Draft

Miller Creek Enhancement Program

Seattle-Tacoma International Airport Master Plan Update Improvements

Port of Seattle

Parametrix, Inc.
August 19, 1998

AR 041760

DRAFT
SEATTLE-TACOMA INTERNATIONAL AIRPORT
MASTER PLAN UPDATE IMPROVEMENTS

MILLER CREEK ENHANCEMENT PROJECTS

Prepared for

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55-2912-01 (03)

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EXECUTIVE SUMMARY

The Washington State Department of Ecology (Ecology) issued the Port of Seattle (Port) a Section 401 Water Quality Certification to allow filling wetland area at Seattle-Tacoma International Airport (STIA) for implementation of Master Plan Update Improvement projects. A condition of this certification requires the Port to "submit for Ecology's review and approval final wetland mitigation plans for the Miller Creek Buffers and Miller Creek/Lora Lake Wetland and Floodplain Enhancement sites."

As requested by Ecology, this document integrates *Miller Creek Relocation Plan* and *Miller Creek Wetland and Floodplain Enhancement Plan* into one cohesive plan, the *Miller Creek Enhancement Projects*. Specifically, this plan integrates three different mitigation elements: (1) establishing and enhancing upland buffer area along the Miller Creek corridor and around Lora Lake, (2) enhancing the Miller Creek and Lora Lake floodplain on and near the Vacca Farm site, and (3) relocating a portion of Miller Creek as well as installing in-stream habitat enhancement features throughout Miller Creek channel.

Impacts from the Master Plan Update Improvements will include filling approximately 980 lineal feet of Miller Creek and approximately 3.1 acres of the 100-year floodplain associated with Miller Creek in an area known as Vacca Farm located downstream of Lora Lake. In addition, prior converted cropland, farmed wetlands, and forested, scrub-shrub, and emergent wetlands will be altered as a result of relocating a segment of Miller Creek and grading a portion of the Vacca Farm site to compensate for lost floodplain storage due to filling activities.

The primary purpose of this mitigation plan is to replace stream channel and floodplain storage that will be filled by runway projects. The secondary purpose is to restore riparian functions to the creek and floodplain area to support and enhance aquatic habitat in and around Miller Creek and Lora Lake. To mitigate for unavoidable actions and adverse impacts from implementing the Master Plan Update projects within the Miller Creek Basin, the Port proposes five mitigation actions. These mitigation actions include:

(1) Relocating a segment of Miller Creek and installing habitat features throughout the creek to replace and enhance aquatic habitat and hydrologic functions;

(2) Replacing Miller Creek floodplain storage area by excavating additional area within the Vacca Farm site;

(3) Planting the existing farm fields at the Vacca Farm site with native woody vegetation and establishing a 50-feet upland buffer between the floodplain enhancement area and Des Moines Memorial Drive;

(4) Establishing and enhancing a 25-feet buffer around Lora Lake; and

(5) Establishing and enhancing an average 100-feet riparian buffer along the Miller Creek corridor within the mandatory buyout area.

All portions of the Miller Creek Enhancement projects will be monitored over a ten-year period. Monitoring reports will be sent to Ecology and the Corps for their approval. In addition, a

maintenance plan will be developed and implemented by the contractor for a five-year period, following plant installation.

Constructing the new Miller Creek channel, planting buffers along the relocated segment of Miller Creek, excavating and enhancing the Miller Creek floodplain, and establishing buffers around the floodplain enhancement area and Lora Lake may begin in 1999. Implementation of buffer enhancement along Miller Creek riparian corridor will occur as the Port secures property along the creek.

1. INTRODUCTION

On July 20, 1998 the Washington State Department of Ecology (Ecology) issued the Port of Seattle (Port) a Section 401 Water Quality Certification to allow filling wetland area at Seattle-Tacoma International Airport (STIA) for implementation of Master Plan Update Improvement projects. A condition of this certification requires the Port to "submit for Ecology's review and approval final wetland mitigation plans for the Miller Creek Buffers and Miller Creek/Lora Lake Wetland and Floodplain Enhancement sites." The mitigation plan must be submitted within thirty days of the issuance of the Section 401 Water Quality Certification (Washington State Department of Ecology 1998). This mitigation plan has been prepared to fulfill this requirement.

The purpose of this document is to integrate *Miller Creek Relocation Plan* (Parametrix 1996) and *Miller Creek Wetland and Floodplain Enhancement Plan* (Parametrix 1998). Specifically, this plan integrates three different mitigation elements: (1) relocating a portion of Miller Creek as well as installing in-stream habitat enhancement features throughout Miller Creek channel, (2) enhancing the Miller Creek and Lora Lake floodplain on and near the Vacca Farm site and establishing an upland buffer between the enhancement and adjacent land uses, and (3) establishing and enhancing upland buffer area along the Miller Creek corridor and around Lora Lake (these projects are collectively referred to as the Miller Creek Enhancement Projects). This report is organized following the *Guidelines for Developing Freshwater Wetlands Mitigation Plans and Proposals* (Washington State Department of Ecology 1994).

2. PROJECT DESCRIPTION

The following sections describe the location, overall project elements, and the type of construction associated with implementing the Master Plan Update improvements. Also included in this section is a description of the functions of Miller Creek, its associated 100-year floodplain. and the farmed wetlands (FW) and prior converted cropland (PCC) on the Vacca Farm site that will be lost or altered by the Master Plan Update improvements and actions to mitigate for the impacts.

2.1 PROJECT LOCATION

The proposed new third runway project is located on the west side of the existing STIA airfield. Much of the new runway project and all of the Miller Creek enhancement projects will occur on land recently acquired or proposed to be acquired by the Port, referred to as the mandatory buyout area. The mandatory buyout area is approximately bounded by 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 (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).

2.2 RESPONSIBLE PARTIES

The Port of Seattle is the applicant for this project. The name and phone number of the representative at the Port in charge of this project and agency coordination is Ms. Barbara Hinkle, Senior Environmental Specialist; P.O. Box 1209, Seattle, WA 98111; (206) 439-6606.

2.3 WETLAND DELINEATIONS

Shapiro and Associates, Inc. and Parametrix, Inc. have conducted wetland delineations throughout the project area. Shapiro and Associates, Inc. conducted initial wetland identification and some delineations for the Environmental Impact Statement (EIS) and the Final EIS (FEIS). The U.S. Army Corps of Engineers has verified wetland delineations conducted by Shapiro and Associates, Inc., and additional wetland delineations completed by Parametrix, Inc. on all properties within the Master Plan Update mandatory buyout area that are either owned by the Port, or have been granted property access to the Port. Further wetland delineations will be conducted by Parametrix, Inc. as the Port purchases or is granted access to properties within the mandatory buyout area. Refer to the Joint Aquatic Resource Permits Application (JARPA) (Parametrix, Inc. 1996) for further details regarding wetland delineations.

2.4 DESCRIPTION OF OVERALL PROJECT

The proposed Master Plan Update projects include a variety of major airport facility improvements at STIA to be constructed over the period from 1997 to 2004. The major projects include a new third runway and parallel taxiway, expansion of the parking garage, new remote parking lots, a new north terminal, reconstruction of Concourse A, development of the South Aviation Support Area (SASA), new air cargo facilities, a new air traffic control tower, and other minor projects (Landrum & Brown 1996).

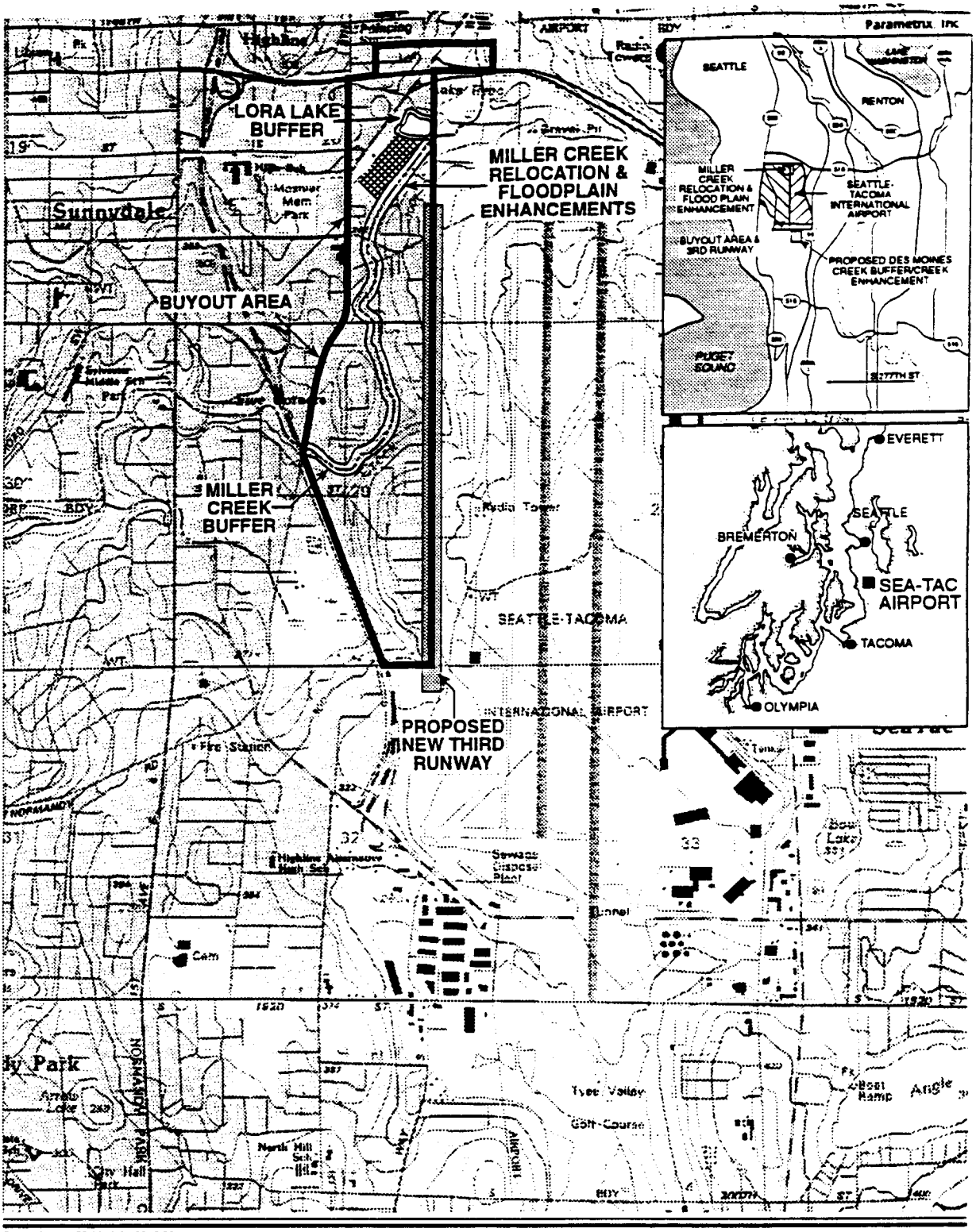

Figure 1.
Location of Seattle-Tacoma International Airport and Miller Creek Enhancement Projects

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The type of construction activities associated with the implementing the Master Plan improvement projects will generally include vegetation removal, demolition, scraping, excavation, grading, filling, and roadway resurfacing.

2.5 DESCRIPTION OF PROPOSED IMPACTS

To accommodate the third runway embankment, perimeter roadways, and the newly relocated South 154th and South 156th Streets, fill material will be placed in approximately 980 lineal feet (1.6 acres) of Miller Creek and approximately 4.9 acres of the 100-year floodplain associated with Miller Creek in an area known as Vacca Farms located downstream of Lora Lake. Filling approximately 980 lineal feet of Miller Creek will result in the loss of aquatic habitat and hydrologic functions.

Alterations to Prior Converted Cropland (PCC), Farmed Wetlands (FW), and vegetated wetlands will occur as a result of relocating a segment of Miller Creek and grading a portion of the Vacca Farm site to compensate for lost floodplain storage due to filling activities. Approximately 4.21 acres of PCC and approximately 0.75 acre of FW will be re-graded to increase floodwater storage. The PCC and FW areas located on the Vacca Farm site have been continuously farmed for the past 30 years. Soil that was previously disturbed through farming practices will be scraped and excavated.

Approximately 1.85 acres of a forested wetland complex will be altered or temporarily disturbed to accommodate the new channel for Miller Creek and or construction staging to build the new Miller Creek channel. Approximately 0.09 acre of scrub-shrub and emergent wetlands located within the Vacca Farm site will be regraded in order to provide additional floodwater storage. Primary impacts will include vegetation removal and soil excavation.

Further descriptions of impacts are described in the following reports:

- *Final Environmental Impact Statement for Seattle-Tacoma International Airport Master Plan Update Development Actions*, (Landrum and Brown 1996);
- *Draft Environmental Impact Statement for Seattle-Tacoma International Airport Master Plan Update Development Actions, April 1995; and*
- *JARPA Application for Proposed Master Plan Update Improvements at Seattle-Tacoma International Airport, December 1996.*

2.6 DESCRIPTION OF PROPOSED MITIGATION ACTIONS

The primary purpose of this mitigation plan is to replace stream channel and floodplain storage that will be filled by runway projects. The secondary purpose is to restore riparian functions to the creek and floodplain area to support and enhance aquatic habitat in and around Miller Creek and Lora Lake. To mitigate for unavoidable actions and adverse impacts from implementing the Master Plan projects within the Miller Creek Basin, the Port proposes five mitigation actions. These mitigation actions include:

(1) Relocating a segment of Miller Creek and installing habitat features throughout the creek to replace and enhance aquatic habitat and hydrologic functions lost;

(2) Replacing Miller Creek floodplain storage area by excavating additional area within the floodplain on the Vacca Farm site;

(3) Planting the existing farmed fields at the Vacca Farm site with native woody vegetation and establishing a minimum 50-feet upland buffer between the floodplain enhancement area and Des Moines Memorial Drive;

(4) Establishing and enhancing a 25-feet buffer around Lora Lake; and

(5) Establishing and enhancing an average 100-feet riparian buffer along the Miller Creek corridor within the mandatory buyout area.

The following sections further describe the proposed mitigation activities. Refer to Figure 2 for the location of the proposed mitigation areas and Table 1 for a summary of the proposed impacts and mitigation actions.

2.6.1 Miller Creek Relocation and Enhancement

A detailed report has been prepared that describes the Miller Creek relocation approach. The following is a summary of *Miller Creek Relocation Plan for the Master Plan Update Improvements at Seattle Tacoma International Airport* that was included in the JARPA form (Parametrix, Inc. 1996).

Approximately 980 feet of Miller Creek, south of Lora Lake, would be realigned and relocated approximately 200 feet west of the existing channel, through the Vacca Farm site. Relocating the creek will increase the length of the channel to approximately 1,080 feet and enhance habitat features and substrate. The new channel section would connect with the existing Miller Creek channel downstream at the earliest possible point to minimize stream relocation impacts.

Design criteria for determining base flow, annual peak flow, and 100-year flow conditions were established from data gathered by King County Surface Water Management (KCSWM). KCSWM has monitored flow rates at the outlet of the Reba Detention Facility (Lake Reba) since 1988 (KCSWM 1994). The flow data provide a good record of normal base flows, seasonal peak flows, average flows by season, and extreme flows during near record events.

The channel will be constructed to meander within the limits of the new stream corridor. In order to provide positive floodwater drainage and reduce persistent standing water in the vicinity of the creek, the bottom 6 inches of the channel side slopes would be vertical. From six inches to one feet, channel side slopes would continue at 1:1 slopes, primarily to enhance stability, provide additional capacity, and simplify construction. From one to two feet, the side slope would be 6:1 or flatter, depending on channel capacity requirements and channel planting and buffer requirements. Above two feet of depth, natural grades would be used; however, if natural slopes were too flat, slope or drainage alterations would be considered to prevent ponding.

