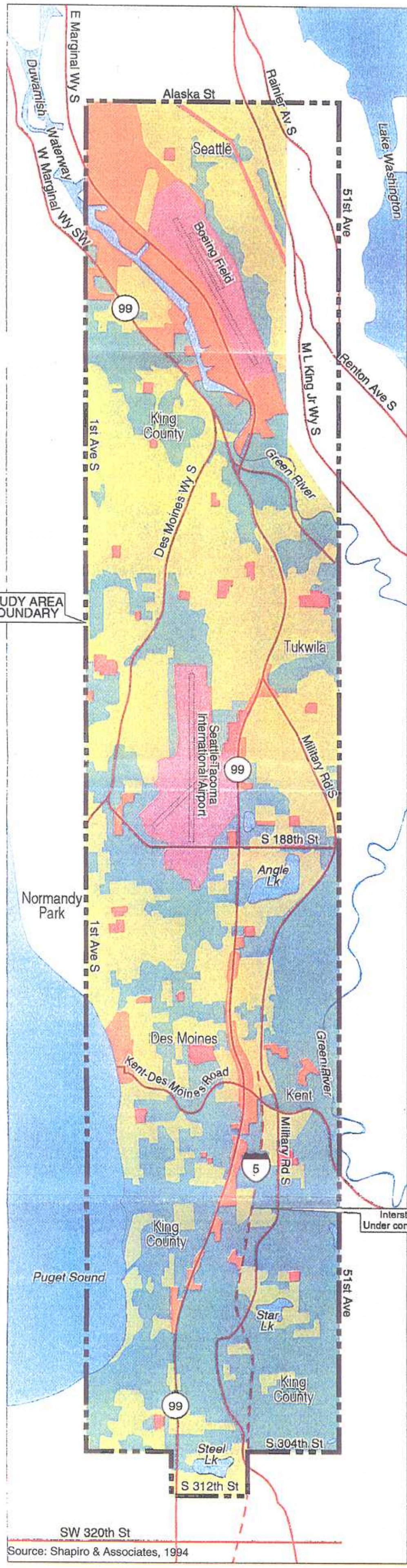

Parametrix, Inc. Sea-Tac Airport /556-2912-001 File: K:\Gis\2912\Arcview\seatac_4_jimkelley.apr
Source: Roads based on King County data. Water bodies derived from USGS hypsography data.
Detention boundaries are approximate. Estimated wetland boundaries are based on field reconnaissance by Parametrix, Inc.

N

1000 0 1000 2000 Feet

Roads
Streams
Subwatershed Boundary
Watershed Boundary
Piped Stream
Constructed Water Feature
Water Bodies
Detention Facilities (existing)
Wetland 43
Sea-Tac Airport
Sea-Tac Airport Runway

**Figure 1**
**Miller Creek, Walker Creek Des Moines Creek and their Watershed Boundaries**




N

SCALE IN FEET

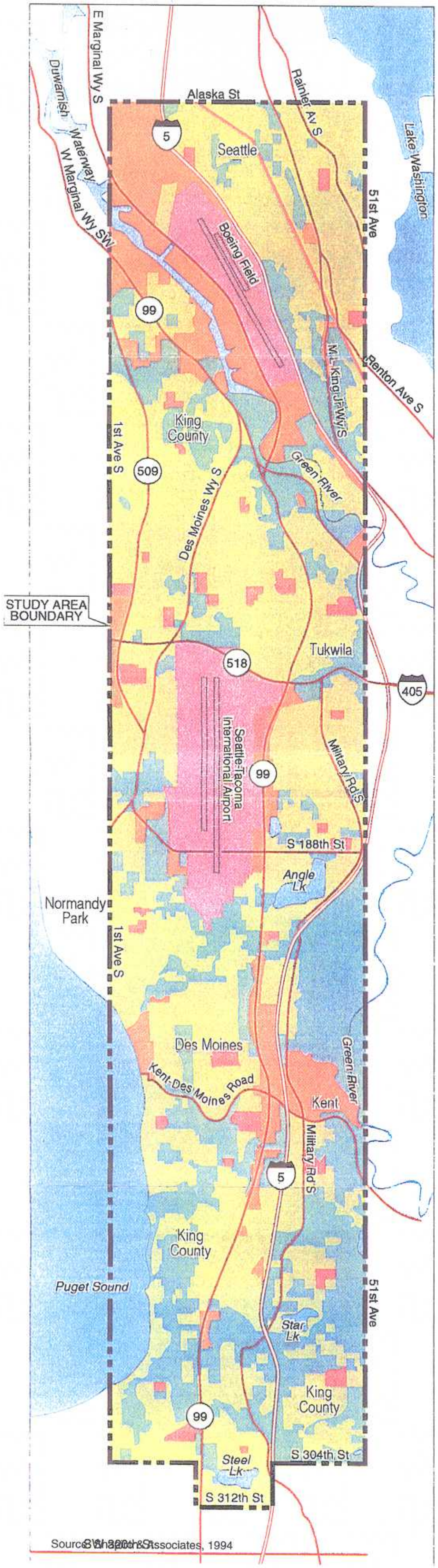
0 3,250 6,500

**LEGEND:**

- Residential
- Commercial/Industrial
- Public Facility
- Airport
- Open Space
- Portion of Study Area Not Included on Aerial Photograph

**Parametrix, Inc.** Cumulative Impact Report 556-2912-001/01(03) 7/01 (K)

**Figure 2**
**Land Use Near STIA in 1948**



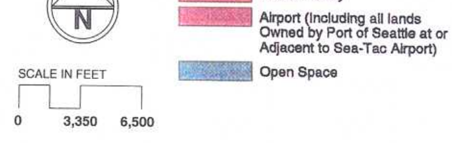
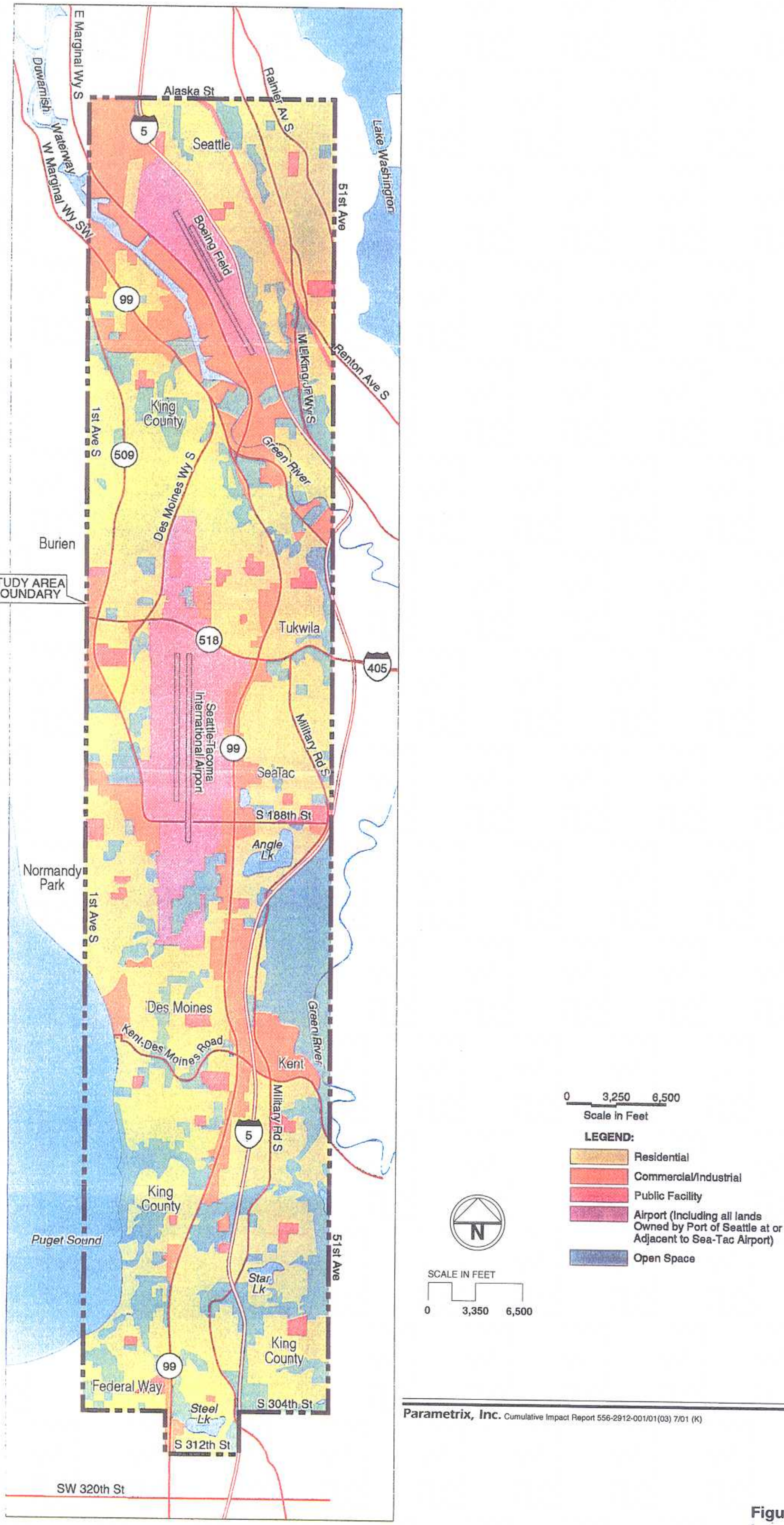





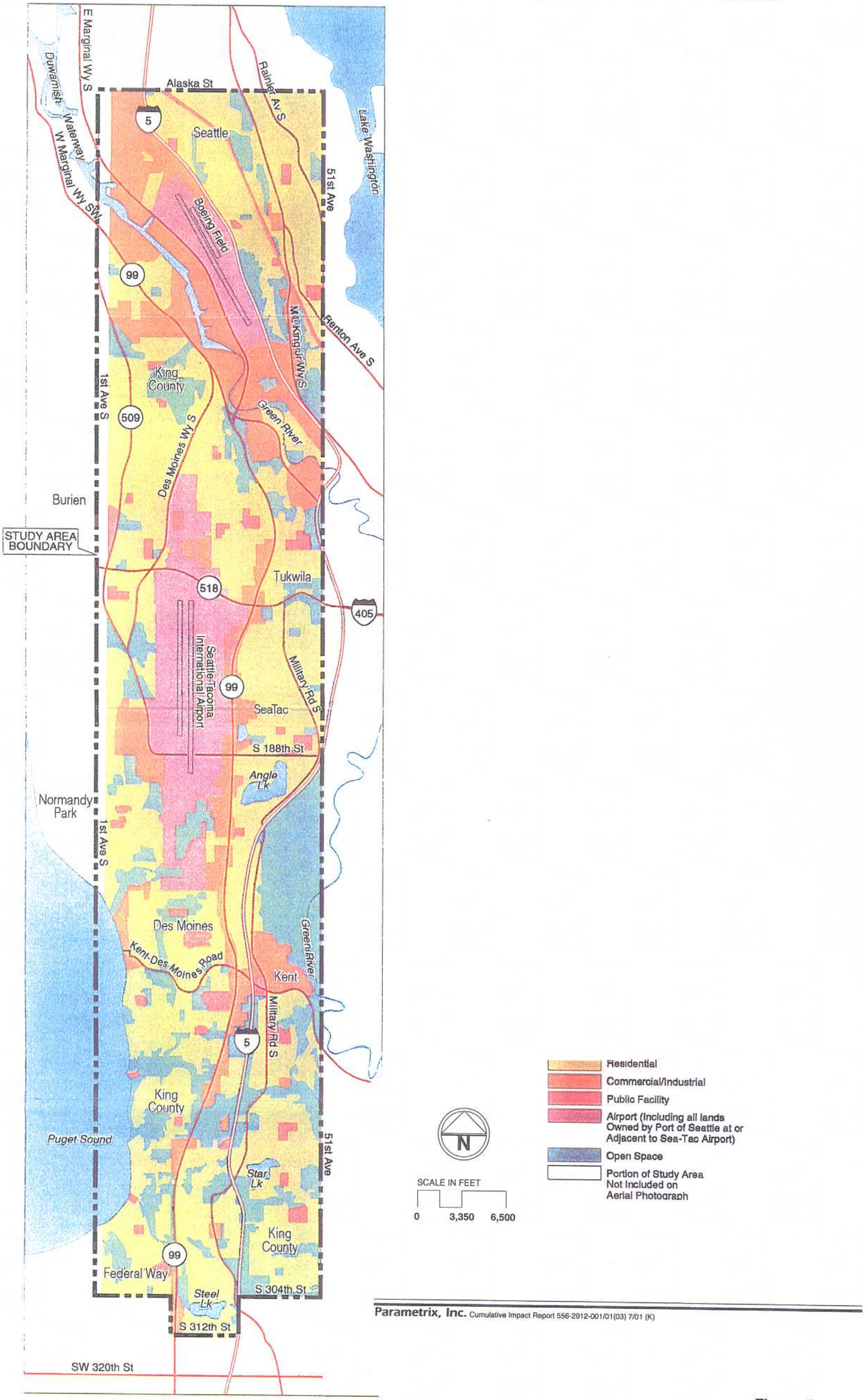

**Figure 3**
**Land Use Near STIA in 1961**




Source: Shapiro & Associates, 1994



**Figure 4**
**Land Use Near STIA in 1974**

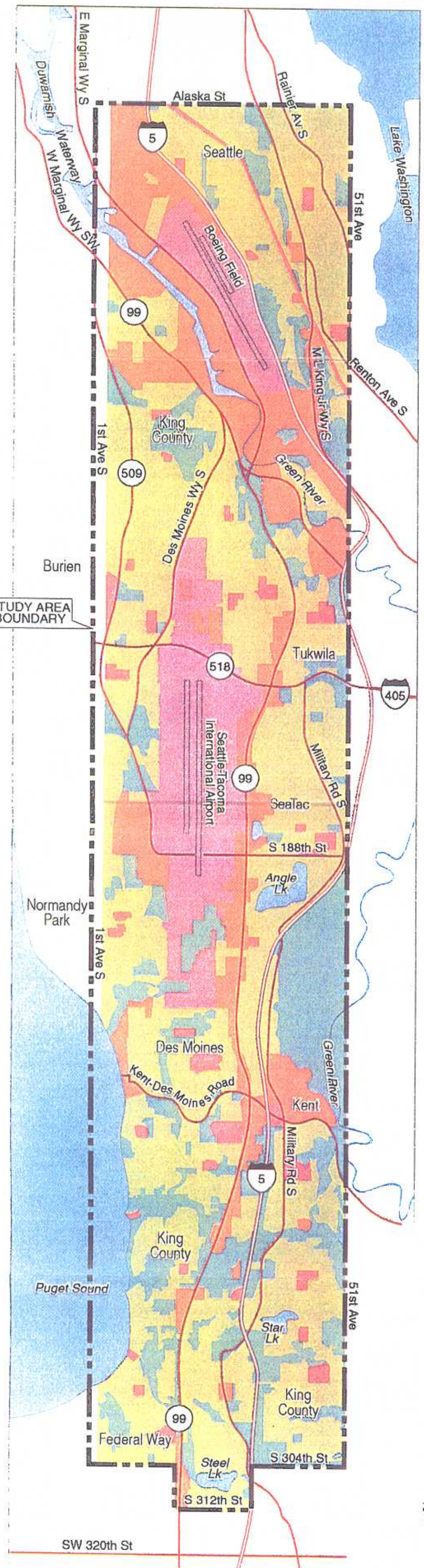



Parametrix, Inc. Cumulative Impact Report 556-2912-001/01(03) 7/01 (K)

Source: Shapiro & Associates, 1994

**Figure 5**
**Land Use Near STIA in 1982**

AR 010092




Source: Shapiro & Associates, 1994

**LEGEND:**

- Residential
- Commercial/Industrial
- Public Facility
- Airport (Including all lands Owned by Port of Seattle at or Adjacent to Sea-Tac Airport)
- Open Space
- Portion of Study Area Not Included on Aerial Photograph

N

SCALE IN FEET

0 3,350 6,500



**Figure 6**
**Land Use Near STIA in 1992**

- **Open space/agriculture.** Agriculture activity, parks, golf courses, lakes. Excludes parcels where roads and cleared land indicate development is occurring.
- **Community and public facilities.** Schools, hospitals, cemeteries, park-and-ride lots, government buildings, and other government facilities.
- **Residential.** Land settles at varying densities; includes land where roads and clearing indicate development is occurring.
- **Other.** Major arterial and freeway right-of-way; transmission line corridors; other land uses not included in the above categories; undetermined land use.

Land use data for 1995 are available from King County (Figure 7), and are also reported in King County and Washington State Conservation Commission (2000). The 1995 land use data are specific to the Miller Creek (Table 2) and Des Moines Creek (Table 3) watersheds. The King County data for the watershed areas do not correspond to the study area for historical data available from Shapiro and Associates (1994). The classification system for land use data in the King County GIS also differs from historical data, but provides a more detailed analysis of land uses. Thus, direct and quantitative comparisons are not possible.

While historical land use is an indicator of watershed development and changes to wildlife habitat, impervious surfaces (pavement, rooftops, etc.) are indicators of potential hydrologic impacts that can degrade fish and other aquatic habitats. Impervious surfaces generate increased stormwater runoff, and if not adequately managed can impact the hydrology and water quality of receiving waters. The current extent of impervious surfaces in the watersheds is identified in Table 4. This table also includes analysis of the new impervious surfaces created by the Master Plan Update projects. Since much of this impervious surface lacks adequate stormwater management controls for water quality treatment and release, it contributes cumulatively to stream impacts.

**Table 2. Current land uses (1995) in the Miller Creek watershed.**

| Land Cover Description | Area ($Mi^2$) | Area (Acres) | % Watershed |
|---|---|---|---|
| Industrial & Commercial | 1.074 | 687.36 | 12.10 |
| Bare Rock/Concrete | 0.044 | 28.29 | 0.50 |
| City Center, Industrial | 0.502 | 321.20 | 5.65 |
| Recently Cleared | 0.059 | 37.81 | 0.67 |
| High-Density Residential | 3.431 | 2,195.82 | 38.64 |
| *Subtotal* | *5.11* | *3,270.48* | *57.56* |
| **Low/Medium Density Residential** | **2.516** | **1,610.39** | **28.34** |
| **Conifer - Early** | **0.002** | **1.54** | **0.03** |
| **Conifer - Mature** | **0.000** | **0.00** | **0.00** |
| **Conifer - Middle** | **0.000** | **0.00** | **0.00** |
| **Deciduous Forest** | **0.669** | **428.46** | **7.54** |
| **Mixed Forest** | **0.093** | **59.61** | **1.05** |

AR 010094

**Table 2. Current land uses (1995) in the Miller Creek watershed (continued).**

| Land Cover Description | Area ($Mi^2$) | Area (Acres) | % Watershed |
|---|---|---|---|
| **Grass - Brown** | **0.236** | **150.92** | **2.66** |
| **Grass - Green** | **0.095** | **60.54** | **1.07** |
| **Shrub** | **0.108** | **69.21** | **1.22** |
| **Open Water** | **0.049** | **31.57** | **0.56** |
| *Subtotal* | *3.768* | *2,412.24* | *42.47* |
| TOTAL | 8.879 | 5,682.71 | 100 |

Notes: Data compiled from King County Geographic Information System (GIS) data set based on 1995 Landsat satellite imagery.

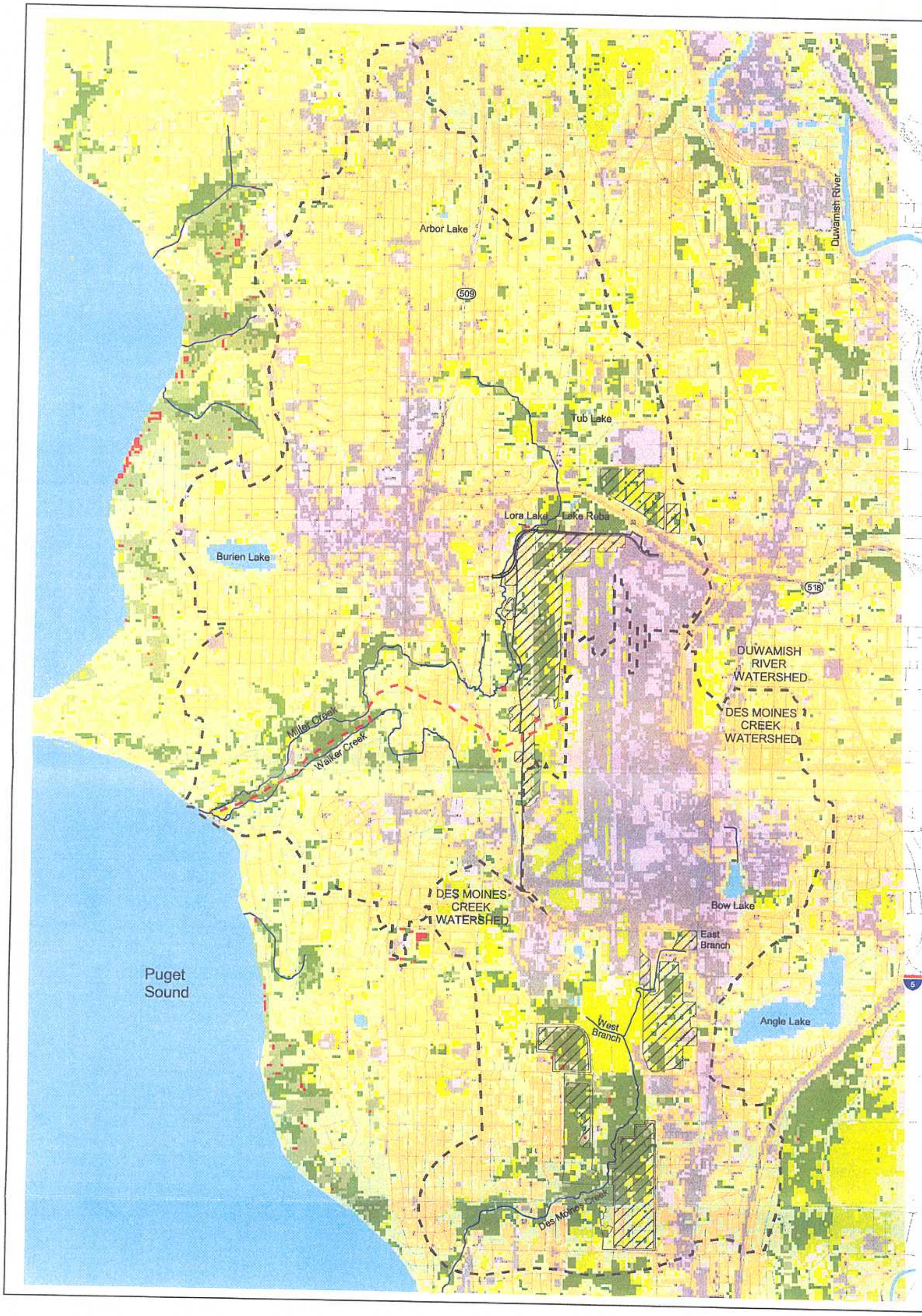
Land uses listed in **bold** are types that are considered to provide low (residential and grass) to moderate or high (remaining types) habitat value to a variety of wildlife (see Chapter 5).

**Table 3. Current land uses (1995) in the Des Moines Creek watershed.**

| Land Cover Description | Area ($Mi^2$) | Area (Acres) | % Watershed |
|---|---|---|---|
| Industrial & Commercial | 1.373 | 878.47 | 23.43 |
| Bare Rock/Concrete | 0.056 | 35.71 | 0.95 |
| City Center, Industrial | 0.600 | 384.14 | 10.25 |
| Recently Cleared | 0.135 | 86.37 | 2.30 |
| High-Density Residential | 1.415 | 905.54 | 24.16 |
| *Subtotal* | *3.579* | *2290.23* | *61.09* |
| **Low/Medium Density Residential** | **1.043** | **667.67** | **17.81** |
| **Conifer - Early** | **0.001** | **0.93** | **0.02** |
| **Conifer - Mature** | **0.000** | **0.00** | **0.00** |
| **Conifer - Middle** | **0.000** | **0.00** | **0.00** |
| **Deciduous Forest** | **0.567** | **362.84** | **9.68** |
| **Mixed Forest** | **0.067** | **42.61** | **1.14** |
| **Shrub** | **0.099** | **63.30** | **1.69** |
| **Grass - Brown** | **0.369** | **236.45** | **6.31** |
| **Grass - Green** | **0.114** | **73.02** | **1.95** |
| **Open Water** | **0.018** | **11.74** | **0.31** |
| *Subtotal* | *2.278* | *1458.56* | *38.91* |
| TOTAL | 5.857 | 3,748.77 | 100 |

Note: Data compiled from King County Geographic Information System (GIS) data set based on 1995 Landsat satellite imagery.