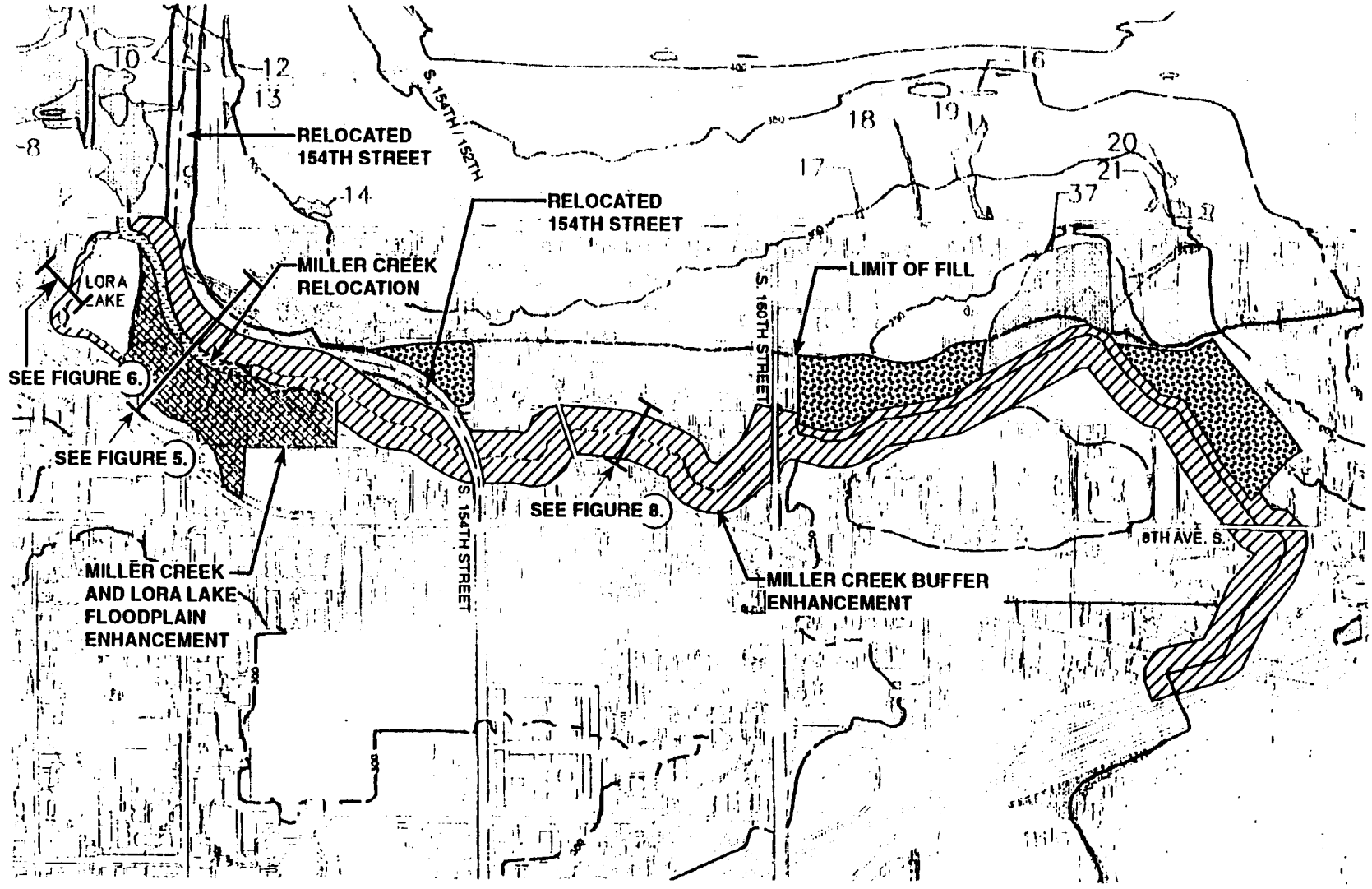

Figure 2.
Location of Miller Creek Relocation, Buffer Enhancement, and Floodplain Enhancement Projects

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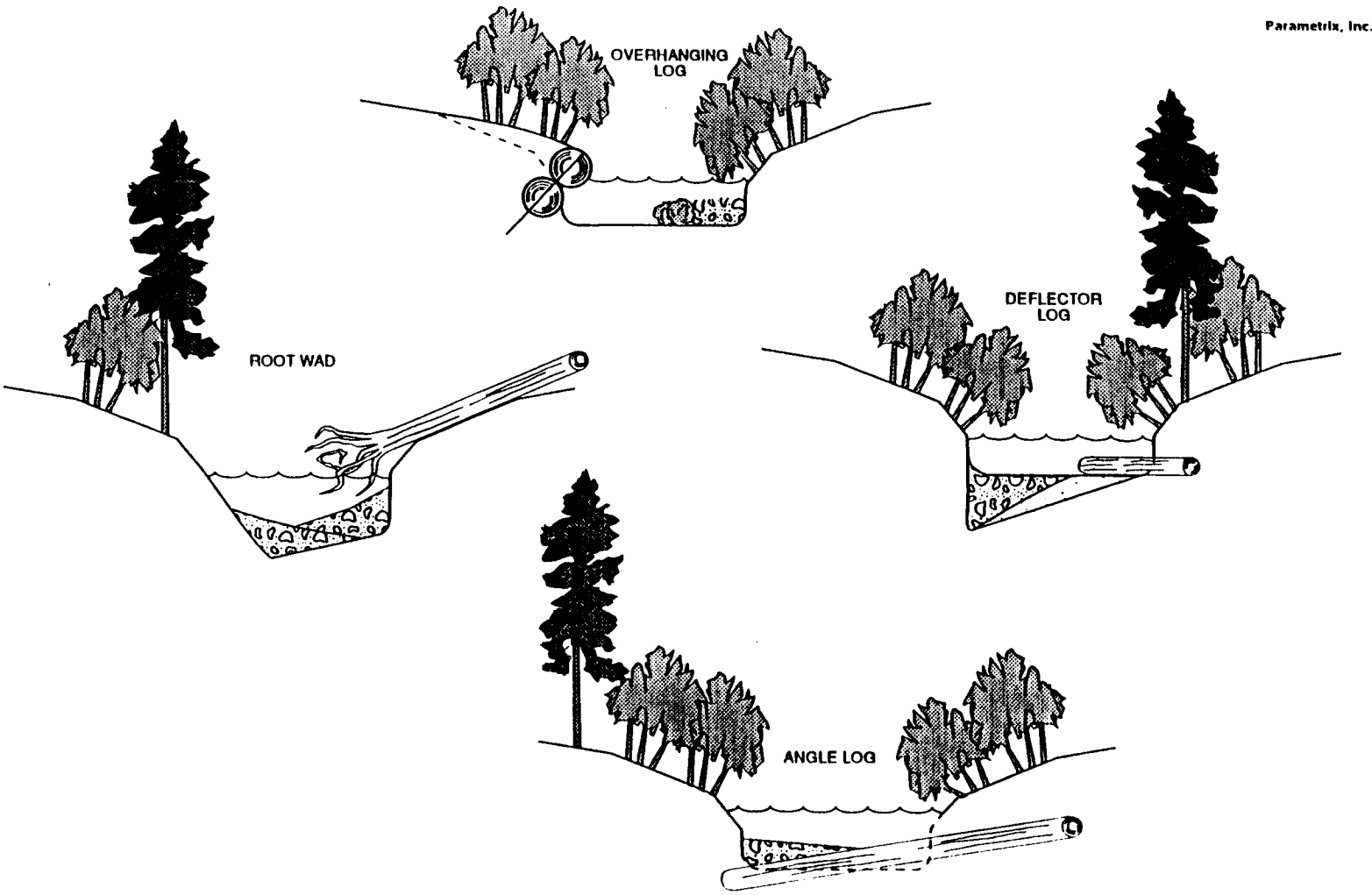
Table 1. Summary of on- site mitigation for impacts to Miller Creek riparian area.

Potential Impact	Mitigation Action	Explanation And Comments
Miller Creek Habitat	Replace approximately 980 lineal ft of creek channel with approximately 1,080 ft of new creek channel and install habitat features within the relocated segment of Miller Creek and throughout the creek channel within the mandatory buyout area. Establish a 50-ft buffer along the new channel.	Channel relocation will replace and enhance aquatic habitat by increasing the length of the channel, provide in-stream habitat features, and provide base flow conveyance. Buffers will be established and planted along the new channel to provide shading and introduce detritus (leaves, branches) input into the creek. Detritus is necessary to support stream invertebrates, which are an important food source for fish.
Miller Creek Floodplain	Excavate approximately 9,400 cy of soil between elevation 262 and 266 on the Vacca Farm site. Establish a minimum 50-ft buffer between the floodplain enhancement and Des Moines Memorial Drive.	The new Miller Creek channel and excavation on the Vacca Farm site will replace floodplain storage that will be lost on the east side of Miller Creek.
Riparian Function	Establish a vegetated riparian buffer along Miller Creek to protect in-stream habitat and water quality. An average 100-ft buffer along 3,900 linear ft of Miller Creek will be established. The buffers will consist of a minimum buffer width of 50 feet on the east side – the outer 50-ft will include storm water features and potentially public trails. A minimum 100-ft buffer will be established on the west side of the creek. Restore existing floodplain with native trees and shrubs on and near the Vacca Farm site. Establish and enhance a 25-ft buffer around Lora Lake.	Provide protective buffers along the entire Miller Creek riparian corridor within the mandatory buyout area to create approximately 12 acres of buffer habitat.

In-stream features such as coarse woody debris, deflector logs, and root wads will be placed at various locations throughout the creek to improve and enhance in-stream fish habitat (Figure 3). And finally, a 50-feet densely planted vegetated buffer will be established along the new channel to provide shading, detritus, and soil stabilization.

2.6.2 Miller Creek Floodplain Compensation

To mitigate for approximately 3.1 acres (8,700 cy) of lost flood storage from the new runway fill; the Port will increase flood storage by excavating approximately 5.2 acres (9,400 cy) of



Data Compiled by Parametrix

Figure 3.
Representative Fish Habitat Enhancement Features

soil between elevations 262 and 266 at the Vacca Farm site, and remove any existing structures within the floodplain area (Figure 4). A net increase of 714 cy flood storage will be created on the west side of Miller Creek to compensate for lost flood storage on the east side of the creek.

2.6.3 Miller Creek Floodplain Enhancement

Existing farmed floodplain area will be restored and enhanced by removing existing impacts associated with farming activities and enhancing the floodplain with native vegetation. Impacts to the floodplain currently include soil erosion and potential runoff of nutrients and agricultural chemicals. The mitigation project will increase the functional value of the floodplain to Miller Creek by providing plant detritus to the creek during flood events that will support stream invertebrates, which are important forage to fish.

The floodplain area will be enhanced by planting native woody vegetation tolerant to saturated soil conditions. It is expected that the floodplain area will have standing water ranging in depth from two to six inches throughout portions of the year. The goal is not to create open water habitat but to create an open canopy forest and shrub community to provide rapid development of woody plant cover, prevent soil erosion, and also to discourage waterfowl (such as Canada geese, mallards, and American widgeons) use of the area as mandated by FAA regulations (see Figures 2 and 4).

In addition, a minimum 50-feet upland buffer will be established from the edge of the enhancement plantings and Des Moines Memorial Drive. This upland buffer area will be enhanced by planting native western Washington vegetation to replace the existing Himalayan blackberry thicket.

2.6.4 Lora Lake Buffer Enhancement

The purpose of this mitigation action is to remove existing impacts from residential uses (e.g. lawn fertilizers) next to Lora Lake and establish and enhance a 25-feet buffer around the lake (Figures 2 and 5). Existing features such as houses, outbuildings, driveways, and other structures will be removed within the proposed 25-feet buffer. By removing residential structures, lawn and landscape area, and failed septic systems within the proposed buffer area, water quality will likely improve because household and yard chemicals and untreated storm water runoff will have less potential to reach the creek or lake. The 25-feet buffer will be established from the edge of ordinary high water mark (OHWM) landward surrounding the north and west sides of Lora Lake. The 25-feet buffer area will be enhanced with native trees and shrubs, to provide approximately 0.60 acre of shoreline buffer.

2.6.5 Miller Creek Riparian Buffer Enhancement

Within the mandatory buyout area, approximately 3,900 lineal feet of Miller Creek will be protected with a riparian buffer on both sides of the creek (Figures 6a and 6b). The buffer area will be protected from clearing and other human impacts, except as noted in Deed Restrictions on Stream Buffer Areas which are currently being developed by the Port (Figure 7). A minimum 100-feet buffer will be established on the west side of the creek; public trails will be allowed to be located in the outer 50 feet. A minimum 50-feet buffer will be established on the east side of the creek, and storm water management facilities and temporary construction areas will be allowed in this area.

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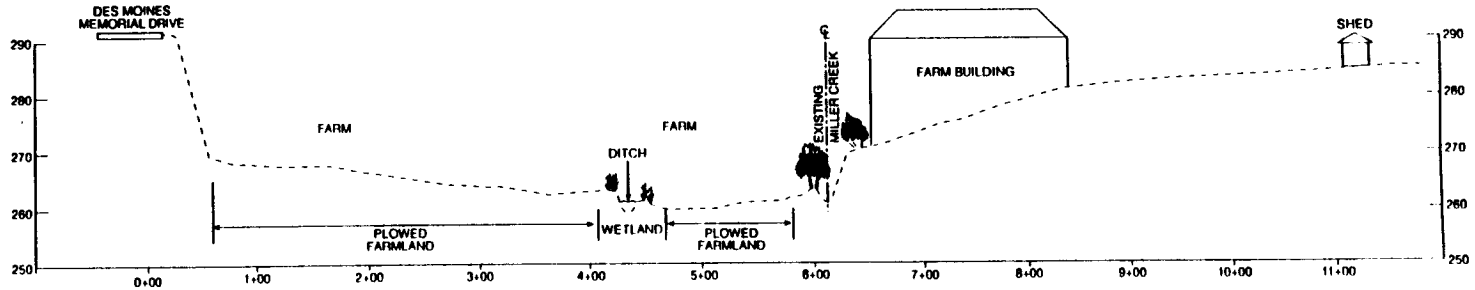
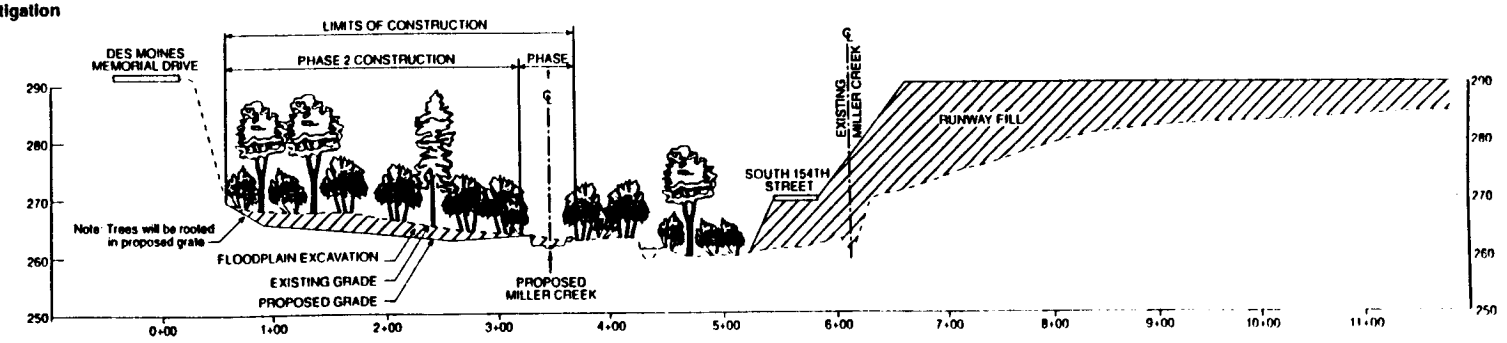
Existing Conditions



Post-Mitigation



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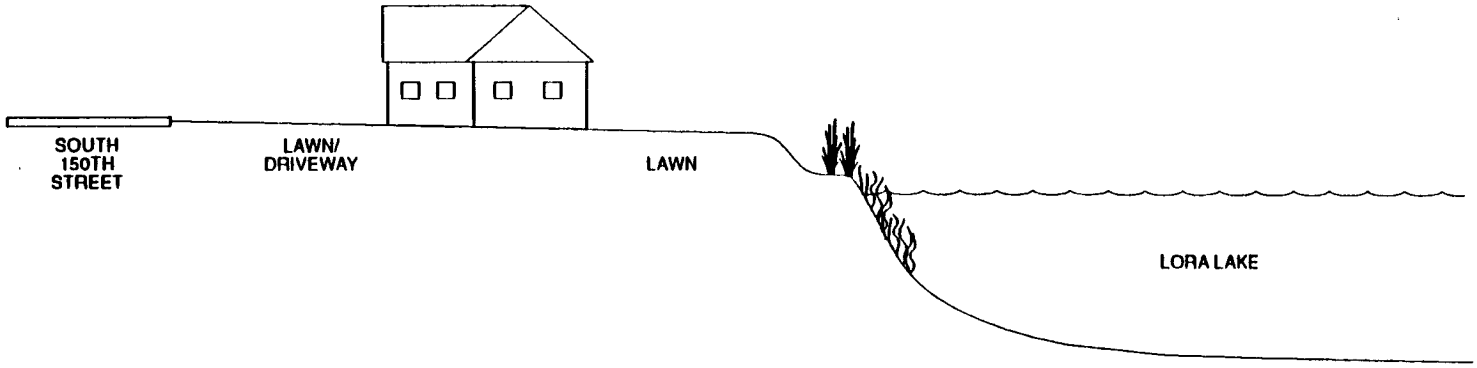
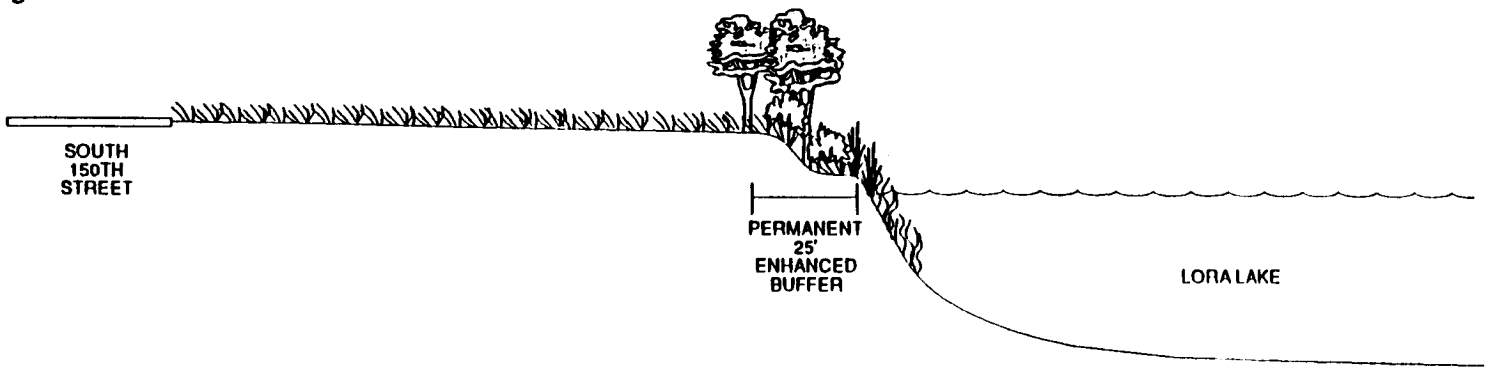
VERTICAL SCALE 1" = 10'
HORIZONTAL SCALE 1" = 50'