Land uses listed in **bold** are types that are considered to provide low (residential and grass) to moderate or high (remaining types) habitat value to a variety wildlife (see Chapter 5).




Parametrix, Inc./Sea-Tac Airport /556-2912-001 File: K:\Gis\2912\Arcview\seatac_4_jimkelley
Source: Roads based on King County data. Water bodies derived from USGS hypsography data.
Land Use data interpreted from the 1995 Landsat Satellite Imagery, (pixel size 82 feet).

N

1000 0 1000 2000 Feet

1:36,000

Streams
Watershed Boundary
Subwatershed Boundary
Water Bodies
Bare Ground, Asphalt or Concrete
Recently Cleared
High Intensity Development
Medium Intensity Development
Low Intensity Development
Coniferous Forest
Mixed Forest
Deciduous Forest
Shrub
Grass
Master Plan Projects

**Figure 7**
**King County Land Use Data in the Vicinity of STIA - 1995**

AR 010096

**Table 4. Effective impervious area in the Miller and Des Moines Creek watersheds in 1994 and predicted effective impervious area by 2006 with Master Plan Update improvements.**

| Year | Sub-Watersheds | Miller/Walker Creek Area | Miller/Walker Creek Percent | Des Moines Creek Area | Des Moines Creek Percent |
|---|---|---|---|---|---|
| **1994 Condition** | STIA Land | 283.65 | 5.0 | 624.54 | 16.6 |
| | Remaining Watershed | 787.69 | 13.9 | 627.93 | 16.8 |
| | **TOTAL** | **1,071.31** | **18.8** | **1,286.03** | **34.3** |
| **2006 Condition** | STIA Land | 397.75 | 7.0 | 848.84 | 22.6 |
| | Remaining Watershed | 787.96 | 13.9 | 627.93 | 16.8 |
| | **TOTAL** | **1,185.71** | **20.9** | **1,476.77** | **39.4** |

Note: Data source is Parametrix (2000b). Effective impervious area is the impervious area that actually drains to stormwater collection systems or surface water, thereby generating hydrologic impacts. Impervious areas that direct stormwater away from collection systems to pervious land where infiltration occurs are not included in effective impervious area.

AR 010097

# 3. WETLANDS

## 3.1 LOCATIONS OF WETLANDS

To evaluate the past and current extent of wetlands in the Miller, Des Moines, and Walker Creek watersheds, historic and recent aerial photographs, soil survey maps, topographic maps, and wetland inventories were examined (wetlands and hydric soils near STIA are shown in Figures 8, 9, and 10).

### 3.1.1 Wetland Inventories

A variety of wetland inventories provide general information on the location of wetlands in the various watersheds. The wetland inventory maps were reviewed and include:

- Historic USGS Topographic Maps (USGS 1900, 1949, 1983) (Appendix A)
- King County Sensitive Areas Map (1990)
- City Sensitive Areas Maps (available at City Planning Departments):
  - SeaTac
  - Burien
  - Tukwila
  - Des Moines
  - Normandy Park
- National Wetland Inventory Map (Des Moines and Seattle South Quadrangles) (USFWS 1987)

Examination of these inventories found no wetland areas that are not previously mapped or identified as hydric soil areas (see Section 3.1.2).

### 3.1.2 Soil Survey Maps

Soil surveys and aerial photographs were used to evaluate historic (i.e., mid 1930s) and current (i.e., mid 1990s) wetland conditions in the project vicinity. Soil surveys map and classify soil types according to general physical, chemical, and environmental properties. These surveys typically identify the general drainage properties of soils, including poorly drained wetland soils, and describe soil types that are now classified by the Natural Resources Conservation Service as hydric or non-hydric (NRC 2000). Although subject to some limitations (see below), soil surveys can be used to evaluate the location and extent of hydric soils which typically are potential wetlands. For King County, soil surveys were published in 1952 (USDA 1952) and 1972 (USDA SCS 1973). The 1972 soil survey excluded detailed mapping of the Miller, Walker, and most of the Des Moines Creek watersheds because a large percentage of the area was developed in 1972 and is no longer of special interest to the Department of Agriculture[1].

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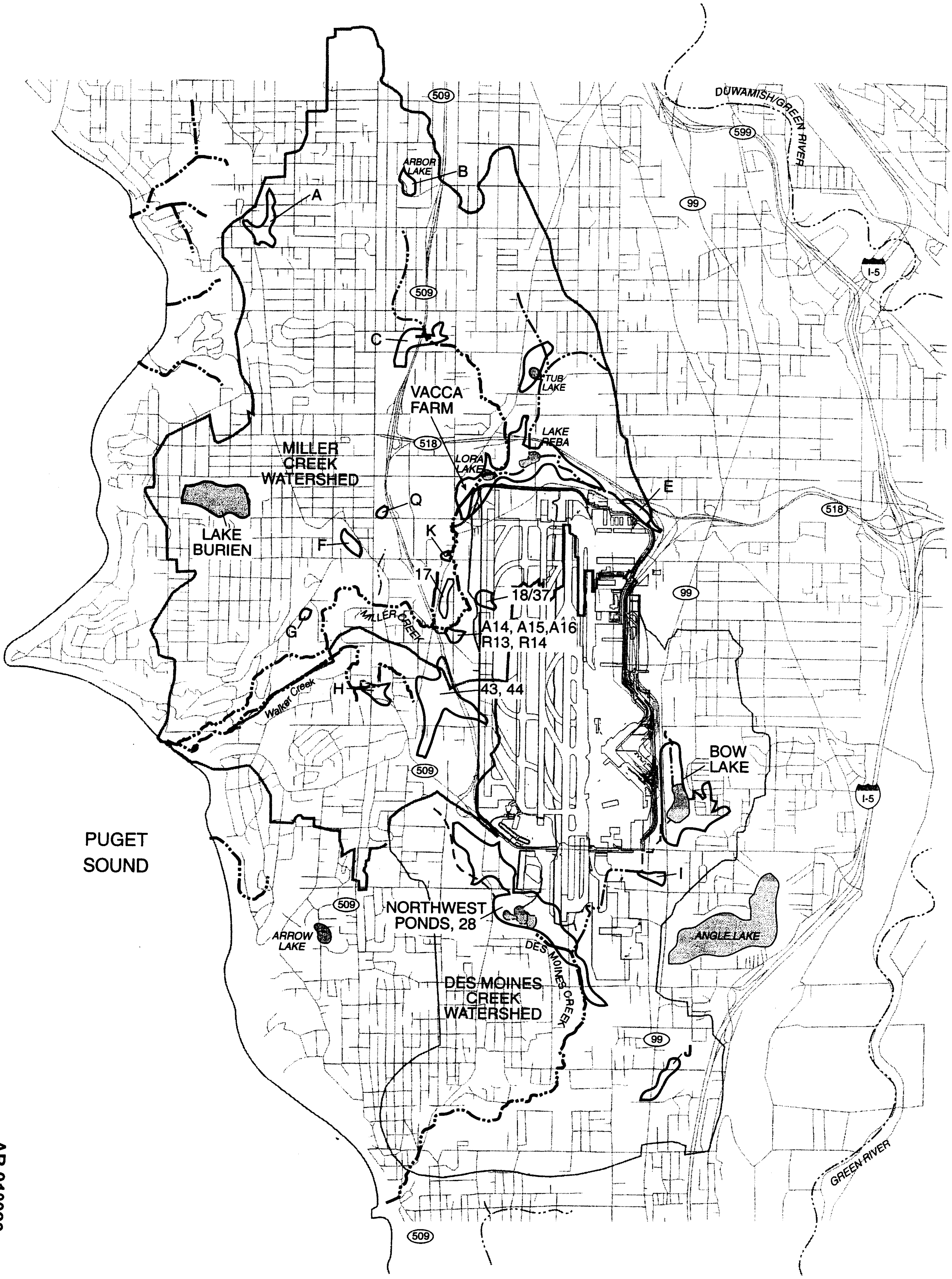
[1]Soil surveys were completed primarily to assist in developing sound and profitable agricultural operations, and as agricultural areas began to urbanize, the soil survey information was no longer updated.




AR 010099

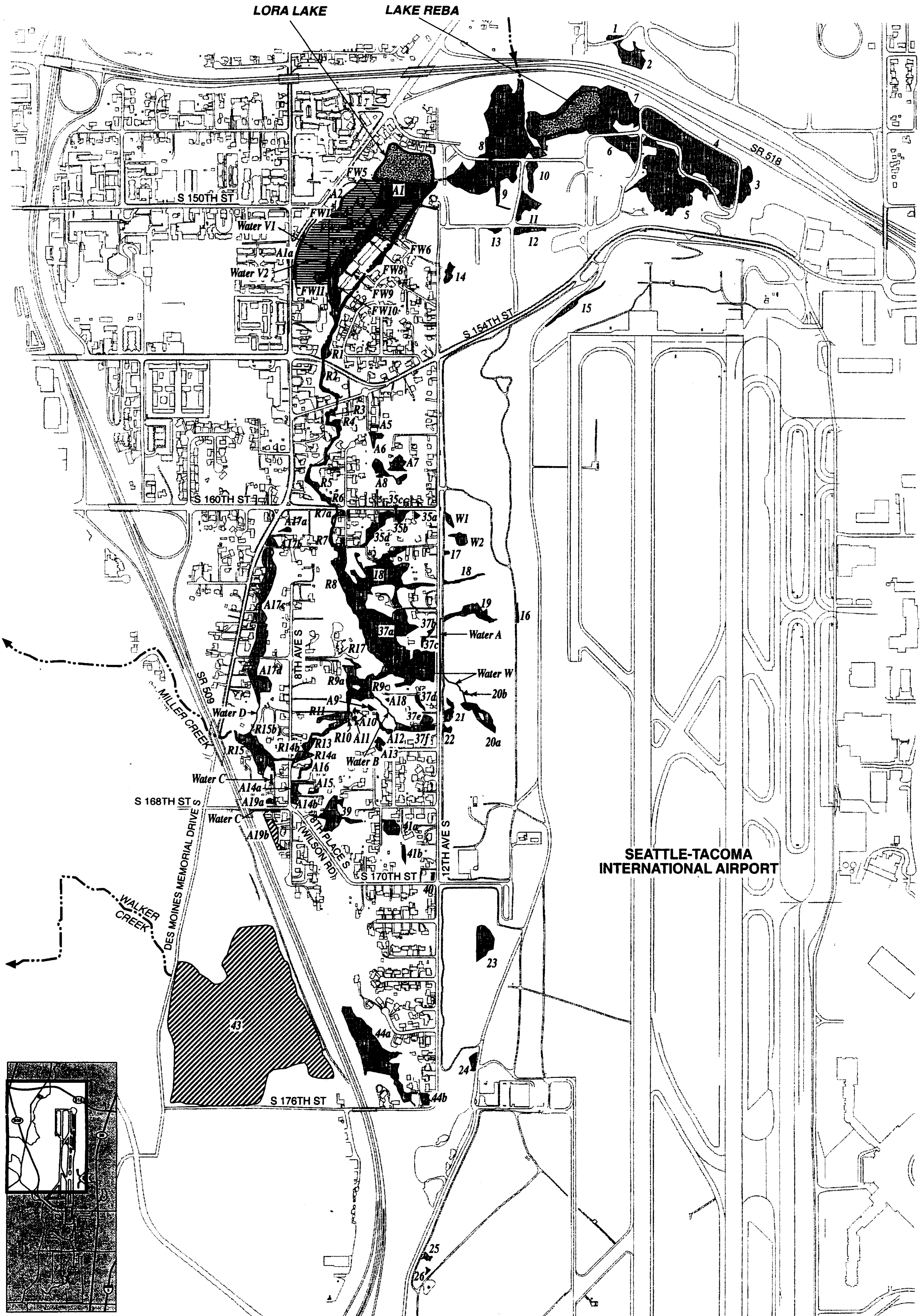


Watersheds Boundary
Stream
Piped Stream
Hydric Soil and Wetland Name
Lake

SCALE IN FEET
0 1500 3000

N

**Figure 8**
**Hydric Soils in the Des Moines Creek, Miller Creek, and Walker Creek Watersheds (1952)**




Note: Updated GIS coverage 11/30/00

**Parametrix, Inc.** Cumulative Impact Report/556-2912-001/01(03) 7/01 (K)

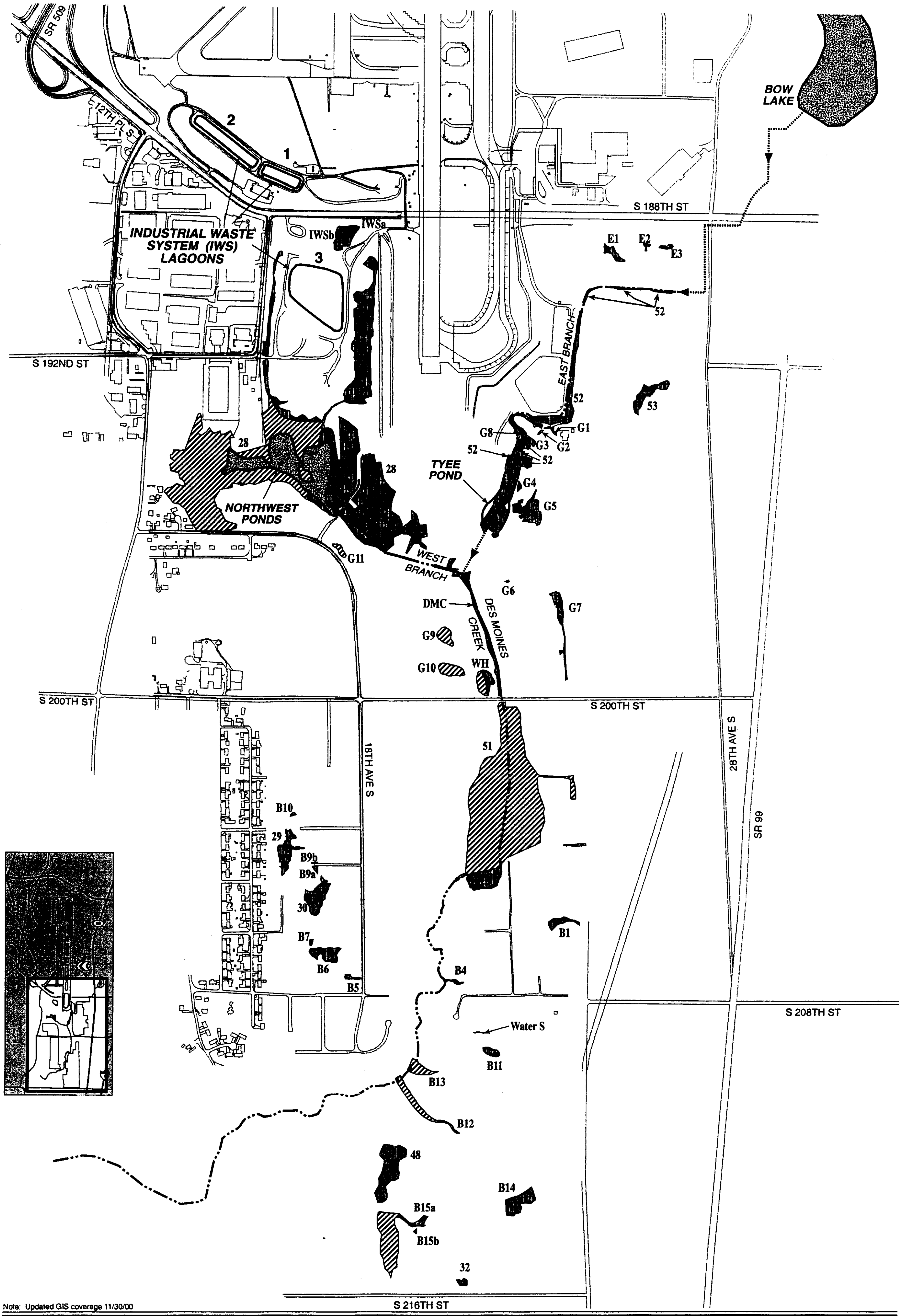
- Water Features
- Delineated Wetlands Verified by ACOE
- Wetlands Not Verified by ACOE
- Prior Converted Cropland
- Stream
- *41a* Wetland Number

SCALE IN FEET
0 400 800

N

**Figure 9**
**Wetlands in the Miller Creek Basin Near STIA**

AR 010100




AR 010101

Note: Updated GIS coverage 11/30/00

**Parametrix, Inc.** Cumulative Impact Report/556-2912-001/01(03) 7/01 (K)

Water Features

Delineated Wetlands Verified by the ACOE

Stream

B12 Wetland Number

Excavation Area

Wetlands not Verified by the ACOE

Piped Stream

SCALE IN FEET

0 400 800

N

**Figure 10**
**Wetlands in the Des Moines Creek Basin Near STIA**

Soil surveys and wetland soil maps are generalized and prepared at a scale insufficient to map all areas that meet wetland criteria. The 1952 King County survey maps soil types on 1:63,360 scale maps (1 inch = 1 mile). At this scale, an acre would be mapped as a square 0.4- x 0.4-inches, and thus the irregular shape and size of even moderate sized wetlands cannot be accurately represented.

In addition, soil surveys do not attempt to map all wet soil areas. In particular, inclusions of wetland soils in non-hydric soils are not generally mapped separately. For example, Poulson (USDA 1952) describes the Alderwood soil-mapping unit (the most common soil type in the three watersheds of concern) as containing between 2 and 15 percent poorly drained soils (potential wetland soil types). The amount of poorly drained soil inclusions found in the Alderwood soil type depends on the slope of the area, with the greatest amounts occurring on flatter terrain:

- Up to 15 percent poorly drained soils on 0 to 6 percent slopes.
- Up to 3 percent poorly drained soils on 6 to 15 percent slopes.
- Up to 2 percent poorly drained soils on 15 to 30 percent slopes.

The preparation of soil maps for the *Soil Survey of King County, Washington* (USDA 1952) (see Figure 8, and Appendix B) were begun in 1937. Fieldwork for the survey is reported as being completed in 1937 and 1938[2], and predates the construction of STIA. The soil survey map was assembled from aerial photographs, and generally does not map the now-developed portion of STIA as containing hydric soil (potential wetlands). It is probable the 1936 aerial photographs examined as part of this report (see Section 3.1.4) were printed from the same negatives used to create the USDA (1952) soil survey. The soil survey would not be expected to accurately map the precise area of all wetlands (especially smaller wetlands), as discussed above. It is possible special attention was made to poorly drained soils in preparation of the survey, as these wetland soils are, when properly drained, some of the most productive agricultural soils. They would have been of special interest in identifying the agricultural capabilities of the region.

The soil survey maps several small areas of hydric soils that are known to correspond to small wetlands. However, the survey map is not expected to identify all wetlands, nor to represent a wetland delineation because wetland delineation criteria were not considered at the time the map was made. Soil types are generally mapped based on general morphology that may not correlate to specific hydric soil criteria. Further, neither wetland vegetation nor wetland hydrologic conditions are thoroughly considered when mapping soils.

### 3.1.3 Mapped Peat Resources

Several of the larger wetland areas in the vicinity of STIA were mapped as peat resources by Rigg (1958). Peat lands identified in the 1958 study include:

- Sunnydale Peat Area (Tub Lake) – 26 acres
- Miller Creek Peat Area (Vacca Farm/Lake Reba area) – 56 acres
- Bow Lake Peat Area – 36 acres

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[2] See notes on soil survey maps included in USDA (1952).

Changes in these peat lands from 1936 to 1995 were evaluated by examining the aerial photographs for changes in vegetation and land use within the peat lands. In addition, changes in land use and vegetation adjacent to the peat lands were noted (see Section 3.1.4).

### 3.1.4 Aerial Photographs

A variety of historical aerial photographs is available for the Miller, Walker, and Des Moines Creek watersheds. These photographs were examined to evaluate changes to wetlands over time and to generally understand the changes in watershed conditions over time. Photographs from four general time periods were evaluated in detail to describe stream and wetland conditions (Table 5):

- Photographs taken prior to any airport development (1936)
- Photographs taken shortly after development of STIA (1948-1947)
- Photographs taken prior to second runway construction (1961)
- Photographs taken in 1995

**Table 5. Dates of aerial photographs reviewed for the cumulative effect analysis.**

| | | Scale | |
|---|---|---|---|
| **Year** | **Date** | **1 Inch Equals (ft)** | **Ratio[a]** |
| 1936 | June 19 and 23 | 806 | 1:9,675 |
| 1948 | Unknown | 972 | 1:11,664 |
| 1961 | August 7 | 400 | 1:4,800 |
| 1965 | May 11 | 3,900 | 1:46,920 |
| 1970 | Unknown | 400 | 1:4,800 |
| 1972 | August 30 | 1,890 | 1:22,690 |
| 1979 | June 26 | 2,080 | 1:24,960 |
| 1985 | August 14 | 1,970 | 1:23,636 |
| 1995 | April 28 | 400 | 1:4,800 |
| 1995 | April 25 | 920 | 1:11,025 |

[a] Scales are approximate and may vary within or between photographic images.

The historic wetlands in the project area identified from soil survey maps and the 1936 aerial photographs are described in Table 6 (see also Figure 8). The photographic sequence from 1936 to 1995 was then examined, using general methods described in Lillesand and Kiefer (1979) to identify vegetation and land use in wetlands from 1936 to 1995. Major changes from 1936 to 1995 in wetland vegetation and land use, as well as land use surrounding the wetlands are described in Tables 7 to 24.

**Table 6. Historic wetlands occurring in the Seattle-Tacoma International Airport project area.**

| Wetland | Vegetation Types | Soil Types |
|---|---|---|
| Wetland A | Open Water<br>Farmland | Carbondale Muck<br>Norma Fine Sandy Loam |
| Wetland B | Open Water<br>Shrub<br>Forest | Greenwood Peat |
| Wetland C | Open Water<br>Farmland | Norma Fine Sandy Loam |
| Wetland D | Forest<br>Farmland | Norma Fine Sandy Loam |
| Tub Lake | Open Water<br>Shrub<br>Forest | Greenwood Peat |
| Wetland E | Forest | Rifle Peat |
| Wetland F | Forest<br>Shrub<br>Farmland | Norma Fine Sandy Loam |
| Wetlands 1-14, A1<br>(Vacca Farm, Lake Reba) | Farmland | Rifle Peat<br>Carbondale Muck<br>Norma Fine Sandy Loam |
| Wetland G | Forest<br>Shrub<br>Farmland | Norma Fine Sandy Loam |
| Wetland H | Farmland | Mukilteo Peat |
| Wetlands 18, 37, and 20 | Forest<br>Farmland | Norma Fine Sandy Loam |
| Wetland A17, K | Farmland | Norma Fine Sandy Loam |
| Wetlands R14, R15 | Farmland | Norma Fine Sandy Loam |
| Wetlands 43, 44 | Farmland | Rifle Peat |
| Wetland I | Farmland | Norma Fine Sandy Loam |
| Bow Lake | Open Water<br>Shrub<br>Forest<br>Farmland | Rifle Peat<br>Bellingham Silty Clay |
| Wetland J | Forest<br>Shrub<br>Farmland | Carbondale Muck |
| Wetland 28 - Tyee Golf Course | Forest<br>Shrub<br>Farmland | Norma Fine Sandy Loam<br>Bellingham Silty Clay<br>Carbondale Muck |
| Lake Burien | Open Water | - |

Note: Wetlands, wetland vegetation types, and soil types were identified on the 1952 King County soil survey (USDA 1952) and 1936 aerial photographs. Wetlands are identified in this table and Figures 9 and 10 as follows: (1) for wetlands identified in the *Wetland Delineation Report* (Parametrix 2000a), the wetlands are named according to that report; (2) for wetlands that are not included in the delineation report, the wetlands are given letter designations. Wetland vegetation types were identified from the 1936 aerial photographs and were classified by Cowardin (Cowardin et al. 1979) wetland classes. Soil types were identified from the 1952 soil survey.

Table 7. **Changes to Wetland A (located near Ambaum Boulevard and 128th Street South) between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | The wetland is farmed and ditched. Surface water is present in the southeast portion of the wetland; it appears to result from excavation for a farm pond. Farmland, farm buildings, and houses border all areas except the northeast side of the wetland. The northeast side of the wetland is bordered by forestland. |
| 1948 | Conditions are generally similar to those of 1936. The farm pond has been enlarged. |
| 1961 | The north part of the wetland has been filled for school buildings, parking lots, and play fields. The south part of the wetland includes orchards, agricultural land, shrub wetland, and a farm pond. |
| 1995 | The majority of this wetland has been filled for a parking lot, buildings, and sports fields. It appears that two rectangular portions of the wetland remain. The wetland consists of abandoned agricultural land, and is vegetated with emergent and forest vegetation. |

Table 8. **Changes to Arbor Lake (near 3rd Avenue South and South 124th Street) and adjacent wetlands between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | The wetland contains forest, shrub, emergent, and open water wetland communities. The wetland is located in a well-defined basin. Roads are located on the south and west sides of the wetland. In most places, the bordering uplands have been recently logged and consist of early stage forest regeneration. A fringe of trees and shrub vegetation borders the wetland. |
| 1948 | The area surrounding this wetland has been developed with houses, and portions of the north and south sides of the wetland have been filled. Greater amounts of open water are present compared to 1936 and it appears that emergent vegetation was removed from portions of the wetland, forming a small lake. |
| 1961 | Conditions are generally similar to 1948. |
| 1995 | Additional areas bordering the lake (including wetlands) have been developed as a park. Vegetation in the park consists of lawn with trees fringing the shoreline. Residential development is located adjacent to the park. |

Table 9. **Changes to vegetation and land use in Wetland C (located near SR 509 and South 140th Street) between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | This wetland is mapped as the source of a tributary to Miller Creek. The wetland occurs on a broad ravine that is farmed. The upland areas surrounding the wetland are farmland or recently harvested forestland, and there is little woody vegetation present. Several farms and houses occur near the perimeter of the wetland. The area at the northern section is in row crops, pasture, and housing. It appears that a portion has been filled for a house. |
| 1948 | Land use in and surrounding the wetland is largely agriculture, but there is an increase in the number of barns, houses, and outbuildings. |
| 1961 | Land use in the wetland is largely agriculture. Increasing amounts of adjacent upland areas have been developed. Some areas of farmland appear abandoned and may be revegetating with shrub vegetation. |
| 1995 | Upland areas surrounding the wetland are developed with residential, school, and commercial buildings. Much of the original wetland was filled as part of this development. The State Route (SR) 509 road fill bisects the wetland. Remaining areas consist of fragments of forest-, shrub-, and grass-dominated wetlands. A narrow and fragmented riparian corridor occurs along a stream channel that flows to the southeast. Between South 144th Way and Des Moines Memorial Drive, a small parcel of forest remains. |

**Table 10. Changes to vegetation and land use near Tub Lake (located near Des Moines Memorial Drive and South 144th Street) between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | Tub Lake is surrounded by shrub dominated wetland, but patches of forested wetland also border the shrub wetland. Upland areas bordering the wetland consist of forestland, pastureland, orchard, recently harvested forestland, and several farms. A gravel mine is located north of the wetland. A dock is located in Tub Lake. |
| 1948 | The wetland area remains similar to 1936; however, the adjacent upland areas include greater development to the east. Several streets are under construction northeast of the wetland, and much of the forested areas around the wetlands have been cleared. |
| 1961 | A school has been constructed near the east side of the wetland, and some clearing and wetland fill has occurred in this area. |
| 1995 | The wetland itself remains largely intact. Shrub communities appear to have a greater number of small trees, and in three locations near the west side, excavations have created new areas of open water. Portions of the wetland perimeter have been filled at the north end for the construction of Sunset Park. The Sunny Terrace school, constructed east of the wetland, has removed much of the upland buffer vegetation. Some houses have been removed from uplands bordering the west side, and the land is now abandoned. Houses and other buildings along Des Moines Memorial Drive have been removed, the land is revegetating to more natural conditions, and there is less development here than in 1948. |

**Table 11. Changes to vegetation and land use in Wetland D (located near 1st Avenue South and South 154th Street) between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | A portion of the wetland is forested, but most is farmed and consists of agriculture fields, pasture, and orchards. |
| 1948 | Portions of the farmed wetland appear to have been abandoned, and there are greater amounts of shrub and forested vegetation in the wetland. The upland areas surrounding the wetland have greater amounts of development, including a school and running track located near the west edge of the wetland. |
| 1961 | The wetland consists of forest and shrub communities. Fill has been placed in portions of the wetland to accommodate widening of 1st Avenue South. |
| 1995 | This wetland has been filled for SR 509, and no evidence of it remains. |

**Table 12. Changes to vegetation and land use in Wetland E (previously located near South 124th Street and 24th Avenue) between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | This wetland is located in a linear depression. South 154th Street was constructed through the northern third of the wetland. The majority of the wetland is undeveloped forestland. The area has been recently logged. A fringe of small trees lines the edge of the wetland. |
| 1948 | The wetland has been excavated to create three open water ponds. A forested buffer is present on the southwest side, but the remaining upland buffer has been logged. A small road surrounds the wetland, and a house is present on the north side. |
| 1961 | The northern portion of the wetland was filled by South 154th Street. The southern portion was filled for houses. About eight houses surround the wetland. The perimeter is nearly all landscaped. |
| 1995 | This wetland has been filled for the construction of SR 518 and the SR 518 interchange to the North Access Freeway and South 154th Street. |

**Table 13. Changes to vegetation and land use in Wetland F (located near Ambaum Boulevard and South 157th Street) between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | The wetland consists of forest and shrub vegetation, with farmland around its perimeter. |
| 1948 | The wetland has greater amounts of forest vegetation, and the wetland no longer appears to be farmed. |
| 1961 | About two-thirds of the wetland has been filled and developed with parking areas and buildings. The remaining wetland is forested. |
| 1995 | The remaining portion of the wetland has been filled for commercial development. |

**Table 14. Changes to vegetation and land use in Wetland G (located near Sylvester Road and 6th Avenue South) between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | The wetland consists of forest and farmland located between several houses. |
| 1948 | Little change since 1936. |
| 1961 | The area is similar to previous years. Greater amounts of forest are present. |
| 1995 | Portions of the wetland have been filled for residential development. Remaining portions appear to be lawn and landscaping. |

**Table 15. Changes to vegetation and land use in Wetland H (located near 1st Avenue South and 166th Place) between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | This wetland occurs in a ravine and is associated with Walker Creek. Fill associated with 1st Avenue South bisects the wetland. The wetland consists of farmland with farm buildings, and farmland is located in adjacent upland areas. The west and south sides of the wetland are bordered by forestland. |
| 1948 | Farming in the wetland area has ceased, and the area has reverted to forest and shrub vegetation. An orchard is located on uplands east of the wetland and farmland is present north of the wetland. |
| 1961 | The area consists of forest and shrub wetland. |
| 1995 | Forest vegetation in the wetland has matured. The perimeter is primarily residential houses. South 174th Street was constructed south of the wetland. |

**Table 16. Changes to vegetation and land use in Wetland I (located between Highway 99 and 28th Avenue South) between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | This area is located in a shallow depression that is downgradient from Bow Lake (see Table 21). The majority of the area is in agriculture use and pasture. Upland areas surrounding the wetland are farmland, recently clear-cut forestlands, roads, and farmsteads. |
| 1948 | The entire area is predominately pasture, with some roads, and houses and outbuildings constructed along the wetland edges. |
| 1961 | Portions of the wetland have been filled and developed. Areas that remain as farmland appear to be ditched. |
| 1995 | The wetland has been filled and the wetland and adjacent upland areas developed. |

**Table 17. Changes to vegetation and land use in Wetland J (located near Highway 99 and South 208th Street) between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | This wetland is in a shallow and linear topographic depression and is divided into three sub-areas by South 204th Street and Highway 99. The northeast portion is forested and shrub wetland, the central portion is farmland, and the southeast portion is forested. A small pond is located near the eastern end of the wetland. |
| 1948 | Most of the wetland is farmed, and a small pond has been excavated in the central portion. The area west of Highway 99 has been filled. A pond has been excavated in the east end where forest and shrub communities are also present. |
| 1961 | Portions of the wetland near Highway 99 and South 208th have been filled and developed. Open water is not visible in the 1961 photograph, but it is present in the 1970 photograph. |
| 1995 | The majority of the area has been filled for commercial and multi-family developments. Three small isolated wetlands remain. The isolated wetlands contain shrub and forest areas surrounded by multi-family development. |

**Table 18. Changes in vegetation and land use near Lake Burien between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | This lake is located in a shallow depression. Farmland, roads, and residential houses are located around the lake. Most houses are present along the north shore of the lake, and about 15 docks are located on the lake. Some of the south shore is bordered by forested upland. |
| 1948 | The majority of the shoreline is developed with single-family houses. Other uses include orchards and farm fields. A patch of forest and some farmland borders the south side of the lake. About 25 to 30 docks are located on the lake. |
| 1961 | Conditions are similar to 1948, but additional residences are present. |
| 1995 | The entire shoreline is surrounded by residential development. Approximately 45 to 50 docks and piers are located on the lake. |

**Table 19. Changes in vegetation and land use in Wetland 28 and the Northwest Ponds between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | Wetland 28 is farmed and there is no open water present. There are a few small areas of shrub or forest vegetation present in the wetland. Des Moines Creek is largely ditched across the wetland, though in areas, there are remnants of a meandering channel. Areas surrounding the wetland are farmland, orchard land, or recently harvested forestland. |
| 1948 | The west branch of Des Moines Creek has been channeled and a tributary to the stream near South 196th Street has disappeared (i.e. was piped, filled, or drained). Wetland 28 is in agriculture production with row crops. North and south of the wetland, additional single-family residences have been constructed. |
| 1961 | The eastern portion of Wetland 28 is in agricultural use, while the western portion is forested. A small area of open water is present in the central portion. |
| 1995 | Most of the Northwest Ponds area was excavated within Wetland 28 between 1961 and 1970. The area south and west of the ponds is forested. Portions of the north side of the wetland have been filled by runway construction. Portions have also been filled for the Industrial Waste System (IWS) lagoon and as part of commercial development located to the west. |
| | The eastern portion of Wetland 28, on the Tyee Valley Golf Course, is an emergent wetland. The remainder consists of open water, emergent, forest, and shrub wetland communities. |

**Table 20. Changes in vegetation and land use in Wetlands 52, 53, and the east branch of Des Moines Creek between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | The area north of South 200th Street is farmland and forestland. The stream channels appear to be confined to ditches. Dense riparian cover is present along the riparian corridor from the confluence to the east. Wetland 52 is farmland and shrubland, while Wetland 53 is farmland. |
| 1948 | This riparian corridor consists of agriculture land with row crops, pasture, and orchard. An intermittent forested corridor occurs along the stream from the confluence with the west branch upstream to Highway 99. The stream channel is not visible above its confluence with the west branch. Wetlands 52 and 53 are a mixture of farmland and shrubland. |
| 1961 | Airfield construction channelized the stream, and portions of Wetland 52 have been excavated. Wetland 53 is farmed. |
| 1995 | The stream has been channelized and the golf course has been constructed. The Tyee Detention Pond has been constructed along the channel, and about 200 ft of the channel is culverted. A narrow band of riparian vegetation is present along most of the channel. Upstream of the golf course, the channel has been constructed between several parking lots and several hundred feet are culverted. |

**Table 21. Changes in vegetation and land use near Bow Lake between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | An emergent and shrub wetland extends up to about 1,500 ft north of the perimeter of the lake and along the west side. Agricultural areas occur in the south and east portions of the wetlands that surround the lake. Upland areas surrounding the lake consist of agricultural land, recently cut forestland, and second-growth forest. The shoreline of the lake itself consists of a narrow fringe of aquatic vegetation and shrubs. A drainage ditch has been constructed to convey water from Bow Lake southwest under Highway 99 via culvert, forming the east branch of Des Moines Creek. Other ditches are present in some areas of farmed wetland. |
| 1948 | Much of the farmed wetlands near the lake appear to have been abandoned. North and west of the wetland, grading and building activities in uplands immediately adjacent to the wetlands are present. Little natural buffer remains around the wetland because most of the area is in agricultural production, and forested areas to the east of the wetland have been recently cleared. A small pond appears to have been excavated east of the wetland. |
| 1961 | Much of the northern third and east side of the wetland surrounding the lake have been recently filled and are currently under development. |
| 1995 | Most of the buffer and wetland surrounding Bow Lake are developed with commercial and residential land uses, including parking lots and a stormwater detention pond. A portion of the east side has developed as a shrub wetland that surrounds an excavated pond. Some forested buffer is present along the north edge of the lake. Several hundred feet of the east branch of Des Moines Creek has been culverted beneath a parking lot. |

**Table 22. Changes in vegetation and land use in Wetlands 43 and 44 between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | The majority of the area is farmed wetland. The farmland appears ditched, and there is no evidence of a natural stream crossing the area. Some forested wetland occurs in the central portion of the wetland, and shrub wetland occurs south of South 176th Street. Upland areas adjacent to the wetland, are a mix of pastureland, cropland, small orchards, and forest patches. Drainage from the wetland appears to pass under Des Moines Memorial Drive and into Walker Creek. |
| 1948 | The wetland is generally similar to that in 1936. The area is farmed with ditches running along the edges of the farmed fields. There is a forested fringe along the steep slope to the east, but some areas in the central portion of the wetland are pastureland instead of cropland. Ditches through the central portion of the site are well defined. There is additional agriculture land use northwest of the wetland. Walker Creek appears to originate west of Des Moines Memorial Drive and flow west through a mixture of agriculture fields and forest. |
| 1961 | Agricultural use in the southern portion of the wetland has been abandoned, and the area is forest- and shrub-dominated. The remaining wetland appears to be farmed or pastured. A small stream channel bordered by a band of shrubs may represent the location of Walker Creek. |
| 1995 | SR 509 has been constructed and divides the wetland area with fill. Most agriculture has been abandoned and the wetland consists of emergent, forested, and shrub-dominated wetland. Some areas of pasture remain in the northern portion of the wetland. Commercial development has filled the wetland located south of 176th Street. A small stream channel is visible in emergent wetland located near the northwestern portion of the area. |

**Table 23. Changes in vegetation and land use in Wetlands 1 through 14 and A1 (Vacca Farm and Lake Reba area) between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | Most of the area is farmed, though forested wetlands are present in Wetlands 3, 4, and 5. Several of the agricultural fields are ditched, and there are no natural stream channels present. Areas adjacent to the wetlands consist of farmland and forestland in various stages of regeneration. The wetlands are crossed by 16th Avenue South. No ponds or other inundated wetlands are present. |
| 1948 | The condition and land uses are generally similar to 1936. There are greater amounts of development near the wetland areas and a portion of Lora Lake has been excavated. |
| 1961 | The area in general continues to be farmed. Increasing amounts of houses and small areas of fill are present near streets and the perimeter. Portions of Wetlands 3, 4, and 5 are forested. |
| 1995 | SR 518 has been constructed across the north portion of the area. Lake Reba and Lora Lake have been excavated. Much of the wetland east of Lora Lake has revegetated to forest, shrub, and emergent communities. Shrub riparian wetlands have developed near the south portions of the area. |

**Table 24. Changes in vegetation and land use in Wetlands 18, 37, 20, and other wetlands west of the airfield between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | Except for much of Wetland 18, most of the wetlands are forested. In many places, the forest vegetation is not dense and may have been subjected to past management. |
| 1948 | New residences and driveways have been constructed in and near several wetlands. Additional areas of Wetland 18 have been cleared and are mowed or grazed. Selective logging has occurred in Wetland 37 and it may also be grazed. There are driveways and residences in and near Wetland 37 that fragment the south portion of the area. |
| 1961 | Much of Wetlands 18 and 36 continue to be farmed, but forest riparian areas are developing on abandoned farmland that is now associated with residential development. Most wetlands in this area contain forest and pasture vegetation. |
| 1995 | The wetland condition is generally similar to 1961, although a greater amount of uses occur along their perimeters. Portions of Wetland 18 and other wetlands located east of 12th Avenue South are located within the airport security fence. In these areas, residential and agricultural land uses have been displaced, and wetlands have revegetated with native vegetation. |

This analysis shows that the pre-developed condition of most of these watersheds were various upland soil types. The pre-developed condition of most of the present airport site was also upland soil types. Various conclusions (see King County 1997) that the watersheds and Seattle-Tacoma International Airport contained large amounts of wetlands are not supported by the data presented by USDA (1952).

## 3.2 WETLAND IMPACTS

Nearly all of the larger wetlands present in 1936 are present today, but they have been impacted by development. Filling of several smaller wetlands (e.g., E, F, and K) has eliminated them. Some of the greatest impacts to the larger wetlands have occurred at Bow Lake, where wetland fill for commercial development has eliminated about 50 percent of the area mapped in 1936 as hydric soil. Other large wetlands have been variously impacted by excavation (Lora Lake and Lake Reba in the Vacca Farm area, and Northwest Ponds), and fill (in Wetlands 43 and 44 for SR 509, Wetland 28 for commercial development).

The examination of historical aerial photographs demonstrates that a variety of significant impacts have occurred to wetlands in the project area over the past 50 to 70 years. Major impacts to wetlands that have occurred include:

- **Clearing.** Land clearing occurred as a result of timber harvest, subsequent farming, or land development. Typical forest practices in the 1930s were to burn slash to promote reforestation, aid in agricultural development, or aid in urban development. Logging and burning were so extensive that not enough trees were left for satisfactory reseeding, and many areas became restocked with bracken fern, blackberry, alder, and vine maple (USDA 1952).

- **Agriculture.** Because wetland soils provide highly productive farmland when drained, wetland soils in the project area were selectively farmed. As a result, over 90 percent of "bottomland" soils[3] in King County were in agriculture by 1936 (USDA 1952). Wetland soils present in the STIA watersheds and their use in King County, as described by Poulson (USDA 1952), are:

  ***Bellingham silty clay:*** About 75 percent of this soil type was cleared and used for pasture or cultivated crops. All of it has been logged, and acreage was brought into cultivation as soon as it was cleared and drained.

  ***Carbondale muck:*** In populated areas, nearly all muck soils were drained and farmed with cultivated crops. In more remote areas, about 75 percent were farmed.

  ***Greenwood peat:*** This is a non-agricultural soil due to its acidity. Selling peat moss or development for cranberry production also provided some revenue from this soil type.

  ***Mukilteo peat:*** About 50 percent of these soils are farmed.

  ***Norma fine sandy loam:*** More than 80 percent of this soil type was used for crops or pasture, with additional areas being cleared and drained.

  ***Norma silty clay:*** This soil occurs in depressions unsuitable for agriculture. The soil survey notes these areas are suitable for reed canarygrass.

  ***Rifle peat:*** Peat soils are drained for cultivation (which can cause them to sink several feet through consolidation and oxidation). Over 70 percent of peat soils were farmed.

  In some cases, the abandonment of agricultural land use has allowed native vegetation to develop in previously farmed areas.

- **Fill.** Direct filling of wetlands became increasingly prevalent during and after the 1960s and 1970s as the area became increasingly urbanized. While some small wetlands were filled for airport and other commercial/industrial development in the 1940s, this analysis and review shows that most of the original STIA site was upland. At STIA, filling of portions of Wetland 28 occurred in about 1970, when the second runway and IWS Lagoon 3 were constructed.

  A considerable amount of wetland filling and fragmentation occurred as a result of road construction from the 1960s on. Filling of Wetland 43, Wetland 44, and Wetland C occurred when SR 509 was constructed in the late 1970s. Filling in the Vacca Farm, Lake Reba wetlands, and Wetland E occurred when SR 518 was constructed in the early 1970s. Widening of Highway 99, 1st Avenue South, and several other streets impacted small amounts of other scattered wetlands.

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[3] Bottomland soils are typically hydric soils and were once wetland.

Fill of wetlands as part of land development was significant for many of the smaller wetlands that existed in 1952, and many of these wetlands have been largely eliminated as a result (i.e., Wetlands A, C, D, I, and J). Larger wetlands where significant fill for site development has occurred include the wetland perimeter of Bow Lake and the northwest portion of Wetland 28. In the third runway acquisition areas, wetland hydrology was not eliminated despite residential development, and many of these wetlands have persisted to the present (i.e., Wetlands A17, 18, 35, 37, 39, 41, and others).

- **Excavation.** Several wetland areas (Lora Lake, Lake Reba, Northwest Ponds, Tub Lake, and Arbor Lake) have been excavated, resulting in open water habitats. Lora Lake was excavated from peat soils in agricultural use to enhance residential development. Lake Reba was excavated from agricultural wetlands for stormwater management. Northwest Ponds, portions of the Tub Lake wetland, and Bow Lake were excavated to obtain horticultural peat. Northwest Ponds is also used for stormwater management. Arbor Lake was excavated for unknown reasons, likely to obtain peat or to enhance its appeal for residential development.
- **Buffer disturbance.** All wetlands have experienced clearing and disturbance of wetland buffers through forestry, farming, and/or urban development. In many cases, buffers have been wholly or partially developed. In some areas, when agricultural areas have been abandoned, native buffer vegetation has grown back.
- **Stormwater discharge.** Some wetlands have been used for stormwater management. Lake Reba and the Northwest Ponds are permitted stormwater facilities. Wetlands 4 through 10 are part of the Miller Creek detention facility. A portion of Wetland 52 was excavated for the Tyee Pond detention facility. Other stormwater treatment facilities were constructed in Wetland 43 to serve SR 509.
- **Sedimentation.** The types of land use changes that have occurred in the STIA area since 1936 typically result in increased sedimentation in wetlands. Farming results in large areas of plowed land that can generate sediments that may be transported to wetlands and streams. Forestry and burning to support reforestation or land clearing for agriculture also leave bare soils subject to erosion. Development of roads and associated drainage ditches increased the probability that sediments would be transported downstream to streams and wetlands. Early roads in the area would have generated a large amount of sediment runoff from their unpaved surfaces. Because of the prevalence of forestry, farming, and gravel road surfaces, sediment transport to creeks and wetlands was probably greater in the past (i.e., pre-1960) than under current conditions, where little soil disturbance occurs without extensive erosion control measures.

## 3.3 REGULATIONS PROTECTING WETLANDS

Prior to the mid-1980s, the small isolated wetlands located in the Miller, Des Moines, and Walker Creek watersheds had little if any land use protection, and were, where economically feasible, filled and drained to support agricultural or urban development. During the late 1980s and since, increasing land use protection levels have been placed on wetlands; now a variety of local, state, and federal laws are designed to prohibit nearly all activities in or near wetlands that would cause additional physical or ecological degradation. The most significant regulations protecting wetlands in the study area are:

- **Clean Water Act – Section 404.** Regulates fill placement in Waters of the U.S. Triggers Section 401 review by Ecology to protect water quality. Revisions to the Nationwide Permits in 2000 placed low thresholds on routine wetland fills and mitigation requirements generally require replacement of function and area. Individual Permits for more substantial wetland alterations require extensive mitigation to replace function and area. Mitigation ratios that require mitigation area in excess of the area of filling help ensure that cumulative losses do not occur over time.

- **Critical Areas Protection.** Critical area protection is included as part of the municipal code of each community in the watershed. These regulations protect, among other elements, wetlands, wetland buffers, streams, stream buffers, and fish and wildlife conservation areas.

  - **SeaTac** - Title 15, Chapter 15.30
  - **Burien** - Title 18, Chapter 18.60
  - **Des Moines** - Title 18, Chapter 18.86
  - **Normandy Park** - Title 13, Chapter 13.16

  The regulations provide specific standards and mitigation requirements for the modification of wetlands and their protective buffers. Local mitigation standards for wetland and buffer alterations require replacement of area and function. Mitigation ratios that require mitigation area in excess of the area of fill help ensure that cumulative losses do not occur over time.

- **Hydraulic Project Approval (HPA).** HPAs are required for projects that use, divert, obstruct, or change the natural flow or bed of any fresh water or saltwater of the state. HPA approvals generally require mitigation adequate to compensate for project impacts to wetlands and to streams that provide fish habitat. These approvals may also be required for projects not occurring in streams or wetlands, but that discharge stormwater runoff to them. Mitigation for these projects can require enhanced stormwater detention and water quality standards to preserve existing runoff patterns and water quality.

- **State and National Environmental Policy Acts (SEPA and NEPA).** SEPA and NEPA provide protection to wetlands by requiring analysis of project impacts to wetlands and for mitigation of adverse impacts.

- **Stormwater Management Standards.** Local stormwater management standards are designed to collect, detain, and treat stormwater runoff from urban areas and prevent degradation of streams.

# 4. STREAMS

The Seattle-Tacoma International Airport project area drains to several streams, including Miller Creek (and its Walker Creek tributary), Des Moines Creek, and the Green River via Gilliam Creek (see Figure 1). Baseline and historic watershed and fish habitat conditions in drainage areas affected by Master Plan Update improvement projects (Miller and Des Moines Creeks) are described in this section.

## 4.1 MILLER CREEK BASIN

The Miller Creek basin includes Miller Creek and Walker Creek. Walker Creek is a tributary to Miller Creek. The current condition and historical changes to the creeks are discussed here.

### 4.1.1 Historical Conditions and Changes Since 1936

Changes to Miller and Walker Creeks have been assessed over time using aerial photographs. These changes are summarized in Tables 25 and 26.

### 4.1.2 Current Conditions in Miller Creek

The Miller Creek watershed drains approximately 8 $mi^2$ of predominantly urban area, mostly within the cities of Burien and SeaTac. STIA facilities located in this basin include the north end of runways 16L and 16R and north air cargo facilities, an area of about 162 acres representing about 3 percent of the watershed. Flows in Miller Creek originate at Arbor, Burien, Tub, and Lora Lakes, Lake Reba, and from seeps located on the west side of STIA.