Figure 4.
Cross-Section Miller Creek/Lora Lake Floodplain Enhancement

Existing Conditions



Post-Mitigation



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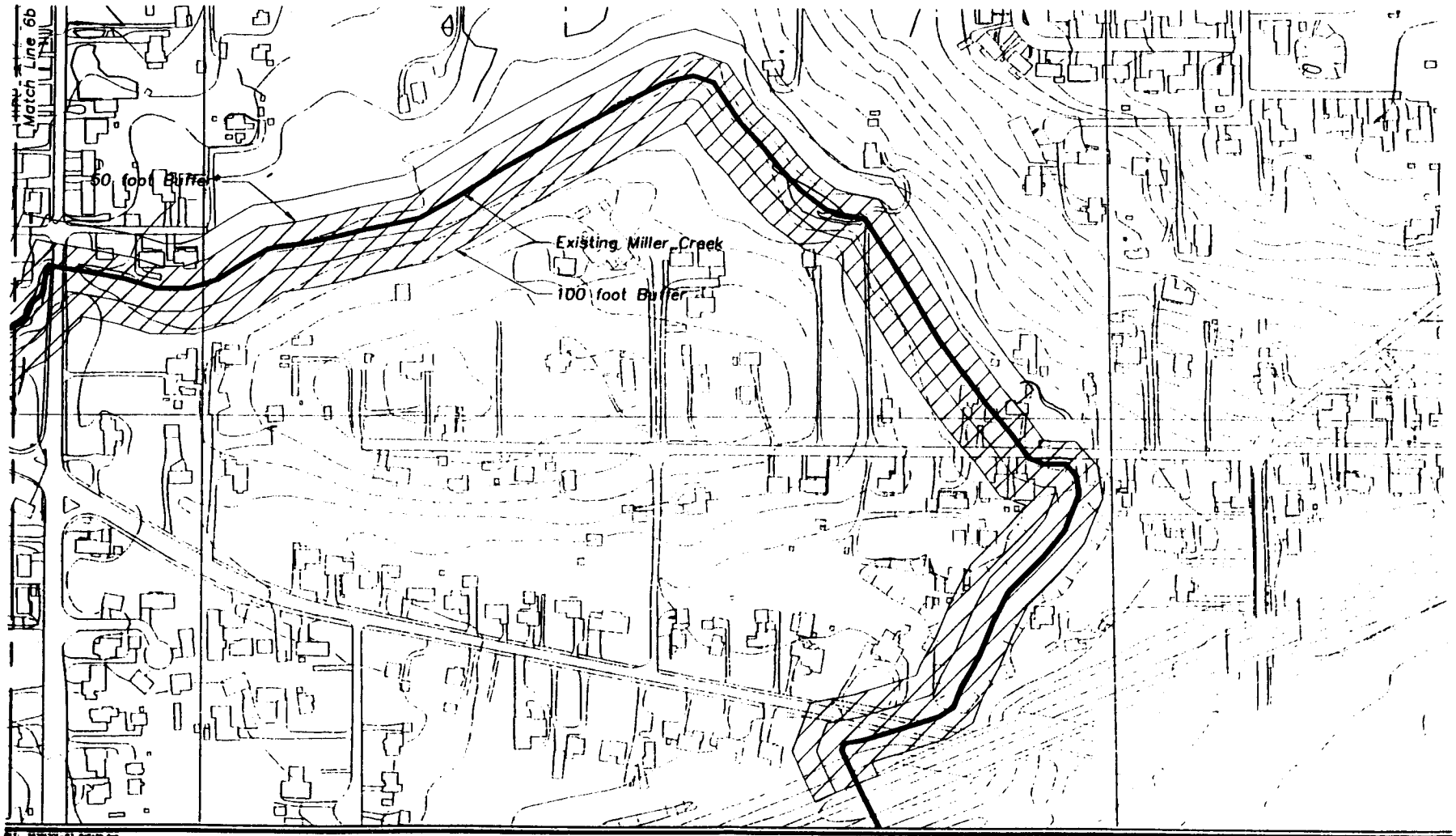
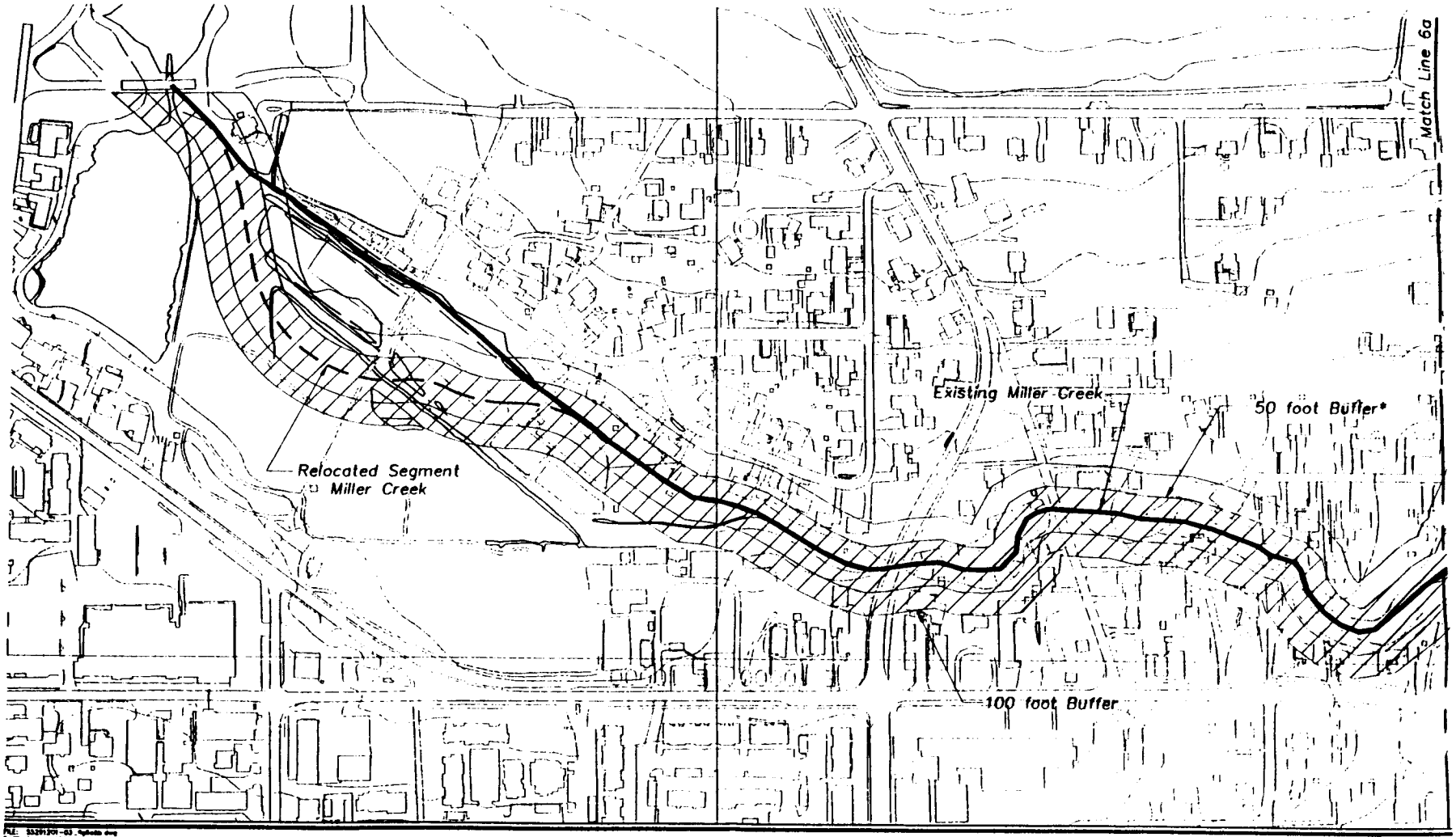
VERTICAL SCALE 1" = 40'
HORIZONTAL SCALE 1" = 40'

Figure 5.
Typical Cross-Section of Lora Lake Buffer Enhancement



*Note:
3 Additional acres of buffer will be established on the east side of Miller Creek once Project Design is complete to provide an average of 100 foot buffers.

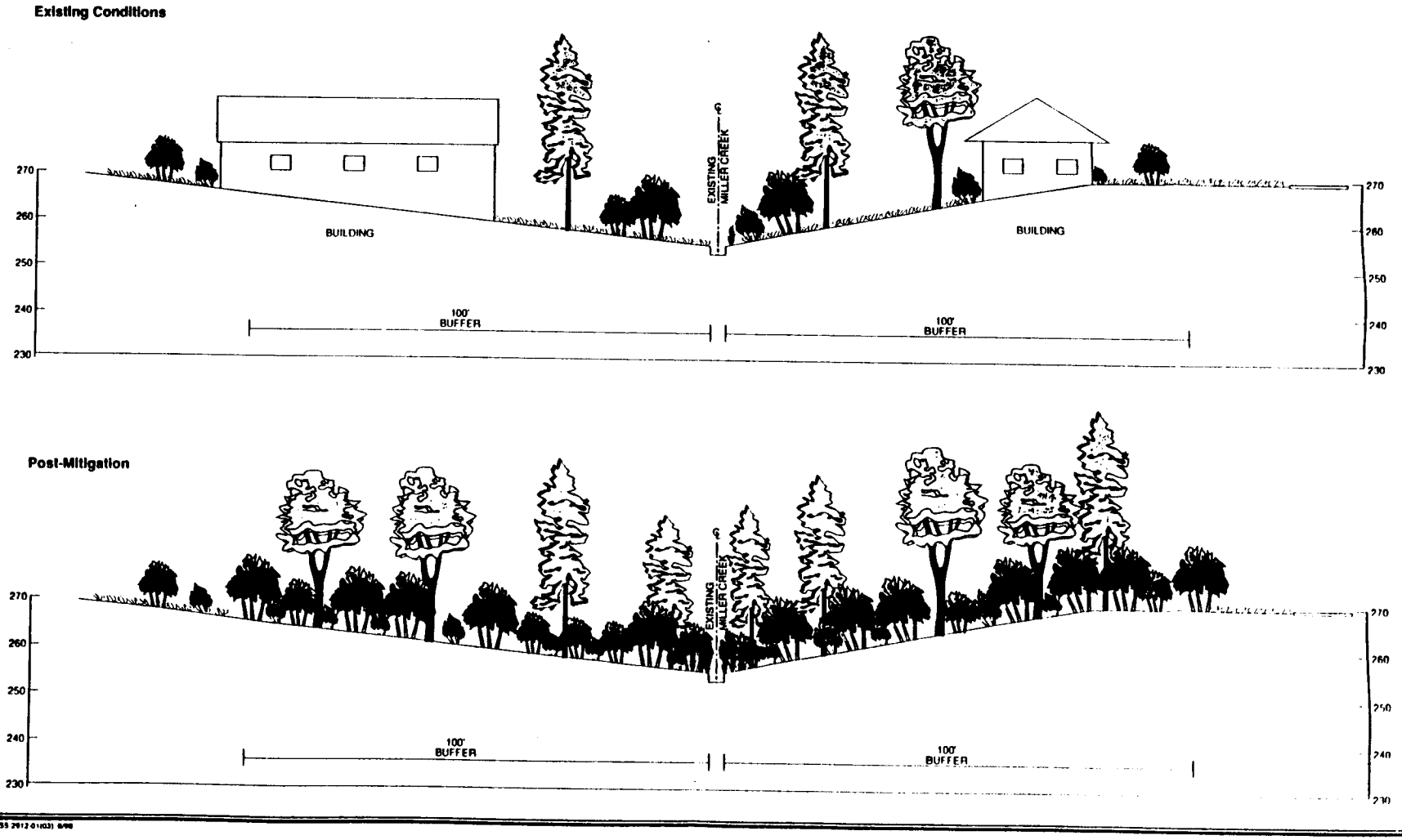
Figure 6a
Stream Buffers Along Miller Creek



0 100 200
Scale in feet

*Note:
3 Additional acres of buffer will be established on the east side of Miller Creek once Project Design is complete to provide an average of 100 foot buffers.

Figure 6b
Stream Buffers Along Miller Creek



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ERTICAL SCALE 1" = 20'
ORIZONTAL SCALE 1" = 20'

Figure 7.
Cross-Section of Miller Creek Stream Buffer Enhancement

Buffer averaging will be used on the east side of the creek where storm water facilities will be included in the calculation of the 100-ft average buffer width. The preliminary locations of storm water facilities are provided in the *Preliminary Comprehensive Stormwater Management Plan for Sea-Tac International Airport Master Plan Improvements* (Parametrix, Inc. 1988). However, the locations of public trails are not known at this time, and the Port wishes to reserve the right to locate a trail in the outer 50 feet of the buffers at a future date.

The buffer area will protect a total of about 12 acres of riparian habitat along Miller Creek. The buffers will also enhance water quality by reducing water temperature, and increasing nutrient cycling through the riparian areas. Residential structures, lawn and landscape area, and failed septic systems within the proposed buffer area will be removed and yard chemicals and untreated storm water runoff will not reach the creek.

Any redevelopment of areas adjacent to the creek floodplain will be reviewed by the Port Environmental Specialist to assure that adequate buffers are planned and maintained. If redevelopment in the mandatory buyout area occurs, buffers adjacent to the new developments will be clearly signed at 50-feet intervals and fenced along the edge of the 100-foot buffer.

In addition, a 50-feet buffer will be established along Des Moines Memorial Drive. Invasive species, such as Himalayan blackberry, will be removed and the buffer will be planted with native upland vegetation. This buffer will protect the floodplain enhancement from adjacent land uses.

Existing bridges that cross over Miller Creek at South 157th Place, South 160th Street and 8th Avenue South will remain. The existing bridge at South 156th Street will be replaced with a new bridge as part of the South 154th Street relocation.

3. ECOLOGICAL ASSESSMENT OF THE IMPACT SITE

This mitigation plan addresses impacts to Miller Creek and portions of the Miller Creek floodplain. Proposed impacts and mitigation to wetlands and water quality/quantity from implementing Master Plan Update projects are described in *Wetland Mitigation Plan for Proposed Master Plan Update Improvements at Seattle-Tacoma International Airport* (Parametrix, Inc. 1996) and *Preliminary Comprehensive Stormwater Management Plan for Sea-Tac International Airport Master Plan Improvements* (Parametrix, Inc. 1998). The following sections describe the existing ecological conditions and functions of Miller Creek and the Miller Creek floodplain that will be impacted by the Master Plan Improvement projects.

3.1 MILLER CREEK

3.1.1 Location

Miller Creek originates north of SR 518, flows south along the west side of the Miller Creek Detention Facility and along the east and south side of Lora Lake. Both the Reba Detention facility and Lora Lake have overflow structures that empty into Miller Creek during periods of high flow. Miller Creek continues south and flows west of 12th Avenue South and ultimately empties into Puget Sound. Figure 8 shows the existing location of Miller Creek in the northern portion of the mandatory buyout area and the 100-year floodplain associated with Miller Creek.

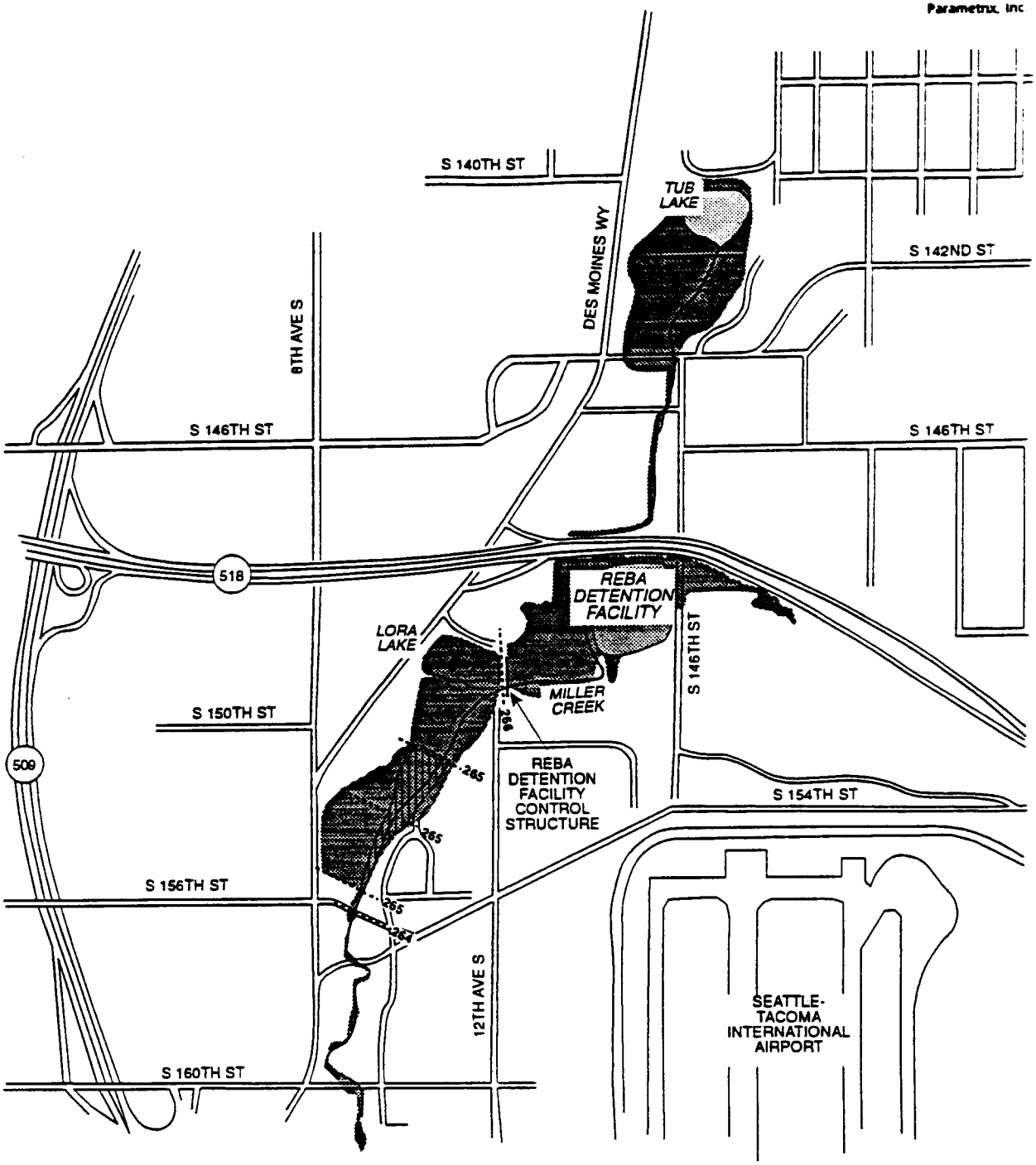
3.1.2 Existing Conditions

Miller Creek, from the Reba Detention Facility outlet to South 156th Way, is not in its natural channel; the creek has been dredged and straightened to drain wetlands and for farmland reclamation. The existing channel currently overflows its banks with at least a two year frequency with a base flow velocity of 1.7 cubic feet per second (cfs) (Shapiro 1995).

The section of the creek that will be filled adjacent to the Vacca Farm site is a ditched reach with a silty bottom substrate. Miller Creek is approximately four to ten feet wide and two feet deep below the outfall of the Reba Detention Facility. The bank is lined with large rocks in the upper segments near Lora Lake, and the channel has a very silty substrate. Below South 156th Street, Miller Creek contains natural meanders that vary from approximately five to ten feet wide. Substrate in the creek below South 156th Street consists of areas of sand and gravel with some silt.

3.1.3 Fish Habitat

Historically, Miller Creek supported anadromous fish runs of coho and chum salmon and sea-run cutthroat trout, as well as resident populations of pumpkinseed sunfish, sculpin, and cutthroat trout (Landrum & Brown 1996). The creek currently supports a small coho salmon run that is maintained by annual releases of hatchery-reared fingerlings raised by the Des Moines Chapter of Trout Unlimited (Shapiro 1995). The last Washington Department of Fish and Wildlife (WDFW)-sponsored spawning survey in 1985 did not observe any coho spawning activities; however, the Des Moines Chapter of Trout Unlimited reported approximately 91 fish in a recent coho spawning survey. Anadromous fish use of the creek is restricted to areas downstream of about South 160th Street where a natural water fall reportedly restricts upstream migration.



Source: FEMA 1995

Sea-Tac Airport - Miller Creek Relocation Plan/55-2912-01(03) 8/98

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100-year Flood Elevation

Floodway

100-Year Floodplain

Figure 8.
100-Year Floodplain On and Near Miller Creek

3.1.4 Stream Rating and Water Quality

The lower reaches of Miller Creek are classified by WDFW as Class II salmon-bearing waters. The upper reaches (above South 160th Street) are reported to be inaccessible to anadromous salmonids because of road culverts and a waterfall at about 0.2 mile upstream of Southwest 160th (Shapiro 1995). Although the Miller Creek watershed is generally classified by Ecology as having Class AA (extraordinary) water quality, storm water runoff from residential, commercial and agricultural properties has contributed to water quality degradation. As a result, Miller Creek fails to meet many of the state water quality standards (Landrum & Brown 1996). Water quality in the basin has degraded as a result of pollutants commonly found in urban storm water runoff. Nutrients, organics, metals, fecal coliform bacteria, and suspended solids have contributed to occasional violations of Class AA water quality standards for pH, dissolved oxygen, and ammonia have also occurred in the basin (Landrum & Brown 1996).

3.2 MILLER CREEK FLOODPLAIN (VACCA FARM SITE)

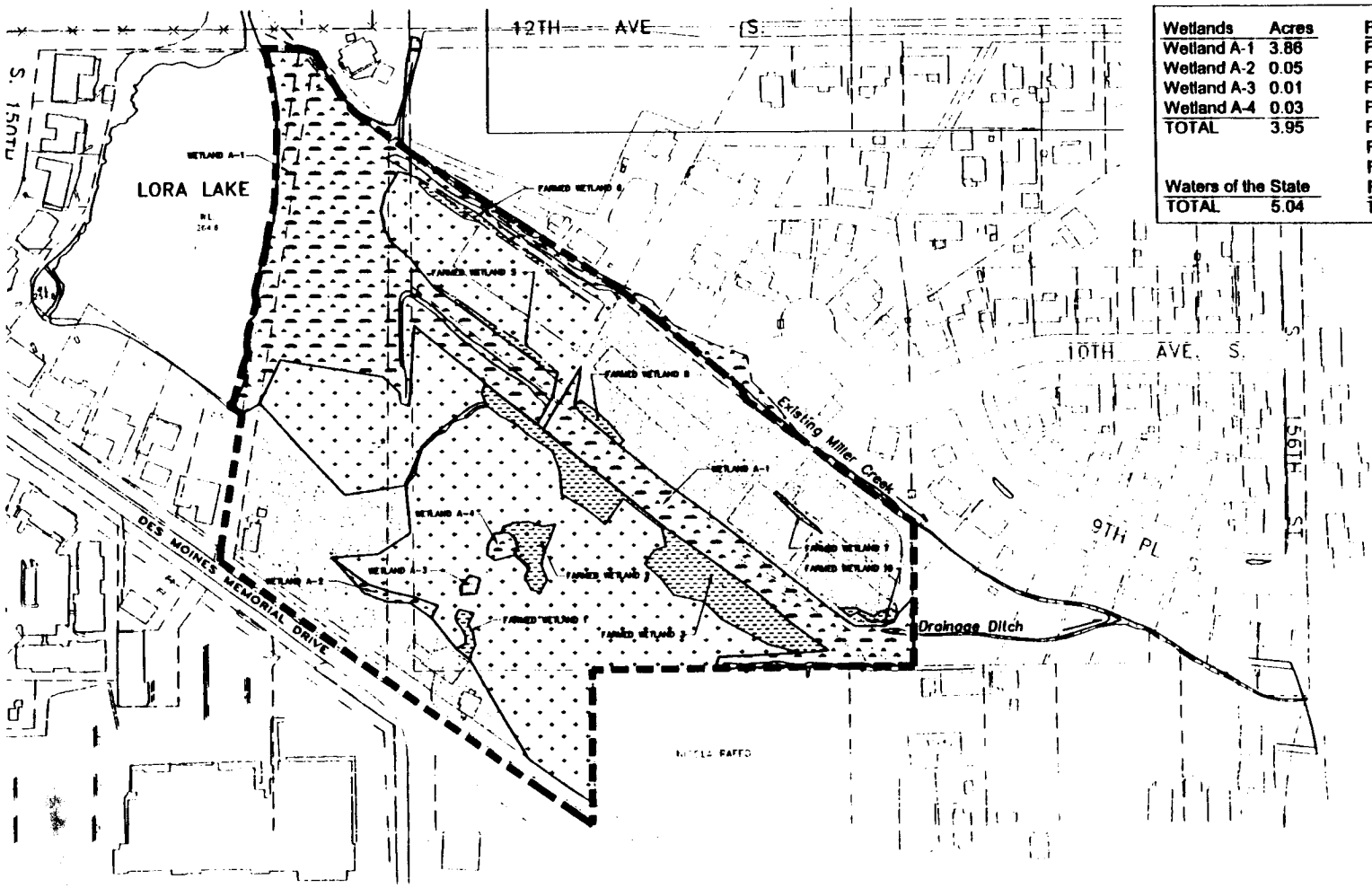
The Vacca Farm site, most of which is located within the 100-year floodplain of Miller Creek, consists of land designated as PCC and FW; forested, scrub-shrub, and emergent wetland; and farmed agricultural fields, and upland.

Wetland areas on-site were delineated by Parametrix, Inc. in May and June 1998 and verified by the U.S. Army Corps of Engineers (Corps) in July 1998 (Figure 9). Topography on the Vacca Farm site ranges in elevation from 262 feet in the southern portion of the site to 292 feet on a knoll in the northwest portion of the site, near Des Moines Memorial Drive. The following sections describe the ecological conditions of the Vacca Farm site that will be impacted from Master Plan Update Improvement Projects. As mentioned above in Section 2.5.2, a total of 3.1 acres of floodplain capacity will be lost on the west side of the existing Miller Creek (Vacca Farm site) from the Master Plan Update Improvement projects.

3.2.1 Prior Converted Croplands and Farmed Wetlands

For agricultural purposes, portions of the Vacca Farm site were historically wetland but have been manipulated by installing drain tiles and a ditch system to create arable land. Under certain conditions, wetlands that have been manipulated for agricultural purposes are regulated under Section 404 of the Clean Water Act (CWA). It has been determined through field investigation and coordination with the Corps and Ecology, that there are three types of jurisdictional wetland areas on the Vacca Farm site that are regulated under Section 404 of the CWA: PCC, FW, and vegetated wetlands.

According to Federal Regulations and the Natural Resources Conservation Service (NRCS) (1985), PCC refers to wetlands that have been drained, dredged, filled, leveled, or otherwise manipulated including the removal of woody vegetation, for the purpose, or to have the effect, of making the production of an agricultural commodity possible and an agricultural commodity has been produced at least once before December 23, 1985. FW refers to wetland areas that were manipulated and



Wetlands	Acres
Wetland A-1	3.86
Wetland A-2	0.05
Wetland A-3	0.01
Wetland A-4	0.03
TOTAL	3.95
Waters of the State	
TOTAL	5.04

Farmed Wetland	Acres
Farmed WL 1	0.03
Farmed WL 2	0.09
Farmed WL 3	0.59
Farmed WL 5	0.04
Farmed WL 6	0.07
Farmed WL 8	0.03
Farmed WL 9	0.01
Farmed WL 10	0.02
TOTAL	0.88

0 75 150
SCALE IN FEET

N

Legend

Jurisdictional Wetlands
- Vegetated Wetlands
- Farmed Wetlands, 14 Day Inundation (Observed, 3/98)

Other Information
- Upland
- Waters of the State

Figure 9
Wetlands on the Vacca Farm Site

AR 041786

used to produce an agricultural commodity prior to December 23, 1985, but have not been converted prior to that date and, therefore, are not prior converted croplands. By excavating approximately 5.2 acres of floodplain area, approximately 4.2 acres of PCC and approximately 0.75 acre of FW will be re-graded to increase floodwater storage.

Both of the PCC and FW areas that will be altered at the Vacca Farm site have been continuously farmed for the past 30 years, therefore no native vegetation is present, only hydric (or wetland) soil and wetland hydrology are present. FW areas typically are ponded with water for a minimum of 15 consecutive days within the growing season. During site review, Ecology determined that the areas identified as PCC are not wetlands, but "waters of the state" due to the presence of wetland hydrology. It is believed that these PCC areas will likely become jurisdictional wetlands after farming practices are abandoned.

3.2.2 Forested Wetland Complex

A forested, scrub-shrub, and emergent wetland complex is located at the north east portion of the Vacca Farms site, south of Lora Lake. Dominant vegetation in the forested portion of the wetland include black cottonwood (*Populus trichocarpa)* and red alder (*Alnus rubra*) in the canopy; Pacific willow (*Salix lucida*), Douglas spiraea (*Spiraea douglasii*), and Himalayan blackberry (*Rubus discolor*) in the shrub stratum; and reed canarygrass (*Phalaris arundinacae*) in the herbaceous layer. Wetland hydrology is primarily derived from groundwater and to some extent, precipitation.

3.2.3 Scrub-Shrub and Emergent Wetland

A narrow band of scrub-shrub and emergent wetland area bisects the farmed agricultural fields. These wetland areas are associated with a north-south drainage channel. Dominant vegetation in these areas includes Pacific willow, Himalayan blackberry, and reed canarygrass. The emergent class of wetland is also associated with a north-south drainage channel and primarily consists of reed canarygrass.

3.2.4 Upland

There are two areas of upland located on the Vacca farm site: one on the northwest and one on the southeast portion of the site. Creating the new Miller Creek channel and excavating to increase floodplain capacity will directly impact the area located in the southeast portion of the site. This upland area primarily consists of actively cultivated cropland with no native vegetation communities present. In addition, upland area surrounds portions of the cultivated fields. Dominant species include Scot's broom (*Cytisus scoparius*), Himalayan blackberry, Canada thistle (*Circium arvense*), and various grass species.

The upland area located in the southeast portion of the site consists of a gravel fill pad covered with various grass species and a dense Himalayan blackberry thicket. Elevations of the upland areas on the Vacca Farm site are typically above elevation 274. Some of the upland areas surrounding Miller Creek and drainage swales were created from side cast material from dredging and maintenance activities of the creek and swales.

3.2.5 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 Farms site. Locations of HWA and Parametrix soil test pits and boring are identified in Figure 10. Results of the soil investigations revealed that the majority of the soils on the site are underlain by soft saturated peat, which overlies dense, glacially deposited material. The conclusion of the soil investigation indicates that due to the presence of peat over much of the site, the area was largely a historic wetland.

3.2.6 Hydrology

Four groundwater monitoring wells were installed at the Vacca Farm site on May 14, 1997 (Figure 10). Groundwater levels were measured during 16 separate site visits from May 30, 1997 to November 12, 1997 (Table 2). Groundwater levels averaged from approximately 1.5 to 2 feet below ground surface. The largest fluctuation occurred at monitoring well P-1, located in the existing forested and shrub wetland. Low groundwater table measurements were reflected in the dry summer conditions, and as expected, higher levels of groundwater occurred in the spring and fall months. The data in Table 2 were used to estimate hydrologic conditions expected to occur in the floodplain restoration site after excavation in the floodplain area is complete.

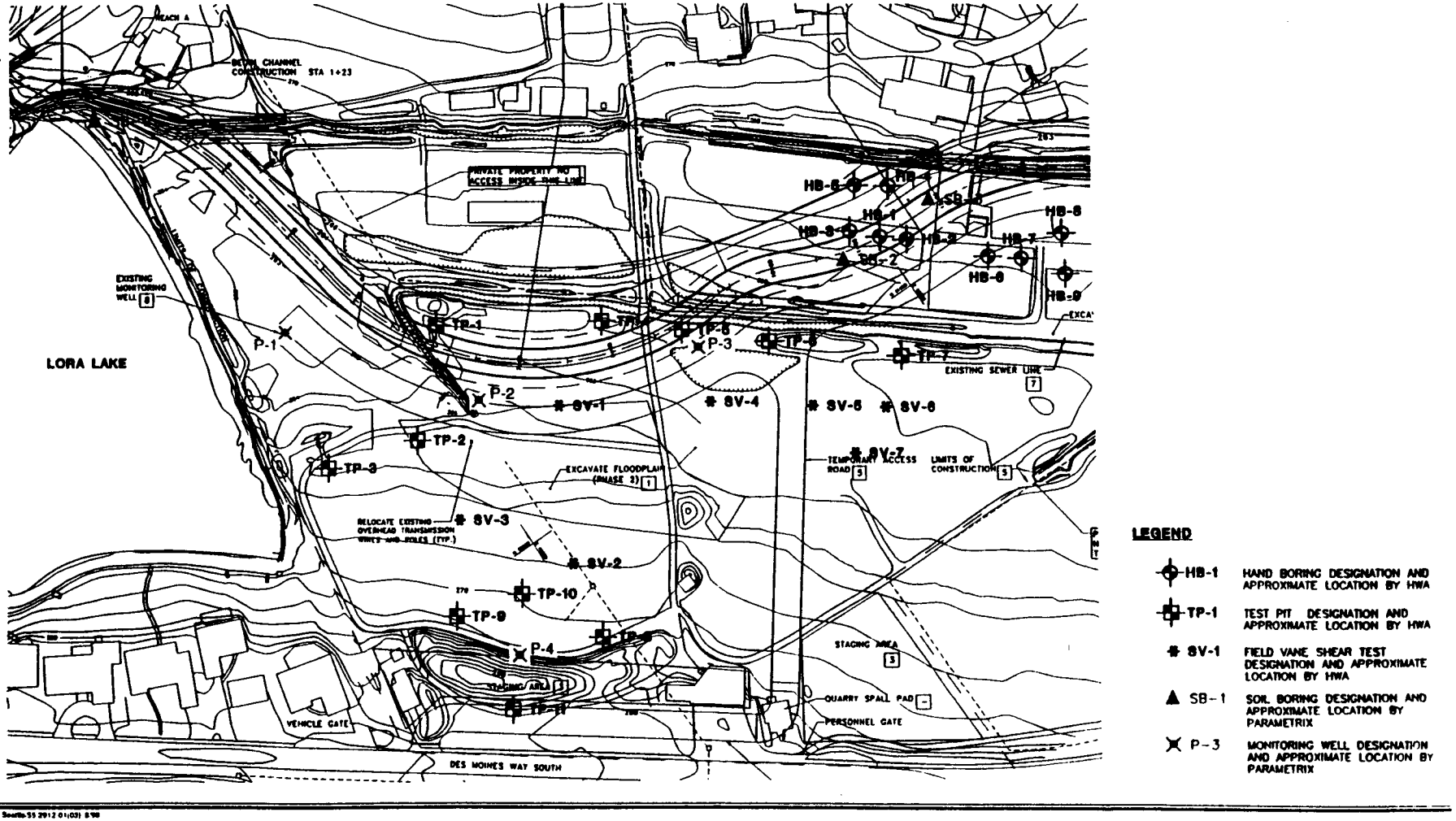
3.2.7 Wetland Functions

To determine the functions and values of the wetlands that will be impacted by the Master Plan Update Improvement projects, a methodology developed by the Corps, *The Wetland Assessment Technique* (Reppert et al. 1979), and an assessment method modeled after Reppert, *DRAFT Wetland and Buffer Functions Semi-Quantitative Assessment Methodology* (Cooke 1996) was used.