The uppermost reaches of Miller Creek (above approximately river mile [RM] 4.1) extend north of SR 518. The Hermes depression in the northwestern part of the basin is artificially drained and piped to a tributary to Arbor Lake. This portion of the watershed drains a gently rolling plateau between the Duwamish/Green River valley and Puget Sound. Although the watershed is generally highly developed, several small bogs, depressions, and wetland lakes remain in the upper basin; this area formerly had a more extensive network of headwater wetlands that buffered the stream from winter storms and provided recharge during summer dry periods (May 1996).

In reaches downstream of 1st Avenue South (RM 1.8), Miller Creek flows through a well-incised ravine and cuts through glacial material before entering Puget Sound via a small estuary. The outlet stream from Burien Lake enters the ravine reach at RM 1.2. A sewage treatment plant operates alongside Miller Creek at approximately RM 1.0. Walker Creek, an anadromous fish-bearing stream that originates in wetlands west of STIA and SR 509, enters Miller Creek approximately 300 ft upstream of its mouth, in a park just upstream of the Miller Creek estuary (Figure 11).

A waterfall, which drops over a hardpan lip at about RM 3.1, has been described as a complete barrier to upstream migrations of anadromous fish (Williams et al. 1975; Ames 1970). That assessment agrees with local historical anecdotes that make many references to salmon in Miller Creek up to about the waterfall location, but not beyond. Recent spawning surveys conducted by Trout Unlimited (Batcho 1999 personal communication) have also identified this waterfall as the upper limit to coho salmon (*Oncorhynchus kisutch*) distributions in Miller Creek.

**Table 25. Changes in vegetation and land use near Miller Creek between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | A stream channel appears to originate in Wetland D. The channel is ditched from South 144th Street south to its confluence with other channels in the Vacca Farm area (Wetland A1, see Table 23). No riparian vegetation is present.<br><br>South of Vacca Farm to South 154th Street, approximately half of the riparian area is in residential use with little riparian vegetation. The remaining area has a narrow forest or shrub buffer present on one or both sides.<br><br>Between South 154th and South 160th, there are several natural meanders, with a fringe of riparian forest or shrub vegetation present. The stream flows through a residential neighborhood, where some of the land is cleared of natural vegetation to the edge of the stream.<br><br>Between south of South 160th and Wetland 37, the area is mostly farmed and the riparian vegetation has been cleared. Farming activities extend to the edge of the stream. Forested riparian vegetation of Wetland 37 borders the stream within most of the wetland and south to 8th Place. West of 8th Place, there is a narrow riparian fringe through farmed fields, with areas lacking riparian vegetation. West of Des Moines Memorial Drive to Ambaum Boulevard, there is approximately 50% forest vegetation along the stream and 50% is farms, orchards, and homes.<br><br>From Ambaum Boulevard to 1st Avenue South, the stream flows through a forested ravine. From 1st Avenue South to the estuary, the area has been logged in places, but forested cover is approximately 70%. |
| 1948 | From South 144th to South 154th, there has been little change since 1936. The stream is ditched within agricultural land and lacks riparian vegetation. From South 154th to South 160th, there has been additional residential development along the stream and subsequent loss of some riparian cover, though a narrow band is often present. There has been selective logging in some areas. South 160th has been constructed across the stream.<br><br>From South 160th south to Des Moines Memorial Drive, small farms and residential land uses occur next to the stream. South of Wetlands 18 and 37, logging has occurred on both sides of the stream. New orchards and single-family residences have been constructed.<br><br>From Des Moines Memorial Drive to Ambaum Boulevard, the area is similar to conditions in 1936, but approximately 75% of the area is forested and 25% is farms and residences.<br><br>From Ambaum Boulevard to 1st Avenue South, the area has been completely cleared. Between 1st Avenue South and the estuary, there is some riparian vegetation along the stream with additional residential development in the basin. South and east of the stream, there is more logging and the forested riparian buffer has been reduced.<br><br>There is dense riparian vegetation from 166th down to 175th Place, but the area is developed from 175th to the estuary. |
| 1961 | Considerable residential and commercial development has occurred. In several locations, particularly at Vacca Farm and near Wetlands 18 and 37, farming continues. |
| 1995 | South of South 144th, the stream flows through residential development. The area has been converted from agriculture to residential and commercial land uses. North of SR 518, the stream flows through a pasture area, with steep slopes on the west side and a narrow corridor of riparian vegetation. The stream flows under SR 518 through the Miller Creek detention facility, where abandoned farmland has reverted to riparian shrub and forested wetlands.<br><br>Across the Vacca Farm area, there is little riparian vegetation present. South of Vacca Farm to South 160th, a narrow vegetated buffer is present in places, but the riparian area is largely dominated by residential land uses.<br><br>The area between South 160th and Des Moines Memorial Drive has been converted from agricultural land uses to residential land uses. The undeveloped areas of Wetland 18 and Wetland 37 are becoming forested. |

**Table 25. Changes in vegetation and land use near Miller Creek between 1936 and 1995 (continued).**

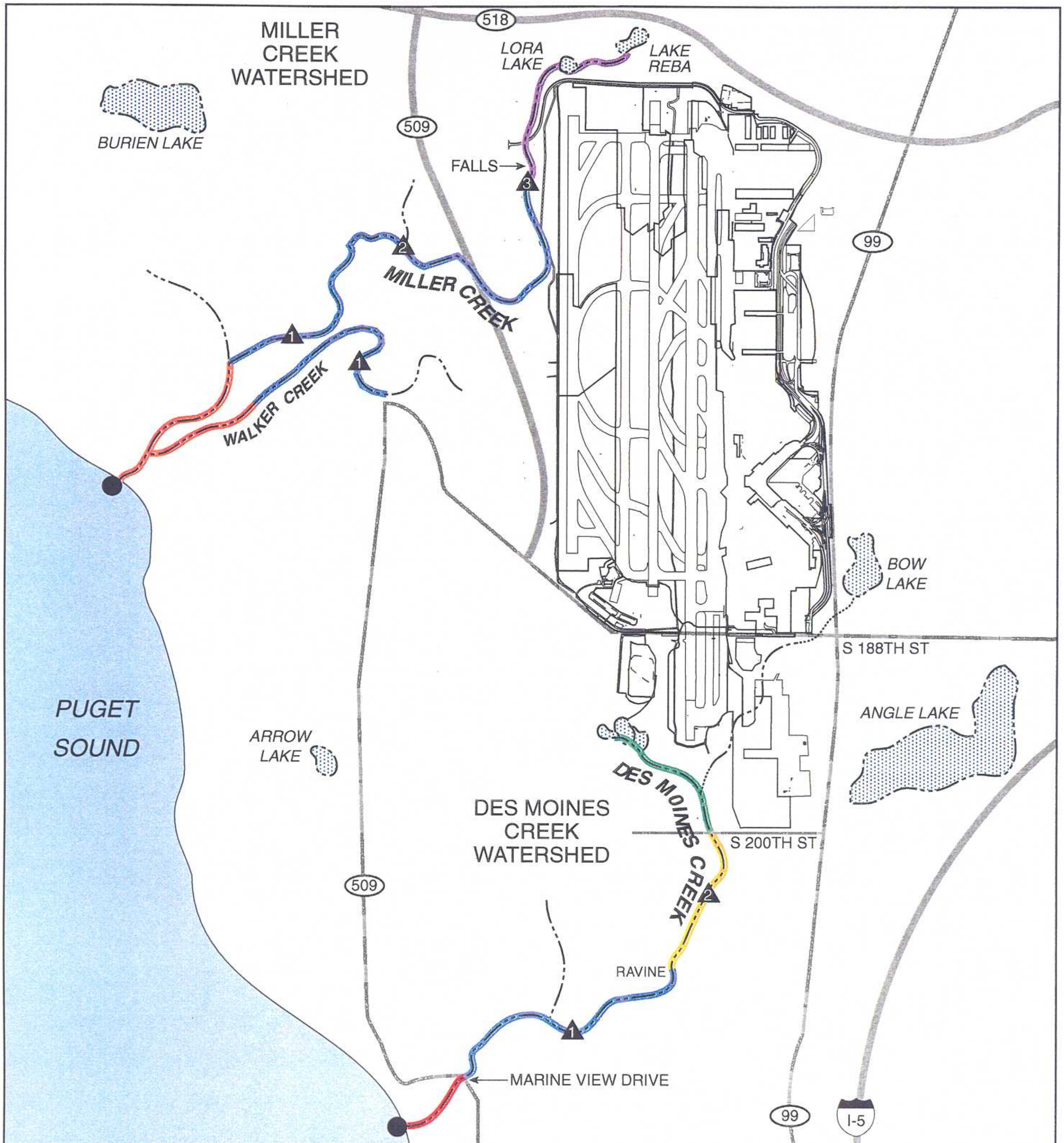
| Year | Vegetation, condition, and land uses |
|---|---|
| | Between Des Moines Memorial Drive and Ambaum Boulevard, a narrow, forested riparian corridor is generally present, but in some places lawns abut the edge of the stream. Between Ambaum Boulevard and 1st Avenue South, the stream flows through an undeveloped forested area. South of 1st Avenue South to the confluence with Walker Creek, the riparian corridor is a forested ravine. Residences and other development generally border the ravine. South of the confluence with Walker Creek, the area is 90% built-out with single-family residences and supporting uses. |

**Table 26. Changes in vegetation and land use near Walker Creek between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | East of 1st Avenue South, Walker Creek can generally be identified by topography and vegetation along ditch lines. The riparian areas adjacent to the stream are largely developed as farmland. Wetland 43 (the origin of Walker Creek) is intensively farmed, and there is no evidence of a stream. West of 1st Avenue South to the estuary, the area has been logged in many places, but forested cover is approximately 70%. |
| 1948 | There is no evidence of Walker Creek east of Des Moines Memorial Drive. Between Des Moines Memorial Drive and 1st Avenue South, the stream flows through a mixture of farm and forestland. There is increased residential development, and in some places, farming has ceased. Between 1st Avenue South and the estuary, there is some riparian vegetation along the stream with additional residential development in the basin. South and east of the stream, additional logging has reduced the width of forested riparian buffers. |
| 1961 | Considerable residential and commercial development has occurred. Farming continues in most of Wetland 43, but activities have changed from row crops to pasture. Additional development has reduced riparian areas in some locations. In the undeveloped areas west of 1st Avenue South, forest vegetation is maturing. |
| 1995 | SR 509 bisects Wetland 43, and farming of the wetland has largely ceased. In many areas west of Des Moines Memorial Drive, riparian areas have matured compared to previous photographs. Some additional development in the watershed has occurred, and losses of riparian vegetation have occurred in limited areas. |

Sampling has found threespine stickleback (*Gasterosteus aculeatus*), pumpkinseed sunfish (*Lepomis gibbosus*), black crappie (*Pomoxis nigromaculatus*), and cutthroat trout (*Oncorhynchus clarki*) in Miller Creek above these falls (see Figure 4-1 in Parametrix 2000b). The warmwater fish species are associated with Lora Lake and Lake Reba and the lower-velocity, fine-substrate reaches of upper Miller Creek. Only coho salmon and cutthroat trout were found rearing below the falls at RM 3.1 (Parametrix 2000b). However, chum salmon (*O. keta*) also spawn in lower Miller Creek (Hillman et al. 1999). During these surveys, no chinook salmon (*O. tshawytscha*) or bull trout (*Salvelinus confluentus*) were observed.

Downstream from the falls, culverts under 1st Avenue South and roads near RM 2.0 have been evaluated as impassable to fish (Williams et al. 1975; Ames 1970). However, adult coho salmon have been found upstream of the culverts (Batcho 1999 personal communication).




Data Sources: Des Moines Creek Basin Committee (1997); Hillman et al. (1999); Parametrix 1999a

**Parametrix, Inc.** Cumulative Impact Report/556-2912-001/01(03) 7/01 (K)

- Stream
- Piped Stream
- Lake
- Potential Chinook and Bull Trout Habitat
- Rivermile

- Coho & Chum Salmon, Cutthroat & Steelhead Trout
- Coho Salmon, Cutthroat Trout
- Cutthroat Trout, Pumpkinseed Sunfish
- Pumpkinseed Sunfish, Largemouth Bass, Cutthroat Trout
- Cutthroat Trout, Coho & Chum Salmon
- Cutthroat Trout, Pumpkinseed Sunfish, Threespine Stickleback

N

SCALE IN FEET

0 1500 3000

**Figure 11**
**Current Fish Use of Miller, Walker, and Des Moines Creeks**

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The lower basin has benefited from instream habitat restoration conducted by Trout Unlimited. The goal is to increase the pool to riffle ratio of stream project segments from the original value of 13:87 calculated when work began in the 1980s, to a level approaching 50:50 (Batcho 1999 personal communication). The goal is also to improve pool quality for rearing juvenile salmonids and to increase habitat complexity. Coho salmon returning to the lower basin appear to have responded favorably; recent returns number about 300 adults per year. In fully restored habitat, the expectation is that Miller Creek would support between 700 and 1,200 adult coho salmon per year (Batcho 1999 personal communication).

Miller Creek enters Puget Sound through a private park in the City of Normandy Park. During low tide, the stream flows onto a low-gradient rocky beach composed of 3-inch-minus[4] coarse and fine gravel embedded with sand. To the north, for several hundred feet, the ordinary high water mark (OHWM) is defined by breakwater walls protecting residential property. To the south, for approximately 200 ft, the OHWM is defined by wrack[5] and large woody debris (LWD). The mouth of Miller Creek is affected by tidal activity, which alters stream morphology for approximately 150 ft upstream. Along this tidal channel, the stream is approximately 15 ft wide with overhanging salt marsh vegetation including Pacific silverweed (*Potentilla pacifica*), saltweed (*Atriplex patula*), and sedge (*Carex* sp.). This 15- x 150-ft (~ 0.05 acre) area comprises the estuarine area of Miller Creek[6] (see Section 4.2).

The confluence of Miller and Walker Creeks is approximately 300 ft upstream from the mouth of Miller Creek. Upstream from the confluence, Walker Creek has a diversion pipe that draws water into a small pond impounded by a control weir. Water leaving the pond enters Miller Creek approximately 10 ft upstream of the outfall to Puget Sound. The 3-ft-wide channel is incised approximately 1.5 ft and is tidally influenced from the confluence with Miller Creek to approximately 100 ft from the control weir. Salt marsh plants occur near its confluence with Miller Creek, and cattails (*Typha latifolia*) dominate the channel upstream near the control weir.

### 4.1.3 Current Condition of Fish Habitat in Miller Creek

The Washington Department of Fisheries (WDF) reported that Miller Creek had undergone extensive alteration and "total deterioration" due to heavy residential and commercial growth in the drainage in the early 1970s (Williams et al. 1975). Stream conditions necessary to adequately support spawning and rearing of salmonids "were virtually nonexistent" upstream of 1st Avenue South (RM 1.9) due to excessive amounts of sand and silts that comprised 70 to 100 percent of the bottom substrate (Ames 1970). King County's Surface Water Management (KCSWM 1987) evaluation of the Miller Creek basin noted that the high level of urbanization had degraded water quality, increased the volume and rate of stormflows, promoted erosion and mass wasting processes, and destroyed riparian habitat and vegetation.[7] These factors (Table 27) had greatly reduced the habitat quality of streams, which in turn affect fish populations.

---

4 Indicating that 95 percent of the gravel present would pass through a 3-inch screen.

5 Wrack is seaweed and other marine debris that is cast up on shore.

6 This estuary may have been larger prior to development of a private park in the vicinity.

7 Despite reported water quality degradation, Miller Creek is not on the 303(d) list of impaired waterbodies.

Table 27. Existing environmental conditions in Miller Creek, near Seattle-Tacoma International Airport.

| | Environmental Baseline | | | |
|---|---|---|---|---|
| **Pathways Indicators** | **Properly Functioning** | **At Risk** | **Not Properly Functioning** | **Explanation** |
| **Water Quality** | | | | |
| Temperature | | | X | Commercial, residential, and agricultural modifications to vegetation along the stream corridor have impacted ambient stream temperature. Causes of increased stream temperatures include the loss of riparian shading, impervious surfaces within the watershed, and the existing stormwater conveyance system. Daily fluctuations in water temperatures are greater in areas where riparian shading has been reduced. Stormwater systems and impervious surfaces have altered basin hydrology by conveying runoff rapidly to the stream. Runoff collected from impervious surfaces during summer may periodically contribute to temperature problems. Reduced infiltration may cause reductions in base flows, which may increase water temperatures during the summer low-flow periods. |
| Sediment | | | X | Urban developments within the watershed have altered native soils and vegetation, resulting in increased sedimentation in Miller Creek. Sedimentation from agricultural runoff as well as from channel alterations occurs at Vacca Farm. Several reaches with heavy sedimentation (highly embedded substrates) are apparent. Unmaintained culverts in low-gradient reaches tend to retain small substrates and reduce the capacity of the streambed to mobilize. Historic changes such as stream channelization and the removal of LWD have increased stream degradation and fine sediment input. Historic loss of wetlands further reduces the basin's capacity to buffer sediment inputs. |
| Chemical and Nutrient Contamination | | X | | Residential development has resulted in replacement of riparian vegetation with lawns. Agricultural runoff from urban development may contain fertilizers, herbicides, pesticides, metals, and oil and grease as pollutants that flow directly into the stream. Failed septic systems may also discharge nutrients and oxygen demand to the stream. The increase in nutrients could increase primary production and respiration, ultimately reducing dissolved oxygen (DO), especially during summer. |
| **Habitat Access** | | | | |
| Physical Barriers | | | X | Several culverts may be barriers to migrations of resident and anadromous fishes at different times of the year, depending on flow conditions. The lack of LWD in the channel and alteration of stream hydrology may alter the ability of fish to pass a natural fall at approximately RM 3.0. |
| **Habitat Elements** | | | | |
| Substrate | | | X | Gravel accumulations suitable for spawning by anadromous salmonids occur at several locations in the channel. Smaller accumulations suitable for resident salmonid spawning are more frequent; however, most spawning substrates are heavily embedded with silt and sand at levels greater than 30%. |

Table 27. Existing environmental conditions in Miller Creek, near Seattle-Tacoma International Airport (continued).

| | Environmental Baseline | | | |
|---|---|---|---|---|
| Pathways Indicators | Properly Functioning | At Risk | Not Properly Functioning | Explanation |
| Large Woody Debris | | | X | Historically, LWD has been cleared from the channel. The reduction or elimination of a native riparian area has impacted the recruitment of coniferous LWD. Loss of LWD has altered channel morphology resulting in reduced sinuosity, decreased pool to riffle ratio, and limited cover and habitat. Non-coniferous LWD recruitment occurs; however, it is routinely cleared from streams by homeowners. |
| Pool Frequency | | | X | Several deep pools exist. However, most are formed by modified channel features (e.g., below culverts, riprap, etc.) and lack quality habitat cover. |
| Off-Channel Habitat | | | X | Residential development has increased channelization and degradation, thereby eliminating opportunity for hydrologically connected seasonal habitats along stream margins. This has decreased side channel salmonid rearing habitat. Historic filling of riparian wetlands and armoring of streambanks may have decreased hydrologic connection to secondary channels. |
| Refugia | | | X | Channelization and reduction of instream structure decreases resting areas for fish. Loss of LWD and increased channel scouring reduces habitats available, especially low-velocity areas for juvenile fish. Riparian alterations, channelization, and lack of LWD result in few bank undercuts. Development to streambanks, channelization, and filling has resulted in loss of wetland and side channel habitat for rearing fish. Riparian impacts reduce overhead cover. |
| **Channel Conditions and Dynamics** | | | | |
| Width to Depth Ratio | | | X | Width to depth ratios vary considerably along the length of Miller Creek, but are generally low in channelized reaches and more favorable in less-developed reaches. |
| Streambank Condition | | | X | Condition of streambanks in the basin is variable. The Vacca Farm reach is channelized; however, riparian vegetation tends to stabilize these reaches with minor undercuts. Several reaches through residential neighborhoods contain large non-coniferous trees that stabilize banks with undercuts. Other areas are armored with riprap or other artificial bank structures. Lower reaches contain areas with natural banks, but most associated vegetation is relatively small. |
| Floodplain Connectivity | | X | | Except for the Vacca Farm area, incised streams of this nature lack a significant floodplain. Some wetlands are hydrologically connected to the channel. In the mid-basin, many residential yards are modified to drain directly to the streambanks, and stormwater is conveyed directly back to the channel. Wetlands have been filled to enlarge developable areas. Impervious surfaces are extensive and may comprise up to 49% of the basin area. |

**Table 27. Existing environmental conditions in Miller Creek, near Seattle-Tacoma International Airport (continued).**

| | Environmental Baseline | | | |
|---|---|---|---|---|
| **Pathways Indicators** | **Properly Functioning** | **At Risk** | **Not Properly Functioning** | **Explanation** |
| **Flow/Hydrology** | | | | |
| Peak/Base Flows | | | X | Negative effects of stormwater runoff in the upper basin have been moderated through regional and STIA detention ponds. Most runoff from residences and roads in the mid- and lower basin is conveyed directly to the channel, with little or no detention. Current conditions result in strong hydrographic peaks immediately following precipitation. Reduced infiltration and water withdrawals reduce summer base flows. |
| Drainage Network Increase | | | X | Impervious surfaces are extensive throughout the basin including the airport, roads, residences, and commercial development. Most runoff from impervious surfaces is conveyed through an extensive network of stormwater pipes and open drainage ditches. This increase in drainage network accentuates peak runoff rates. |
| **Watershed Conditions** | | | | |
| Road Density and Location | | | X | Roads, parking lots, and other impervious surfaces are extensive throughout the basin. |
| Disturbance History | | | X | Human disturbances in the basin are extensive. Residential developments in the mid- and lower basin have maintained some riparian areas. |
| Riparian Reserves | | | X | Riparian areas have been extensively altered. The upper basin associated with the airport has little functioning riparian area. Riparian areas are extensively altered in agricultural areas. Limited functioning riparian areas exist in residential areas, but these are fragmented and have been invaded by exotic species that dominate many locations. |

Trout Unlimited (1993), Luchessa (1995), Parametrix (2000b), and Hillman et al. (1999) have completed Miller Creek stream surveys. The 1995 survey by Luchessa was conducted as a Level I Stream Special Study using King County methodology (King County Building and Land Development 1991). Surveys agreed on Miller Creek's deteriorated habitat, particularly in the upper basin above RM 1.9. Factors contributing to loss of instream habitat included: degradation of water quality by pollutants, sediment, eutrophication of lakes and wetlands, and filling of wetlands; loss of protective streamside vegetation; and loss of instream large organic debris, natural meanders, and other diversity. In addition, high water temperatures in Miller Creek during the summer constitute a water quality concern, as do high fecal coliform counts, low dissolved oxygen (DO) levels, and residues of lawn and garden chemicals, especially in the upper reaches (Parametrix 2000b).

In Miller Creek, benthic macroinvertebrate sampling near the Master Plan Update projects found benthic index of biotic integrity (B-IBI)[8] scores of 10. These scores are similar to scores observed in other urban streams subjected to similar levels of hydrologic and habitat degradation (Kleindl 1995; Fore et al. 1996; Horner et al. 1996; Ecology 1999; May et al. 1997). Studies of Puget Sound lowland streams have demonstrated that the macroinvertebrate community, as evaluated through B-IBI analysis, correlates to fish use.

Specifically, coho salmon abundance diminishes in streams with B-IBI scores of 33 or lower; these degraded stream reaches were used by resident cutthroat trout and not by anadromous salmon (Ecology 1999; May et al. 1997). These findings are consistent with observations of fish use in Miller Creek and support surveys that suggest the portions of the stream adjacent to the Master Plan Projects do not currently provide high-quality habitat for coho salmon.

## 4.2 MILLER CREEK ESTUARY

### 4.2.1 Historical Conditions in Miller Creek Estuary

Historical conditions in the Miller Creek estuary are summarized in Table 28.

**Table 28. Changes in vegetation and land use in the Miller Creek Estuary between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | A broad intertidal delta is located at the mouth of Miller Creek. A small road, separated from Puget Sound by a small berm, has modified the shoreline. East of the road, estuarine wetland is present, but portions have been filled for a house and parking area. East of the wetland, forested areas have been logged and contain small logging roads. |
| 1948 | Conditions are generally similar to those of 1936. A bridge was constructed and the road crosses the stream. Portions of the intertidal area have been bulldozed, and the shoreline area south of the estuary has been cleared and leveled. Forested areas east of the wetland now contain streets and a few houses. |

[8] B-IBI for Puget Sound lowland streams (Kleindl 1995) quantifies the overall biotic condition of a stream based on measurements of benthic macroinvertebrate diversity, abundance, and species composition. B-IBI scores for streams in the Puget Sound lowlands correlate with levels of urbanization (Fore et al. 1996; Horner et al. 1996) and fish use (Ecology 1999; May et al. 1997).

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**Table 28. Changes in vegetation and land use in the Miller Creek Estuary between 1936 and 1995 (continued).**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1961 | Portions of emergent wetland have been excavated to create a pond. The Miller Creek channel has been relocated. A building and parking areas have been constructed in the riparian zone. |
| 1995 | The stream channel has been relocated to the north side of the wetland. Wetland fill near the south end has occurred to construct a parking area, and the road crossing the estuary has been abandoned. A pond has been excavated on the south side of the estuary. The area now includes a mowed lawn, which occurs on fill in the central portion of the area. |

### 4.2.2 Current Conditions in Miller Creek Estuary

A small estuary occurs where Miller Creek enters Puget Sound. Analysis of baseline conditions in the estuary (see Table 28) indicates significant modification of this area by park development. As Miller Creek approaches the beach, there is a private park to the south and several houses border the north side. The park is mainly a grassy area with deciduous trees growing near the streambank. The stream enters the beach about 75 ft downstream of a small footbridge and an adjacent house.

The shoreline adjacent to Miller Creek is predominantly gravel and sand, with driftwood marking the high tide mark. This shoreline type continues for several hundred feet north and south of the stream, where houses and cement bulkheads have been built at the high tide mark. The slope of the upper intertidal beach is moderate, dropping approximately 5 ft over a distance of 30 ft, then gently into the water, dropping approximately 4 ft over 150 yards to mean lower low water (MLLW).

The intertidal zone at the mouth of Miller Creek is predominantly of mixed gravel and sand substrate. Some cobble, boulders, and sandy areas are also present. The stream channel in the upper intertidal zone contains more cobble than adjacent areas.

The channel is vegetated with green algae (*Enteromorpha intestinalis).* The substrate has some attached barnacles, mussels, and snails. Upper intertidal areas adjacent to the stream have very little algae or other attached marine life; however, amphipods and isopods are abundant under rocks and in the sand. In the middle intertidal zone, *E. intestinalis* becomes less abundant in the stream channel, while barnacles and mussels become the dominant species adjacent to the stream. In the lower intertidal zone, the stream channel is poorly defined and the substrate within and adjacent to the stream channel is a mixture of gravel and sand. Barnacles and mussels are present, but less dense than found in the middle intertidal zone. Additionally, species of brown, red, and green algae are all sporadically present, and bivalve siphons can be observed in the sandy areas.

### 4.2.3 Current Conditions in Walker Creek

Walker Creek drains an approximately 2.5-$mi^2$ subbasin of the Miller Creek watershed. The stream originates in a 30-acre wetland (Wetland 43) located between Des Moines Memorial Drive and SR 509. The stream flows through both residential and commercial development before its confluence with Miller Creek approximately 300 ft upstream from Puget Sound. Much of the riparian areas adjacent to the stream have been eliminated or altered by adjacent development.

Walker Creek parallels Miller Creek for roughly one-half its length, and they share similar effects from urbanization. King County Surface Water Management (KCSWM 1987) reports several problems in the Miller/Walker Creek watershed created by urbanization; these include excessive runoff from streets, parking lots, and commercial areas that has increased the volume and rate of stormflows. These increased flows have lead to mass-wasting and stream erosion, flooding, and loss of habitat. Runoff from this development has also reduced water quality and impaired fish usage.

Even though coho salmon occur in the lower reaches of Walker Creek (Batcho 1999 personal communication), the absolute upstream limit of coho salmon use has not been documented. Coho salmon use in Walker Creek is approximated in Figure 11. Hillman et al. (1999) conducted spawning surveys in Walker Creek from October 1998 to March 1999, and tallied 66 coho salmon redds in the lower 3.6 km (2.3 miles). They also found seven chum salmon redds up to RM 1.35, and one potential cutthroat trout redd in the lower 1500 ft of the stream. During these surveys, chinook salmon and bull trout were not observed.

While a small portion of the Walker Creek watershed (approximately 5.2 acres) will be developed for the third runway project, the project will not remove or directly alter fish habitat in Walker Creek. The runway project would fill about 0.26 acre of Wetland 44 (upslope of the defined Walker Creek channel and fish habitat). Potential indirect impacts to the stream could occur as a result of changes in water quality and hydrology.

## 4.3 DES MOINES CREEK

Des Moines Creek originates in Bow Lake (east branch) east of STIA and Northwest Ponds (west branch) southwest of STIA. Current and historical conditions in the stream are discussed in this section.

### 4.3.1 Historical Conditions in Des Moines Creek

Changes to Des Moines Creek have been assessed over time using aerial photographs. These changes are summarized in Table 29 and see Table 20.

**Table 29. Changes in vegetation, land use, and riparian conditions in Des Moines Creek near Des Moines Creek Park between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | The riparian corridor associated with Des Moines Creek and within Des Moines Creek Park is densely forested. Vegetation cover becomes increasingly patchy towards South 200th Street. There is evidence of logging within the corridor. Wetlands 29, 30, B5, B6, and B7 are generally forested. Wetlands in Borrow Area 1 are forested or farmed. Wetland 51 is forested. |
| 1948 | Riparian forested cover is present along most of the stream. Agricultural uses are also present in the riparian area. North of South 200th Street, land use is mixed and includes more residential development and logging. Wetland conditions are generally similar to those of 1936. |
| 1961 | Wetlands are generally farmed and surrounded by residential development. Wetlands 29 and 30 are generally forest- and shrub-dominated, but portions appear to be pasture. Wetland 51 remains forested. |
| 1995 | The majority of the area is forested, with an open field on the west side of the stream. The riparian buffer is approximately 100 ft wide (minimum) and continuous. Surrounding land uses include high-density residential and small areas of pasture to the south. Wetlands in Borrow Area 3 are forested, while those in Borrow Area 1 are generally shrub-dominated. |

### 4.3.2 Current Conditions in Des Moines Creek

The Des Moines Creek watershed covers about 5.8 $mi^2$ of predominantly residential, commercial, and industrial area lying within the cities of SeaTac and Des Moines; it also includes a small area of unincorporated King County (Des Moines Creek Basin Committee 1997). STIA occupies 23 percent of the upper Des Moines Creek watershed. Baseline environmental conditions in the stream (Table 30) are highly modified from natural conditions by a variety of development and land use practices.

The headwaters of the east branch (considered the main stem by most locals) originate at Bow Lake, 3.7 RM from Puget Sound. The upper half-mile of the east branch, from Bow Lake downstream to about RM 3, is conveyed through underground pipes. The west branch originates from the Northwest Ponds stormwater detention complex located at the western edge of the Tyee Valley Golf Course and joins the east branch at approximately RM 2.4. Downstream of South 200th Street (RM 2.2), the stream flows through Des Moines Creek Park, a forested riparian wetland. The park includes an incised ravine at about RM 1.8. The ravine is a high-gradient reach in which the stream has cut to hardpan for most of the length, providing little quality fish habitat. The stream is paralleled within this ravine by a paved trail and/or service road and sewer line protected in places by rock bank armoring.

Documentation of fish use in Des Moines Creek is provided in a Des Moines Creek Basin Committee report (1997) and Hillman et al. (1999), and is mapped in Figure 11. A variety of native salmonids use the lower 0.4 mile (below Marine View Drive), and include chum salmon and coho salmon, as well as cutthroat and steelhead (*O. mykiss*) trout. Only steelhead, cutthroat trout, and coho salmon are known to pass the partial migratory blockage under Marine View Drive. Coho salmon use extends to approximately RM 1.5. The upper plateau reach supports a mixture of cutthroat trout and non-native warmwater fish species, particularly pumpkinseed sunfish. Largemouth bass (*Micropterus salmoides*) are found in lower numbers than pumpkinseed sunfish in the upper stream. Warmwater fish found in the stream mainstem are presumed to originate from larger populations in Bow Lake and the Northwest Ponds. Chinook salmon and bull trout have not been observed in Des Moines Creek.

A cascade at RM 1.5 in the ravine reach was mapped as impassible to upstream-migrating fish (Williams et al. 1975). However, recent surveys have not identified this cascade as a fish barrier (Resource Planning Associates et al. 1994). The Midway Sewage Treatment Plant is located at RM 1.1 where the ravine widens. The channel in this reach contains several aging weirs originally intended to be fish-passage structures; in their present state they may act as impediments to fish passage. Just below the treatment plant, the gradient decreases and the stream develops a floodplain that allows a more meandering channel, better habitat conditions, and well-developed riparian vegetation.

**Table 30. Existing environmental conditions in Des Moines Creek, near Seattle-Tacoma International Airport.**

| | Environmental Baseline | | | |
|---|---|---|---|---|
| Pathways Indicators | Properly Functioning | At Risk | Not Properly Functioning | Explanation |
| **Water Quality** | | | | |
| Temperature | | | X | Commercial and residential development in the stream corridor have impacted riparian conditions, affecting stream temperature. Daily fluctuations in water temperatures are greater in areas where riparian shading has been reduced, such as the Tyee Valley Golf Course. Stormwater systems and impervious surfaces have altered basin hydrology by conveying runoff rapidly to the stream. Runoff collected from impervious surfaces during summer may periodically contribute to temperature problems. Reduced infiltration may cause reductions in base flows, which may increase water temperatures during summer low-flow periods. |
| Sediment | | | X | Urban development within the watershed has resulted in alteration of native soils and vegetation, resulting in increases in the sediment discharge and transportation in Des Moines Creek. Several reaches with heavy sedimentation (highly embedded substrates) are apparent. Historic changes such as stream channelization and removal of LWD have increased stream incision and fine sediment input. Historic loss of wetlands may reduce capacity of basin to buffer sediment inputs. |
| Chemical and Nutrient Contamination | | X | | The Tyee Valley Golf Course may be a source of fertilizer and chemical runoff. Increases in nutrients increase biological activity in the stream, ultimately reducing DO, especially during summer. Residential and commercial development near Bow Lake or parking lots south of the runway has likely increased loading of fertilizers, pesticides, metals, and organic hydrocarbons (oil and grease) to the stream. |
| **Habitat Access** | | | | |
| Physical Barriers | | | X | Several weirs on the Tyee Valley Golf Course and culverts on Marine View Drive or South 200th Street may be barriers to resident and anadromous fish at different times of the year, depending on flow conditions. |
| **Habitat Elements** | | | | |
| Substrate | | | X | Gravel accumulations suitable for spawning by anadromous salmonids occur at several locations in the lower reaches of the channel. Smaller accumulations suitable for resident cutthroat trout spawning are more frequent. Most spawning substrates are heavily embedded with silt and sands. |

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Table 30. Existing environmental conditions in Des Moines Creek, near Seattle-Tacoma International Airport (continued).

| Pathways Indicators | Environmental Baseline: Properly Functioning | At Risk | Not Properly Functioning | Explanation |
|---|---|---|---|---|
| Large Woody Debris | | | X | LWD has been cleared from the channel. The reduction or elimination of a native riparian area has impacted the recruitment of coniferous LWD. Loss of LWD has altered channel morphology resulting in reduced sinuosity, decreased pool to riffle ratio, and limited cover and habitat. Coniferous and non-coniferous LWD recruitment occur below South 200th Street on the east bank of the stream (Parametrix 1997). |
| Pool Frequency | | | X | Des Moines Creek streambed does not meet optimal pool frequency conditions in the Tyee Valley Golf Course. Channelization, increased sediment input, alterations to the hydrography, removal of LWD, and riparian alterations have decreased pool frequency and may have impacted the development of future pools. A high pool frequency occurs below South 200th Street where the stream grade increases to a step/pool system formed mainly by boulders. |
| Pool Quality | | | X | The stream is channelized within the Tyee Valley Golf Course where a few deeper pools exist, especially below weirs. Quality habitat features do not exist within these pools. Boulders and some LWD form several deep pools below South 200th Street. |
| Off-Channel Habitat | | | X | Channelization through the Tyee Valley Golf Course has eliminated opportunities for hydrologically connected habitat along stream margins, resulting in a decrease in side channel rearing habitat. Below South 200th Street, the steep slope of the stream confines the channel, offering little off-channel habitat. |
| Refugia | | | X | Channelization and reduction of instream structure decreases hydraulic heterogeneity resulting in the loss of resting areas for fish. Loss of LWD and increased channel scouring reduces habitats available, especially low-velocity areas for juvenile fish. Riparian alterations, channelization, and lack of LWD result in few bank undercuts. Channelization and filling have resulted in loss of wetland and side channel habitat for rearing fish. Riparian impacts also reduce overhead cover. Within the ravine south of South 200th Street, the steep slopes offer some overhanging vegetation and LWD. |
| **Channel Condition & Dynamics** | | | | |
| Width to Depth Ratio | | | X | Width to depth ratios vary considerably along the length of Des Moines Creek, but are generally low in channelized reaches and more favorable in less developed reaches. |
| Streambank Condition | | | X | Condition of streambanks in the basin is variable. The upper portion of the stream is largely culverted or channelized through parking lots, streets, and a golf course. Stream width is narrow, with portions of the banks containing riprap. Lower reaches of the stream (below South 200th Street) contain areas with natural banks and forested riparian vegetation. |
| Floodplain Connectivity | | X | | Large wetlands connected to the channel occur on the Tyee Valley Golf Course. Some stormwater detention exists in the upper basin associated with STIA. Wetlands have been filled to enlarge developable areas. |

**Table 30. Existing environmental conditions in Des Moines Creek, near Seattle-Tacoma International Airport (continued).**

| Pathways Indicators | Environmental Baseline: Properly Functioning | At Risk | Not Properly Functioning | Explanation |
|---|---|---|---|---|
| **Flow/Hydrology** | | | | |
| Peak/Base Flows | | | X | Impervious surfaces are extensive and may comprise up to 49% of the basin area. Little of this area receives adequate stormwater management. Return of stormwater in the upper basin has been moderated through detention ponds associated with airport runoff. Most runoff from residences and roads in the mid- and lower basin is conveyed directly back to the channel, with little or no detention. Current conditions likely result in strong hydrographic peaks immediately following precipitation. |
| Drainage Network Increase | | | X | Impervious surfaces are extensive throughout the basin and include the roads, residences, commercial development, and airport facilities. Most runoff from impervious surfaces is conveyed through ditches and pipe systems to the stream without adequate stormwater management. |
| **Watershed Conditions** | | | | |
| Road Density and Location | | | X | Roads are extensive throughout the basin. |
| Disturbance History | | | X | Basin disturbances are extensive; however, parkland or residential development in the mid- and lower basin have maintained some riparian areas. |
| Riparian Reserves | | | X | Riparian areas have been extensively altered in the upper reaches. The riparian areas upstream of South 200th Street are extensively altered by golf course and other development. Lower reaches contain a relatively continuous riparian corridor. The width of the corridor is variable and frequently limited by residential uses and exotic species. |

At Marine View Drive (RM 0.4), a 225-ft-long box culvert conveys the stream under the roadway, but acts as an impediment to migrating salmon and trout because of its high velocities (greater than 7 ft per second) and length (Des Moines Creek Basin Committee 1997). Below Marine View Drive, the stream reach through Des Moines Beach Park provides some of the most accessible and more heavily spawned fish habitat in the system. Hillman et al. (1999) found coho and chum salmon redd densities of 26.3 and 20.0 redds/mi, respectively, during studies in this reach in 1998-1999.

#### 4.3.2.1 Condition of Fish Habitat in Des Moines Creek

King County has estimated that the Des Moines Creek basin is 32 percent impervious surface, based on digitized land use data and GIS (Parametrix 2000b). May (1996) reported a value of 49.1 percent, based on aerial photo analysis. Previous stream studies and habitat inventories dating back to 1974 (Des Moines Creek Basin Committee 1997) established that Des Moines Creek has been severely degraded by urbanization. Little usable salmonid habitat exists in the system upstream of South 200th Street. Downstream of South 200th Street, where the stream flows through a forested wetland area, a short reach harbors resident trout and pumpkinseed sunfish. Better native fish habitat exists in meanders below the Midway Treatment Plant; however, the culvert under Marine View Drive restricts migrating salmon and trout from reaching this habitat. The stream reach through Des Moines Beach Park provides the most fish use, with coho salmon, chum salmon, cutthroat trout, and steelhead observed in this reach.

Des Moines Creek is on the Washington State 303(d) list of impaired water bodies for exceeding standards for fecal coliform levels at both stormflows and base flows (Parametrix 2000b; Ecology 1998a; Des Moines Creek Basin Committee 1997). High water temperatures in summer have also been identified as a water quality concern (Parametrix 2000b; Des Moines Creek Basin Committee 1997).

Des Moines Creek enters Puget Sound through Des Moines Park Beach located in the City of Des Moines. During low tide, the stream flows onto a low-gradient rocky beach composed of 3-inch-minus coarse and fine gravel embedded with sands. To the north for several hundred feet, the OHWM is defined by wrack (accumulations of debris at the high-tide line). To the south for approximately 50 ft, the OHWM is defined by breakwater walls protecting residential property. Beyond the house to the south, the beach is composed of riprap protecting the Des Moines Marina.

## 4.4 DES MOINES CREEK ESTUARY

### 4.4.1 Historical Conditions in Des Moines Creek Estuary

Changes to Des Moines Creek estuary are summarized in Table 31.

AR 010130

**Table 31. Changes in vegetation and land use near the Des Moines Creek estuary between 1936 and 1995.**

| Year | Vegetation, condition, and land uses |
|---|---|
| 1936 | The mouth of Des Moines Creek and estuary are largely developed. At the mouth of the stream, a building is constructed on piers over the stream channel and the upper intertidal area. A road crosses the stream mouth and appears to be located on an earthen seawall. Adjacent to the stream channel is a meadow, small roads, and small cabins. Des Moines Memorial Drive crosses the stream ravine on fill. North of the road crossing, a forested corridor (up to 800 ft wide) is present, which continues to the northeast in a relatively wide riparian corridor (greater than 100 ft). |
| 1948 | The area is similar to the 1936 condition. The small meadow is now a parking area, and portions of the slopes of the ravine are less thickly forested. |
| 1961 | The area is similar to the 1948 condition. |
| 1995 | The area has been developed into a park. Buildings have been removed from intertidal and some riparian areas. |

## 4.4.2 Current Conditions in Des Moines Creek Estuary

A small estuary is present where Des Moines Creek enters Puget Sound. Baseline environmental conditions in this estuary have been highly modified by park development. Before entering the beach, Des Moines Creek runs through Des Moines Beach Park, which consists of lawn, roads, parking areas, etc. Two bridges cross the stream, and the streambank is stabilized with riprap.

The marine shoreline is stabilized with riprap for about 200 ft north of Des Moines Creek before a vegetated bluff starts and continues north. Approximately 400 ft north of Des Moines Creek, some houses are protected by cement bulkheads located near the high tide mark. Immediately south of the stream, a riprap wall runs south and west across the beach to a fishing pier and the Des Moines Marina. Within the marina, the shoreline continues as riprap. The beach at the stream mouth and north of the stream has a gentle slope, dropping approximately 5 ft over 100 yards. South of the stream mouth, the riprap wall drops steeply from the high tide mark to the lower intertidal zone over a span of 25 to 30 ft.

The intertidal zone at the mouth of Des Moines Creek is composed of gravel and sand with some cobble and boulders. This substrate type is fairly uniform throughout the intertidal zone north of the stream. South of the stream, starting at the fishing pier, riprap covers the entire intertidal zone. *Enteromorpha intestinalis* is the dominant algae in the upper intertidal zone, covering cobble and boulders about 75 ft into the Des Moines Creek channel. Lesser amounts of *E. intestinalis* are attached to rocks adjacent to the stream with barnacles sporadically present. Barnacles and mussels dominate the middle intertidal zone, except in the stream channel, where *E. intestinalis* dominates most cobble with some presence of barnacles. The lower intertidal zone continues to have abundant numbers of barnacles and mussels with green, brown, and red algae being common. Isopods, shore crabs, and snails were more readily found in this zone, and bivalve siphons were periodically observed in sandy areas. The riprap south of the stream hosts an intertidal community very different from the gradual beach to the north of the stream. Barnacles, mussels, and the red algae *Mastocarpus papillatus* densely occupy the majority of the intertidal zone. *Littorina* snails and limpets are also abundant throughout this area.

**AR 010131**

## 4.5 STREAM IMPACTS

Environmental impacts to streams that have occurred in the STIA watersheds over the past 50 to 70 years are similar to those that are found in small urban streams throughout the region. They include the following:

- **Channelization and confinement of stream channels.** This impact has occurred in several reaches of Miller, Walker, and Des Moines Creeks. These impacts reduce channel complexity, increase velocities, eliminate pools for holding and rearing, eliminate spawning gravel, fill side channels, reduce wood recruitment, and reduce connectivity with floodplain and riparian zones.
- **Loss of riparian vegetation.** Riparian vegetation has been removed as a result of urbanization, forestry, and agriculture. As a result, overhanging vegetation, stream shade, and cover are reduced. Resulting increased solar radiation can elevate water temperatures. Vegetation loss reduces LWD recruitment, terrestrial insect influx, and leaf litter influx, thus altering the energy cycle.
- **Loss of forested areas.** Urbanization, forestry, and agriculture have reduced forest cover, which alters the runoff cycle affecting the timing and magnitude of flows. This can increase erosion and change channel morphology.
- **Loss of wetlands.** Loss of riparian wetlands can reduce detrital input and energy cycles.
- **Creation of impervious surfaces.** Urbanization alters the runoff cycle, affecting the timing and magnitude of flows. This can increase erosion, degrade water quality, increase stormwater runoff, and change channel morphology. Stormwater runoff introduces pollutants to aquatic habitats.
- **Culverts, pipes, and ditches.** The creeks contain numerous culverted and ditched reaches. These obstruct fish passage, reduce movement of gravel, and can strand fish in ditches. Ditch networks increase runoff rates and connect the stream system to impervious surfaces and other high-runoff areas.
- **Loss of estuarine and nearshore habitats.** Much of the freshwater to saltwater transition habitats of Miller and Des Moines Creeks have been altered or filled. Habitat, including cover and food production for smolts and adults, is limited.
- **Erosion and sedimentation.** Increased turbidity from stormwater runoff, inputs of fine sediment from construction sites, and channel erosion from high streamflows can reduce water and sediment quality. The transition from agricultural and forestry land uses to urban land uses has probably reduced the amount of land disturbance and sedimentation rates.
- **Fertilizer and pesticide use.** Degraded water quality and increased toxicity may result in biological degradation. A change from agricultural to urban land uses has likely shifted the spectrum of nutrient and chemical use in the watersheds. Agricultural use included application of barnyard manure, fertilizers, and pesticides. These applications were frequently in farmed wetlands with direct connections to streams through drainage ditches. Quantitatively, use of these chemicals may be lower than in the recent past. However, new land uses result in pollutants from stormwater and risks of accidental spillage from a wide variety of commercial chemicals.

### 4.5.1 Current Regulatory Protection for Streams and Aquatic Habitats

Many of the regulations that protect wetlands also protect Miller, Walker, and Des Moines Creeks from the potential adverse impacts of nearby development. These are briefly described below. Additional information and requirements are found in Ecology (1998b).

- **Clean Water Act – Section 404.** Regulates fill placement in Waters of the U.S., and triggers Section 401 review by Ecology to protect water quality. Mitigation ratios that require mitigation area in excess of the area of fill help ensure that cumulative losses do not occur over time.
- **Critical Areas Protection.** Critical area protection is included as part of the municipal code of each community in the watershed. These regulations protect, among other elements, wetlands, wetland buffers, streams, stream buffers, and fish and wildlife conservation areas.
  - **SeaTac** - Title 15, Chapter 15.30
  - **Burien** - Title 18, Chapter 18.60
  - **Des Moines** - Title 18, Chapter 18.86
  - **Normandy Park** - Title 13, Chapter 13.16

  The regulations provide specific standards and mitigation requirements for the modification of streams and their protective buffers. Local mitigation standards for stream and buffer alterations require replacement of area and function.
- **Hydraulics Project Approval.** HPAs are required for projects that use, divert, obstruct, or change the natural flow or bed of any fresh water or saltwater of the state. HPA approvals generally require mitigation adequate to compensate for project impacts to streams. These approvals may also be required for projects not occurring in streams or wetlands, but that discharge stormwater runoff to them. Mitigation for these projects can require enhanced stormwater detention and water quality standards to preserve existing runoff patterns and water quality.
- **State and National Environmental Policy Acts.** SEPA and NEPA provide stream protection by requiring analysis of project impacts to streams and by requiring mitigation of adverse impacts.
- **Stormwater Management Standards.** Local stormwater management standards are designed to collect, detain, and treat stormwater runoff from urban areas and prevent degradation of streams.
- **Endangered Species Act.** The listing of chinook salmon and bull trout under the Endangered Species Act (ESA) provides additional protection to the streams. Review of development projects or other watershed activities under the ESA is often necessary to ensure that habitat or water quality impacts are avoided in the estuarine mouths (where the listed species could occur).

The above permits and other related environmental approvals (Ecology 1998b) help prevent cumulative impacts to streams, water quality, and aquatic habitat.