The functions assessed in this methodology include water quality improvement, natural groundwater recharge/support, hydrologic support (streamflow maintenance), natural biological support, and habitat functions. Other functions assessed in this methodology include storm and floodwater attenuation; aquatic study areas, and erosion shoreline protection. Because there are many small individual wetland areas, the functional assessment is performed on the types of wetland present, instead of each individual wetland. Refer to Appendix B for copies of the functional assessment forms.

3.2.7.1 Prior Converted Cropland (Waters of the State) and Farmed Wetland

Due to their overall small size, lack of vegetative cover throughout portions of the year (when not in farm production), long periods of exposed soil, repeated soil disturbance (through disking and tilling), and application of pesticides and herbicides, PCC and FW merit a low rating for water quality improvements, biological support, and overall habitat functions. However, due to the presence of a high water table and location near drainage swales that empty into Miller Creek, the PCC and FW merit a moderate-to high rating for hydrologic (stream flow maintenance) function.



SCALE IN FEET
0 50 100

Source: HWA GeoSciences Inc.
Reference: Base map by Parametrix, Inc.

Figure 10.
Site and Soil Exploration Plan
Miller Creek Relocation

Table 2. Groundwater monitoring well data[1] on the Vacca Farms 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 is represented and as depth to groundwater in ft.
[2]Elevations are represented as ft above mean sea level.

3.2.7.2 Forested Wetland

Overall, the forested wetland located on the south shore of Lora Lake merits moderate ratings for water quality improvements, natural groundwater recharge/support, hydrologic support (stream flow maintenance), biological support, and habitat functions. The wetland provides a moderate to high rating for storm and floodwater retention due to its location adjacent to Lora Lake and Miller Creek. The wetland contains a dense shrub understory with a relatively dense canopy cover; therefore, the vegetation communities provide not only habitat for invertebrates, amphibians, birds, and some

small mammals, but also allow sediments and potentially excess nutrients to settle out before flowing downstream.

3.2.7.3 Scrub-shrub and Emergent Wetland

This wetland community is located in a narrow band along the north-south drainage swale. This wetland merits moderate ratings for natural groundwater recharge/support, hydrologic support (streamflow maintenance), biological support, and habitat functions because the wetland is located in an area with a relatively high water table and located adjacent to a drainage feature associated with a fish bearing stream. Additionally, the wetland contains dense brush that provides protective cover, foraging opportunities and nesting material and area for predominantly passerine birds and small mammals.

Emergent wetlands on the Vacca Farm site are located adjacent to cultivated agricultural fields and the drainage swale. Overall, low ratings are merited for water quality improvements, biological support, habitat functions, storm and floodwater attenuation, erosion shoreline protection, and because of their lack of structurally diverse vegetation communities, potential input of chemicals, and small size. Moderate rating is merited for natural groundwater recharge/support and hydrologic support (streamflow maintenance) due to its location near Miller Creek.

4. MITIGATION APPROACH

4.1 MITIGATION SEQUENCE

According to the State Environmental Policy Act (SEPA) (WAC 197-11-768) "mitigation" is defined as:

(1) Avoiding the impact altogether by not taking a certain action or parts of an action;

(2) Minimizing impacts by limiting the degree or magnitude of the action and its implementation, by using appropriate technology, or by taking affirmative steps to avoid or reduce impacts;

(3) Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;

(4) Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action;

(5) Compensating for the impact by replacing, enhancing or providing substitute resources or environments: and/or

(6) Monitoring the impact and taking appropriate corrective measures.

Measures to mitigate for adverse impacts associated with development of the Master Plan Update Improvement projects at Sea-Tac Airport have been made throughout the planning and design process to avoid, minimize, rectify, and compensate for adverse impacts to sensitive and critical resources within the Master Plan Update area. These mitigation efforts are described throughout the following sections and the remainder of this document as mandated by SEPA.

4.2 GOALS AND OBJECTIVES

The overall goal of this plan is to increase water quality and aquatic habitat in the Miller Creek basin. Table 3 describes the goals, design objectives, design criteria, and final performance standards for all the Miller Creek Enhancement Projects. Separate goals and objectives have been identified for each of the main mitigation elements; some of the stated goals overlap.

4.3 PERFORMANCE STANDARDS

A set of final performance standards are described in Table 3. An additional set of interim performance standards has been established that will determine if the goals and objectives listed in Table 3 have been achieved. When the performance standards have been met, then the mitigation should be determined to be a success. If the performance standards are not met then implementation of a contingency plan will likely be necessary. The following outlines performance standards for the floodplain enhancement planting, upland buffer plantings within the Miller Creek floodplain enhancement area, and within the Miller Creek and Lora Lake buffer enhancement area:

Table 3. Mitigation goals, design objectives, design criteria, and final performance standards for Miller Creek enhancement projects.

Design Objectives	Design Criteria	Final Performance Standard
Miller Creek Relocation Goal 1: The stream would continue to provide base flow conveyance functions		
Provide minimum flow depth to prevent fish stranding and water quality problems.	Design a natural channel assuming a gravel or stony bottom and a Manning's *n* constant of 0.035.	Minimum flow depth is 0.25 ft (at 0.5 cfs).
	Construct vertical channel side slopes from the bottom up 0.5 ft; construct side slopes of 1:1 or flatter (typical) from 0.5 to 1.0 ft to provide capacity for wet season base flow.	Approximate wet season (October to April) average base flow depth is 1 ft (at 5.0 cfs).
	Set channel slope to provide minimum and maximum velocity criteria (Goal 4).	
	Adjust channel bottom width for minimum depth criteria.	
Miller Creek Relocation Goal 2: The new Miller Creek channel should provide enhanced fish habitat		
Provide enhanced fish habitat without fish passage barriers.	Provide minimum flow depth (Goal 1).	New channel meets design criteria (Goal 1).
	Provide a natural channel configuration, 0.5-ft vertical slopes, 1:1 slopes from 0.5 ft to 1 ft depth (Goal 1).	
	Provide habitat features, including in-stream features such as deflectors and overhanging logs as needed to maximize available habitat.	Stream habitat features are stable.
	Provide channel substrate that enhances habitat; design channel to manage flow velocity that is consistent with substrate types (Goal 4).	
	Reduce silting, sedimentation, and scouring by meeting minimum and maximum average flow velocity standards.	

Table 3. Mitigation goals, design objectives, design criteria, and final performance standards for Miller Creek enhancement projects (continued).

Design Objectives	Design Criteria	Final Performance Standard
Miller Creek Relocation Goal 3: The channels would accommodate peak flows up to the 100-year flow; no net 100-year floodplain storage lost		
Accommodate the 100-year peak flow.	Do not confine or constrict 100-year flood flows in the new channel; flows in excess of the channel design will freely overflow the channel into the flood plain.	The 100-year flood stage outside the project area is not changed by more than 0.1 ft.
Allow no net 100-year floodplain storage loss in the project area.	Mitigate 100-year floodplain storage by providing lost storage compensation.	The 100-year flood stage outside the project area is not changed by more than 0.1 ft.
Limit channel scouring for the 100-year flow.	Channel velocity cannot exceed the gravel movement velocity for the 100-year flow (Goal 4).	Channel substrate present; no bare scoured channel sections in excess of 25 ft.
Miller Creek Relocation Goal 4: Minimum channel flow velocity should minimize fine sediment deposition		
Minimize sedimentation with minimum flow velocity.	Adjust channel slope, by channel segment, to provide minimum dry season base flow velocity that is greater than the silt transport velocity (0.7 ft/sec). Adjust channel bottom width to achieve minimum velocity criteria.	Minimal sedimentation in riffles, runs or gravel substrate.
Minimize channel scouring with a maximum design flow velocity.	Channel flow velocity cannot exceed the gravel movement velocity (4 ft/sec) for the 100-year flow. Increase channel capacity above 0.5 ft depth (up to 2 ft depth) to reduce peak flow channel velocity.	Channel substrate present; no bare scoured channel bottom sections in excess of 25 ft.
Miller Creek Relocation Goal 5: The channels would replace or enhance riparian habitat		
Provide riparian habitat.	Provide a minimum 25-ft buffer on the airport side (east) of the channel from the edge of the proposed channel. Provide a minimum 100-ft buffer on the west side of the channel that accommodates public access (Goal 7).	An average of 80% of the planted species survive over the ten-year monitoring period and 80% of trees and shrubs species are native to western Washington.

Table 3. Mitigation goals, design objectives, design criteria, and final performance standards for Miller Creek enhancement projects (continued).

Design Objectives	Design Criteria	Final Performance Standard
Miller Creek Relocation Goal 6: The channels would not include expansive, long-standing water pools or wetlands that could potentially attract wildlife		
Provide surface drainage for depressions and pools in the replacement channel floodplain.	Provide positive floodplain drainage to reduce persistent standing water.	No permanent or persistent floodplain or riparian pools develop that support waterfowl habitat.
Prevent long-term standing water in the Miller Creek floodplain.	Provide positive floodplain drainage to reduce persistent standing water.	
Miller Creek Relocation Goal 7: The proposed Miller Creek corridor should accommodate passive recreational uses, such as walking trails		
Provide for passive recreation and public access to the new channel.	Provide a channel buffer that allows for pedestrian trail construction.	A minimum buffer width is provided to allow for trail construction.
Miller Creek Floodplain Compensation Goal 1: Compensate for loss of floodplain and flood water storage		
Provide additional floodplain area by excavating approximately 9,400 cy of area on the Vacca Farm site.	Excavate approximately 9,400 cy of soil between elevation 262 ft and 266 ft. Create a north-south drainage swale that provides positive drainage from the floodplain to avoid standing water conditions.	A topographic survey of the area will be conducted to ensure that the appropriate amount of soil has been excavated to compensate for lost floodplain.
Protect floodplain enhancement area from adjacent land uses by establishing a buffer between the floodplain enhancement and DesMoines Memorial Drive.	A minimum 50-ft buffer will be established from the edge of the floodplain grading area west. Blackberry species will be removed and planted with native woody vegetation.	Eighty percent (80%) of the planted species will survive over the ten-year monitoring period.
Miller Creek Floodplain Enhancement Goal 1: Increase functional value of the floodplain to Miller Creek		
Remove existing agricultural practices from the floodplain area on the Vacca Farm site.	Purchase the Vacca Farm site and cease all farming activities, remove existing structures from floodplain area.	No farming activities nor structure will found on the site during the as-build survey.
Increase detritus and the flow of nutrients to the creek.	Plant the approximately 6 acres of the floodplain with native trees and shrubs.	Average of 80% survival of planted material and between 70% and 80% vegetation cover after the ten-year monitoring period has ended.

Table 3. Mitigation goals, design objectives, design criteria, and final performance standards for Miller Creek enhancement projects (continued).

Design Objectives	Design Criteria	Final Performance Standard
Lora Lake Buffer Enhancement Goal 1:	**Protect, establish, and enhance a shoreline buffer around Lora Lake**	
Increase the aquatic habitat in Lora Lake and downstream habitats (Miller Creek) by providing an upland buffer around Lora Lake.	Establish a 25-ft buffer around Lora Lake. The buffer will be established from the OHWM or appropriate topographic benchmark.	As-built survey will identify a 25-ft wide buffer area surrounding Lora Lake.
	All structures within the 25-ft buffer will be demolished and failing septic systems will be removed.	No structures will be present on the as-built survey of the buffer.
Provide shading along and detritus to Lora Lake and downstream habitats.	Densely plant the 25-ft buffer around Lora Lake with native trees and shrubs.	As-built survey will depict the locations and number of planted vegetation species.
Miller Creek Buffer Enhancement Goal 1:	**Enhance aquatic habitat in and downstream of the Miller Creek riparian corridor**	
Remove existing impacts associated with residential development in the riparian area.	Demolish all structures, maintained lawn, landscaping, located within 100 feet of the creek. Remove potential water quality impacts such as failed septic systems and untreated storm water runoff from the buffer area.	No structures will be present within the 100-ft buffer area adjacent to the creek. The 100-ft buffers on the east side of the creek will be averaged and storm water facilities may be allowed within the outer 50-ft of the riparian buffers. Buffers on the west side will be a minimum of 100-ft and a public trail may be located in the outer 50-ft of the buffer.
Plant portions of the buffer area with native vegetation.	Conduct a survey of the existing vegetation within the 100-ft buffer area to determine what areas will be enhanced. A detailed planting plan will be developed after the vegetation survey is complete.	As-built survey of the areas identifying locations, numbers, and species of planted material. Final monitor report identifies a minimum of 80% survival of planted material and between 80% and 100% vegetative cover.
Increase shade and detritus to the aquatic environment.	Densely plant the buffer area adjacent to the creek with native trees and shrubs to provide overhanging vegetation.	Percent cover of the creek will be a minimum of 50% at the end of the ten-year monitoring period.
Reduce erosion and sedimentation to Miller Creek.	Use BMPs during demolition, planting removal and installation to prevent soil erosion to Miller Creek.	Periodic inspection of the demolition areas and vegetation planting and removal area to ensure BMPs are being used properly.

Note: Data compiled by Parametrix, Inc.

- Eighty percent (80%) of the planted trees and shrubs will survive after the first year.
- A minimum of eighty percent (80%) of the planted trees and shrubs will survive during the first three years.
- An average of eighty percent (80%) of the planted trees and shrubs will survive by the end of the ten-year monitoring period.
- Approximately thirty percent (30%) of Miller Creek will be shaded with overhanging vegetation by year five and fifty percent (50%) will be shaded in the tenth monitoring year.
- Average percent cover of woody vegetation will be a minimum of forty percent (40%) in the fifth year and eighty (80%) in the tenth monitoring year as measured with a quadrants and line-intercept methods. The percent cover may include naturally recruited vegetation.
- No more than thirty percent (30%) of any planted area will consist of non-native invasive vegetation including, but not limited to, Himalayan blackberry, thistle, and reed canarygrass.
- An average of one piece of woody debris per 30 linear feet of Miller Creek and around Lora Lake will be installed. Woody debris will consist of trunks eight inches minimum butt diameter and 10-feet minimum length.

5. MITIGATION SITE

Areas that have been identified as mitigation sites for unavoidable impacts associated with the construction and implementation of the Master Plan Improvement projects are located in Miller Creek channel, at the Vacca Farm site, Lora Lake, and along the Miller Creek riparian corridor, within the mandatory buyout area. The existing conditions of Miller Creek and the Vacca Farm site are described above in Section 3. The following sections describe the existing conditions of the Lora Lake and Miller Creek riparian corridor mitigation sites.

5.1 LORA LAKE

5.1.1 Existing Conditions and Vegetation

Lora Lake is a man-made pond located in the floodplain of Miller Creek; cement bulkheads surround the majority of the shoreline. The upland buffer surrounding the north and west sides of Lora Lake consist of single-family residences, outbuildings, landscaping, mown lawn, and impervious surfaces such as roads and driveways. The buffers along the south and east shores of Lora Lake consist of deciduous forested wetland, Miller Creek, and upland shrub areas. Typical species in these areas include Douglas fir (*Pseudotsuga menzeisii*), red alder, and black cottonwood with thickets of Himalayan blackberry.

5.1.2 Soils and Hydrology

Soils within much of the Lora Lake buffer area is comprised of peat. Hydrology of Lora Lake is controlled through a 12-inch concrete culvert located in a berm that forms the south shore of the lake. When inflow exceeds the lake storage and outlet pipe capacity, water flows over a low spot in the berm. In extreme conditions, it is likely that the lake becomes part of the Miller Creek floodplain and completely overwhelms the south shore berm. Storm water runoff that flows into Lora Lake overflows into Miller Creek.

5.2 MILLER CREEK RIPARIAN CORRIDOR

Approximately 12 acres of buffer along Miller Creek will be established as part of a mitigation action. The following sections describe the existing conditions, vegetation, and soils within the Miller Creek riparian buffers.

5.2.1 Vegetation

Much of the riparian area along Miller Creek area currently consists of lawn or landscaping, which extends to the edge of the creek in some areas. Residential structures (such as houses and outbuildings), blackberry thickets, introduced grass species, farmland, and patches of native vegetation are also present throughout the riparian areas. Native tree and shrub species such as red alder, black cottonwood, Pacific and Sitka willow, hardhack, lady fern, horsetail, and various grasses are present in patches along the creek channel.

5.2.2 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/Lora Lake area. Soils in these areas were found to be primarily composed of peat. Soils throughout the remainder of the Miller Creek riparian corridor, south of the Vacca Farm site, typically consist of disturbed soils due to residential development. Even though these areas are unmapped, soil profiles in the riparian corridor appear to resemble the Alderwood series described in the Soil Survey of King County Area Washington (Snyder et al. 1973). Alderwood series are primarily made up of moderately well drained soils located on uplands formed under conifers in glacial deposits. Soils observed along the Miller Creek riparian corridor were predominantly sandy loam. The new bridge will be environmentally superior to existing bridge as it will span Miller Creek and associated floodplain.

6. IMPLEMENTATION

The proposed buffer enhancements along Miller Creek and around Lora Lake will be implemented as the Port acquires land within the mandatory buyout area and after existing residents have been relocated. The relocation of Miller Creek and excavation of the floodplain enhancement area at the Vacca Farm site is expected to begin construction in 1999. Buffer enhancements along the relocated portion of Miller Creek will occur after construction of the creek channel is complete. Minor deviations from this plan may occur as construction documents are prepared. The following sections describe the mitigation plan approach.

6.1 PRE-CONSTRUCTION MEETING

A pre-construction meeting will be held with contractors prior to implementing any part of this plan. The purpose of a pre-construction meeting is to ensure that the specifications outlined in this report are understood and properly implemented. Throughout the construction operations, close coordination with the contractors and mitigation design team will occur. Routine, on-site inspections will also occur throughout the construction period to monitor BMPs.

6.2 DEMOLITION

Demolition of structures within the creek buffer areas will follow BMPs presented in the Storm water Pollution Prevention Plan (SWPPP) prepared by the Port and approved by Ecology. Specifically, demolition in the creek buffer areas will be conducted to minimize removal or damage to existing vegetation. Any wetland areas within the demolition area will be clearly marked with orange barrier fencing or with other highly visible material so that no damage to existing wetland vegetation or soil occurs.

6.3 VEGETATION INVENTORY

Following demolition activities, an inventory of all parcels along Miller Creek and around Lora Lake will be conducted by a qualified biologist to evaluate existing native and non-native vegetation within the proposed buffer areas. Vegetation in the proposed buffer areas that is determined to be undesirable because it is either non-native, invasive, or may pose a hazard will be tagged or staked and removed. Large non-native trees or shrubs within the proposed buffer areas that will be beneficial to the creek or would pose significant erosion or stream bank damage if removed, will remain.

The buffer area inventory will be used to develop specific landscape plans to revegetate bare or hydroseeded areas within the proposed buffer with native vegetation. Detailed plans will be developed that focus on providing shade to the creek and stabilize the creek banks to prevent erosion. In addition, logs and snags in varying stages of decay that had been identified during the vegetation survey, will be randomly placed within the buffer areas to provide protective cover and microhabitat for amphibians, invertebrates, fungi, and bacteria. Adding fallen logs and snags to the mitigation area will add to the structural complexity of the mitigation area and increase the amount of organic matter input into the riparian system.

6.4 GRADING PLAN AND EROSION CONTROL

Grading activities to implement the Miller Creek Enhancement projects will occur to (1) construct the new Miller Creek channel, (2) remove existing structures in the proposed designated buffer areas, and (3) excavate approximately 9,400 yd^3 of Vacca farm site for increase in floodwater storage. Most construction staging, excavating, and grading for the new channel of Miller Creek will occur along the east side of the proposed new channel. Construction will be limited to approximately 5- to 10-feet on the west side of the new channel bank. The construction zone will be marked in the field with a silt fence and/or orange barrier fencing to avoid impacts to existing forested wetland located west of the proposed new channel.

Grading activities will occur in upland buffer areas around Lora Lake and along Miller Creek primarily to remove existing structures. Grading to increase floodwater storage at the Vacca Farm site will occur from approximately late May to October.

To prevent erosion and sedimentation in or near Miller Creek or Lora Lake after demolition, grading activities, or after undesirable vegetation has been removed from the buffer area, all soils left exposed for greater than 48 hours during October 1 through March 31 or greater than seven days from April 1 through September 30 will be covered with jute matting, or other appropriate BMPs. Immediately upon completing grading activities exposed soils will be hydroseeded with an upland seed mixture (Table 4) or a wetland seed mixture (Table 5) to prevent soil erosion.

6.5 EXPECTED HYDROLOGY

Due to the high water table (as described in Section 3.26) post-construction hydrology in the floodplain enhancement area is expected to result in soils saturated to the surface for the majority of the year. Standing water ranging in depth from two to six inches is expected to occur during the winter, spring, and potentially early summer months. (A north-south drainage swale will be constructed through the floodplain enhancement area to provide positive drainage from the site to avoid creating open water conditions.) Because of the high water table, dewatering may be necessary during grading activities. The contractor will be required to dewater to upland areas near the site to allow sediments to settle prior to discharging to any surface water features.

6.6 PLANTING

Final planting plans for buffer plantings and in-stream enhancements features along and within the Miller Creek riparian corridor cannot be prepared at this time since much of the proposed buffer enhancement area is located on property that has not yet been acquired by the Port. As soon as properties become available, vegetation surveys will be conducted and planting plants will be developed. However, a detailed planting plan has been developed for the buffer area around the Miller Creek relocation projects.

Three different planting zones have been identified that will require different mixtures of plant species tolerant to a variety of hydrologic and soil conditions within the enhancement areas.

Table 4. Proposed seed mix for erosion control and for upland areas.

Common Name	Scientific Name	Percent
Elka perennial ryegrass	*Lolium perenne var. Elka*	80%
Creeping red fescue	*Festuca rubra*	20%

Applications rate 50-lbs. acre.

Table 5. Proposed wetland seed mix.

Common Name	Scientific Name	Application Rate
Canada Bluegrass	*Poa compressa*	0.17
Tufted Hairgrass	*Deschampsia cespitosa*	0.70
Canada Reed	*Calamagrostis canadensis*	0.38
Western Mannagrass	*Glyceria occidentalis*	2.20
Common Rush	*Juncus effusus*	0.43
Canada Bluegrass	*Poa compressa*	0.35
Blue Wildrye	*Elymus glaucus*	5.10
Chewing Red Fescue	*Festuca rubra var. comutata*	1.74
Bentgrass	*Agrostis tenuis*	0.15

[1]Rate is pounds pure live seed per acre.

6.6.1 Planting Zones

The three planting zones identified for the Miller Creek Enhancement Projects include upland, streamside/transitional, and floodplain. The upland zones will consist of plant species with UPL, FAC-, or FAC Wetland Indicator Status (WIS). The landscape plan and contractor will integrate this planting zone with the streamside/transitional-planting zone at appropriate topographic elevations. The streamside/transitional zone will consist of species with FAC-, FAC, and FACW WIS. The streamside/transitional zone is defined as the area within 20 to 30 feet of the Ordinary High Water Mark of the creek. The floodplain planting zone will consist of species with FAC, FACW, and OBL WIS. Table 6 identifies the species within each of the planting zones, the condition of the material planted (container, bareroot, or live stakes), and approximate spacing.

A detailed planting plan has been developed for the 50-feet buffer along new Miller Creek channel (Figures 11a and 11b). Refer to Figure 12 for locations of the planting zones identified in the floodplain enhancement area and around Lora Lake. Figure 13 depicts typical planting zones along the Miller Creek Corridor (see Figures 6a and 6b). Note that new plantings will be

Table 6. Suggested plants for riparian buffer and floodplain enhancement.

Scientific Name	Common Name	Condition[1]	Approx Spacing	Upland Zone	Streamside/ Transitional Zone	Floodplain Enhancement Zone
Trees						
Alnus rubra	Red alder	Container		X	X	X
Fraxinus latifolia	Oregon ash	Container			X	X
Pseudotsuga menziesii	Douglas fir	Container		X		
Rhamnus purshiana	Cascara	Container		X		
Salix Scoulerana	Scouler willow	Bareroot/live stake	4' o.c.		X	
Populus trichocarpa	Black cottonwood	Container			X	X
Acer macrophyllum	Big-leaf maple	container	-	X		
Shrubs						
Acer circinatum	Vine maple	Container	5' o.c.	X	X	
Cornus stolonifera	Red-osier dogwood	Container	4' o.c.		X	X
Corylus cornuta	Western hazelnut	Container	6' o.c.	X		
Kalmia microphylla	Western bog laurel	Container	5' o.c.			X
Gaultheria shallon	Salal	Container (6-12")	3' o.c.	X		
Ledum groenlandicum	Labrador tea	Container	5' o.c.			X
Lonicera involucrata	Twinberry	Container	5' o.c.		X	X
Physocarpus capitatus	Pacific ninebark	Container	5' o.c.		X	X
Rosa pisocarpa	Clustered rose	Container	6' o.c.		X	
Salix sitchensis	Sitka willow	Bareroot/live stake	6'o.c.		X	X
Salix lucida	Pacific willow	Bareroot/ live stake	4' o.c.		X	X
Salix hookeriana	Hooker willow	Bareroot/ live stake	4' o.c.		X	X
Spiraea douglasii	Hardhack spiraea	Container	4' o.c.			X

[1]Plant species will range from 24 to 36 inches in height. Also, it may be appropriate to substitute the plant condition given availability and season.

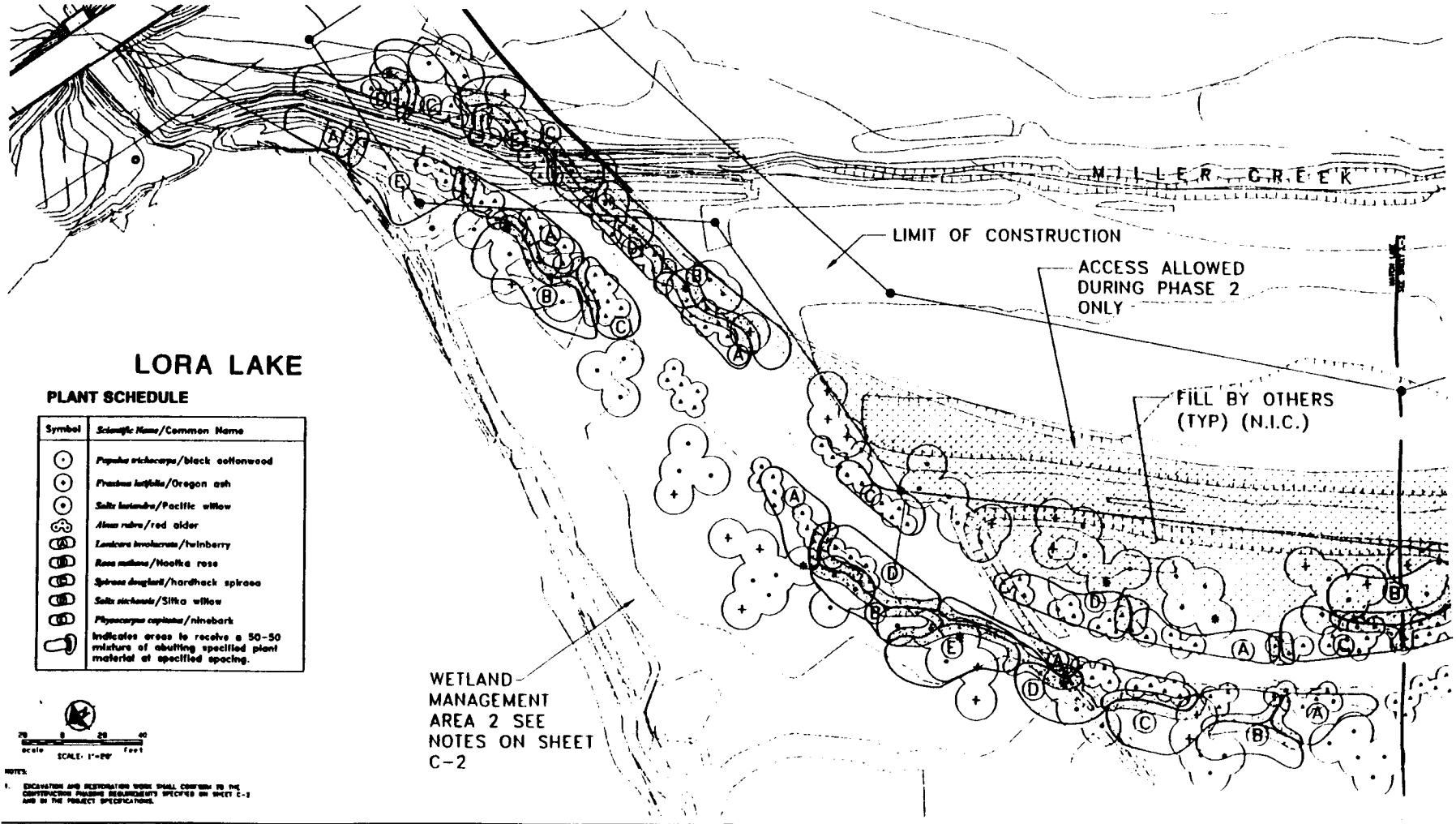


Figure 11a
Landscape Planting Plan
North Segment

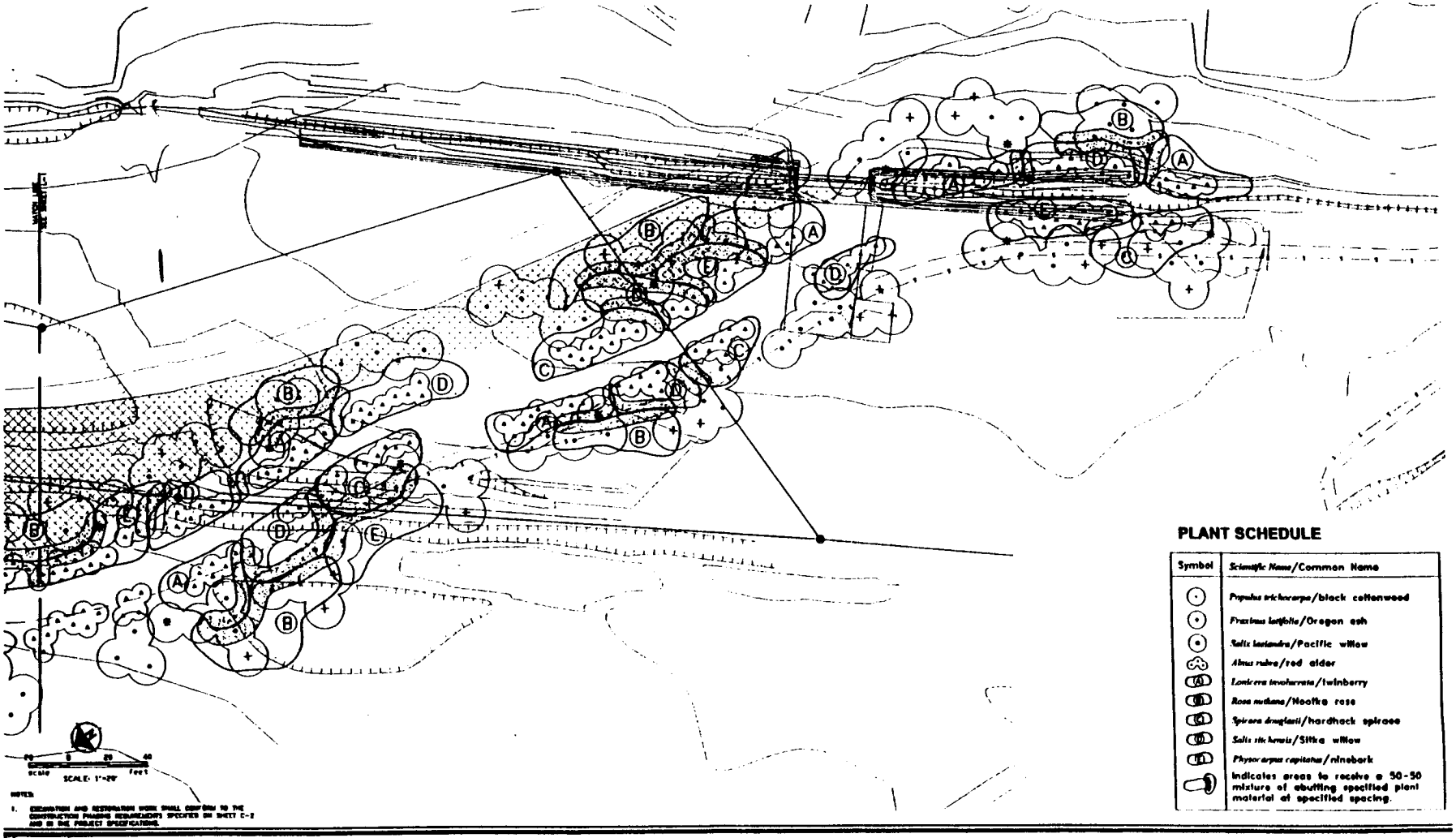


Figure 11b
Landscape Planting Plan
South Segment

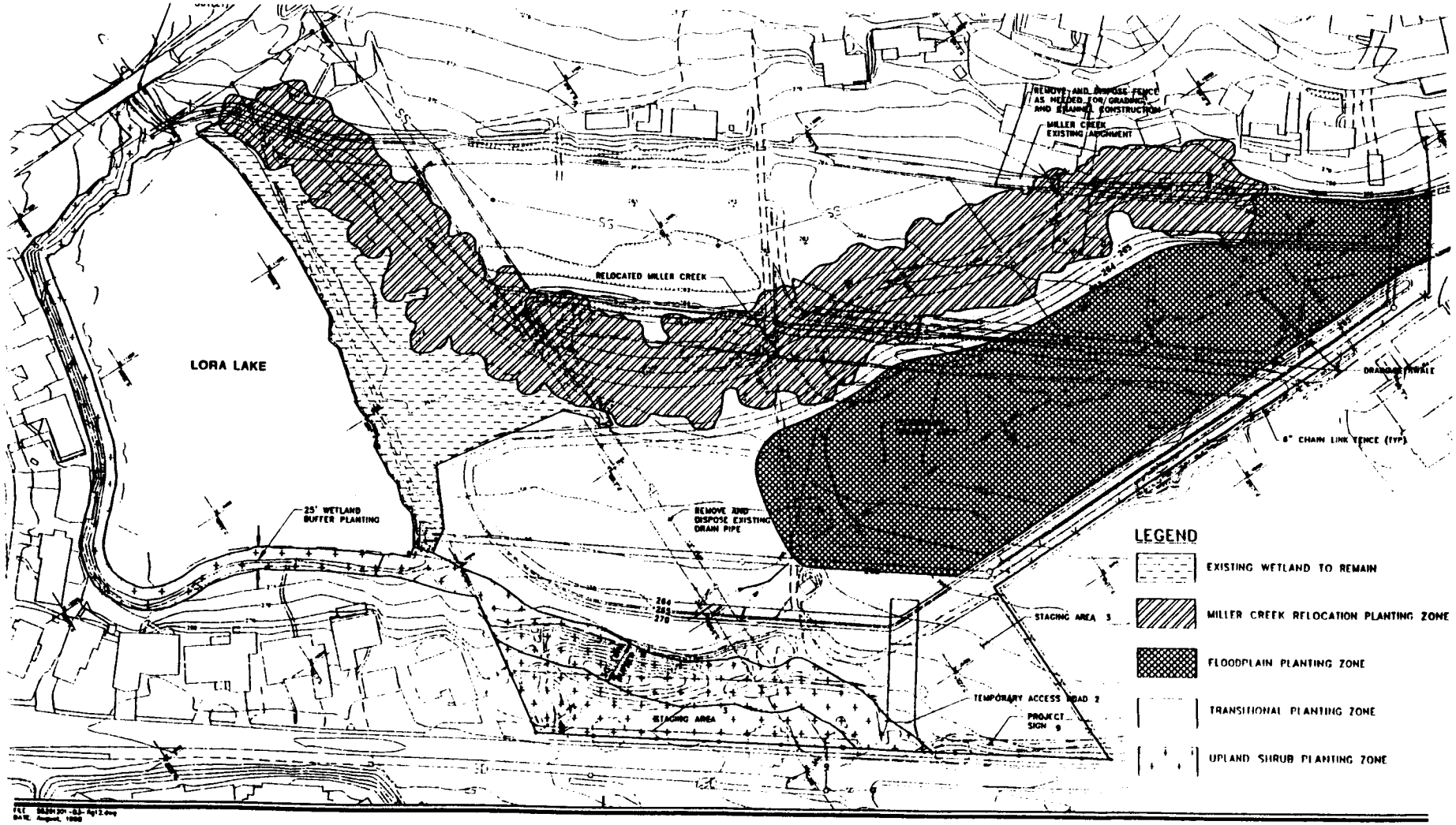
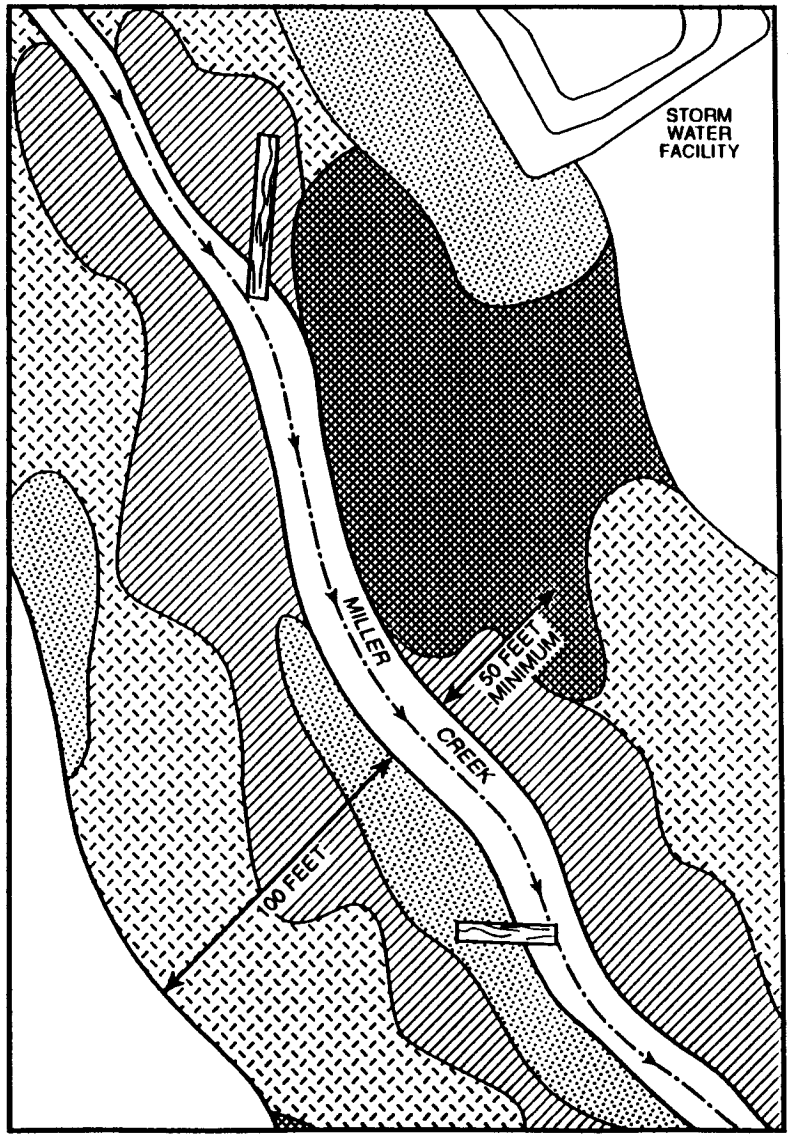


Figure 12
Planting Zones for the Miller Creek/ Lora Lake Enhancement Projects



Streamside Zone	Upland Buffer
Red Alder	Vine Maple
Oregon Ash	Hazelnut
Scouler Willow	Douglas-fir
Vine Maple	Nootka Rose
Red-osier Dogwood	Clustered Rose
Pacific Ninebark	Red Alder
Sitka Willow	Cascara
Pacific Willow	Large Woody Debris
Hooker Willow	
Hydroseed mix/ Natural Colonization	

- Stream Side Planting Zone
- Upland Buffer Zone
- Existing vegetation to remain
- Existing non-native invasive plant species to be removed and replaced

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SCALE IN FEET

0 25 50

Figure 13.
Typical Planting Plan for the Miller Creek Upland, and Streamside Buffer Planting Zones

interspersed throughout areas of existing native vegetation around Lora Lake in the Miller Creek riparian buffer area.

Prior to installing the plant material, the locations of trees and shrubs will be staked in the field by the landscape contractor. A minimum tree density of 300 stems per acre and a minimum shrub density will be between 1,000 and 2,000 stems per acre. To insure rapid development of shade along the creek, the landscape plan will concentrate plantings on the stream bank to ensure partial shading of the stream immediately following planting. Streamside plantings of fast-growing willow and red-osier dogwood (*Cornus stolonifera*) should provide substantial shade in as little as three years.

6.6.2 Planting Procedure

Planting will occur in the fall (October to November) or early spring (March or April) when soil moisture is optimal. Trees should be at least three-year old branched seedlings and at least 24 inches tall. Trees of varying heights (between approximately 24 and 48 inches) would be planted to provide height diversity and simulate a more natural condition. Shrub species throughout the buffer zones will be planted in patches to simulate natural occurrences varying from approximately 4 to 6 foot centers. Trees and shrubs would be planted at densities sufficient to attain the performance standards (see above). To reduce competition with grass species, mulch, or landscape fabric if necessary, will be placed around the base of trees and shrubs to reduce competition with existing grass species.

Sun-tolerant species such as Douglas fir, red alder, and black cottonwood 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.

To prevent girdling or damage from small or large mammal grazing, the stems of installed plant material will be painted with a mixture of pruning wax and a natural or chemical deterrent such as cayenne pepper. This mixture, or a similar substitute, is anticipated to reduce the need to replant due to animal grazing.

An aluminum tag (or other appropriate identification marker) will be affixed to all the planted trees and shrubs in order to identify planted material from naturally recruited vegetation. This will allow simple and accurate calculation of total percent survival of planted vegetation.

Permanent irrigation is not planned for the site; however, temporary irrigation will be provided during the first and second year following planting to insure success of the planted material. The Port will explore using existing water utilities within the mandatory buyout area to provide temporary irrigation. After it is determined that irrigation is not necessary, the temporary irrigation system will be removed and the water utility lines abandoned.

6.7 STREAM INVENTORY AND ENHANCEMENT

Concurrent with the plant inventory and as property access becomes available, a stream survey along approximately 3,900 linear feet of Miller creek will be conducted to identify areas within the creek channel that would benefit from installing habitat features such as root wads, gravel (if appropriate), and tree deflectors. Examples of in stream habitat features are shown in Figure 3.

In addition, during the stream inventory, areas where it is necessary to provide stream bank restoration will be identified. Examples of areas that will be restored are portions of the stream bank where severe undercutting is occurring and active erosion will cause significant downstream sedimentation. BMPs and bioengineering techniques will be implemented to repair the integrity of the stream bank.

6.8 CONSTRUCTION OVERSIGHT

Oversight during the construction of the buffer and stream enhancement will be required to ensure that the contractors are following the requirements identified in the plans and specifications identified in this report and in the final construction documents. If minor changes to the wetland design are required (as a result of new information regarding site conditions); they must be reviewed and approved by the wetland biologist prior to implementation. Any modifications that affects the ability of the completed project to meet the performance standards would be presented to the Corps in writing for approval prior to implementation.

7. MONITORING

Monitoring activities will occur before, during, and after implementing the proposed mitigation plan. During the acquisition period, quarterly inspections of demolition areas will be completed. Examination of demolition sites will confirm that all structures and debris have been removed and that vegetation identified during the inventory has been appropriately removed or retained after demolition has been completed. Site visits will occur periodically during the construction period to ensure that BMPs are properly maintained. The following sections describe monitoring schedule and activities for vegetation plantings and stream construction.

7.1 VEGETATION MONITORING

All new plantings will be monitored over a ten-year period. Monitoring activities will take place in years 1, 2, 3, 5, 7, and 10 to determine plant survival, growth, and overall condition. Hydrology in the floodplain enhancement area will also be monitored. An initial site visit will take place after planting and installation of in stream habitat features has been completed. The purpose of the initial site visit is to describe the exact number and locations of the installed planted material and number and location of in stream habitat features. Annual visits as described in Table 7 will occur in the subsequent spring/summer, following the initial visit. Timing of the first annual visit may deviate from the aforementioned schedule depending upon when the plantings are installed.

Table 7. Monitoring methods and reporting schedule for buffer and floodplain enhancement projects.

Design Objective	Performance Standard	Method	Month	Frequency
Vegetation Cover	Average plant survival of 80% from year 3 to year 10	Count live and dead plants along belt transect to provide data to calculate percent survival.	Early to mid-summer (i.e. June July)	Baseline and Years 1, 2, 3, 5, and 10
	Tree and shrub density/cover	Measure by line-intercept method and quadrants along permanent transects (Daubenmire 1959)	Early to mid-summer	Baseline and Years 5, 7, and 10
	Plant growth	Walk-through surveys to estimate annual shoot growth and survival rates	Early to mid-summer	Baseline and Years 5, 10
	Vegetation structure	Describe from walk-through surveys, incorporating data from above analysis as available	Early to mid-summer	Baseline and Years 1, 5, 7, and 10
Woody debris	Amount of woody debris per lineal ft and acre.	Count number of downed logs in buffer areas	-	As-built and year 10

Activities to be conducted during the initial site visit include inspecting the plants for overall health, recommending replacement if necessary, establishing permanent vegetation sampling locations, establishing photographic points, and determining the most appropriate vegetation and stream sampling techniques for the site. The photo points will provide a visual representation of plant

cover, species present, and general health. Vegetation sampling should occur once per year in the late spring or early summer (June, or early July).

Data collected during the annual monitoring periods will include general plant health, percent cover, percent mortality for each species. Plant survival will be calculated as percent survival. A photographic record documenting buffer conditions will also be made. Data collection procedures will include, but are not limited to, methodologies described by Canfield (1914) and Daubenmire (1959).

7.2 STREAM MONITORING

In addition to monitoring vegetation, in-stream habitat features will also be monitored to ensure that these features provide the desired fish habitat and bank stabilization. Table 8 includes the inspection schedule for monitoring the Miller Creek stream relocation and enhancement. The schedule includes routine inspections and emergency inspections, in case of a major flood.

Table 8. Monitoring schedule for Miller Creek enhancement projects.

Inspect	Frequency	Action Threshold	Action
Habitat structures	Annually (May), or after flows in excess of the 2-year peak flow	Structure displaced[1], causing erosion or collecting debris	Repair or replace[2]
Buffer Vegetation	Annually	Mortality results in less than 200 trees per acre or less than 300 shrub stems per acre	Evaluate reasons for mortality, replace plantings, and substitute with other species if appropriate.
Substrate	Semi-annually (February/August)	Winter - sediments (sand or smaller) in shallow, flowing segments or riffles Summer - Fine sediment (silt or smaller) in flowing segments or riffles	Prepare options for reducing stream bottom width (i.e., lateral logs, and boulders) if sedimentation persists for a second year.
Erosion or Scouring	Annually (May), or after 2-year storm	Bottom sediment eroded; Excessive stream bank erosion causing sloughing; Excessive habitat damage	Repair damaged creek bank (using bioengineering, techniques) and enlarge channel if damage re-occurs in the 2nd year and is deemed appropriate.
Control Structures	Annually (May), or after 2-year storm	Structural damage or failure; Obvious scouring or cavitation	Determine cause and repair
Adverse Flooding	Twice yearly (November/February)	Trapped standing or ponding water; Persistent slow drainage	Improve surface drainage paths

Note: Data compiled by Parametrix, Inc.
[1]A structure can be damaged or displaced and still provide habitat consistent with mitigation goals.
[2]The benefits of repair or replacement would be balanced against the potential impacts.

7.3 MONITORING REPORTS

A qualified landscape architect and biologist will prepare a set of as-built drawings of the buffer, stream, and floodplain enhancement areas. These drawings will establish the baseline conditions for measuring the progress of the mitigation area toward the defined goals and performance standards. The as-built drawings will establish all vegetation sampling and photographic locations for future monitoring activities. Deviations from the as-built drawings will be noted and evaluated with the U.S. Army Corps of Engineers. A brief report will be prepared that describes the as-built conditions, proposed monitoring methods, procedures for vegetation and stream monitoring, as well as the locations of permanent transects.

After a full year of monitoring has been completed, the Port will supply a copy of the annual monitoring report to the Corps and Ecology. A minimum of six reports will be produced over the ten- year monitoring period. The first report will include a description of the as-built conditions, monitoring methods, location of permanent transects, and locations of permanent photopoints. The remaining five reports will describe the results of the annual monitoring activities and any necessary maintenance or contingency planning that may be necessary. If deemed appropriate by the Corps, the number of monitoring visits and reports may be modified if the performance goals have been attained sooner than anticipated.

7.4 CONTINGENCY AND MAINTENANCE PLAN

A contingency plan will be developed if the established performance standards have not been attained. The following are examples of potential conditions where contingency planning may be necessary. For example:

- If structures or debris are found to remain within the buffer area, the Port will take action to remove them and re-grade and replant the area;
- Plant species exhibiting greater than 30% mortality within the first two years may be replaced with species of similar form and function if deemed appropriate by a qualified professional; and
- If average plant survival is less than 80% after the ten-year monitoring period, replanting those areas to attain 80% vegetative cover will be necessary.
- If topographic survey reveals inadequate floodplain storage, contingency measures will be developed.

If additional problems/issues that have not been identified in this contingency plan will be evaluated on a case-by-case basis and discussed with the Corps and Ecology to develop and implement appropriate contingency actions.

In addition, a maintenance plan will be required from the contractor under the project specifications. The maintenance plan will include weeding, maintenance of landscape fabric, maintenance of temporary irrigation system, and trash removal. This maintenance plan will occur during the first five years after installation of the planted material has been completed. Because plantings may occur in phases, as property becomes available, the maintenance plan may continue five years after

the last planting area has been completed. The landscape contractor will be responsible for the health of planted material and replacing dead or severely stressed plant material for a period of one year after initial planting.

The most important factor in the success of mitigation projects is the control of invasive plant species. Ruderal species including, but not limited to, Scot's broom, reed canarygrass, and Himalayan blackberry will be monitored and removed if vegetative cover is greater than thirty percent of the planted community or threatens the survival of the planted species. If necessary, weed control mats or landscape fabric will be placed around the base of planted material to prevent competition from invasive species. If necessary, the use of chemical means for control will be approved by the Corps and Ecology prior to implementation.

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APPENDIX B

FUNCTION AND VALUE ASSEMENT FORMS

Wetland and Buffer Functions and Semi-quantitative Performance Assessment

Wetland # Prior Converted Cropland's Staff M. Louther Date 8-98
Farmed Wetlands

Location S T R

Function	Criteria		
	Group 1 — 1 pt	Group 2 — 2 pts	Group 3 — 3 pts
Flood/ Storm Water Control points 8 (max 15) (L)	X size < 5 acres — riverine or lakeshore wetland X < 10 % forested cover X unconstrained outlet — located in lower 1/3 of the drainage	— size 5-10 acres — mid-sloped wetland — 10 - 30 % forested cover — semi-constrained outlet X located in middle 1/3 of the drainage	— size > 10 acres X depressions, headwaters, bogs,flats — > 30 % forested cover — culvert/bermed outlet — located in upper 1/3 of the drainage
Base Flow/ Ground_Water Support points 10 (max 15) (M)	X size < 5 acres — riverine or lakeshore wetland — located in lower 1/3 of the drainage — temporarily flooded or saturated — no flow-sensitive fish populations on-site or downstream	— size 5-10 acres — mid-sloped wetland X located in middle 1/3 of the drainage X seasonally or semi-permanently flooded or saturated X low flow-sensitive fish populations on-site or downstream	— size > 10 acres X depressions, headwaters, bogs,flats — located in upper 1/3 of the drainage — permanently flooded or saturated, or intermittently exposed — high flow-sensitive populations contiguous with site in highly permeable strata
Erosion/ Shoreline Protection points NA (max 9)	— sparse grass/herbs or no veg along OHWM — wetland extends < 30 m from OHWM — highly developed shoreline or subcatchment	— sparse wood or veg along OHWM — wetland extends 30 - 60 m from OHWM — moderately developed shoreline or subcatchment	— dense wood or veg along OHWM — wetland extends > 200 m from OHWM — undeveloped shoreline or subcatchment
Water Quality Improvement points 6 (max 12) (L)	X rapid flow through site X < 50 % veg cover — upstream in basin from wetland is undeveloped X holds < 25 % overland runoff	— moderate flow through site — 50 - 80 % cover — 50% of basin upstream from wetland is developed — holds 25 - 50 % overland runoff	— slow flow through site — > 80 % veg cover X > 50% of basin upstream from wetland is developed — holds > 50 % overland runoff

N/A = Not Applicable, N/I = No information available

Dominant Vegetation:

Wildlife:

PCC
FW

Wetland and Buffer Functions and Semi-quantitative Performance Assessment

Natural Biological Support points 12 5 (max 36) 30	X size < 5 acres X ag land, low veg structure X seasonal surface water NA one habitat type PAB POW PEM PSS PFO EST X low plant diversity (< 6 species) X > 50 % invasive species X low primary productivity X low organic accumulation X low organic export X few habitat features X buffers very disturbed I isolated from upland habitats	— size 5 - 10 acres — 2 level veg — permanent surface water NA two habitat types PAB POW PEM PSS PFO EST — moderate plant diversity (7-15 species) — 10 to 50 % invasive species — moderate primary productivity — moderate organic accumulation — low organic export — some habitat features — buffers slightly disturbed X partially connected to upland habitats	— size > 10 acres — high veg structure — open water pools through summer NA ≥ 3 habitat types PAB POW PEM PSS PFO EST — high plant diversity (> 15 species) — < 10% invasive species — high primary productivity — high organic accumulation — high organic export — many habitat features — buffers not disturbed — well connected to upland habitats
Overall Habitat Functions points 3 (max 9)	X size < 5 acres X low habitat diversity X low sanctuary or refuge	— size 5-10 acres — moderate habitat diversity — moderate sanctuary or refuge	— size > 10 acres — high habitat diversity — high sanctuary or refuge
Specific Habitat Functions points 5 (max 18)	X low invertebrate habitat X low amphibian habitat X low fish habitat X low mammal habitat X low bird habitat	— moderate invertebrate habitat — moderate amphibian habitat — moderate fish habitat — moderate mammal habitat — moderate bird habitat	— high invertebrate habitat — high amphibian habitat — high fish habitat — high mammal habitat — high bird habitat
Cultural/ Socioeco-nomic points 7 (max 21)	X low educational opportunities X low aesthetic value X lacks commercial fisheries, agriculture, renewable resources X lacks historical or archeological resources X lacks passive and active recreational opportunities X privately owned X not near open space	— moderate educational opportunities — moderate aesthetic value — moderate commercial fisheries, agriculture, renewable resources — historical or archeological site — some passive and active recreational opportunities — privately owned, some public access — some connection to open space	— high educational opportunities — high aesthetic value — high commercial fisheries, agriculture, renewable resources — important historical or archeological site — many passive and active recreational opportunities — unrestricted public access — directly connected to open space

Notes:

Wetland and Buffer Functions and Semi-quantitative Performance Assessment

Wetland # Forested wetland Staff M. Louthur Date 8-98

Location S T R

Function	Criteria		
	Group 1 — 1 pt	Group 2 — 2 pts	Group 3 — 3 pts
Flood/ Storm Water Control points 8 (max 15) (L)	X size < 5 acres X riverine or lakeshore wetland — < 10 % forested cover X unconstrained outlet — located in lower 1/3 of the drainage	— size 5-10 acres — mid-sloped wetland — 10 - 30 % forested cover — semi-constrained outlet X located in middle 1/3 of the drainage	— size > 10 acres — depressions, headwaters, bogs, flats X > 30 % forested cover — culvert/bermed outlet — located in upper 1/3 of the drainage
Base Flow/ Ground_Water Support points 8 (max 15) (M)	X size < 5 acres X riverine or lakeshore wetland — located in lower 1/3 of the drainage — temporary flooded or saturated — no flow-sensitive fish populations on-site or downstream	— size 5-10 acres — mid-sloped wetland X located in middle 1/3 of the drainage X seasonally or semi-permanently flooded or saturated X low flow-sensitive fish populations on-site or downstream	— size > 10 acres — depressions, headwaters, bogs, flats — located in upper 1/3 of the drainage — permanently flooded or saturated, or intermittently exposed — high flow-sensitive populations contiguous with site in highly permeable strata
Erosion/ Shoreline Protection points 5 (max 9) (M)	— sparse grass/herbs or no veg along OHWM — wetland extends < 30 m from OHWM X highly developed shoreline or subcatchment	X sparse wood or veg along OHWM X wetland extends 30 - 60 m from OHWM — moderately developed shoreline or subcatchment	— dense wood or veg along OHWM — wetland extends > 200 m from OHWM — undeveloped shoreline or subcatchment
Water Quality Improvement points 9 (max 12) (M)	— rapid flow through site — < 50 % veg cover — upstream in basin from wetland is undeveloped X holds < 25 % overland runoff	X moderate flow through site — 50 - 80 % cover — ≥ 50% of basin upstream from wetland is developed — holds 25 - 50 % overland runoff	— slow flow through site X > 80 % veg cover X > 50% of basin upstream from wetland is developed — holds > 50 % overland runoff

N/A = Not Appicable, N/I = No information available

Dominant Vegetation:

Wildlife:

Wetland and Buffer Functions and Semi-quantitative Performance Assessment

PFO

Natural Biological Support points 21 (max 36) (M)	X size < 5 acres ag land, low veg structure X seasonal surface water X one habitat type PAB POW PEM PSS PFO EST — low plant diversity (< 6 species) — > 50 % invasive species — low primary productivity — low organic accumulation — low organic export — few habitat features — buffers very disturbed — isolated from upland habitats	— size 5 - 10 acres X 2 level veg — permanent surface water — two habitat types PAB POW PEM PSS PFO EST X moderate plant diversity (7-15 species) X 10 to 50 % invasive species X moderate primary productivity X moderate organic accumulation X low organic export X some habitat features X buffers slightly disturbed X partially connected to upland habitats	— size > 10 acres — high veg structure — open water pools through summer — ≥ 3 habitat types PAB POW PEM PSS PFO EST — high plant diversity (> 15 species) — < 10% invasive species — high primary productivity — high organic accumulation — high organic export — many habitat features — buffers not disturbed — well connected to upland habitats
Overall Habitat Functions points 5 (max 9) (M)	X size < 5 acres — low habitat diversity — low sanctuary or refuge	— size 5-10 acres X moderate habitat diversity X moderate sanctuary or refuge	— size > 10 acres — high habitat diversity — high sanctuary or refuge
Specific Habitat Functions points 6 (max 16) (M)	— low invertebrate habitat — low amphibian habitat X low fish habitat X low mammal habitat — low bird habitat	X moderate invertebrate habitat X moderate amphibian habitat — moderate fish habitat — moderate mammal habitat X moderate bird habitat	— high invertebrate habitat — high amphibian habitat — high fish habitat — high mammal habitat — high bird habitat
Cultural/ Socioeconomic points 8 (max 21) (L)	X low educational opportunities low aesthetic value X lacks commercial fisheries, agriculture, renewable resources X lacks historical or archeological resources X lacks passive and active recreational opportunities X privately owned X not near open space	X moderate educational opportunities X moderate aesthetic value — moderate commercial fisheries, agriculture, renewable resources — historical or archeological site — some passive and active recreational opportunities — privately owned, some public access — some connection to open space	— high educational opportunities — high aesthetic value — high commercial fisheries, agriculture, renewable resources — important historical or archeological site — many passive and active recreational opportunities — unrestricted public access — directly connected to open space

Notes:

Wetland and Buffer Functions and Semi-quantitative Performance Assessment

Wetland # Scrub-Shrub Staff M. Lowther Date 8-98

Location S T R

Function	Criteria		
	Group 1 — 1 pt	Group 2 — 2 pts	Group 3 — 3 pts
Flood/ Storm Water Control points 6 (max 15) (L)	X size < 5 acres X riverine or lakeshore wetland X < 10 % forested cover X unconstrained outlet — located in lower 1/3 of the drainage	— size 5-10 acres — mid-sloped wetland — 10 - 30 % forested cover — semi-constrained outlet X located in middle 1/3 of the drainage	— size > 10 acres — depressions, headwaters, bogs,flats — > 30 % forested cover — culvert/bermed outlet — located in upper 1/3 of the drainage
Base Flow/ Ground Water Support points 8 (max 15) (M)	X size < 5 acres X riverine or lakeshore wetland — located in lower 1/3 of the drainage — temporarily flooded or saturated — no flow-sensitive fish populations on-site or downstream	— size 5-10 acres — mid-sloped wetland X located in middle 1/3 of the drainage X seasonally or semi-permanently flooded or saturated X low flow-sensitive fish populations on-site or downstream	— size > 10 acres — depressions, headwaters, bogs,flats — located in upper 1/3 of the drainage — permanently flooded or saturated, or intermittently exposed — high flow-sensitive populations contiguous with site in highly permeable strata
Erosion/ Shoreline Protection points NA (max 9)	— sparse grass/herbs or no veg along OHWM — wetland extends < 30 m from OHWM — highly developed shoreline or subcatchment	— sparse wood or veg along OHWM — wetland extends 30 - 60 m from OHWM — moderately developed shoreline or subcatchment	— dense wood or veg along OHWM — wetland extends > 200 m from OHWM — undeveloped shoreline or subcatchment
Water Quality Improvement points — (max 12)	— rapid flow through site — < 50 % veg cover — upstream in basin from wetland is undeveloped X holds < 25 % overland runoff	X moderate flow through site X 50 - 80 % cover — ≤ 50% of basin upstream from wetland is developed — holds 25 - 50 % overland runoff	— slow flow through site — > 80 % veg cover X > 50% of basin upstream from wetland is developed — holds > 50 % overland runoff

N/A = Not Applicable, N/I = No information available

Dominant Vegetation:

Wildlife:

PSS

Wetland and Buffer Functions and Semi-quantitative Performance Assessment

Natural Biological Support points 12 (max 36) (L)	X size < 5 acres X ag land, low veg structure X seasonal surface water X one habitat type PAB POW PEM PSS PFO EST X low plant diversity (< 6 species) X > 50 % invasive species X low primary productivity X low organic accumulation X low organic export X few habitat features X buffers very disturbed X isolated from upland habitats	— size 5 - 10 acres — 2 level veg — permanent surface water — two habitat types PAB POW PEM PSS PFO EST — moderate plant diversity (7-15 species) — 10 to 50 % invasive species — moderate primary productivity — moderate organic accumulation — low organic export — some habitat features — buffers slightly disturbed — partially connected to upland habitats	— size > 10 acres — high veg structure — open water pools through summer — ≥ 3 habitat types PAB POW PEM PSS PFO EST — high plant diversity (> 15 species) — < 10% invasive species — high primary productivity — high organic accumulation — high organic export — many habitat features — buffers not disturbed — well connected to upland habitats
Overall Habitat Functions points 3 (max 9) (L)	X size < 5 acres X low habitat diversity X low sanctuary or refuge	— size 5-10 acres — moderate habitat diversity — moderate sanctuary or refuge	— size > 10 acres — high habitat diversity — high sanctuary or refuge
Specific Habitat Functions points 5 (max 15) (L)	X low invertebrate habitat X low amphibian habitat X low fish habitat X low mammal habitat X low bird habitat	— moderate invertebrate habitat — moderate amphibian habitat — moderate fish habitat — moderate mammal habitat — moderate bird habitat	— high invertebrate habitat — high amphibian habitat — high fish habitat — high mammal habitat — high bird habitat
Cultural/ Socioeco-nomic points 8 (max 21) (L)	X low educational opportunities — low aesthetic value X lacks commercial fisheries, agriculture, renewable resources X lacks historical or archeological resources X lacks passive and active recreational opportunities X privately owned X not near open space	— moderate educational opportunities X moderate /aesthetic value — moderate commercial fisheries, agriculture, renewable resources — historical or archeological site — some passive and active recreational opportunities — privately owned, some public access — some connection to open space	— high educational opportunities — high aesthetic value — high commercial fisheries, agriculture, renewable resources — important historical or archeological site — many passive and active recreational opportunities — unrestricted public access — directly connected to open space

Notes:

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Wetland and Buffer Functions and Semi-quantitative Performance Assessment

Wetland # Emergent Staff M. Louthur Date 8-98

Location S T R

Function	Criteria		
	Group 1 — 1 pt	Group 2 — 2 pts	Group 3 — 3 pts
Flood/ Storm Water Control points 8 (max 15) (L)	X size < 5 acres — riverine or lakeshore wetland X < 10 % forested cover X unconstrained outlet — located in lower 1/3 of the drainage	— size 5-10 acres — mid-sloped wetland — 10 - 30 % forested cover — semi-constrained outlet X located in middle 1/3 of the drainage	— size > 10 acres X depressions, headwaters, bogs,flats — > 30 % forested cover — culvert/bermed outlet — located in upper 1/3 of the drainage
Base Flow/ Ground_Water Support points 10 (max 15) (M)	X size < 5 acres — riverine or lakeshore wetland — located in lower 1/3 of the drainage — temporarily flooded or saturated — no flow-sensitive fish populations on-site or downstream	— size 5-10 acres — mid-sloped wetland X located in middle 1/3 of the drainage X seasonally or semi-permanently flooded or saturated X low flow-sensitive fish populations on-site or downstream	— size > 10 acres X depressions, headwaters, bogs,flats — located in upper 1/3 of the drainage — permanently flooded or saturated, or intermittently exposed — high flow-sensitive populations contiguous with site in highly permeable strata
Erosion/ Shoreline Protection points NA (max 9)	— sparse grass/herbs or no veg along OHWM — wetland extends < 30 m from OHWM — highly developed shoreline or subcatchment	— sparse wood or veg along OHWM — wetland extends 30 - 60 m from OHWM — moderately developed shoreline or subcatchment	— dense wood or veg along OHWM — wetland extends > 200 m from OHWM — undeveloped shoreline or subcatchment
Water Quality Improvement points 5 (max 12) (L)	X rapid flow through site X < 50 % veg cover — upstream in basin from wetland is undeveloped X holds < 25 % overland runoff	— moderate flow through site — 50 - 80 % cover X 50% of basin upstream from wetland is developed — holds 25 - 50 % overland runoff	— slow flow through site — > 80 % veg cover — > 50% of basin upstream from wetland is developed — holds > 50 % overland runoff

N/A = Not Applicable, N/I = No information available

Dominant Vegetation:

Wildlife:

Wetland and Buffer Functions and Semi-quantitative Performance Assessment PEM

Natural Biological Support points 12 (max 36) L	X size < 5 acres X ag land, low veg structure X seasonal surface water X one habitat type PAB POW PEM PSS PFO EST X low plant diversity (< 6 species) X > 50 % invasive species X low primary productivity X low organic accumulation X low organic export X few habitat features X buffers very disturbed X isolated from upland habitats	— size 5 - 10 acres — 2 level veg — permanent surface water — two habitat types PAB POW PEM PSS PFO EST — moderate plant diversity (7-15 species) — 10 to 50 % invasive species — moderate primary productivity — moderate organic accumulation — low organic export — some habitat features — buffers slightly disturbed — partially connected to upland habitats	— size > 10 acres — high veg structure — open water pools through summer — ≥ 3 habitat types PAB POW PEM PSS PFO EST — high plant diversity (> 15 species) — < 10% invasive species — high primary productivity — high organic accumulation — high organic export — many habitat features — buffers not disturbed — well connected to upland habitats
Overall Habitat Functions points 3 (max 9) L	X size < 5 acres X low habitat diversity X low sanctuary or refuge	— size 5-10 acres — moderate habitat diversity — moderate sanctuary or refuge	— size > 10 acres — high habitat diversity — high sanctuary or refuge
Specific Habitat Functions points 2 (max 15) L	X low invertebrate habitat X low amphibian habitat X low fish habitat X low mammal habitat X low bird habitat	— moderate invertebrate habitat — moderate amphibian habitat — moderate fish habitat — moderate mammal habitat — moderate bird habitat	— high invertebrate habitat — high amphibian habitat — high fish habitat — high mammal habitat — high bird habitat
Cultural/ Socioeco-nomic points 1 (max 21) L	X low educational opportunities X low aesthetic value X lacks commercial fisheries, agriculture, renewable resources X lacks historical or archeological resources X lacks passive and active recreational opportunities X privately owned X not near open space	— moderate educational opportunities — moderate Aesthetic value — moderate commercial fisheries, agriculture, renewable resources — historical or archeological site — some passive and active recreational opportunities — privately owned, some public access — some connection to open space	— high educational opportunities — high aesthetic value — high commercial fisheries, agriculture, renewable resources — important historical or archeological site — many passive and active recreational opportunities — unrestricted public access — directly connected to open space

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