# 5. WILDLIFE HABITATS

Wildlife habitat is defined as an area with an adequate combination of resources (e.g., food, cover, water) and environmental conditions (climate, suitable levels of predators or competitors, etc.) that support use (i.e., survival and reproduction) by individuals of a given species. The types of habitat resources and features that meet a species' biological needs identifies the habitat niche a species occupies. A species habitat niche is used to predict species responses to past, present, and future land uses of an area.

## 5.1 WILDLIFE HABITAT TYPES

In the Miller and Des Moines Creek watersheds, a number of wildlife habitat types are present. The present and past (since 1936) habitats (as defined by Brown [1985] and Johnson and O'Neil [2001]) occurring in the STIA watersheds are briefly described below. Current habitats are mapped in Figure 7.

### 5.1.1 Upland Successional

Upland successional habitats in the area (listed below) are various, due to the wide variety of human disturbances that have occurred in the watersheds.

- **Grass/forb stage.** Generally this area consists of abandoned pastures and recently cleared land. Shrub communities consisting of blackberry (*Rubus discolor*) or Scots broom (*Cytisus scoparius*) quickly replace it.
- **Lowland shrub.** Abandoned pastures, lawn areas, and other disturbed sites generally become dominated by introduced blackberry and Scots broom shrubs. This stage can persist for many years.
- **Coniferous.** All coniferous forests in the area are in early- to mid-stages of succession. The larger tracts of this community type occur in the stream ravines or relatively steep slopes bordering the Puget Sound shoreline. Some areas north and south of STIA that were formerly developed neighborhoods have an open overstory of native and non-native conifer trees and an understory of blackberry and ornamental shrubs. Since 1936, large amounts of this habitat have been replaced by development.
- **Deciduous.** Deciduous and mixed coniferous and deciduous forests occur scattered throughout the area. They typically occur on steeper slopes, bordering wetland areas. Since 1936, large amounts of this habitat have been developed.

### 5.1.2 Agricultural Habitats

Agricultural habitats have been essentially abandoned, and agricultural lands have generally been developed. Smaller areas have reverted to wetland or upland successional communities. In 1936, plant communities in large portions of the watershed had been altered, and included the following habitat types:

AR 010134

- **Herbaceous cropland**
- **Orchard**
- **Unmowed, stable** (i.e., pasture)
- **Mowed, stable** (i.e., hayfields)

### 5.1.3 Urban Habitats

Urban habitats in the watersheds have increased dramatically since 1936, when urban areas were almost absent.

- **Mostly vegetated.** This habitat consists of low-density residential areas where, in addition to home sites, larger yards, landscaped areas, and small areas of undeveloped land provide habitat.
- **Moderately vegetated.** This habitat type consists of medium-density residential development.
- **Poorly vegetated.** This habitat type consists of high-density residential development, commercial/retail development, etc.

### 5.1.4 Wetland and Aquatic Habitat

A variety of commonly recognized wetland habitats are found in the watersheds.

- **Freshwater lake/pond.** These habitats occurred in several locations. In the Des Moines Creek watershed, they are limited to the Northwest Pond (Wetland 28) area and Bow Lake. In the Miller Creek watershed, they occur at Lake Burien, Arbor Lake, Tub Lake, Lake Reba, and Lora Lake. The area of open water habitat appears to have increased since 1936.
- **Salt marsh.** There is no salt marsh habitat present in either watershed. Small amounts of salt marsh habitat may have once occurred at the mouths of both Miller and Des Moines Creeks.
- **Shrub wetland.** Many of the wetlands contain shrub wetland habitat. In the Miller Creek basin, the largest areas occur in the Tub Lake area, the Lake Reba area, and in Wetland 43. In the Des Moines Creek Basin, the largest area of this habitat type occurs in the Northwest Ponds and Bow Lake areas. The amount of shrub wetland habitat appears to have increased since 1936.
- **Freshwater marsh.** Little freshwater marsh was historically present, and little is present today. Fringes of this habitat border the Northwest Pond area, Lake Reba and associated wetlands, and ditches on the Vacca Farm site.
- **Bog.** Tub Lake remains as a high-quality bog system. Peat mining has removed some bog vegetation. Other wetland areas that may have once contained bog communities are Bow Lake, Vacca Farm, and the Northwest Pond areas.
- **Wet meadow.** All wet meadow habitats in the watersheds are artificial. Seasonally saturated areas of the Tyee Valley Golf Course, portions of the Vacca Farm area, Wetland 22

on the airfield, and several small wetlands in lawn or pasture within the acquisition area are wet meadow habitats.

- **Forested wetland.** Historically, most vegetated wetland habitats were likely forested wetlands. The larger areas of this habitat occur in the Lake Reba wetland complex, Wetland 43, and Wetland 44 in the Miller Creek Watershed. In the Des Moines Creek watershed, the largest areas occur in Wetland 28 and Wetland 51. The area of this habitat type has increased since 1936.

## 5.2 HISTORICAL CONDITIONS AND CHANGES IN HABITAT TYPES AND AREA SINCE 1936

To provide ACOE with information on the watersheds as a whole, and on changes to wildlife habitat that have occurred over time, additional data has been reviewed and organized.

Available information on historical habitat conditions in the watersheds can be estimated from Shapiro and Associates (1994) (see Table 1 and Figures 2 through 6), which evaluated historical land use in a 27,650-acre area (2.5 miles wide and 13 miles long) rectangle centered on STIA. The study area is generally between 1$^{st}$ Avenue South and 51$^{st}$ Avenue South and between Alaska Street and 304$^{th}$ Street South. While this analysis is not specific to the watersheds of concern, it includes the entire Des Moines Creek watershed and a portion of the Miller Creek watershed. Coupled with review of historical aerial photographs, it provides a basis for estimating habitat conditions in the watersheds prior to and immediately following STIA development.

In 1948, over 67 percent of the area was in open space. Evaluation of 1936 and 1948 aerial photographs indicate the open space consists of agricultural lands, early successional forestland, and farmed wetlands. Throughout the mosaic of habitat types, scattered farms and homes are present, as are a number of golf courses. Urban land uses present in the study area near STIA were generally low- to medium-density residential areas (about 24 percent of the study area).

The impact of Master Plan Update development projects on vegetation and wildlife habitat was evaluated in the Final Environmental Impact Statement (FEIS) (FAA 1996) for the project. This analysis included classifying and mapping wildlife habitats in the construction areas and vicinity (totaling about 6,600 acres of land) (Table 32).

The areas impacted by the project do not provide high-quality wildlife habitat for many wildlife species (FAA 1996, 1997). Approximately 300 of the roughly 700 acres are managed grasslands associated with the airport operations area and a golf course, with relatively low habitat value for most native wildlife communities. Approximately 80 acres are lower-quality shrub habitat typically consisting of non-native Himalayan blackberry that provides limited habitat value to a small number of animal species. The remaining areas of impact (early successional deciduous and coniferous forest) typically occur in former residential neighborhoods. In these areas, development has eliminated native understory shrub and herbaceous vegetation, snags, downed logs, or other habitat features that reduces their suitability to wildlife. The forest understory is typically colonized by non-native plants (both the shrub and herbaceous layers) and is fragmented by streets or more highly developed areas that further reduce their habitat suitability.

**AR 010136**

Table 32. Impacts to vegetation and wildlife habitat (from FEIS data [FAA 1996 and Parametrix 2001a]).

| Vegetation Class | Existing Area (Acres) | Alternative 3 Impact Area (Acres)[a] |
|---|---|---|
| Managed Grassland | 900 | 283 |
| Grassland | 142 | 57 |
| Shrubland | 253 | 83 |
| Deciduous Forest | 723 | 244 |
| Coniferous Forest | 112 | 14 |
| Wetlands[b] | | |
| Forest | 54 | 8.17 |
| Shrub | 54 | 2.98 |
| Emergent | 42 | 7.22 |
| Urban (density varies) | 4, 320 | |

a Values overestimate habitat impacts due to avoidance of wetlands in Borrow Areas 1 and 3, and do not reflect changes that occur as a result of mitigation.

b Wetland values are from Parametrix (2001a).

## 5.3 WILDLIFE USE

Patterns of wildlife use in the study area are expected to change with the changes in habitat types available to them, as shown by King County (1987), Raedeke (1988), and Penland (1984).

### 5.3.1 Amphibians and Reptiles

In western Washington, most amphibian and reptile species inhabit wetland and forested habitats, with few, if any, species found in agricultural or urban habitat types. In 1936 and 1948, considerable forestland had been converted to agricultural use, and most wetlands were largely in agricultural land uses. These areas (including the Vacca Farm, Lake Reba, Wetland 28, Wetlands 43 and 44 and Bow Lake wetland complexes) are largely in agricultural uses, and therefore, little amphibian use would be expected.

During later years, some of these agricultural uses were abandoned. Portions of wetlands were filled (wetlands surrounding Bow Lake) or converted to other uses (portions of Wetland 28 were filled or converted to golf course uses) and do not provide significant amphibian habitat. However, in other areas where agricultural uses have been abandoned, portions of the Vacca Farm/Lake Reba wetlands and most of Wetlands 43 and 44 have reverted to wetland plant communities and provide improved habitat for amphibians compared to their 1936 condition.

### 5.3.2 Small Mammals

In 1936 and 1948, considerable forestland had been converted to agricultural use, and most wetlands were largely in agricultural land uses. These areas (including the Vacca Farm, Lake Reba, Wetland 28, Wetlands 43 and 44, and Bow Lake wetland complexes) are largely in agricultural uses, and therefore, little small mammal use would be expected.

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During later years, some of these agricultural uses were abandoned. Portions of wetlands were filled (wetlands surrounding Bow Lake) or converted to other uses (portions of Wetland 28 were filled or converted to golf course uses) and do not provide significant small mammal habitat. However, in other areas where agricultural uses have been abandoned, portions of the Vacca Farm/Lake Reba wetlands and most of Wetlands 43 and 44 have reverted to wetland plant communities and provide improved habitat for small mammals compared to their 1936 condition.

In western Washington, many small mammal species inhabit wetland and forested habitats. Agricultural and urban habitats contain fewer species than are found in natural habitats. Thus, as timber harvest, farming, and urban development have occurred, the habitat for many species of small mammals has decreased or been eliminated.

In addition to habitat loss, mobility of small mammals is decreased by fragmentation of habitats. In the Miller and Des Moines Creek watersheds, fragmentation has occurred through commercial and residential development, and by highway development. Development has isolated wetland habitats from other natural areas, which could reduce the overall habitat value and species diversity. Likewise, highways crossing wetlands (i.e., SR 509 crossing Wetlands 44 and 43 and SR 518 separating Vacca Farm and Lake Reba from other undeveloped areas to the north [including Tub Lake]) fragments a larger system, which reduces the overall habitat value for some small mammal species.

A number of small mammals in Washington prefer freshwater wetland and aquatic habitats. Historically, in the Miller, Walker, and Des Moines Creek watersheds, these could have included Northern water shrew, beaver, Richardson's vole, muskrat, mink, and river otter. Miller, Walker, and Des Moines Creeks and several associated wetlands provide potential habitat for beaver and muskrat.

### 5.3.3 Large Mammals

Prior to settlement, large mammals expected to occur in the area would have included coyote, red fox, mountain lion, bobcat, elk, mule deer, and black bear. By 1936, given the extent of agriculture in the area, the extent of deforestation, distance from the foothills of the Cascades, and past and on-going hunting pressure, mountain lion, elk, and black bear could have been extirpated from the area. In the present condition, these species would not be expected to occur in the watersheds, and habitat for other species would be much reduced. Only coyote and red fox would be expected to occur in the less-developed urban habitats.

### 5.3.4 Birds

Bird life in the Miller and Des Moines Creek watersheds is expected to be diverse (Table 33), and to reflect the variety of wetland, upland, and shoreline habitats present. Because of their mobility, even in highly urbanized or fragmented watersheds, the habitat areas available to bird populations using the watershed also extends beyond watershed boundaries.

Bird use of urban Puget Sound environments (including wetlands) is documented by Gavareski (1976), King County (1987), Milligan (1985), Norman (1998), Penland (1984), and Richter and Azous (2001). Many migratory (and resident) birds disperse widely and use urban habitat for

**Table 33. Bird species reported near Seattle-Tacoma International Airport (FAA 1996), in wildlife surveys at Dumas Bay (Norman 1998), and in the Kent Christmas Bird Count area (Audubon Society 2001).**

| Common Name | STIA MPU* EIS | Dumas Bay | Christmas Bird Count |
|---|---|---|---|
| Red-throated loon | No | Yes | Yes |
| Pacific loon | No | Yes | Yes |
| Common loon | No | Yes | Yes |
| Pied-billed grebe | Yes | Yes | Yes |
| Horned grebe | No | Yes | Yes |
| Red-necked grebe | No | Yes | Yes |
| Eared grebe | No | Yes | Yes |
| Western grebe | No | Yes | Yes |
| Double-crested cormorant | No | Yes | Yes |
| Brandt's cormorant | No | Yes | Yes |
| Pelagic cormorant | No | Yes | Yes |
| American bittern | No | No | No |
| Great blue heron | Yes | Yes | Yes |
| Green heron | No | Yes | Yes |
| Trumpeter swan | No | No | Yes |
| Great white-fronted goose | No | No | Yes |
| Snow goose | No | Yes | Yes |
| Black brant | No | Yes | Yes |
| Canada goose | Yes | Yes | Yes |
| Wood duck | Yes | No | Yes |
| Green-winged teal | Yes | Yes | Yes |
| Mallard | Yes | Yes | Yes |
| Northern pintail | No | Yes | Yes |
| Cinnamon teal | No | Yes | Yes |
| Northern shoveler | No | Yes | Yes |
| Gadwall | Yes | Yes | Yes |
| Eurasian wigeon | No | Yes | Yes |
| American wigeon | Yes | Yes | Yes |
| Canvasback | No | Yes | Yes |
| Redhead | No | No | Yes |
| Ring-necked duck | No | No | Yes |
| Greater scaup | No | Yes | Yes |
| Lesser scaup | No | Yes | Yes |
| Harlequin duck | No | No | Yes |
| Black scoter | No | Yes | Yes |
| Surf scoter | No | Yes | Yes |
| White-winged scoter | No | Yes | Yes |
| Common goldeneye | No | Yes | Yes |

**Table 33. Bird species reported near Seattle-Tacoma International Airport (FAA 1996), in wildlife surveys at Dumas Bay (Norman 1998), and in the Kent Christmas Bird Count area (Audubon Society 2001) (continued).**

| Common Name | STIA MPU* EIS | Dumas Bay | Christmas Bird Count |
|---|---|---|---|
| Barrow's goldeneye | Yes | Yes | Yes |
| Bufflehead | No | Yes | Yes |
| Hooded merganser | No | Yes | Yes |
| Common merganser | Yes | Yes | Yes |
| Red-breasted merganser | No | Yes | Yes |
| Ruddy duck | No | Yes | Yes |
| Osprey | No | Yes | Yes |
| Bald eagle | Yes | Yes | Yes |
| Northern harrier | Yes | No | Yes |
| Sharp-shinned hawk | Yes | Yes | Yes |
| Cooper's hawk | Yes | Yes | Yes |
| Northern goshawk | No | No | Yes |
| Red-tailed hawk | Yes | Yes | Yes |
| Rough-legged hawk | No | Yes | Yes |
| Swainson's hawk | No[a] | No | No |
| American kestrel | No | Historic | Yes |
| Merlin | No | Yes | Yes |
| Peregrine falcon | No | Yes | Yes |
| Ring-necked pheasant | No | Historic | Yes |
| Ruffed grouse | No | Historic | Yes |
| California quail | No | Yes | Yes |
| Virginia rail | No | Historic | Yes |
| Sora | No | Historic | Yes |
| American coot | No | Yes | Yes |
| Black-bellied plover | No | Yes | Yes |
| Semipalmated plover | No | Yes | No |
| Killdeer | Yes | Yes | Yes |
| Greater yellowlegs | No | Yes | Yes |
| Lesser yellowlegs | No | No (Expected) | No |
| Spotted sandpiper | No | Yes | Yes |
| Black turnstone | No | No (Expected) | Yes |
| Western sandpiper | No | Yes | Yes |
| Least sandpiper | No | Yes | Yes |
| Dunlin | No | Yes | Yes |
| Sanderling | No | Yes | No |
| Long-billed dowitcher | No | No (Expected) | Yes |
| Short-billed dowitcher | No | Yes | No |
| Common snipe | No | Yes | Yes |
| Whimbrel | No | No | No |

Table 33. **Bird species reported near Seattle-Tacoma International Airport (FAA 1996), in wildlife surveys at Dumas Bay (Norman 1998), and in the Kent Christmas Bird Count area (Audubon Society 2001) (continued).**

| Common Name | STIA MPU* EIS | Dumas Bay | Christmas Bird Count |
|---|---|---|---|
| Parasitic jaegar | No | Yes | No |
| Mew gull | No | Yes | Yes |
| Ring-billed gull | No | Yes | Yes |
| California gull | No | Yes | Yes |
| Herring gull | No | Yes | Yes |
| Thayer's gull | No | Yes | Yes |
| Western gull | No | Yes | Yes |
| Glaucous-winged gull | Yes | Yes | Yes |
| Glaucous x western gull | No | Yes | Yes |
| Gull sp. | No | Yes | Yes |
| Heerman's gull | No | Yes | Yes |
| Caspian tern | No | Yes | No |
| Common tern | No | Yes | No |
| Common murre | No | Yes | Yes |
| Pigeon guillemot | No | Yes | Yes |
| Marbled murrelet | No | Yes | Yes |
| Rhinoceros auklet | No | Yes | Yes |
| Band-tailed pigeon | Yes | Yes | Yes |
| Rock dove | Yes | Yes | Yes |
| Mourning dove | No | Historic | Yes |
| Common barn-owl | No | Yes | Yes |
| Western screech-owl | No | Yes | Yes |
| Great horned owl | Yes | Yes | Yes |
| Northern pygmy-owl | No | No | Yes |
| Snowy owl | No[a] | No | No |
| Short-eared owl | No | No | Yes |
| Northern saw-whet owl | No | Yes | Yes |
| Anna's hummingbird | No | Yes | Yes |
| Rufous hummingbird | No | Yes | No |
| Black swift | No[a] | No | No |
| Common nighthawk | No[a] | No | No |
| Belted kingfisher | Yes | Yes | Yes |
| Downy woodpecker | Yes | Yes | Yes |
| Hairy woodpecker | Yes | Yes | Yes |
| Northern flicker | Yes | Yes | Yes |
| Pileated woodpecker | Yes | Yes | Yes |
| Red-breasted sapsucker | No | Yes | Yes |
| Willow flycatcher | No | Yes | No |
| Pacific-slope flycatcher | No | Yes | No |

**Table 33. Bird species reported near Seattle-Tacoma International Airport (FAA 1996), in wildlife surveys at Dumas Bay (Norman 1998), and in the Kent Christmas Bird Count area (Audubon Society 2001) (continued).**

| Common Name | STIA MPU* EIS | Dumas Bay | Christmas Bird Count |
|---|---|---|---|
| Olive-sided flycatcher | Yes | Yes | No |
| Tree swallow | Yes | Yes | No |
| Violet-green swallow | No | Yes | No |
| Purple martin | No | Yes | No |
| Northern rough-winged swallow | No | Yes | No |
| Barn swallow | Yes | Yes | No |
| Cliff swallow | No | Yes | No |
| Bank swallow | No[a] | No | No |
| Horned lark | No[a] | No | No |
| Steller's jay | Yes | Yes | Yes |
| Common raven | No | Yes | Yes |
| Black-capped chickadee | Yes | Yes | Yes |
| Mountain chickadee | No | Yes | Yes |
| Chestnut-backed chickadee | No | Yes | Yes |
| Bushtit | Yes | Yes | Yes |
| Red-breasted nuthatch | Yes | Yes | Yes |
| White-breasted nuthatch | No | Historic | No |
| Brown creeper | Yes | Yes | Yes |
| Bewick's wren | Yes | Yes | Yes |
| Winter wren | Yes | Yes | Yes |
| Marsh wren | No | Yes | Yes |
| American dipper | No | Yes | Yes |
| Golden-crowned kinglet | No | Yes | Yes |
| Ruby-crowned kinglet | No | Yes | Yes |
| Hermit thrush | No | Yes | Yes |
| American robin | Yes | Yes | Yes |
| Varied thrush | No | Yes | Yes |
| Swainson's thrush | No | Yes | No |
| Townsend's solitaire | No | Yes | No |
| American pipit | No | Yes | Yes |
| Cedar waxwing | No | Yes | Yes |
| Northern shrike | No | Yes | Yes |
| European starling | Yes | Yes | Yes |
| Western warbling-vireo | No | Yes | No |
| Solitary vireo | No | Historic | No |
| Hutton's vireo | No | Yes | Yes |
| Orange-crowned warbler | Yes | Yes | Yes |
| Nashville warbler | No | Yes | No |
| Yellow warbler | Yes | Yes | No |

**Table 33. Bird species reported near Seattle-Tacoma International Airport (FAA 1996), in wildlife surveys at Dumas Bay (Norman 1998), and in the Kent Christmas Bird Count area (Audubon Society 2001) (continued).**

| Common Name | STIA MPU* EIS | Dumas Bay | Christmas Bird Count |
|---|---|---|---|
| Black-throated gray warbler | No | Yes | No |
| Common yellowthroat | No | Yes | Yes |
| Townsend's warbler | No | Yes | Yes |
| Audubon's warbler | No | Yes | Yes |
| MacGillivray's warbler | No | Yes | No |
| Wilson's warbler | No | Yes | No |
| Black-headed grosbeak | No | Yes | No |
| Western tanager | No | Yes | No |
| Rufous-sided towhee | Yes | Yes | Yes |
| Rustic bunting | No | No | Yes |
| Vesper sparrow | No | No | Yes |
| American tree sparrow | No | No | Yes |
| Savannah sparrow | No | Historic | Yes |
| Fox sparrow | No | Yes | Yes |
| Song sparrow | Yes | Yes | Yes |
| Lincoln's sparrow | No | No (Expected) | Yes |
| Swamp sparrow | No | No | Yes |
| White-throated sparrow | No | No | Yes |
| Golden-crowned sparrow | No | Yes | Yes |
| White-crowned sparrow | Yes | Yes | Yes |
| Harris' sparrow | No | No | Yes |
| Dark eyed junco | Yes | Yes | Yes |
| Red-winged blackbird | No | Yes | Yes |
| Western meadowlark | No | No | Yes |
| Brewer's blackbird | No | No | Yes |
| Brown-headed cowbird | No | Yes | Yes |
| Purple finch | No | Yes | Yes |
| House finch | No | Yes | Yes |
| Red crossbill | No | Yes | Yes |
| Pine siskin | No | Yes | Yes |
| American goldfinch | Yes | Yes | Yes |
| Evening grosbeak | No | Yes | Yes |
| House sparrow | Yes | Yes | Yes |

[a] This species has been reported as salvaged on the STIA airfield.

* MPU = Master Plan Update.

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breeding, foraging, and as migration corridors. The large amounts of marginal urban habitat suitable for use by migrating birds will remain following Master Plan Update project development. Since urban habitats similar to those being eliminated are common in Puget Sound and the STIA vicinity, significant impacts on the regional populations of birds are unlikely. The area of habitat available to bird life near STIA includes, *at a minimum*, that habitat occurring within the Miller and Des Moines Creek watersheds, as well as nearby areas such as the adjacent Puget Sound subwatersheds of WRIA 9 (Table 34).

**Table 34. Current land uses in the WRIA 9 Puget Sound sub-watersheds.**

| Land Cover Description | Area (Mi$^2$) | Area (Acres) | % Watershed |
|---|---|---|---|
| Industrial & Commercial | 5.97 | 3818.13 | 6.29 |
| Bare Rock/Concrete | 0.24 | 156.41 | 0.26 |
| City Center, Industrial | 3.21 | 2054.80 | 3.38 |
| Recently Cleared | 0.33 | 208.52 | 0.34 |
| High-Density Residential | 19.52 | 12493.81 | 20.57 |
| *Subtotal* | *29.27* | *18731.67* | *30.84* |
| **Low/Medium Density Residential** | **11.18** | **7,154.25** | **11.78** |
| **Conifer - Early** | **0.05** | **32.05** | **0.05** |
| **Conifer - Mature** | **0.00** | **0.00** | **0.00** |
| **Conifer - Middle** | **0.02** | **15.30** | **0.03** |
| **Deciduous Forest** | **3.77** | **2412.09** | **3.97** |
| **Mixed Forest** | **1.28** | **817.56** | **1.35** |
| **Shrub** | **0.45** | **285.07** | **0.47** |
| **Grass - Brown** | **1.20** | **765.24** | **1.26** |
| **Grass - Green** | **0.48** | **307.03** | **0.51** |
| **Open Water** | **0.34** | **215.56** | **0.35** |
| *Subtotal* | *18.77* | *12,004.15* | *19.77* |
| TOTAL | 48.025 | 30,735.82 | 100 |

Note: Land uses listed in **bold** are land uses that are considered to provide low (residential and grass) to moderate or high (remaining types) habitat value to wildlife.

Detailed information regarding bird species of concern (Norman 2001) that use upland habitats are discussed below and in FAA (1997). All species would be expected to use the wetland, upland, and riparian habitat protected in both the on- and off-site mitigation areas.

- **Band-tailed pigeon.** Although the band-tailed pigeon is in decline, the main threat to the species appears to be habitat loss and direct human-caused mortality in Central America (Audubon Society 2001). In urban parks and gardens in western Washington, the species is actually becoming more common (Audubon Society 2001). Consequently, loss of habitat due to the proposed action is not expected to significantly affect the species populations.

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- **Belted kingfisher.** Belted kingfishers use wetland habitats with open water components. Wetlands that will be impacted by the Master Plan Update improvements do not provide suitable kingfisher habitat. Mitigation at Lora Lake and in Auburn could improve habitat for this species.

- **Pileated woodpecker.** As stated in Appendix M of the FEIS (FAA 1996), pileated woodpeckers have been observed in the approximately 187-acre deciduous forest in the central portion of the south borrow areas. Under the proposed action, some of this forested area would be removed. Loss of this acreage will not have a significant effect on pileated woodpeckers regionally, as large tracts of their preferred habitat, mature coniferous forests, will be unaffected.

- **Barn swallow, tree swallow, cliff swallow, willow flycatcher, black-capped chickadee, bushtit, orange-crowned warbler, song sparrow, white-crowned sparrow, black-headed grosbeak, Wilson's warbler, American goldfinch.** These species are all common in suburban environments. Abundant habitat outside of the project area will remain for these species following construction of Master Plan Update projects, because the birds are widely distributed in urban and non-urban areas throughout Puget Sound.

- **Swainson's thrush.** This species occurs in coniferous and mixed forests with dense undergrowth. The majority of the acreage impacted by the proposed action does not contain adequate cover to provide habitat for the species. Habitat in the project area that will be impacted contains marginal nesting habitat for this species, and these areas are most likely used for foraging habitat during migration. Remaining habitat in nearby areas outside of the project area will provide foraging habitat. Suitable Swainson's thrush nesting habitat in the low-elevation coniferous forests of western Washington will be unaffected.

- **Hutton's vireo.** This species is a resident of mixed forests with evergreens and oaks, with moderate to dense canopy cover (Davis 1995). Most of the habitat impacted by the Master Plan Update projects does not contain adequate canopy cover to provide habitat for the species. Because only a small amount of marginal Hutton's vireo habitat will be impacted by the proposed action, the project will not have a significant affect on the species.

- **Sharp-shinned hawk and Cooper's hawk.** Loss of forest represents loss of habitat for these species. However, forest types impacted under the proposed action (i.e., young, deciduous forest) are relatively common in the Puget Sound region, and adequate habitat outside the project area will remain for these species.

- **Northern harrier, American kestrel, and western meadowlark.** Harriers, kestrels, and meadowlarks prefer open habitats. Approximately two-thirds of the existing unmanaged grassland habitat will remain upon completion of the proposed action. Although some existing managed grassland will be impacted, the total acreage of managed grasslands will increase overall (due to creation of new managed grassland areas).

- **Common nighthawk.** This species nests in open areas and forages in a wide variety of habitats (Csuti et al. 1997). By increasing the amount of open habitat, the project will increase the amount of nighthawk nesting habitat. Some loss of foraging habitat will occur where areas are paved and similarly developed. However, given the wide variety of foraging habitat that this species will use, foraging habitat is not expected to be a limiting factor for this species, and other habitat in surrounding areas will remain as foraging areas.

- **Vaux's swift.** This species uses a wide variety of habitats where suitable cavities (i.e., dead trees, chimneys) are available (Smith et al. 1997). Removal of trees and abandoned houses (with chimneys) will reduce available cavities for this species, although remaining trees within and near the project site will continue to provide cavities for the species.
- **Streaked horned lark.** This species has been extirpated from most of the Puget Trough, and no breeding records for the species are present in the project vicinity (Smith et al. 1997). Use of the project area is likely limited to occasional fly-overs and stop-overs during migration.

Richter and Azous (2001) report on bird use in a variety of urban, suburban, and rural wetlands in King County, Washington. They report 90 species of birds as occurring in the wetlands. With the exception of water birds, the avifauna was generally found to be an extension of the adjacent upland fauna.

The potential for wetland fill to impact birds is most significant for those species with narrow habitat requirements, particularly for those species restricted to wetland habitat types. Using the versatility rating[9], the potential for the Master Plan Update projects to impact birds adapted to specialized wetland habitats was considered. Species with versatility ratings of less than 15 are listed in Table 35. Also listed are the potential habitats for these species in wetlands located near STIA, and for the mitigation site in Auburn. While fill of several wetlands will impact habitat used by several species of these birds, replacement habitat will be constructed in Auburn. With the exception of waterfowl, on-site wetland mitigation would also provide habitat suitable for use by most species.

[9] Versatility rating is an indicator of the sensitivity of wildlife species to habitat loss or change. The rating is based on the sum of primary and secondary habitats that a species uses for feeding or breeding. Species with versatility ratings of 15 or less are considered to have low versatility rating, ratings between 16 and 28 are moderate, and ratings greater than 29 are high.

**Table 35. Potential use of wetlands near Seattle-Tacoma International Airport by bird species with low habitat versatility ratings[a].**

| Bird Species[b] | Versatility Rating | Potential Habitat in STIA Wetlands[c] | Habitat in Auburn |
|---|---|---|---|
| Marsh wren | 8 | **A1**[d], 28, 43 | Emergent |
| Common yellowthroat | 8 | **A1**, 28, 43 | Emergent |
| Red-winged blackbird | 11 | **A1**, 28, 43 | Emergent |
| Great blue heron | 14 | **A1**, 28, 43, 18, and 37 | Emergent/Open Water |
| Mallard | 10 | **A1**, 28, 43, 18, and 37, **Farmed Wetlands** | Emergent Open Water |
| Belted kingfisher | – | **A1**, 28, 43, 18, and 37 | Open Water |
| Virginia rail | 10 | **A1**, 28, 43 | Emergent |
| Pied-billed grebe | – | Lora Lake, 28 | Open Water |
| House sparrow | – | **Various** | Not Present |
| Killdeer | 4 | **Farmed Wetlands** | Emergent |
| Gadwall | 10 | A1, 28, 43 | Open Water |
| Canada geese | 8 | **A1**, 28, 43, **Farmed Wetlands** | Emergent/Open Water |
| Hooded merganser | 12 | Not present | Open Water |
| Green heron | 6 | 43 | Emergent |
| Sora | 10 | 43 | Emergent |
| Glaucous-winged gull | – | A1, 28 | Open Water |
| Red-eyed vireo | 10 | **18**, **37**, 28, 43, **44** | Forested/Shrub/Buffer |
| Blue-winged teal | 10 | A1, 28, 43 | Open Water |
| Caspian tern | – | Not Present | Not Present |
| American coot | 10 | A1, 28 | Open Water |

[a] Versatility ratings refer to the sum of the number of plant communities or stand conditions used for breeding and feeding by a species (Brown 1985). A low versatility rating (less than 15) indicates a more specialized species that may require special habitat or management actions to maintain it in an area. Other species found in King County wetlands are adapted to a wide variety of wetland and non-wetland habitats. A " – " means the species was not assigned a rating by Brown (1985).

[b] Species listed are those species with low versatility ratings (Brown 1985) that occur in one or more of 19 wetlands studied in King County (Richter and Azous 2001). Wetlands in this study averaged 10.29 acres in size and were located in urban, suburban, and rural land use areas.

[c] **Bold** lettering indicates that project impacts to specific areas of suitable habitat for these species may occur through construction of Master Plan Update improvements or mitigation.

[d] Impacts to emergent habitat in Wetland A1 occur from project fill, stream relocation, and mitigation.

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# 6. SUMMARY

This analysis has documented changes to land use, wetlands, streams, and wildlife habitats in the Miller and Des Moines Creek watersheds for the purpose of determining cumulative effects. The findings are summarized in Table 36.

While large changes in land use have occurred in the watersheds that have impacted streams, wetlands, and wildlife habitat, it appears that the most substantial changes have occurred prior to airport development. These changes included clearing old-growth forest and development of agriculture lands at the time of settlement (late 1800s and early 1900s). More recently, the development of forest and agricultural lands for residential, commercial, and transportation (roads and airport uses) facilities has continued to impact stream, wetland, and wildlife habitats in the watersheds. Most of this development occurred without environmental mitigation and has contributed to cumulative losses of wetland, stream, and habitat resources.

The development of STIA has contributed to wetland, stream, and habitat impacts at levels that appear proportionate to other development that has occurred in the watershed. While the large footprint associated with the development of airport facilities (primarily between 1946 and 1972) resulted in wetland loss and stream modifications, such losses were also common to many of the private- and public-sector development projects that occurred prior to the establishment of environmental regulations. The need for large buffers as part of noise remedy programs near STIA has resulted in purchase of wetlands associated with agricultural and residential land uses by the Port. The removal of these land uses has resulted in the revegetation and preservation of several wetland areas.

The historical impacts to wetlands, streams, and wildlife habitat are typical for urban areas in King County (Azous and Horner 2001). Clearing of forestland to accommodate agricultural uses has occurred throughout the Puget Sound region. As has occurred in the Miller, Walker, and Des Moines Creek watersheds, the development of agriculture in the region routinely included the modification of wetlands, soil drainage, and stream channel conditions to improve land for crop production. Conversion of forest and agricultural lands to urban uses has occurred throughout the Seattle-Tacoma metropolitan areas. These conversions have included wetland filling, stream channel modification, watershed hydrology modification, and wildlife habitat loss. In the Miller, Walker, and Des Moines Creek watersheds, these impacts have been similar to other localities. The impacts in these watersheds have been less severe than in many areas (i.e., wetland and tideland filling at the mouths of the Puyallup, Duwamish, and Snohomish Rivers, or wetland fill and stream channelization for commercial development in the lower Green River Valley).

Current and future development (including the STIA Master Plan Update actions) must comply with a variety of environmental regulations affecting wetlands, streams, and habitat. These regulations and substantial mitigation requirements reduce the potential that additional cumulative impacts would occur. For the Master Plan Update projects, wetland, stream, and hydrologic mitigation improves wetland and stream functions by enhancing wetlands and streams, and by retrofitting previous development lacking stormwater quality and quantity controls to meet current standards.

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Table 36. **Cumulative effects analysis of wetlands, streams, and other aquatic resources in the Des Moines, Miller, and Walker Creek basins.**

| | | Proposed Action[a] | | | Other |
|---|---|---|---|---|---|
| **Resource** | **Past Actions** | **Construction** | **Operation** | **Mitigation** | **Present and Future Actions[b]** |
| **Wetland Area** | Losses have occurred as a result of farming, commercial, residential, and airport development. | Loss of 18.37 acres would occur. | None. | Designation of over 134 acres of mitigation (67 acres on-site and over 65 acres in Auburn). | No net loss. Federal state and local regulations are increasingly protective of wetlands. Section 404 Nationwide Permits (NWPs) and Individual Permits require mitigation, typically exceeding area impacts. |
| **Biological Wetland Functions** | Losses to biological functions have occurred. In addition to filling and draining wetlands, past development and land uses have reduced the natural vegetation in and near wetlands and affected wildlife habitats. Development has affected the rates and quality of runoff, which has impacted aquatic habitat in some wetlands. | Construction will eliminate the biological functions of 18.37 acres of wetland. Without mitigation, wetland loss and buffer impacts would cause losses of biotic functions. | Without mitigation, operation impacts to wetland habitat could include habitat disturbance, wildlife management activities, and runoff impacts. | No net loss. Wetland restoration and enhancement coupled with buffer protection and enhancement will increase in-basin biotic function and connectivity of remaining wetlands. Out-of -basin mitigation creates 65 acres of high quality wetland and buffer habitats. Long-term protection and preservation of greater amounts of higher-quality wetlands balance temporal losses of habitat. | No net loss. Federal state and local regulations are increasingly protective of wetlands. Section 404 NWPs and Individual Permits require mitigation, typically exceeding area impacts. Mitigation planning increasingly focuses on replacing and enhancing functions, and local regulations protect wetland buffers. |
| **Physical Wetland Functions** | Filling of wetlands has eliminated the flood storage, water quality, and groundwater exchange functions they provide from several areas.<br>Past development and land uses have reduced the vegetation in and near remaining wetlands, which | Construction will eliminate the physical functions of 18.37 acres of wetland. Without mitigation, wetland loss and buffer impacts would cause losses of physical functions. | Without mitigation, operation impacts to physical wetlands functions could include decreased water quality, groundwater exchange, and stormwater storage functions. | No net loss. Wetland restoration and enhancement coupled with buffer protection and enhancement will increase in-basin biotic function and connectivity of remaining wetlands. Out-of-basin mitigation creates 65 acres of high-quality | No net loss. See above. |

**Table 36. Cumulative effects analysis of wetlands, streams, and other aquatic resources in the Des Moines, Miller, and Walker Creek basins (continued).**

| Resource | Past Actions | Proposed Action[a] | | | Other |
|---|---|---|---|---|---|
| | | Construction | Operation | Mitigation | Present and Future Actions[b] |
| | may reduce water quality and other functions they provide. | | | wetland and buffer habitats. Long-term protection and preservation of greater amounts of higher-quality wetlands balance temporal losses of habitat. | |
| **Instream Habitat** | Impacts to instream habitat have occurred from forestry, farming, and urban development. These activities have eliminated high quality in-stream habitats. | Fill of a portion of the Miller Creek stream channel would occur. Without mitigation, the loss of degraded habitat would occur. | Without mitigation, increased runoff could further degrade instream habitat. | Beneficial. Relocation and enhancement of Miller Creek, instream habitat projects, buffer enhancement, and wetland restoration improve instream habitat. | Beneficial. Sensitive areas regulations protecting streams and buffers, coupled with restoration and enhancement projects, including the planned Des Moines Creek regional detention facility, should improve habitat conditions for fish and aquatic life. |
| **Stream Hydrology - Low Flow** | Impacts to stream hydrology have occurred from forestry, farming, and urban development. Land clearing from forestry and farming activities could have increased recharge and low flows. Urban development and pavement would have decreased groundwater recharge and reduced low flows. | Construction of new impervious surfaces, without mitigation, would reduce groundwater recharge and reduce low flow. | None. | Maintain. Low flow conditions are maintained by infiltration and stormwater storage. | Degrade. Current municipal stormwater regulations do not address low flow impacts, nor require mitigation. For projects undergoing state or federal permitting, low flow mitigation may be required. |
| **Stream Hydrology - Peak Flow** | Impacts to stream hydrology have occurred from forestry, farming, and urban development. Land clearing from forestry and farming activities would have | Constructions of new impervious surface, without mitigation, would increase peak flows and degrade aquatic habitat. | None. | Beneficial. Stormwater detention facilities for new and past development will mitigate peak runoff rates and retrofit for past development. | Beneficial. Stormwater detention facilities for new and past development will mitigate peak runoff rates. Some projects (i.e. transportation projects funded |

Table 36. **Cumulative effects analysis of wetlands, streams, and other aquatic resources in the Des Moines, Miller, and Walker Creek basins (continued).**

| | | Proposed Action[a] | | | Other |
|---|---|---|---|---|---|
| **Resource** | **Past Actions** | **Construction** | **Operation** | **Mitigation** | **Present and Future Actions[b]** |
| | increased runoff rates and peak flows. Urban development and pavement constructed without stormwater management facilities would have increased peak flows significantly. | | | | by Washington State Department of Transportation [WSDOT]) may provide detention facilities for past development. The Des Moines Creek regional detention facility should improve Des Moines Creek peak flows above the baseline level. |
| **Floodplains** | Land development and loss of flood storage has occurred in some floodplains. | Fill of floodplain and loss of flood storage would occur. | None. | Maintain. Floodplain fill will be balanced by floodplain mitigation. | Maintain. Local regulations adequately protect floodplain areas. |
| **Water Quality** | Impacts to water quality have resulted from past forestry, farming, and urban development in the watersheds. Land clearing from forestry and farming activities would have increased sediment runoff rates. Runoff from fertilizers and agricultural chemicals would have degraded water quality. Urban development has resulted in untreated stormwater runoff, which degrades water quality. | Without mitigation, sediment runoff could degrade water quality. | Without mitigation, new impervious surface could generate contaminated runoff and degrade water quality. | Maintain. New stormwater quality best management practices (BMPs) will treat runoff from new and existing impervious surfaces. | Maintain. Stormwater treatment facilities for new development will prevent significant degradation of water quality. Some projects (i.e., WSDOT-funded transportation projects) may provide treatment facilities for past development. |

[a] Effects of the proposed actions on wetlands and streams are discussed in the *Natural Resources Mitigation Plan* (Parametrix 2001b), the *Wetland Impact and Functional Analysis Report* (Parametrix 2001a), the *Biological Assessment* (Parametrix 2000b), the *FEIS* (FAA 1996), the *FSEIS* (FAA 1997), and the *Comprehensive Stormwater Management Plan* (Parametrix 2000a).

[b] Evaluated with mitigation that would be required to meet federal, state, and local regulations.

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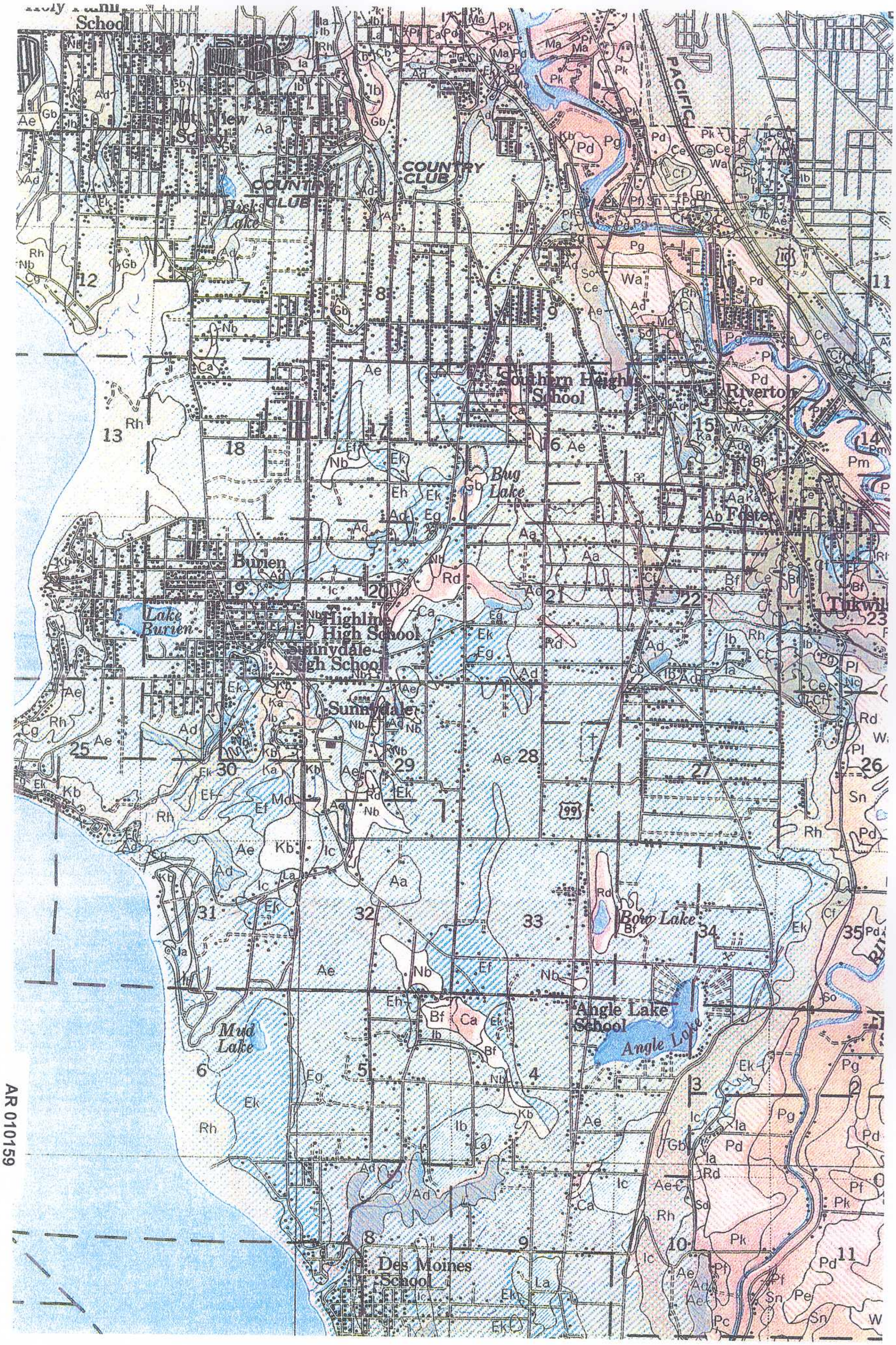
# APPENDIX A

# KING COUNTY SOIL SURVEY - 1952

**Soil classification map key.**

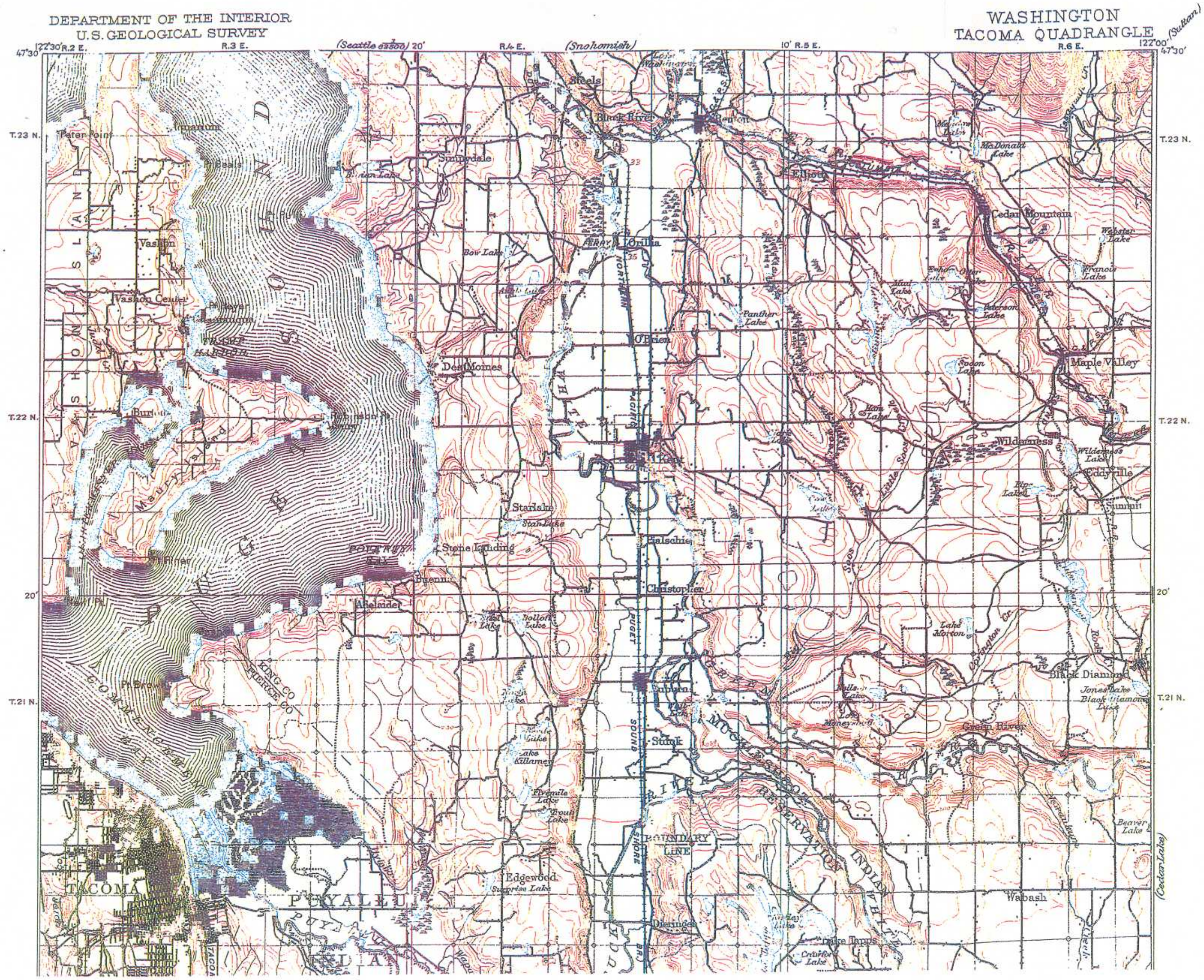
| Soil | Map Symbol |
|---|---|
| Alderwood gravelly loam | |
| Gently undulating | Aa |
| Rolling | Ab |
| Alderwood gravelly sandy loam | |
| Hilly | Ad |
| Rolling | Ae |
| Bellingham silty clay | Bf |
| Carbondale muck | Ca |
| Shallow | Cb |
| Cathcart loam | |
| Hilly | Ce |
| Rolling | Cf |
| Coastal beach | Cg |
| Everett gravelly loamy sand, rolling | Ef |
| Everett gravelly sandy loam | |
| Gently undulating | Eh |
| Hilly | Eg |
| Rolling | Ek |
| Greenwood peat | Gb |
| Indianola fine sandy loam | |
| Hilly | Ia |
| Rolling | Ib |
| Indianola loamy fine sand, rolling | Ic |
| Kitsap silt loam | |
| Hilly | Ka |
| Undulating | Kb |
| Lynden loamy sand | La |
| Made land | Ma |
| Mukilteo peat | Md |
| Norma fine sandy loam | Nb |
| Norma silty clay | Nc |
| Puget silty clay | Pc |
| Puget silty clay loam | Pd |
| Puyallup fine sandy loam | Pf |
| High bottom | Pg |
| Puyallup silt loam | Pk |
| Low bottom | Pl |
| Puyallup very fine sandy loam | Pm |
| Rifle peat | Rd |
| Rough broken and stony land | Rh |
| Snohomish silt loam | Sd |
| Sultan silt loam | Sn |
| High bottom | So |
| Woodinville silt loam | Wa |

AR 010158

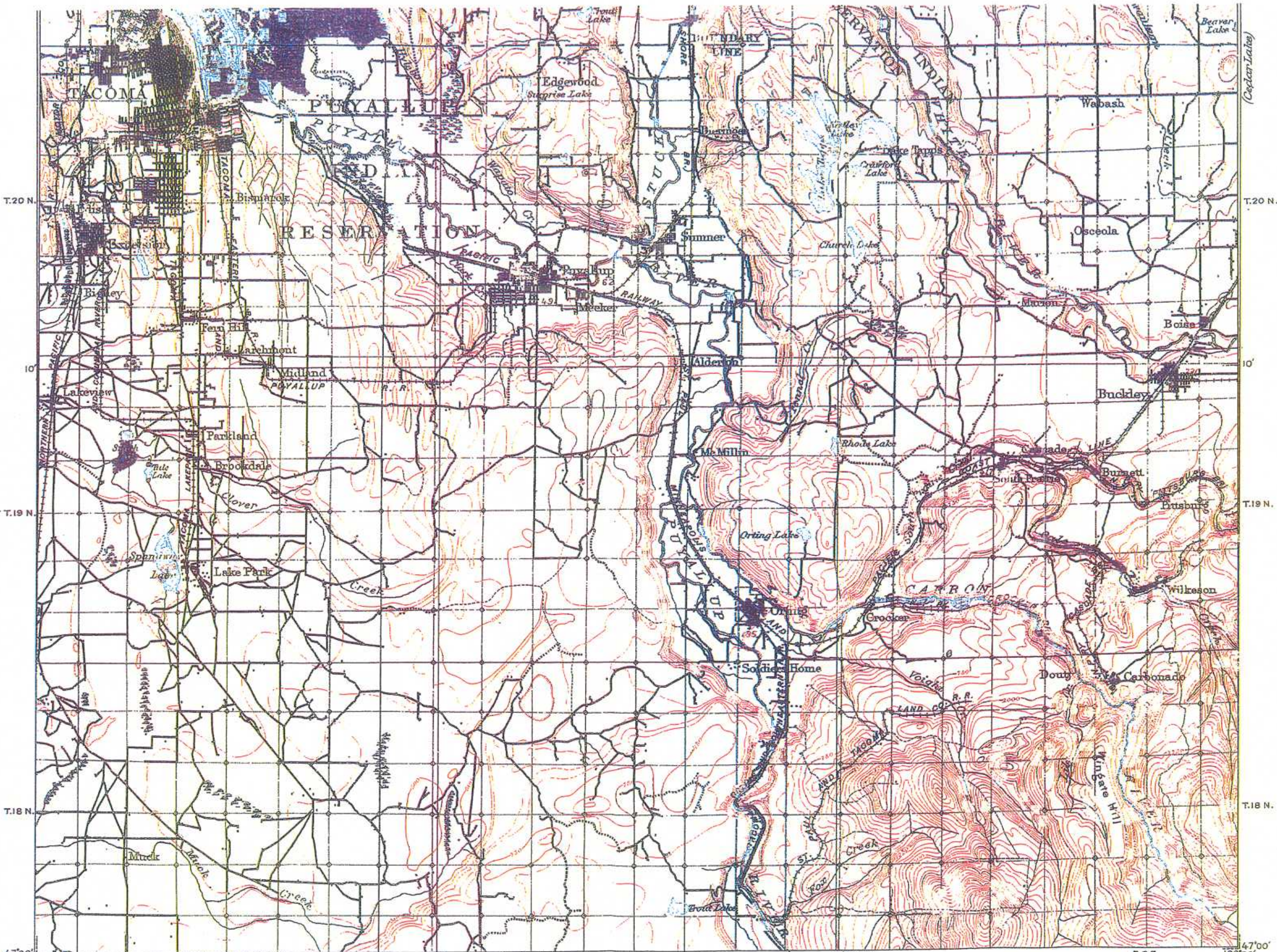

School
View School
COUNTRY CLUB
Hicks Lake
Southern Heights School
Riverton
Bug Lake
Foster
Burien
Lake Burien
Highline High School
Sunnydale High School
Sunnydale
Tukwila
PACIFIC
Bow Lake
Angle Lake School
Angle Lake
Mud Lake
Des Moines School

# APPENDIX B

# HISTORICAL TOPOGRAPHIC MAPS


DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
WASHINGTON
TACOMA QUADRANGLE
(Seattle)
(Snohomish)
(Sultan)
(Cedar Lake)
R.2 E.
R.3 E.
R.4 E.
R.5 E.
R.6 E.
T.23 N.
T.22 N.
T.21 N.
VASHON ISLAND
PUGET SOUND
TACOMA
PUYALLUP
Des Moines
Kent
O'Brien
Orillia
Christopher
Auburn
Stuck
Edgewood
Maple Valley
Cedar Mountain
Black Diamond
Green River
Wilderness
Eddyville
Summit
Wabash
Dieringer
Stone Landing
Starlake
Sunnydale
Renton
Vashon
Vashon Center
BOUNDARY LINE
INDIAN RESERVATION
MUCKLESHOOT
KING CO
PIERCE CO

AR 010161




Henry Gannett, Chief Topographer.
R.U.Goode, Geographer in charge.
Control by W.T.Griswold and U.S.Coast and Geodetic Survey.
Topography by G.E.Hyde and R.H.McKee.
Surveyed in 1894-95.

Engraved April 1897 by U.S.G.S.

Hyde

Scale $\frac{1}{125000}$

Contour interval 50 feet.
*Datum is mean sea level.*

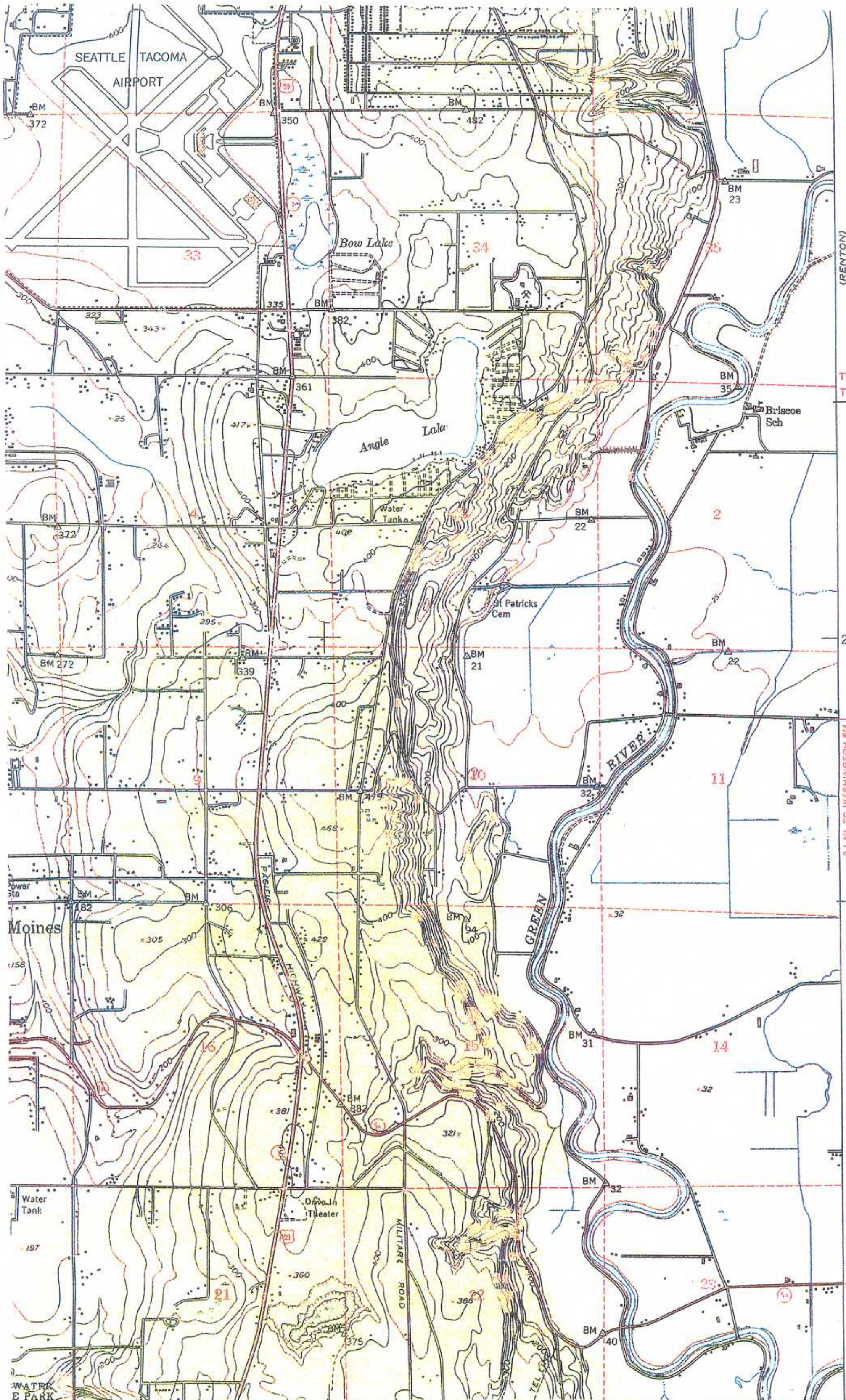
Edition of Mar. 1900, reprinted 1924.

Polyconic projection. To place on North American datum move projection lines 140 feet south and 160 feet east. To join Cedar Lake, Chehalis, and Sultan use dotted projection corners.

TACOMA WASH.

44130 1

AR 010162




SCALE 1:24000

0 1 MILE

000 3000 4000 5000 6000 7000 FEET

0 1 KILOMETER

'OUR INTERVAL 25 FEET
TUM IS MEAN SEA LEVEL

SENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
ANGE OF TIDE IS APPROXIMATELY 12 FEET

WITH NATIONAL MAP ACCURACY STANDARDS
DERAL CENTER, DENVER, COLORADO OR WASHINGTON 25, D. C.
APHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

ROAD CLASSIFICATION

Heavy-duty 4 LANE | 6 LANE Light-duty
Medium-duty 4 LANE | 6 LANE Unimproved dirt
U. S. Route State Route

(AUBURN)

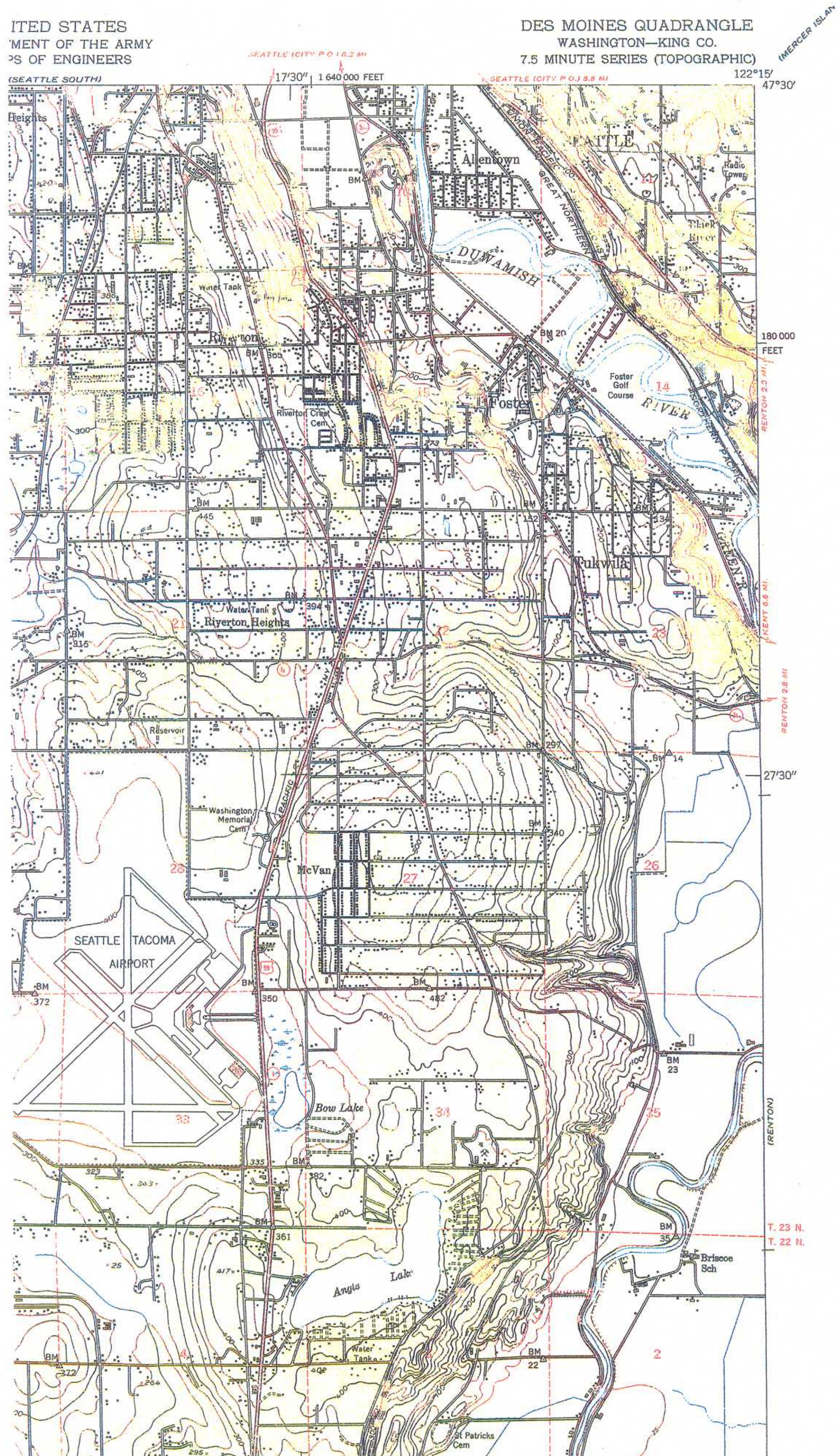
WASHINGTON

QUADRANGLE LOCATION

DES MOINES, WASH
N4722.5—W12215/7.5

1949

AR 010163


ITED STATES
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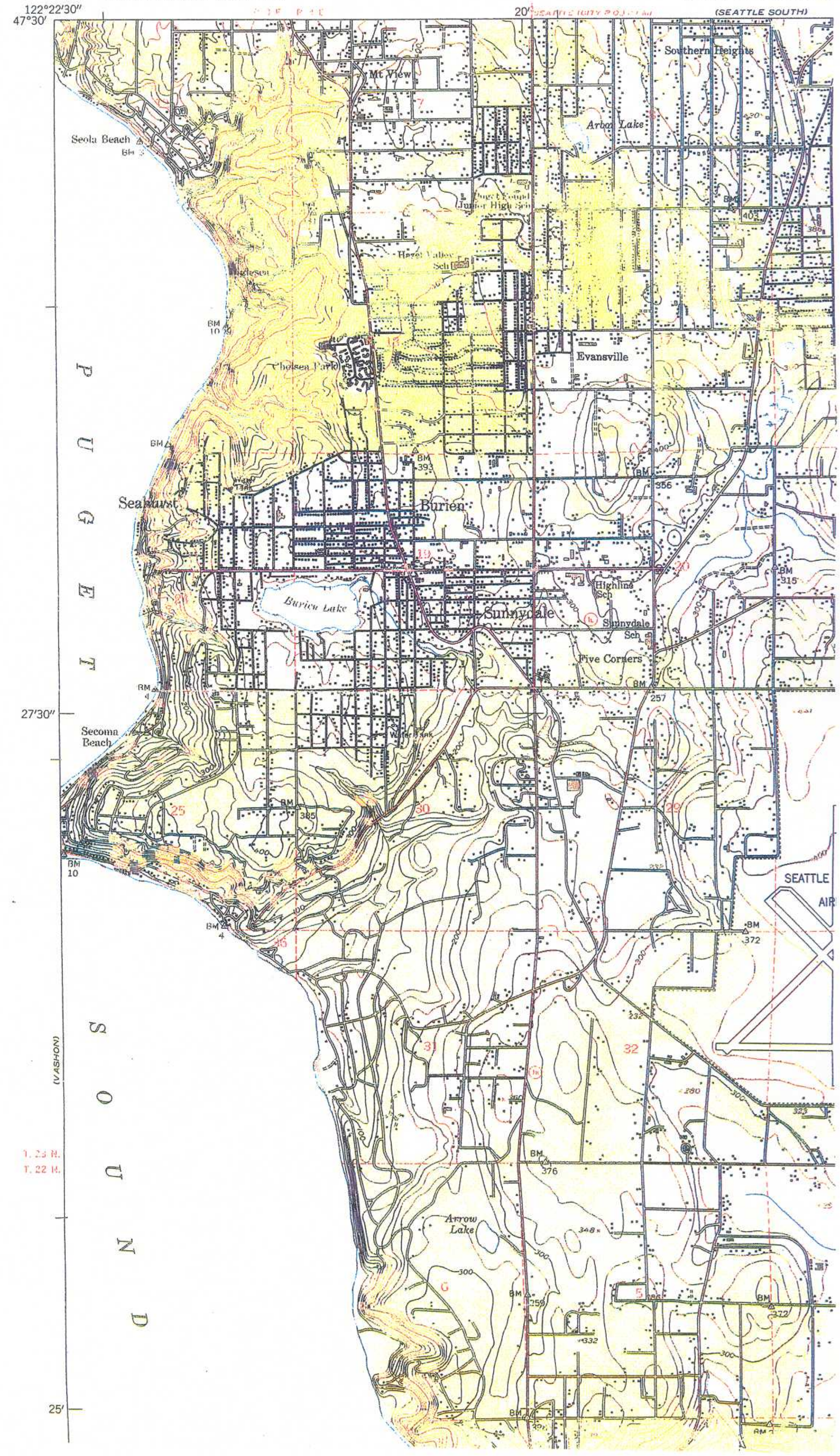
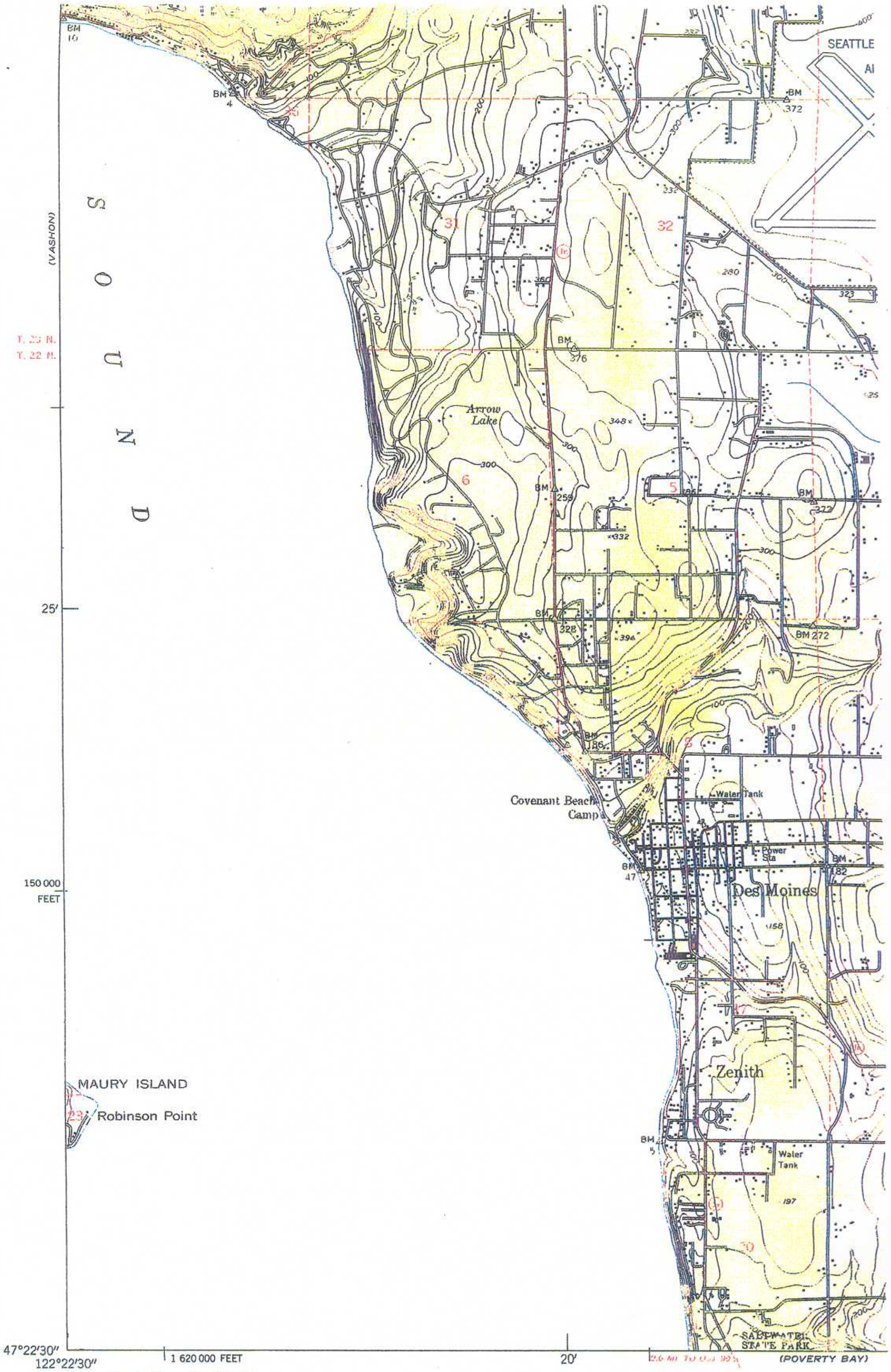
DES MOINES QUADRANGLE
WASHINGTON—KING CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
(MERCER ISLAN
(SEATTLE SOUTH)
17'30"
1 640 000 FEET
122°15'
47°30'
Allentown
DUWAMISH
Riverton
Foster
Foster Golf Course
RIVER
Riverton Cres Cem
Tukwila
Water Tank
Riverton Heights
Reservoir
180 000 FEET
27'30"
Washington Memorial Cem
McVan
SEATTLE TACOMA AIRPORT
Bow Lake
Angle Lake
Briscoe Sch
St Patricks Cem
Water Tank
(RENTON)
T. 23 N.
T. 22 N.
25'

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

UNITED STATES
DEPARTMENT OF THE A
CORPS OF ENGINEERS




AR 010165




Mapped by the Army Map Service
Published for civil use by the Geological Survey

Control by USC&GS and King County Engineer Office

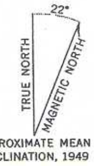
Topography from aerial photographs by multiplex methods
Aerial photographs taken 1943. Field check 1949

Polyconic projection. 1927 North American datum
10,000-foot grid based on Washington coordinate system, north zone

No distinction is made between dwellings, barns, commercial and industrial buildings

Unchecked elevations are shown in brown

Dashed land lines indicate approximate locations




APPROXIMATE MEAN DECLINATION, 1949

SCALE 1:24000

CONTOUR INTERVAL 25 F
DATUM IS MEAN SEA LEVEL

SHORELINE SHOWN REPRESENTS THE APPROXIMATE LIN
THE AVERAGE RANGE OF TIDE IS APPROXIMA

THIS MAP COMPLIES WITH NATIONAL MAP ACC
FOR SALE BY U. S. GEOLOGICAL SURVEY, FEDERAL CENTER, DEN
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBO