Biological Assessment

Master Plan Update Improvements
Seattle-Tacoma International Airport

Federal Aviation Administration

Port of Seattle

June 2000

Parametrix, Inc.

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BIOLOGICAL ASSESSMENT FOR THE REINITIATION AND INITATION OF CONSULTATION FOR CERTAIN MASTER PLAN UPDATE IMPROVEMENTS AND RELATED ACTIONS

BIOLOGICAL ASSESSMENT
MASTER PLAN UPDATE IMPROVEMENTS

SEATTLE-TACOMA INTERNATIONAL AIRPORT

Prepared for

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LIST OF ACRONYMS AND ABBREVIATIONS

Abbreviation/Acronym	Complete Word, Phrase, or Formal Name
ac	Acres
ACOE	United States Army Corps of Engineers
ADAF	Anti-De-icing and Anti-Icing Fluids
ADAF	All known available and reasonable treatments
AMA	Aircraft Movement Area
ARFF	Airport Rescue and Fire Fighting
ASDE	Airport Surface Detection Equipment
ASR	Airport Surveillance Radar
BA	Biological Assessment
B-IBI	Benthic Index of Biotic Integrity
BMPs	Best Management Practices
BOD	Biochemical Oxygen Demand
cfs	Cubic ft per second
CMA	Calcium magnesium acetate
CPS	Coastal Pelagic Species
CWA	Clean Water Act
cy	Cubic yard
DO	Dissolved oxygen
DPS	Distinct population segments
Ecology	Washington State Department of Ecology
EFH	Essential Fish Habitat
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FAA	Federal Aviation Administration
FEIS	Final Environmental Impact Statement
FSEIS	Final Supplemental Environmental Impact Statement
FHWA	Federal Highway Administration
HSPF	Hydrological Simulation Program – Fortran
IFR	Instrument Flight Route
IWS	Industrial Wastewater System
IWTP	Industrial Wastewater Treatment Plant
KA	Potassium Acetate
LWD	Large Woody Debris
MCDF	Miller Creek Detention Facility
mi	Miles

LIST OF ACRONYMS AND ABBREVIATIONS

Abbreviation/Acronym	Complete Word, Phrase, or Formal Name
MLLW	Mean Lower Low Water
MPU	Master Plan Update
NAVAIDS	Navigational Aids
NEPL	North Employees' Parking Lot
NMFS	National Marine Fisheries Service
NPDES	National Pollution Discharge Elimination System
NTU	Nephelometric Turbidity Unit
OHWM	Ordinary High Water Mark
PFCs	Passenger Facility Charges
PGIS	Pollution Generating Impervious Surface
Port	Port of Seattle
PSHA	Probabilistic Seismic Hazard Assessment
RDF	Regional Detention Facility
ROD	Record of Decision
RM	River Mile
RSA	Runway Safety Areas
SASA	South Aviation Support Area
SDS	Stormwater Drainage System
SMP	Stormwater Management Plan
SR	State Route
STEP	South Terminal Expansion Project
STIA	Seattle-Tacoma International Airport
STS	Satellite Transit Shuttle
SWPPP	Stormwater Pollution Prevention Plans
TESC	Temporary Erosion and Sedimentation Control
TPH	Total Petroleum Hydrocarbon
TRACON	Terminal Radar Approach Control
USFWS	United States Fish and Wildlife Services
USGS	United States Geological Survey
VFR	Visual Flight Rule
WDFW	Washington Department of Fish and Wildlife
WET	Whole Effluent Testing
WM	Willamette Meridian
WSDOT	Washington State Department of Transportation

EXECUTIVE SUMMARY

This Biological Assessment (BA) is prepared for reinitiation and initiation of consultation by the Federal Aviation Administration (FAA)[1] and initiation of consultation by the U.S. Army Corps of Engineers (ACOE) with the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) (the Services) under Section 7 of the Endangered Species Act (ESA). Section 7(a)(2) of the ESA requires federal agencies to ensure, in consultation with the Services, that their actions do not jeopardize listed species or adversely modify their designated critical habitat. To fulfill the requirements of Section 7, action agencies must reinitiate (or initiate) consultation if new species are listed or critical habitat designated that may be affected by a discretionary agency action. See 50 C.F.R. § 402.16; 50 C.F.R. §402.03. As discussed below, recent listings of salmonids by the Services serve as the basis for this ESA Section 7 consultation.

Section 305(b) of the Magnuson-Stevens Act and associated implementing regulations provide that Federal agencies must consult with NMFS concerning all actions that may adversely affect designated essential fish habitat (EFH). NMFS EFH guidance documents provide that EFH consultations should be combined with ESA consultations to accommodate the substantive requirements of both Acts. Therefore, the enclosed BA analyzes the effects of FAA and ACOE actions on designated EFH.

On July 3, 1997, FAA issued a record of decision (ROD) for approving Master Plan Updates (MPU) development actions that were adopted by the Port of Seattle (Port) on August 1, 1996, as amended on May 27, 1997. These actions were necessary for FAA to provide support for: (1) a new 8,500 ft dependent air carrier runway; (2) a 600-foot extension of runway 34R; (3) extend runway safety areas to meet FAA standards; and (4) for various landside MPU improvements scheduled to be completed through the year 2010. FAA is presently consulting with the Services over construction of navigation aids, future grants, and grants issued since May 24, 1999 related to implementation of certain Seattle-Tacoma International Airport MPU (STIA) improvements. This consultation also covers FAA's future approval of certain passenger facility charges (PFCs) for collection and use authorizations related to implementation of MPU improvements.

The ROD was based on a multi-year environmental process which included a February 1996 Final Environmental Impact Statement (FEIS) and a May 1997 Supplemental EIS (SEIS) prepared for the MPU development project. A BA was prepared in support of the ROD, which analyzed the effects of relevant MPU actions on the bald eagle and the peregrine falcon. That BA concluded that the proposed actions were not likely to adversely affect the species. FWS concurred with that determination.

On March 24, 1999, and November 1, 1999, respectively, the Services listed Puget Sound chinook salmon and Puget Sound bull trout. The FAA is now reinitiating and initiating formal consultation with the Services for these species over certain actions for which it possesses discretionary

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[1] In accordance with applicable regulations, the FAA designated the Port of Seattle as its non-Federal representative for the purposes of preparing this biological assessment. See 50 C.F.R. § 402.08.

involvement or control. Through this BA the ACOE also initiates formal consultation with the Services concerning its approval of a Clean Water Act (CWA) Section 404 permit application pertaining to the STIA MPU improvements.

The STIA MPU improvements are necessitated by the growing inability of the airport to efficiently support existing and future regional air travel demands. Airport activity is expected to increase as a result of regional population growth, regardless of these proposed improvements. MPU improvements, which are intended to reduce delays in aircraft operations, include upgrading the roadway system, terminal space, gates, cargo, and freight processing space to improve efficiency, reduce congestion, and improve the quality of service provided to the community.

This BA concludes that the proposed FAA and ACOE actions: (1) "may affect" but are "not likely to adversely affect" bald eagles, Puget Sound chinook salmon, and Puget Sound bull trout; (2) "may affect" but are "not likely to destroy or adversely modify" designated critical habitat of chinook salmon; (3) within the range of expected circumstances, will have "no effect" on marbled murrelet or its designated critical habitat; and (4) will not adversely affect designated pelagic or west coast groundfish EFH.

LISTED SPECIES ADDRESSED

Consultation with the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) identified the endangered peregrine falcon (*Falco peregrinus*), threatened bald eagle (*Haliaeetus leucocephalus*), and threatened Coastal/Puget Sound bull trout (*Salvelinus confluentus*) as potentially occurring near the project. Subsequently, peregrine falcons were delisted on August 25, 1999, and thus are not addressed further in this report. Marbled murrelet (*Brachyramphus marmoratus*) were reported to the ACOE as occurring in the project area in November 1999. In December 1999, and dates thereafter, the potential presence of marbled murrelets in the action area was discussed with USFWS and it was concluded they would be addressed in a revised BA.

NMFS identified Puget Sound chinook salmon (*Oncorhynchus tshawytscha*), a threatened species, as also occurring in the project vicinity. NMFS has also designated critical habitat for Puget Sound chinook salmon in the project vicinity.

PROPOSED ACTION

Implementing the STIA MPU will involve the construction of runways, taxiways, borrow areas, runway safety areas (RSAs), FAA and navigation aids (e.g., the new Airport Traffic Control Tower, airport surveillance radar [ASR], and airport surface detection equipment [ASDE]), airfield building improvements, terminal and air cargo area improvements, roads, parking, the South Aviation Support Area (SASA), stormwater management facilities and the Industrial Wastewater System (IWS) facilities. Implementation of the STIA MPU also involves acquisition and demolition of certain structures and soundproofing others together with relocation and transaction assistances. At this time, FAA is consulting over construction of the FAA control tower and navigation aids, future grants, and grants issued since May 24, 1999 related to implementation of certain STIA MPU improvements, and approval of certain as yet unapproved passenger facility charges (PFC) for collection and use authorizations related to implementation of MPU improvements. Included in the proposed action will also be the relocation of Miller Creek, the development of avian habitat at a mitigation site near the Green River in Auburn, and certain other actions for which a CWA Section

404 permit is required from ACOE. The "action area" for this proposed action was determined to be the area of the airport project construction and vicinity where direct, indirect, or cumulative effects could reasonably be expected to occur (i.e., the aquatic habitat of Miller, Des Moines, and Walker creeks downstream of the airport and the associated nearshore estuary, and the IWS Puget Sound outfall).[2] The Auburn wetland mitigation site and vicinity, where indirect or cumulative effects could reasonably occur, are also included in the action area.

WATER AND FISH RESOURCES

Potential effects of the proposed MPU were evaluated in the BA by first considering the water and fish resources (critical habitat) present in the identified action area. Two primary hydrologic systems are located in the action area—Miller Creek Basin and Des Moines Creek Basin. Additionally, the Auburn Wetland Mitigation site is located within the Green/Duwamish Watershed. The Miller Creek watershed drains approximately 8 mi^2 of predominantly urban area, mostly within the cities of Burien and SeaTac, and provides habitat for coho salmon (*O. Kisutch*), threespine stickleback (*Gasteroseus aculeatus*), pumpkinseed sunfish (*Lepomis gibbosus*), black crappie (*Pomoxis nigromaculatus*), and cutthroat trout (*O. clarki*). Walker Creek, a tributary of Miller Creek, joins this creek approximately 300 ft upstream from the mouth. A highly urbanized watershed that is estimated to be 23 to 49.4 percent impervious surface, the Miller Creek basin has undergone extensive alteration. The result is that the riparian and stream habitats available for fish use are degraded.

The Des Moines Creek watershed covers about 5.8 mi^2 of predominantly residential, commercial, and industrial area lying within the cities of SeaTac and Des Moines, and a small area of unincorporated King County. The native salmonids present in parts of Des Moines Creek include chum (*O. keta*) and coho salmon, cutthroat and steelhead (*O. mykiss*) trout as well as the non-native warmwater fish species pumpkinseed sunfish (*Lepomis gibbosus*) and largemouth bass (*Micropterus salmoides*). The approximate area of impervious surface in the Des Moines Creek basin is estimated to range from 32 to 49 percent. Overall, urbanization has degraded the aquatic habitats in Des Moines Creek.

The Green River watershed comprises some 482 mi^2. Of the more than 30 fish species identified in the Green River basin, eight are anadromous salmonids, including chinook salmon, coho salmon, sockeye salmon (*O. nerka*), chum salmon, pink salmon (*O. gorbuscha*), steelhead, coastal cutthroat trout, and bull trout (*Salvelinus confluentus*). Within this watershed, a 67-acre (ac) parcel of land west of the Green River in the City of Auburn has been chosen to provide off-site wetland habitat mitigation by creating in-kind replacement of wetland habitat functions, primarily for avian species. Additionally, overwintering bald eagles use the Green River for foraging, and may perch in trees located 300 ft from the mitigation site.

Natural and hatchery populations of chinook salmon are currently found in the Green/Duwamish River watershed, the Puyallup River watershed, and in the marine areas adjacent to the mouths of Miller and Des Moines creeks. Recent spawning surveys of Miller, Walker, and Des Moines creeks

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[2] A water tower will be constructed in the Outfall 012 and 013 subbasins that drain to Gilliam Creek and the Green River. This project will redevelop existing impervious surfaces and have no impact on Gilliam Creek or the Green River, as discussed in the BA.

have not observed any use of these creeks by chinook salmon. Additionally, there is no evidence to support the historical use of these creeks by chinook for spawning or rearing.

The freshwater portions of both Miller and Des Moines creeks do not contain essential critical habitat features; rather, such features are limited to the estuary areas of both creeks. While parts of both creeks are accessible to these fish, there is no documented historical use of either creek by chinook salmon. Additionally, the general features (habitat flow regime and morphology) are not conducive to chinook use for spawning or rearing. Critical habitat for chinook salmon is restricted to the mouths of Miller and Des Moines creeks where salinities would support use of this species in its marine life-stages. Outmigrating juveniles that have completed their osmotic adjustment to marine salinities (i.e., smoltification) do not return to freshwater during the first year. Similarly, returning adults do not enter freshwater until they reach their natal stream for spawning. Future use of the streams by chinook (i.e., through straying from other basins) is unlikely and not expected. This is because the overall characteristics of these basins, including spawning substrate accumulations and particle sizes, stream width, and hydraulic conditions appear inadequate to support chinook on a long-term basis, even under restored conditions. Consequently, fish migrating in Puget Sound and passing the mouths of Miller and Des Moines creeks will use only the creek estuaries for feeding and resting.

The Green River, adjacent to the Auburn wetland mitigation site is critical habitat for chinook salmon. At this location, the river is a migration corridor for adult salmon returning to spawn in the fall, and for juvenile chinook out-migrating to Puget Sound during the spring months. During fall and early winter months, salmon would undergo intragravel development. During winter and spring months, juvenile salmon would be expected to rear in the area.

Although the USFWS has not defined critical habitat for bull trout, analysis of the needs for this fish indicate that it is highly unlikely that Miller and Des Moines creeks provide the habitat features required, other then estuary habitat for anadromous adult and semi-adult bull trout that may be present in Puget Sound. These creeks do not meet this species' cold water temperature requirements.

WILDLIFE RESOURCES

Bald eagles, which are present in the action area, have established nesting sites and foraging perches in these areas that could be potentially affected through various disturbances. Overall, construction and operation of the airport during and after implementation of the MPU improvements are not expected to adversely effect bald eagles. Additionally, construction of the Auburn Wetland Mitigation site is anticipated to provide habitat to waterfowl (eagle prey), and thus provide potential benefit to wintering eagles nests or forage sites. Consequently, an overall determination for the STIA MPU improvements project was made that this project "may affect," but is "not likely to adversely affect" bald eagles (Table E-1).

Marbled murrelets are much less likely to be present in the action area, but they have been observed in Puget Sound (greater than 1.5 miles from proposed construction). Designated critical habitat for marbled murrelets (old growth forest) does not exist in the project vicinity. Given the rarity of marbled murrelets in adjacent marine waters, as well as the distance between STIA and these marine waters, the water quality benefits to be derived from the STIA MPU, the absence of marbled murrelet designated critical habitat in the action area, and the very low probability of an aircraft striking a murrelet, the project was determined to have "no effect" on marbled murrelets or its critical habitat (Table E-1).

Table E-1. Summary effect determinations for wildlife species.

Common and *Scientific name*	ESA Status	Life Stages Considered	Critical Habitat	Effects Determination
Bald eagle *Haliaeetus leucocephalus*	T	Nesting and wintering	Not identified	May affect, not likely to adversely affect
Marbled Murrelets *Brachyramphus marmoratus*	T	Nesting and foraging	None present	No effect

T = threatened

WATER QUALITY IMPACTS AND MITIGATION

Potential water quality impacts to Miller and Des Moines creeks, resulting from construction and operation of MPU improvement projects and associated mitigation actions, include construction sedimentation, as well as sediment and erosion control practices that themselves may result in potential impacts (e.g., changes in stream temperature and pH, release of flocculation agents, and changes in base and peak flows). Potential water quality impacts in the proposed MPU action area related to operations include changes in storm water quality and quantity associated with increased impervious surfaces, airport anti-icing and de-icing operations, application of nutrients and pesticides to landscape management areas, as well as hydrology changes in hydrology affecting Miller and Des Moines creeks.

Operations at STIA following implementation of the MPU projects could affect water quality through the discharge of conventional pollutants and chemicals used in ground and aircraft de-icing to adjacent creeks, and the discharge of these same chemicals to the Puget Sound in IWS effluent. Overall, the MPU improvements will result in a greater volume of stormwater undergoing detention and treatment. This will be accomplished through retrofitting areas currently inside and outside of the project area as these improvement projects are completed as well as detaining and treating all stormwater associated with new impervious surface. An additional result of the retrofitting will be reductions in copper and zinc currently discharged to Miller, Walker, and Des Moines creeks through the collection and routing of stormwater to the IWS system that currently goes to these creeks. The concentrations of zinc and copper in this stormwater will be either unchanged from existing baseline conditions or lower than stormwater currently discharged from areas lacking water quality treatment. Therefore, the proposed actions will not increase the exposure of chinook salmon or bull trout to copper or zinc attributable to the MPU improvement projects at the mouths of Miller or Des Moines Creeks. Similarly, in the unlikely event that either adult chinook salmon or bull trout could wander into these creeks, the proposed action will not increase their exposure to zinc and copper. Additionally, chinook critical habitat present at the mouths of Miller and Des Moines creeks will not be adversely affected by any changes in water quality related to MPU project construction or operations.

Analysis of aircraft anti-icing and de-icing fluids (ADAFs) used at STIA as well as the projected loadings of copper and zinc to stormwater and IWS effluent indicate that the concentrations of these chemicals will not significantly impact either chinook salmon or bull trout or at the IWS outfall or these fish or chinook critical habitat present at the mouths of Miller and Des Moines creeks. For example. this analysis found that all types of ADAFs used at STIA are present at maximum concentrations in stormwater or IWS effluent at least seven times below their relevant toxicity thresholds to chinook salmon or bull trout. Similar comparisons of relevant toxicity thresholds to the predicted amounts for zinc at the IWS outfall indicates that these concentrations are 4 to 64 times below the LC50 value for chinook and 20 to 300 times below the LC_{50} value for bull trout for the time periods assessed. Copper concentrations in the vicinity of the outfall are predicted to be between 1.4 and 21 times below the chinook LC50 and 4 to 55 times below the bull trout LC50.

None of the predicted concentrations of zinc or copper at the mouths of Miller and Des Moines creeks for these exposure periods will result in any significant adverse effects on chinook salmon or bull trout or their critical habitat over the 49 years that were modeled. This conclusion is based on these observations: (1) zinc concentrations in each exposure location are always below the adverse affects level; (2) copper concentrations at the mouths of Miller and Des Moines creeks are always below the brook trout[3] copper toxicity value, (3) copper concentrations for exposure durations relevant to the toxicity tests used to develop these toxicity values (96 hours or more) are significantly below the chinook copper toxicity values; (4) copper concentrations at the Midway Sewer District Outfall 10 meters or more from the diffuser ports are significantly below the toxicity values, and (5) bioavailable concentrations of copper and zinc in Miller and Des Moines creeks will likely be much less than those presented here. The active foraging behavior of the adult chinook and bull trout that could be present in the vicinity of the marine outfall will further reduce their exposure to these chemicals.

The effect of stormwater runoff on critical habitat downstream of the Port discharge points was also assessed through toxicity testing of Miller Creek and Des Moines Creek downstream of STIA stormwater outfalls. These tests demonstrated no toxicity to either fathead minnows or the invertebrate, *Daphnia pulex*. In addition to instream samples, whole-effluent toxicity (WET) testing of STIA stormwater discharge outfalls using these same test organisms was performed. Overall, these tests demonstrated an overall lack of toxicity in samples consisting of 100 percent stormwater from Port discharges on samples reflective of the future conditions after the MPU projects have been completed.

All identified water quality impacts will be mitigated (to maintain or improve the existing baseline condition) by establishing and maintaining water quality treatment best management practices (BMPs). These BMPs are not only protective of listed species and their critical habitat but they also meet or exceed the requirements of the Washington State Department of Ecology's (Ecology) Manual (Ecology 1992). Additionally, existing developed areas lacking BMPs consistent with the Manual will be retrofitted with water quality treatment BMPs, to the maximum extent practicable, to further protect listed species and their habitat. The MPU improvements will treat both new pollutant generating impervious surface (PGIS) and existing impervious areas in a ratio of 1:1.89 (for each acre of new impervious surface, 0.45 ac of existing impervious will be retrofitted). Additional measures to mitigate water quality impacts include source control and the operation and expansion of an IWS to treat stormwater runoff generated from high-use areas.

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[3] Brook trout were used as a surrogate for bull trout in this analysis. This was necessary due to the unavailability of published bull trout toxicity data.

In addition to the proposed water quality BMPs, existing degraded wetlands in the Miller Creek and Des Moines Creek basins will be enhanced to: (1) restore water quality functions, (2) benefit water quality by eliminating existing pollution sources from agricultural land, (3) increase settling and mechanical trapping of particulates, (4) remove metals and other toxics that bind to particulates, (5) reduce and bind metals in humic material, (6) biologically remove and uptake nutrients, and (7) enhance the Miller Creek buffer.

HYDROLOGIC IMPACTS AND MITIGATION

MPU improvements will increase impervious surface areas in the Miller Creek and Des Moines Creek watersheds, which could further increase stormwater runoff rates, volumes, and pollutant loads to the receiving streams. Additionally, the filling of wetlands could affect stormwater storage, ground water recharge, and groundwater discharge, all of which could affect the hydrology of surface streams.

The Port will construct stormwater conveyance, detention, and treatment facilities to manage runoff from both newly developed project areas and existing airport areas, as described below. The net result of flow controls for the MPU improvements will be to reduce peak flows in Miller, Walker, and Des Moines creeks downstream of the STIA discharges. These actions will enhance baseline hydrologic conditions in the streams and associated estuaries. The target flow regime will achieve the level of flow control required by regulations and reduce flows in the stream channels to a stable condition that reduces sedimentation in the creek estuaries where chinook critical habitat is present.

The Port has proposed mitigation in each watershed to compensate for any potential reductions in base flows in Miller and Des Moines creeks. This will be accomplished through the acquisition of real property in the Project Area, which will concomitantly transfer all water rights associated with these properties to the Port. On Miller Creek, the Port is acquiring and will cease exercise of water right permits, certificates, and claims associated with acquired properties. Additionally, any unapproved water uses will be terminated once these properties have been acquired. The Port is currently proposing to transfer these water rights in the Miller Creek drainage to the Washington Department of Ecology's Trust Water Rights Program[4]. On Des Moines Creek, the Port will augment flow using an existing well to which it already has all required water rights. The effects of these actions will compensate for any potential reductions in base flows[5] related to MPU Improvement projects in Miller or Des Moines creeks.

AQUATIC HABITAT IMPACTS AND MITIGATION

Wetland and stream habitat impacts resulting from MPU improvements include relocating approximately 980 ft of Miller Creek and the direct permanent filling of 18.33 ac of wetlands as well as temporary construction impacts to 2.17 ac of wetlands. Impacts to streams resulting from MPU improvements include filling approximately 980 ft of Miller Creek.

Several on-site mitigation elements are proposed to compensate for the MPU improvement projects' potential impacts to stream, wetlands, and aquatic habitat. The mitigation establishes 48.06 ac of on-

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[4] Such a transfer will be dependent on acceptance by Ecology.

[5] Maintenance of base flows will ensure adequate flows of freshwater at the estuaries of the mouths of Miller and Des Moines creeks where critical habitat for chinook salmon can be found.

site wetland enhancement and stream buffer that will be restored and protected in perpetuity from future development. In-basin mitigation is directed toward restoring all impacted wetland and stream functions, except avian habitat. In-basin mitigation is also directed toward removing certain existing land use conditions that degrade on-site wetland and aquatic habitat. Mitigation for wildlife habitat (bird and small mammals) is provided out-of-basin and consists of creating a large, high-quality wetland system in the city of Auburn at the mitigation site. Overall, this mitigation will maintain or enhance baseline conditions in the creeks and critical habitat in their estuaries.

EFFECTS DETERMINATION FOR CHINOOK SALMON

Chinook salmon have not been documented to occur in the Miller Creek, Walker Creek, or Des Moines Creek basins upstream of their discharge with Puget Sound (Batcho 1999, personal communication; Des Moines Creek Basin Committee 1997; Hillman et al. 1999). Therefore, direct effects of construction and operation are not expected to affect the freshwater life stages or critical habitat of chinook salmon. Although results of this action are intended to improve baseline habitat conditions for salmonids in the Miller Creek and Des Moines Creek basins (through increased stormwater management and habitat restoration), future use of the streams by chinook (i.e., through straying from other basins) is unlikely and not expected. Therefore, since chinook salmon do not occur in these basins, construction and operation of the project will have no effect on freshwater stages of chinook salmon in the Miller Creek or Des Moines Creek basins proper. When the potential effects of the proposed STIA MPU improvements on chinook salmon and its estuarine and marine habitats in the action area are considered relative to the proposed conservation measures, the action agencies determine the proposed action "may affect" but is "not likely to adversely affect" this species and "may affect" but is not likely to destroy or adversely modify designated critical habitat (see Table E-2).

EFFECTS DETERMINATION FOR BULL TROUT

Bull trout are not known to have occurred in the Miller Creek and Des Moines Creek watersheds, and they have not been found in recent creek evaluations (Batcho 1999, personal communication; Des Moines Creek Basin Committee 1997; Hillman et al. 1999). Therefore, construction and operational phases of the proposed action will have no direct or indirect effects on freshwater phases of bull trout in Miller or Des Moines creeks. Anadromous phases of bull trout originating from other Puget Sound basins could potentially inhabit nearshore marine areas at the outlets to these basins. When the potential effects of the proposed STIA MPU improvements on bull trout and its estuarine and marine habitats in the action area are considered relative to the proposed conservation measures, the action agencies determine the proposed action "may affect" but is "not likely to adversely affect" this species (see Table E-2).

Table E-2. Summary effect determinations for fish species.

Common and *Scientific name*	ESA Status	Life Stages Considered	Critical Habitat	Effects Determination
Chinook salmon *Oncorhynchus tshawytscha*	T	Freshwater and marine phases	Estuaries of Miller and Des Moines creeks and Marine Waters at the IWS Outfall	May affect, not likely to adversely affect
Bull trout *Salvelinus confluentus*	T	Freshwater and marine phases	Not identified	May affect, not likely to adversely affect

T = threatened

Introduction

1. INTRODUCTION

This Biological Assessment (BA) is prepared for reinitiation and initiation of consultation by the Federal Aviation Administration (FAA)[6] and initiation of consultation by the U.S. Army Corps of Engineers (ACOE) with the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) (the Services) under Section 7 of the Endangered Species Act (ESA). Section 7(a)(2) of the ESA requires federal agencies to ensure, in consultation with the Services, that their actions do not jeopardize listed species or adversely modify their designated critical habitat. To fulfill the requirements of section 7, action agencies must reinitiate (or initiate) consultation if new species are listed or critical habitat designated that may be affected by a discretionary agency action. See 50 C.F.R. § 402.16; 50 C.F.R. §402.03. As discussed below, recent listings of salmonids by the Services serve as the basis for this ESA Section 7 consultation.

Section 305(b) of the Magnuson-Stevens Act and associated implementing regulations provide that Federal agencies must consult with NMFS concerning all actions that may adversely affect designated essential fish habitat (EFH). NMFS EFH guidance documents provide that EFH consultations should be combined with ESA consultations to accommodate the substantive requirements of both Acts. Therefore, the enclosed BA analyzes the effects of FAA and ACOE actions on designated EFH.

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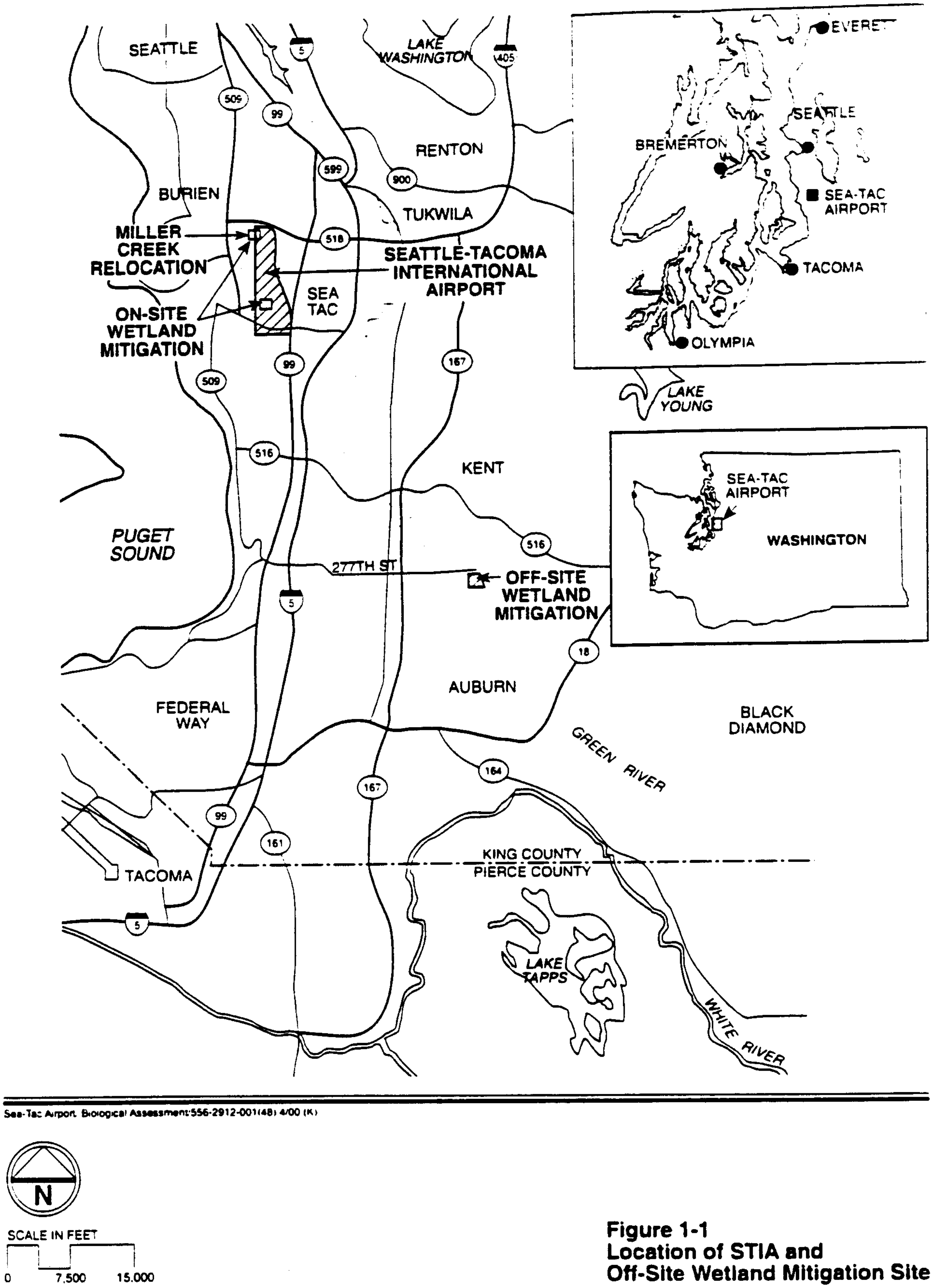


Sea-Tac Airport Biological Assessment 556-2912-001(48) 4/00 (K)

Figure 1-1
Location of STIA and Off-Site Wetland Mitigation Site

On March 24, 1999, and November 1, 1999, respectively, the Services listed Puget Sound chinook salmon and Puget Sound bull trout. The FAA is now reinitiating and initiating formal consultation with the Services for these species over certain actions for which it possesses discretionary involvement or control. Through this BA the ACOE also initiates formal consultation with the Services concerning its approval of a Clean Water Act (CWA) Section 404 permit application pertaining to the STIA MPU improvements.

The STIA MPU improvements are necessitated by the growing inability of the airport to efficiently support existing and future regional air travel demands (Figure 1-2). Airport activity is expected to increase as a result of regional population growth, regardless of these proposed improvements. MPU improvements, which are intended to reduce delays in aircraft operations, include upgrading the roadway system, terminal space, gates, cargo, and freight processing space to improve efficiency, reduce congestion, and improve the quality of service provided to the community.

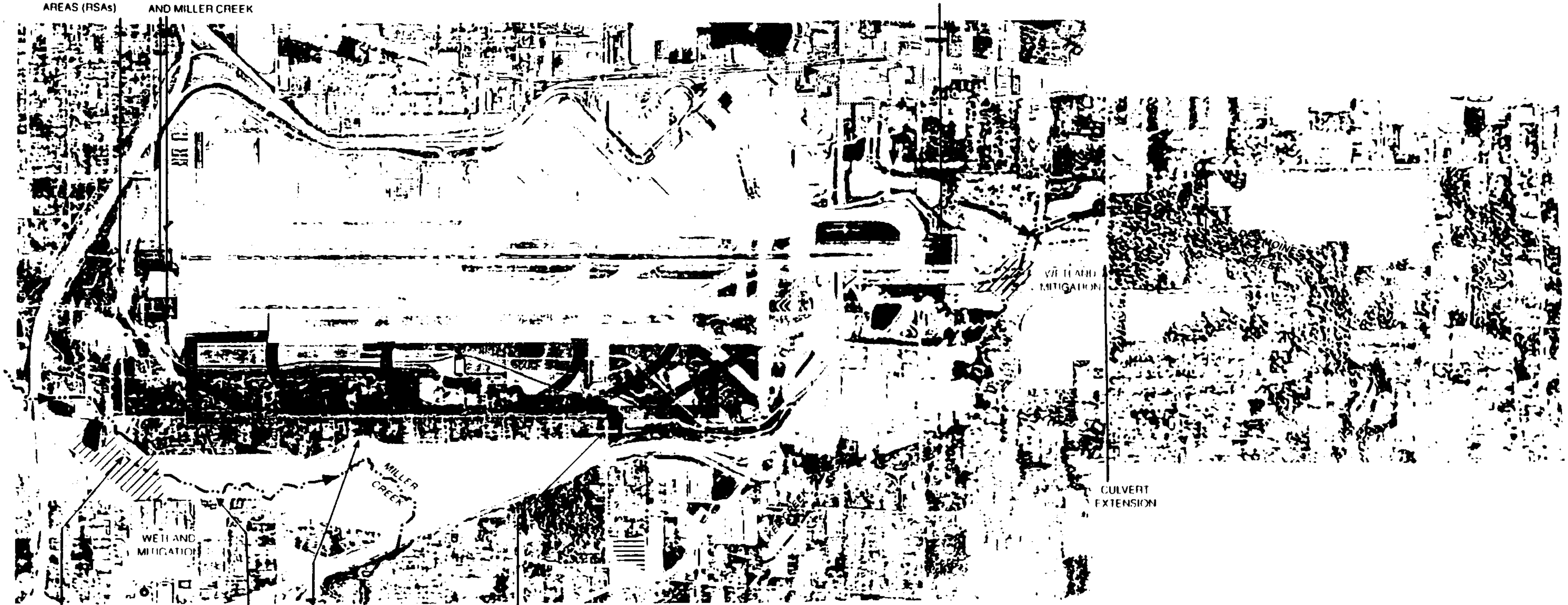
Before and during preparation of the proposed MPU, regional officials identified the following needs for STIA:

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

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

Using average aircraft operating costs developed by the FAA, calculations indicate that STIA aircraft delays cost the airlines about $42 million annually under 1992 demand. When annual aircraft operations reach 425,000, delay costs are anticipated to exceed $176 million annually. Without the third parallel runway, at this level of activity, average VFR 2 arrival delay would exceed 40 minutes and IFR delay would exceed 70 minutes.

A third parallel runway, located 2,500 ft west of existing 16R/34L runway, would permit staggered dual-stream arrivals during poor weather conditions. It would decrease average arrival delays by about 80 percent, as compared to taking no action, and result in a saving of $132 million per year. Federal actions needed to support implementation of the MPU improvements include FAA funding for certain airport improvements by FAA, construction of a control tower and navigational aids by



Note: Photo 1995

Parametrix, Inc.

Completed Acquisition
Fill Area
Commercial Easement Acquisition
South Aviation Support Area (SASA)
Retaining Walls
Air Field Development
Completed Air Field Development
Borrow Areas

SCALE IN FEET
0 900 1800

N

Figure 1-2
New Third Runway Construction at STIA

AR 044703

FAA[7], and issuance of a CWA Section 404 permit by the ACOE. Section 7 of the ESA requires federal agencies to ensure that their actions do not jeopardize the continued existence of endangered or threatened species, or their critical habitats. This BA was prepared to evaluate the effect of the STIA MPU improvements on threatened and endangered species as required by Section 7 of the ESA.

To initiate review of a project or action, an agency or its representative requests a list of endangered and threatened species from the USFWS and the NMFS. If a listed species may be present in the project vicinity, the lead agency, or its designee, must complete a BA describing how the project would affect the species. If the assessment determines that a listed species is likely to be harmed by the project, the agency must enter formal consultation with USFWS or NMFS to ensure that its actions will conserve the species and its critical habitats.

This BA evaluates potential effects of STIA MPU improvements on threatened and endangered species.

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[7] A Record of Decision supported by the Final Supplemental Environmental Impact Statement (FSEIS) providing FAA approval of the MPU development actions adopted by POS and providing FAA approval of FAA actions necessary to provide FAA support for the third runway, extension of runway 16L/34R, for expanded runway safety areas for runways 16R and 16L, and for various landside MPU improvements scheduled to be completed through the year 2010 was issued by the FAA in 1997. FAA's decision granting final approval of the MPU developments was upheld by the Ninth Circuit Court of Appeals in City of Normandy Park v. Port of Seattle, 165 F 3d 35 (1998).

Species Addressed

2. SPECIES ADDRESSED

Parametrix requested from the USFWS and NMFS an updated list of federally threatened and endangered species (May 27, 1999) that might occur in the project vicinity. Subsequent to receiving their replies, bull trout were listed as a threatened species (USFWS 1999a). Species on these lists (Appendix A) were further evaluated to determine their presence in the project area and any potential project impacts that may affect the species.

This BA addresses impacts of the proposed FAA and ACOE actions and more broadly STIA MPU improvements on the listed species identified by these agencies. It addresses direct disturbance impacts of the projects during construction, as well as impacts occurring once the completed projects are operational. This assessment of effect to the species and their habitats is based on literature review, agency consultation, and field reconnaissance.

2.1 ESA LISTED SPECIES MANAGED BY USFWS

USFWS identified the endangered peregrine falcon (*Falco peregrinus*), threatened bald eagle (*Haliaeetus leucocephalus*) and threatened Coastal/Puget Sound bull trout (*Salvelinus confluentus*) as potentially occurring near the project (Appendix A). Subsequently, peregrine falcons were delisted on August 25, 1999 (USFWS 1999b) and thus are not addressed further in this report. No candidate species managed by USFWS were identified as occurring in the project area. Marbled murrelet (*Brachyramphus marmoratus*) were reported to the ACOE as occurring in the project area in November 1999. In December 1999, the potential presence of marbled murrelets in the action area was discussed with USFWS and it was concluded they would be addressed in a revised BA.

Several species of concern were identified as potentially occurring in the project area (Table 2-1) and they were briefly evaluated for their potential presence. They were not evaluated further because the project area does not provide significant areas of natural habitat for these species.

Table 2-1. Species of concern identified by USFWS (see Appendix A and B) as potentially in the project area.

Scientific Name	Common Name	Potential of Occurrence
Myotis evotis	Long-eared myotis	Potentially occurring; may roost in abandoned buildings; more common in coniferous forest habitat.
Myotis volans	Long-legged myotis	Potentially occurring; may roost in abandoned buildings; more common in coniferous forest habitat.
Corynorhinus townsendii	Pacific Townsend's big-eared bat	Unlikely occurrence; roost primarily in caves and highly sensitive to human disturbance.
Lampetra tridentata	Pacific lamprey	Potentially occurring; typically found in larger rivers; not reported from Miller Creek and Des Moines Creek fish surveys.
Lampetra ayresi	River lamprey	Potentially occurring; Typically found in larger rivers; not reported from Miller Creek and Des Moines Creek fish surveys.

2.2 ESA-LISTED SPECIES MANAGED BY NMFS

NMFS identified Puget Sound chinook salmon, a threatened species (Appendix A), and the candidate species Puget Sound coho salmon as occurring in the project vicinity. Section 7 of the ESA does not require federal agencies to evaluate effects of agency actions on candidate species. Therefore, coho salmon were not evaluated in this biological assessment. Consultation with NMFS would be reinitiated if coho salmon are listed as a threatened or endangered species, and if federal agencies retain discretionary involvement or control over any STIA MPU projects at that time.

Proposed Action

3. PROPOSED ACTION

The STIA MPU improvements are located within the cities of SeaTac and Des Moines, in King County, Washington (Sections 4 and 5 of Township 22N, Range 4E, and Sections 20, 21, 28, 29, 32, and 33 of Township 23N, Range 4E, W.M.) (United States Geological Survey (USGS) Des Moines Quadrangle, 7.5-minute series). An additional project element, the construction of associated off-site wetland mitigation, is located southeast of STIA in the City of Auburn (Section 31, Township 22N, Range 5E, W.M.) (see Figure 1-1). FAA's proposed actions at this time are construction of the Airport Traffic Control Tower and navigational aids, future grants and grants issued to the Port since May 24, 1999 related to the implementation of STIA MPU improvements, and future approval of PFC collection and use authorization related to implementation of MPU improvements. ACOE's proposed actions relate to those MPU actions for which the Port has applied for a Section 404 permit.

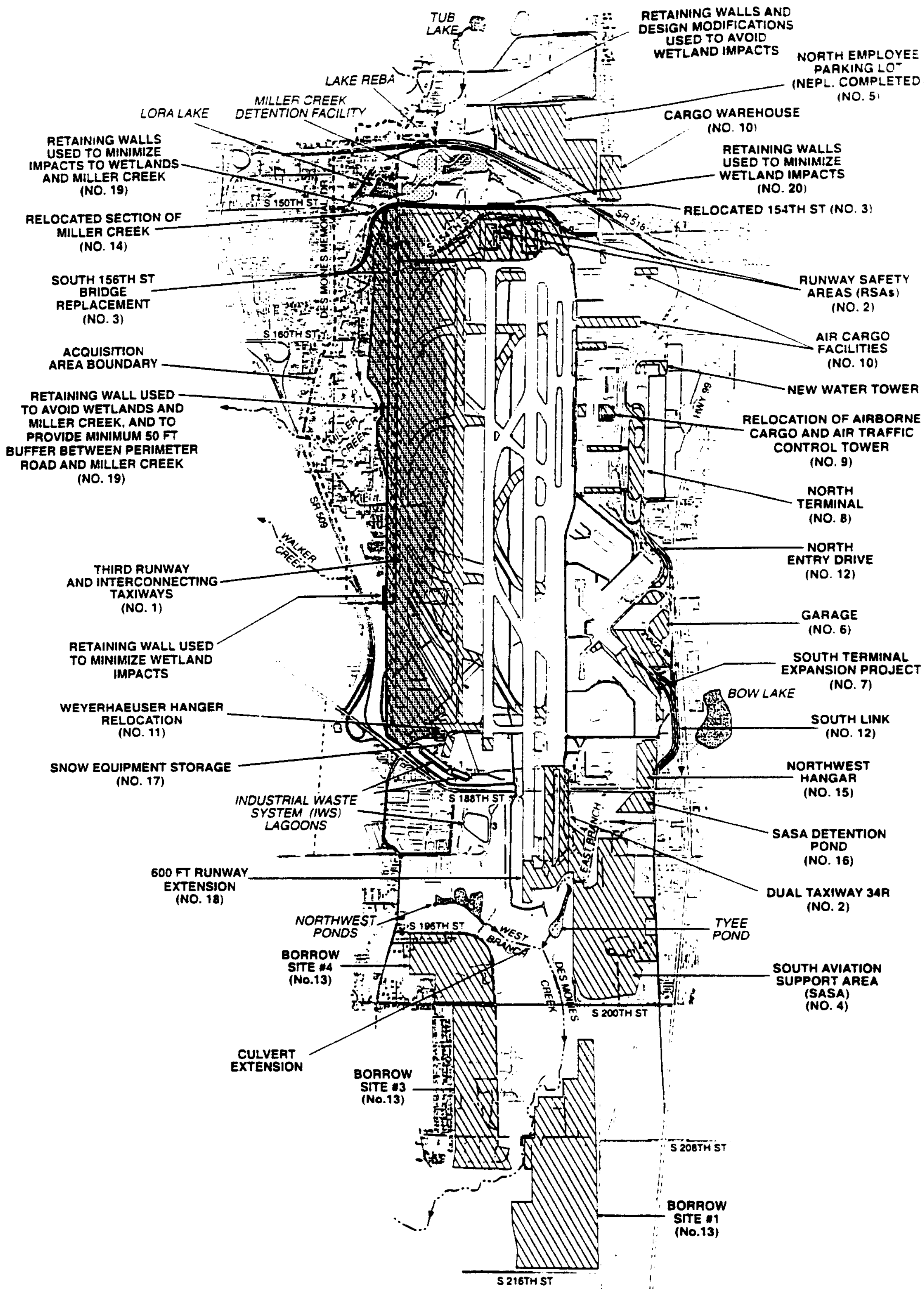
3.1 MASTER PLAN UPDATE ACTIONS

3.1.1 Project Description

MPU improvements would develop portions of property located on and near the existing STIA (Figure 3-1), as well as the wetland mitigation site near the Green River in Auburn. Generally, MPU improvements are categorized as noted here; they are discussed in detail in Table 3-1.

- **Runways and Taxiways:** A third parallel runway, 8,500 ft long, would be constructed on approximately 16.5 million cubic yards (cy) of fill. This action requires acquisition and vacation of existing residential areas on the west side of the airport. Temporary associated impacts include construction facilities, erosion and sediment control facilities, equipment staging, and security. Emergency access roads would be constructed around the runway perimeter. New and relocated interconnecting taxiways are also to be constructed. Runway 34R will be extended by 600 ft.
- **On-Site Borrow Areas:** On-site borrow areas are planned to be excavated as a source of fill to be used to construct portions of the runway embankment. The three borrow areas are located south of the airport, between 24th Avenue S. and 15th Avenue S, and between S. 200th and S. 216th streets. These borrow areas would provide up to about 7.9 million cubic yards of fill. Excavation and transportation of this fill to construction sites from excavation areas is evaluated in this BA. No off-site sources of runway fill are evaluated here[8].
- **RSA:** The RSA Extensions are to be created at the north end of the existing airport runways, south of State Route (SR) 518 and at the southern end of the new third runway. RSA extensions are necessary for the existing runways to meet current FAA standards. Part of a sewer line will be relocated.

[8] The source(s) of imported fill needed to construct the runway are not known. The Environmental Impact Statement and Final Supplemental Environmental Impact Statement identified several permitted sources of fill material, within 20 miles of STIA, with sufficient material to provide all or some of the fill needed for construction of the master plan projects. Private industry, however, may permit and develop new sources. The source and placement of fill material is subject to competitive bid and market conditions. The Port cannot pre-select sites, nor will the Port award contracts to facilities without approved permits. The potential impacts to listed species from obtaining fill from off-site sources would be speculative and are not reasonably foreseeable; therefore, they are not addressed in the BA.



Sea-Tac Airport/ Biological Assessment/556-2912-001(48) 8/00 (K)

AR 044710

SCALE IN FEET
0 900 1,800

N

- Fill Embankment for Third Runway
- Runway Safety Area (RSA) Boundary
- Master Plan Projects
- Relocated Segment of Miller Creek
- Existing Detention Facilities
- Water Features
- Acquisition Area Boundary
- Piped Creek
- Creek

Figure 3-1
Master Plan Update Improvements at STIA

Table 3-1. Proposed Master Plan Update improvement projects at Seattle-Tacoma International Airport.

Project Name [1]	Description
Runway and Taxiway Projects	
Property Acquisition, Street and Utility Vacation	Includes purchasing property between existing STIA boundary west to Des Moines Memorial Drive and SR 509. Required for third runway embankment fill and construction impact mitigation.
Embankment Fill (No. 1) [1]	Embankment for third runway, constructed using imported fill. Approximately 16.5 million cy will be placed over a 5- to 7-year period. Existing roads and streets under embankment footprint will be removed.
Interconnecting Taxiways (No. 1) [1]	New connecting taxiways between existing runway and third runway. Project is located on existing airfield, requiring only minimal grading.
Runway 16X/34X (No. 1) [1]	Paving of third runway after completion of embankment fill.
Extension of Runway 34R by 600 ft (No. 18) [1]	Extend runway by 600 ft for improved warm weather and large aircraft operations. Project is located at the southern end of the east runway.
Additional Taxiway Exits on 16L/34R	Construction of new ramps to the existing terminal apron.
Dual Taxiway 34R (No. 2) [1]	Improvements to taxiways serving the SASA area and south apron.
Borrow Sites	
Borrow Sites (No. 13) [1]	Sources of fill for third runway embankment, located on STIA property south of the airport. Approximately 7.9 million cy of material to be excavated from 3 sites and transported across airport property to the embankment.
Runway Safety Areas (RSAs)	
Runway 34R Safety Fill (No. 2) [1]	Extend runway safety fill to meet FAA standards.
RSAs 16R/16L (No. 2) [1]	Extend safety fills by 1,000 ft to meet FAA standards.
Relocation of Displaced Threshold on Runway 16L (No. 2) [1]	Airfield taxiway improvements. The runway threshold (i.e., the emergency landing pad at end of runway pavement) to be relocated onto new RSA.
Miller Creek Sewer Relocation (No. 3) [1]	Relocate sewer for third runway embankment and runway safety fills. New sewer to run along alignment of new 154th/156th Street.
FAA Navigation Aids (NAVAIDS)	
New Airport Traffic Control Tower (No. 9) [1]	New air traffic control tower to be located in existing developed area near terminal.
Relocate Airport Surveillance Radar (ASR), Airport Surface Detection Equipment (ASDE), NAVAIDS	Existing radar and navigation equipment will be relocated to allow construction of third runway.
Airfield Building Improvements	
New Snow Equipment Storage (No. 17) [1]	New building to house snow removal equipment.
Weyerhaeuser Hangar Relocation (No. 11) [1]	Relocate existing hangar on west side of airfield to allow construction of third runway. New hangar will be located near south end of third runway.

Table 3-1. Proposed Master Plan Update improvement projects at Seattle-Tacoma International Airport (continued).

Project Name [1]	Description
Terminal/Air Cargo Area Improvements	
Relocation of Airborne Cargo (No. 9) [1]	Relocate existing cargo building from air traffic control tower site to north cargo area. Located in existing developed area near terminal.
Central Terminal Expansion	Passenger terminal remodel. Located in existing developed area at terminal.
South Terminal Expansion Project (STEP) (No. 7) [1]	Passenger terminal remodel. Located in existing developed area to the south of the main passenger terminal.
Northwest Hangar Relocation (No. 15) [1]	Relocate Northwest Hangar to site now occupied by Delta Hangar. Located in existing developed area.
Satellite Transit Shuttle (STS) System Rehabilitation	Remodel and upgrade underground transit system linking terminal to satellites.
Redevelopment of North Air Cargo (No. 10)	New or expanded air cargo facilities along Air Cargo Road at north end of airport.
Expansion of North Unit Terminal (North Pier) (No. 8) [1]	Addition to new passenger terminal located north of existing terminal. Located in existing developed area (Doug Fox parking lot and airport access freeway).
New Airport Rescue and Fire Fighting facility (ARFF)	Replaces facility displaced by new North Terminal. The new facility will be located to the north of the North Terminal.
Cargo Warehouse at 24th Avenue S. (No. 10) [1]	New air cargo facility located north of SR 518 on 24th Avenue S.
Westin Hotel	New hotel located immediately north of main passenger terminal. Located in existing developed area at terminal.
New Water Tower	Construct new water tower and piping in engineering yard south of South 160th Street in subbasins served by stormwater outfalls 012 and 013.
Roads [9]	
Temporary SR 518 and SR 509 Interchanges	Temporary access ramps to serve construction of third runway embankment and runway safety fill; to be removed after project completion.
154th/156th Street Relocation (Nos. 3, 19, and 20) [1]	Relocate public roadway to allow construction of third runway embankment and runway safety fills. Existing road to be demolished.
154th/156th Street Bridge Replacement (No. 3) [1]	Relocate existing 156th Street bridge over Miller Creek to accommodate the third runway footprint and 154th/156th Street relocation. In-water work associated with this project is limited to the removal of the existing bridge and bank restoration.
Improvements to Main Terminal Roads (No. 12 and others) [1]	Transportation circulation, seismic and other improvements to roadway systems serving terminal.
Improved Access and Circulation Roadway Improvements	Improvements to existing roadway system serving passenger terminal, garage and air cargo facilities.
North Unit Terminal Roadways (No. 8) [1]	Improvements to existing roadway system to serve the new North Terminal and garage.

[9] Temporary roads used to haul fill material from 3 on-site borrow areas to construction sites are included in the analysis of the borrow areas and not listed here.

Table 3-1. Proposed Master Plan Update improvement projects at Seattle-Tacoma International Airport (continued).

Project Name [1]	Description
Improvements to South Access Connector Roadway (South Link) (No. 12) [1]	Improvements to existing roadway system serving passenger terminal, garage, and air cargo facilities. Will connect terminal and garage area to South Access roadway and SR 509 extension south of airport.
Parking	
Main Parking Garage Expansion (No. 6) [1]	Expand parking facility at main passenger terminal on north and south sides (existing developed areas), and add floors to portions of existing garage.
The North Employees Parking Lot (NEPL), Phase 1 (No. 5) [1]	New parking facility for employees, located north of SR 518.
North Unit Parking Structure (No. 8) [1]	Construction of new garage serving new North Terminal facility. Facility will be located at existing Doug Fox parking lot.
The South Aviation Support Area (SASA)	
The SASA and Access Taxiways (No. 4) [1]	New airport support facility for cargo and/or maintenance, located at the south end of the airport south of the Olympic Tank Farm and S. 188th Street. Airplane access will be by new parallel taxiway constructed along Runway 34R.
Relocation of existing facilities to the SASA (No. 4) [1]	Airport operation support facilities will be relocated to the SASA once SASA site development is completed. Many of these facilities must be relocated from their present locations due to main terminal expansion (i.e., STEP and North Terminal), including Northwest Hangar, Ground Support Equipment, ground and corporate aviation facilities, new airport maintenance building, and United maintenance complex.
Stormwater Facilities[2]	
Miller Creek Detention Facility (MCDF) Expansion	Expand the Miller Creek Detention Facility by 16.4 acre-ft to provide flow control retrofitting for existing STIA discharges to Miller Creek. All construction would take place in uplands, and would create free-draining detention volume.
SASA Detention Pond (No. 16) [1]	Create regional stormwater detention pond for the SASA project and other sites. Pond is 22.5 acre-ft and discharges to Des Moines Creek.
NEPL Vault	A 4.0 acre-ft vault to serve the NEPL; discharges to Miller Creek via Lake Reba.
Third Runway Vaults and Ponds	North pond (13.0 acre-ft; discharges to Miller Creek), central vault (8.3 acre-ft; Walker Creek), south vault (6.3 acre-ft; Des Moines Creek), and interconnecting taxiways vault (5.9 acre-ft; Des Moines Creek).
STIA Retrofit Facilities	Detention vaults or ponds to provide flow control retrofitting for existing STIA discharges to Des Moines Creek. Vaults to be constructed in existing or new fill.
Cargo Vault	Detention vault for North Cargo Facility, 1.9 acre-ft discharging to Miller Creek via Lake Reba.
Natural Resources	
Miller Creek Relocation	Approximately 980 ft of Miller Creek immediately downstream of the MCDF will be relocated to accommodate third runway embankment and runway safety fill.
Miller Creek Buffer Enhancement	Establish a 100-ft buffer (average) along approximately 6,500 linear ft of Miller Creek within the acquisition area.
Miller Creek Floodplain Restoration	Excavate approximately 9,600 cy from the Vacca Farm site adjacent to Miller Creek to compensate for 8,500 cy of floodplain fill for third runway embankment and north safety fill.

Table 3-1. **Proposed Master Plan Update improvement projects at Seattle-Tacoma International Airport (continued).**

Project Name [1]	Description
Miller Creek Instream Habitat Enhancement	Site 1: south of the Vacca Farm site, approximately 650 ft of channel. Remove rock riprap, footbridges, and trash. Place large woody debris (LWD) throughout this section of the creek. The associated wetland and upland areas along the creek will be planted with native wetland and upland vegetation species.
	Site 2: approximately 150 ft upstream of S. 160th Street, approximately 140 ft of channel. Install LWD in the creek channel, grade a small section of the west bank of the creek to create a gravel bench in the floodplain, and plant the upland area with native trees and shrubs.
	Site 3: Immediately downstream of S. 160th Street, approximately 600 ft of channel. Grade a section of the east bank, remove a rubber tire bulkhead and install LWD in the creek and on its banks. Plant buffer areas with native trees and shrubs.
	Site 4: Miller Creek immediately upstream of 8th Avenue S., approximately 820 ft of channel. Grade portions of both banks. Remove footbridges and portions of concrete block walls. Install LWD in the creek and on its banks. Plant buffer areas with native trees and shrubs.
	In addition to these specific enhancements, debris such as tires, garbage, and fences will be removed throughout the entire stretch of Miller Creek from the Vacca Farm site south to Des Moines Memorial Drive. In areas where access is readily available, LWD will be selectively placed throughout the creek to improve instream habitat conditions.
Drainage Channels Relocation	Relocate approximately 1,290 linear ft of drainage channels to accommodate the third runway embankment. The buffer along the drainage channel will be vegetated with native grass and shrubs.
Restoration of Temporarily Impacted Wetlands	Approximately 2.17 ac of wetland located west of the third runway embankment, north of relocated S. 154th Street and west of the Miller Creek relocation project, will be temporarily filled or disturbed during embankment construction. When construction activities are completed, remove fill material, restore pre-disturbance topography, and plant wetlands with native shrub vegetation.
Tyee Valley Golf Course Wetlands Enhancement	Restore approximately 4.5 ac of emergent wetland area, located within Tyee Valley Golf Course, to a native shrub vegetation community. The enhancement actions would be integrated into plans to construct a RDF on the golf course (King County CIP Design Team 1999). The enhancement would convert the existing turf wetland to native shrub wetland community.
Avian Habitat near the Green River in Auburn	Construct an approximately 36-acre wetland mitigation area on a 67-acre parcel near the Green River in the city of Auburn. Create approximately 25.96 ac of forest, 3.40 ac of shrub, 5.17 ac of emergent, and 0.03 acre of open-water wetland. Create upland buffers totaling about 15 ac.

[1] Numbers indicated are mapped on Figure 3-1.

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

- **Airport Traffic Control Tower and other Navigation Aids:** FAA is constructing a new airport traffic control tower on a 2.5-acre site that is developed with parking lots and buildings. Existing radar and other navigation facilities will be relocated to allow construction of the runway[10].

[10] Navigation aids include Approach lights that will be constucted at the north end of the existing east runway. The towers supporting these lights will be located in uplands, and will not impact any wetlands.

- **Airfield Building Improvements:** A new snow equipment storage shed will be constructed, and the Weyerhaeuser Hangar relocated.

- **Terminal and Air Cargo Area Improvements:** Passenger and cargo terminal buildings, ramp areas, a hotel, and the fire/rescue facility will be constructed and/or undergo redevelopment. A new water tower will be constructed south of S. 160th Street.

- **Roads:** New construction and redevelopment of roads around the terminals will improve access and circulation. S. 154th/156th Street will be relocated around the new RSA footprints. Temporary interchanges will be constructed on SR 518 and SR 509 for fill haul access. The temporary interchanges on SR 518 and SR 509 are not funded by FAA and do not require FAA authorization. If there is no discharge of fill material to wetlands or other waters of the United States, an ACOE Section 404 permit is not required.

- **Parking:** This effort includes not only construction of the NEPL north of SR 518 that was completed in 1998, but also expansion of the main Parking Terminal, and construction of a new parking facility to serve the new north terminal.

- **SASA:** Located southeast of the airport between 20th and 28th Avenue S. and north of S. 200th Street, SASA will include aircraft maintenance/support and air cargo facilities.

- **Stormwater Facilities:** New stormwater vaults and ponds will be constructed to serve new and existing airport areas. The Miller Creek Detention Facility will be expanded, and a new stormwater detention facility will be constructed for SASA.

- **Natural Resources:** A portion of Miller Creek will be relocated. Miller Creek floodplain volume, impacted by the RSA footprint, will be replaced at the Vacca Farm. Instream habitat will be enhanced at four locations along Miller Creek, and stream buffers will be established along 6,500 ft of Miller Creek. Drainage channels will be relocated, and temporarily impacted wetlands restored. Wetlands on Tyee Valley Golf Course will be enhanced. An avian habitat will be created at a mitigation site near the Green River in Auburn.

- **Construction Related Facilities:** Various temporary construction laydown facilities, temporary office facilities, temporary contractor parking, etc. are components of the larger master plan projects, and generally occur within the development footprints of the finished project. These temporary facilities are necessary to support construction projects.

3.1.2 Construction Schedule

The MPU improvements would be constructed over a 10-year (or longer) time frame; however, major construction projects are anticipated to be completed by 2005. While most construction occurs in uplands, the potential effect to listed species is primarily through the indirect effects of stormwater runoff. Therefore, information on project scheduling related to the installation and/or upgrading of the stormwater management system is provided to show that when new projects are finished, proper stormwater management controls will be operational. Because some elements of the project involve in-water construction that could cause sedimentation of surface water, a detailed description of project sequencing is provided. Finally, construction of these improvements will only proceed once the appropriate federal and state permits (e.g., 401 Water Quality Certification, Section 404 permit, and HPA[11]) have been obtained. Mitigation measures required by these permits are also described below.

3.1.2.1 Stormwater Management Facilities

Stormwater detention and water quality facilities will be constructed in advance of MPU improvements so that sufficient stormwater treatment is in place and functioning at the time construction of new impervious surfaces begins. The phased construction of these facilities will ensure that water quality, flow conditions, and downstream habitat will be protected from potential indirect impacts.

Stormwater treatment facilities for temporary construction sediment and erosion control must be operational at the onset of clearing and grading activities, as required by project-specific stormwater pollution prevention plans (SWPPPs) for construction activities. Anticipated start and completion dates of the principal MPU improvements that would require permanent stormwater detention, the stormwater detention facilities that would serve those projects, and estimated dates when detention facilities would be required to be on-line are shown in Figure 3-2. Since multiple MPU improvements could be served by a single detention facility, certain detention facilities may need to be constructed several years before construction begins on the principal MPU improvement slated to contribute to that facility.

The following conclusions have been reached about scheduling stormwater facilities for MPU improvements:

- **Stormwater detention facilities for the third runway project.** Permanent detention facilities for the third runway can be constructed just prior to Phase 3 Runway 16X/34X (i.e., before runway paving). Design should begin in 2001, followed by facility construction in early 2003. This would allow these facilities to be available when runway paving starts.
- **S. 156th Street relocation.** This project will not generate any net increase in impervious surfaces. It includes property acquisition and demolition of existing houses and local streets. Thus, stormwater detention would not be required. The project will include sediment and erosion control during construction, as specified in project specific SWPPP.
- **Miller Creek detention facility expansion.** Expansion of this facility should be implemented by 2001 to serve the redevelopment projects in the North Air Cargo area. Expansion and timing is contingent on the North Air Cargo redevelopment schedule.
- **The SASA detention facility.** Construction of this detention pond, which would replace the Tyee Pond[12], depends on scheduling the SASA and South Access road projects. The SASA pond is needed only to serve the detention needs of these two projects. Similar to the

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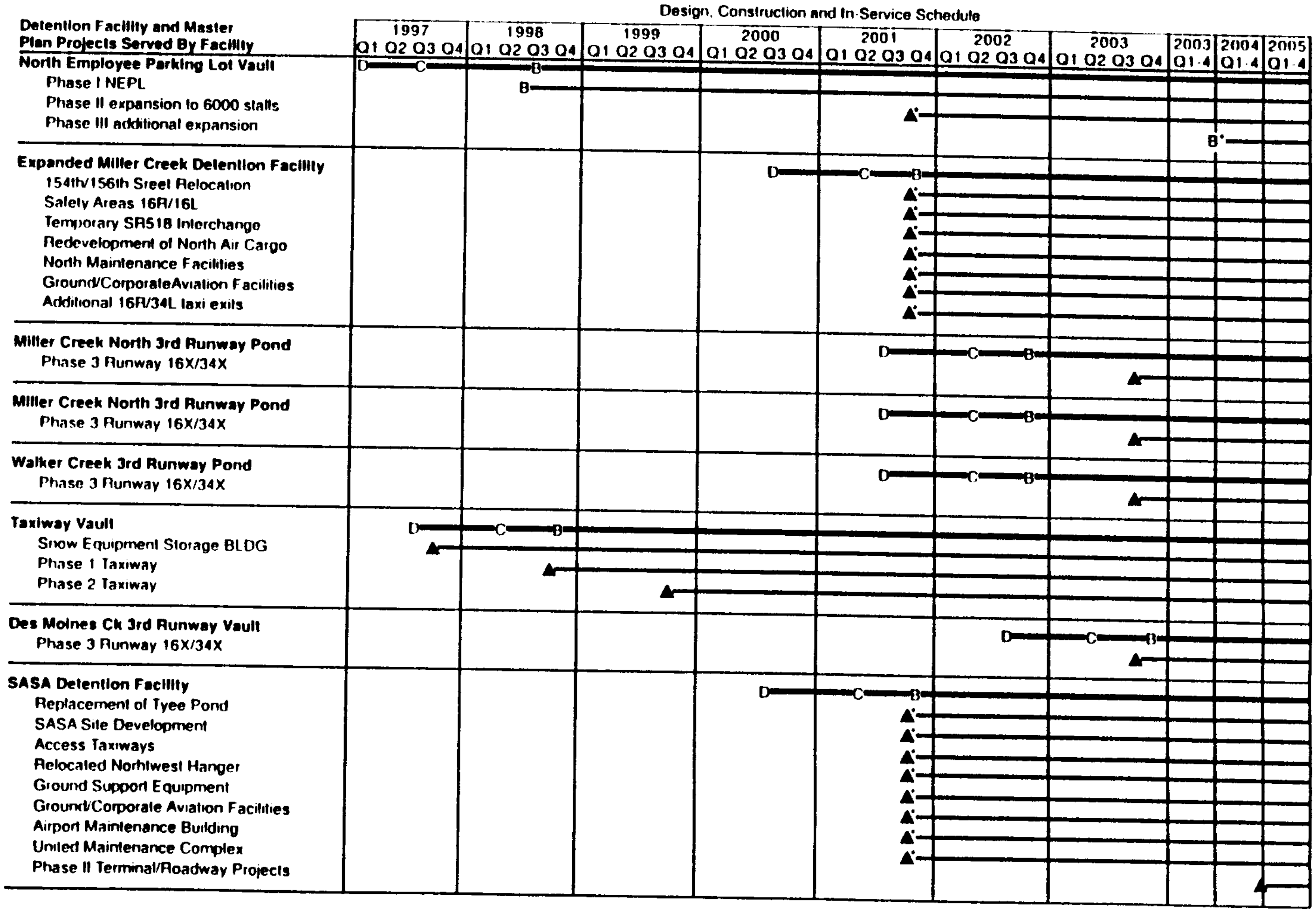
[11] HPA, issued by the Washington Department of Fish and Wildlife is a permit required for any activity which uses, obstructs, diverts, or changes the bed or flow of state fresh and marine waters.

[12] It is anticipated that the Tyee Pond will be decommissioned as a result of constructing the South Access Project. The South Access project is not part of the MPU improvements, and no filling of wetland within the pond is proposed.



* Earliest potential completion - some projects may be completed later

Stormwater Facilities
D-design
C-construction
B built and in service

Master Plan Projects
▲ built and in service

Figure 3-2
Construction Schedule for Master Plan Update Stormwater Detention Facilities

Tyee Pond, the new SASA pond would be fitted with a spill-control feature, even though the Tank Farm[13] would not drain to this facility.

- **Terminal and air cargo projects.** No new detention is needed for projects in the terminal and air cargo area. A net reduction in stormwater drainage area has resulted due to diversion of stormwater to the IWS, caused by IWS reroute projects and the garage expansion. Construction of the new water tower will include removal of existing pavement to result in no net increase in impervious area.

3.1.2.2 Auburn Wetland Mitigation

The main construction elements for the Auburn Wetland Mitigation project include construction of temporary access/haul roads, development of on-site staging areas, site dewatering, excavation of east and west wetland basins, preparation and placement of wetland soils, installation of irrigation system, construction of site maintenance roads, and phased plantings.

This section presents a detailed phasing of the construction of this facility to assist the consulting services (NMFS and USFWS) with their review. Additionally, an understanding of this phasing is important to determining potential impacts to the chinook critical habitat present in this area.

The work will occur in three phases and may take one or two construction seasons, depending on construction methods start date and hauling restrictions. A construction season is expected to begin in late June and end by early October, using the driest time of the year. Planting may occur at other times of the year to take advantage of plant availability and optimum planting periods during the dormant period.

After award of the contract, the selected Contractor will provide any required pre-construction submittals such as qualifications statements, workplans and construction schedule. Notice to proceed will be given pending review of the pre-construction submittals. The following phases and construction elements are ordered in the construction sequence that they are expected to occur. While each phase must be substantially complete before proceeding to the next phase, some overlap of the general construction elements within each phase is likely.

Phase 1 - East Wetland Basin Construction

1. Install the site dewatering system of pumping wells, manifold piping, and discharge structure.
2. Construct temporary access/haul roads and wetland crossings.
3. Implement Temporary Erosion and Sedimentation Control (TESC) plan.
4. Develop staging/stockpile areas.
5. Bring in temporary and permanent utilities (electric power and irrigation main).
6. Install site security fence.
7. Clear and remove brush.

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[13] After a petroleum spill from the Tank Farm entered Des Moines Creek in the mid-1980s, a containment berm around the facility was constructed and drainage from the tank farm was routed directly to the IWS.

8. Excavate east side wetland basin.
9. Process and stockpile wetland soils.
10. Place wetland soils over east side basin.
11. Install east side control weir.
12. Construct maintenance roads and gravel paths on east side.
13. Install irrigation system on east side.
14. Install habitat logs.
15. Install erosion control matting where needed and hydroseed.

Phase 2 - West Wetland Basin Construction

1. Excavate east side wetland basin.
2. Place wetland soils over east side basin.
3. Install west side control weir.
4. Construct maintenance roads and gravel paths on west side.
5. Install irrigation system on west side.
6. Install habitat logs.
7. Install erosion control matting where needed and hydroseed.

Phase 3 - Outlet Channel and Weir Construction

1. Excavate outlet channel and wetland basin tie-ins.
2. Install erosion control matting and hydroseed.

Note: Planting may begin after substantial completion of each phase.

Water from the dewatering wells would be conveyed and discharged to the Green River. Well water would discharge to an existing ditch system located north of the site at an existing outfall. The ditch system would convey water to the Green River north of the site.

3.1.2.3 Miller Creek Relocation

The Miller Creek Relocation project includes the stream relocation, floodplain expansion, and enhancements to Miller Creek and stream buffers between the relocated section and the bridge at 154th Street.

Phasing of construction work required to implement this project has been designed to minimize potential erosion and sedimentation in Miller Creek. As requested by reviewing agencies, the construction section is discussed below. Construction elements for the stream relocation and the floodplain expansion occur concurrently, and are expected to occur during the driest time of the year, taking approximately 15 weeks, beginning in late June and ending by early October.

After award of the contract. the Contractor will provide the Port with any required pre-construction submittals such as workplans and construction schedule. Notice to proceed will be given pending review of the pre-construction submittals.

The work will begin with implementation of the TESC plan. This includes placing silt fence around work areas and staging areas, and placing straw bales at key locations within the project limits. A temporary sediment pond will also be constructed at the south (the lowest) end of the proposed floodplain grading area. The TESC elements will be in place prior to the start of other construction activities. Clearing and brush removal will be limited to only those work areas that the contractor is scheduled to begin within the following two weeks.

Next, temporary facilities such as access roads and staging areas will be developed. Once the temporary facilities are in place, the contractor will likely implement a plan for controlling water during excavation of the floodplain and stream relocation areas. This may include excavating dewatering trenches, french drains, and sumps.

It is anticipated that the construction for the relocated portion of Miller Creek will be completed in two phases. Phase 1 would consist of constructing the main portion of the new channel. Phase 2 would consist of completing the tie-ins to the existing stream at each end. As it is expected to occur, a more detailed description of this work is as follows:

Phase 1 Stream Relocation – Main Section

- Recontour the agricultural drainage ditch and other low areas along the new channel alignment.[14]
- Implement dewatering for new channel construction.
- Excavate new channel subgrades (except at tie-in areas).
- Confirm new channel subgrades with field survey.
- Place geotextile over new channel subgrade.
- Install log weirs: logs and quarry spalls.
- Place streambed (spawning) gravel and grade low-flow channel.
- Confirm new channel finish grades.
- Construct new channel banks of geotextile fabric-wrapped streambank material.
- Install rolled geotextile material logs and mattresses.

The above construction elements will likely occur over 100- to 200-ft lengths of the new channel, beginning at the downstream end. Subsequent elements would follow as soon as practicable.

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[14] The drainage ditch connects at its lower end to Miller Creek, and construction sediment and erosion control facilities will be used to prevent water quality impacts to the creek.

Phase 2 Stream Relocation – End Tie-ins

- Install sheeting and base-flow stream diversion sumps at tie-in areas.
- Relocate any fish present[15] in the existing channel to downstream locations.
- Place fill in existing channel at tie-in areas.
- Excavate new channel grades at tie-in areas.
- Place geotextile fabric over new channel subgrade at tie-in areas.
- Install transition area log weirs: logs and quarry spalls at tie-in areas.
- Place streambed (spawning) gravel and grade low-flow channel at tie-in areas.
- Confirm new channel finish grades.
- Construct new channel banks of geotextile fabric-wrapped streambank material at tie-in areas.
- Install rolled geotextile fabric logs and mattresses at tie-in areas.

Once the Phase 2 tie-ins have been made, the flow from Miller Creek will be intermittently introduced to the new channel section to allow the streambed gravels to sort and stabilize. During this time a collection sump located at the downstream end of the new channel construction will collect any turbid water and convey it to the sediment pond until the new channel flows clear. Landscape plantings along the new channel and stream buffer may occur as the construction proceeds or follow afterwards as appropriate.

Excavation of the floodplain grades may occur as soon as the contractor can control the groundwater sufficiently for the method of excavation selected. Once the new floodplain grades have been established and verified by field survey, the irrigation system piping will be installed followed by seeding and landscape planting.

Enhancements to the stream and buffers between the relocated section and 154th Street will include the removal of manmade features such as footbridges and tires used to stabilize the streambanks. Limited clearing and brush removal will be necessary prior to planting the stream buffers with new landscape plantings. Employing BMP's during these activities will minimize impacts to the stream's water quality. In-stream work should be scheduled during dry weather and when base flows are at a minimum. The size of the area being worked at any one time should be limited to as small an area as practicable for that activity. The disturbed areas should be stabilized immediately after work in that area is completed.

Once the site is stabilized with respect to erosion, the temporary sediment pond can be decommissioned. This work will involve removing the outlet structure and lower section of the pond containment berm.

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[15] No cutthroat trout, bull trout, chinook salmon, coho salmon, nor any other salmon species have been observed by the Port in this stream reach.

3.2 INTERDEPENDENT AND INTER-RELATED ACTIONS

The effects of the action evaluated in this BA include not only the direct and indirect effects described above, but also all associated inter-related and interdependent actions. Inter-related actions are those that are part of the larger action, the STIA MPU improvements, and depend on this larger action for their justification (USFWS and NMFS 1999). Interdependent actions are those that have no independent utility apart from the action under consideration (USFWS and NMFS 1999). The interdependent and inter-related projects included in the action are:

- Natural resource mitigation projects required to obtain federal and state permits such as the Auburn wetland mitigation, on-site creek relocation and restoration, wetland restoration at the Vacca farm and Tyee Valley Golf Course, and construction of stormwater management facilities (detention ponds, water quality treatment facilities, and conveyance structures).
- Relocation of facilities to accommodate new master plan projects such as the relocation of 154th Street for the new runway and runway safety areas and relocation or upgrading of utilities.
- Temporary construction facilities, including temporary interchanges, temporary office facilities, construction lay down areas, etc.
- The existing IWS would be expanded, and IWS Lagoon 3 would be enlarged per requirements of the Port's National Pollution Discharge Elimination System (NPDES) permit.
- Construction of a new water tower which will convert existing pervious area to impervious and convert an equal amount of impervious area to pervious.
- Construction of the Terminal Radar Approach Control (TRACON) on the westside of the airport.[16]

For most inter-related or interdependent projects, potential effects to listed species are limited to the potential indirect effect of stormwater runoff on downstream habitat. However, some mitigation projects involve in-water construction that could potentially impact water quality and indirectly effect downstream habitat.

3.3 ACTION AREA

The action area (Figure 3-3) was determined to be those areas of the airport project where project construction will occur and the vicinity where direct, indirect, or cumulative effects could reasonably occur (i.e., the aquatic habitat of Miller, Des Moines, and Walker creeks downstream of the airport and the associated nearshore estuary, and the IWS Puget Sound outfall). The Auburn wetland mitigation site and vicinity (Figure 3-4) where indirect or cumulative effects could reasonably occur are also included in the action area.

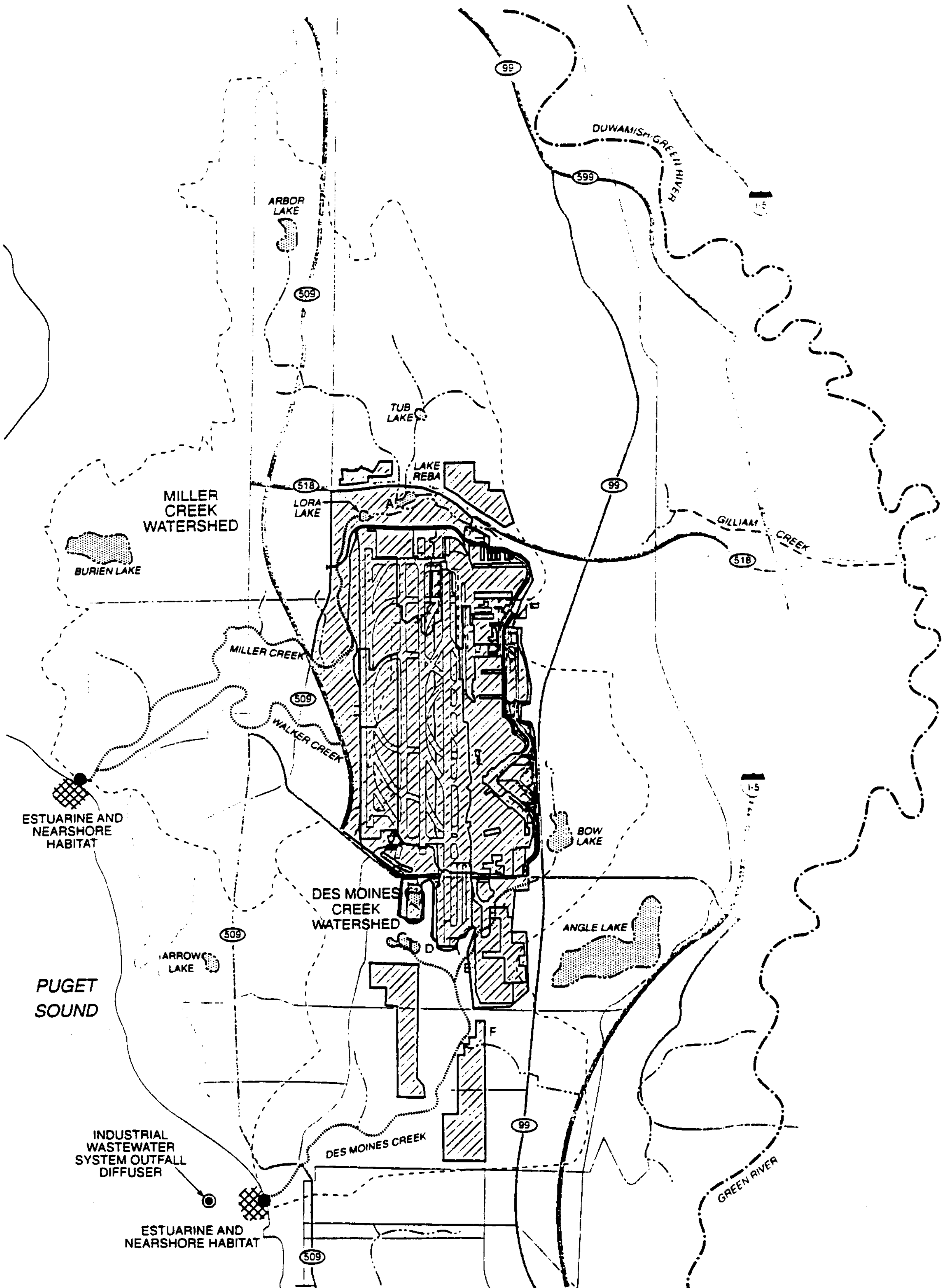
[16] As a future federal action that is not a part of the STIA MPU improvements, the effects of constructing and operating the TRACON facility will be determined in consultation with the Services when this project ggoes forward in the future.

Available information and analysis indicated that the listed aquatic species and their critical habitat do not occur at or near construction sites (see Chapter 4 for a detailed discussion). Therefore, there are no direct impacts to listed species or their critical habitats. Listed species could be affected by indirect impacts resulting from new stormwater runoff that enters habitat potentially occupied by them. The action area is thus limited to the locations where indirect effects may occur, and the locations where construction or other activities may generate runoff and includes:

- **Construction sites at STIA** where construction and operation could result in transport of sediments, nutrients, and other chemicals to downstream waters (Miller, Des Moines, and Walker creeks). Construction in wetlands, the Miller Creek relocation, and creek crossings (replacement of a bridge on Miller Creek, replacement of a culvert on Des Moines Creek) would involve in-water work that could affect water quality and creek habitat conditions, with indirect impacts down gradient where listed species occur.
- The **Miller, Des Moines, and Walker creek channels** downstream of STIA construction where changes in runoff or water quality conditions from the action could affect habitat conditions in the creeks. The estuaries and adjacent nearshore habitat of Miller and Des Moines creeks are included in the action area because these areas are critical habitat for chinook, and potential habitat for bull trout. Changes in creek hydrology and/or water quality conditions could effect these habitats.
- The **piped sections of Gilliam Creek** where fish species may temporarily enter during periods when the Green/Duwamish River experiences high water due to simultaneous flooding and high tides. Changes in runoff rates or water quality could affect fish occupying the pipes.
- The **Green River**, where changes in runoff rates or water entering from the Gilliam Creek tributary could impact chinook critical habitat.
- The **existing IWS** outfall located in Puget Sound near Des Moines Creek is included in the action area because increasing the area served by the IWS at STIA will result in increased discharge of treated stormwater runoff at the outfall. The outfall is located in about 170 ft of water, about 1,700 ft offshore, and changes in discharges could affect critical habitat.
- Construction of **off-site mitigation in Auburn** would occur up to 200 ft west of the Green River. During construction, changes in runoff and water quality could impact critical habitat of the Green River through construction dewatering and conveyance of runoff through existing farm and roadside ditches to the Green River.

Some minor MPU improvements included in Table 3-1 are not shown on Figure 3-3. Nevertheless, they have been evaluated during the FEIS and permitting process. Other minor projects not included in Table 3-1 are the relocation of airport tenants and facilities to make land available for the MPU improvements, the temporary facilities needed during construction, and the infrastructure needed for the improvements.

Inter-related and interdependent activities that are reasonably certain to occur are also included in the action and action area. Actions that may occur but are not reasonably certain to occur, or actions that are likely to have a Federal nexus and undergo ESA review at some future date are excluded from analysis in the BA. The activities in the action area that are not considered reasonably certain to occur (as defined in Consultation Handbook, USFWS and NMFS 1998) are presented in Table 3-2.



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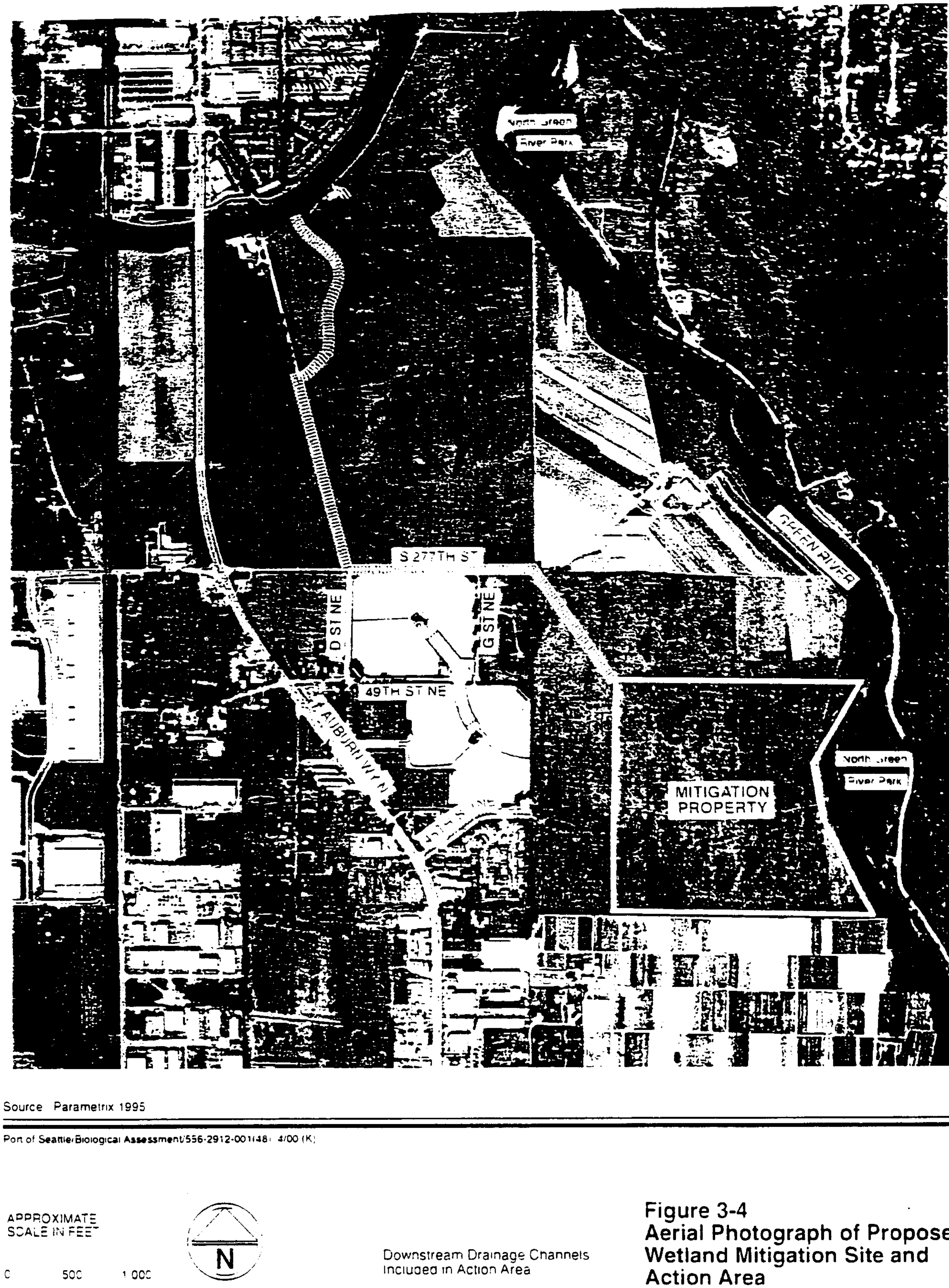
SCALE IN FEET
0 1500 3000

N

Basin Boundary
Stream
Piped Stream
Action Area

Action Area for Potential Chinook and Bull Trout Habitat
Action Area for IWS Outfall
Action Area for Downstream Effects and Seasonal use by Bull Trout
Lake

Figure 3-3
Des Moines Creek, Miller Creek, Walker Creek, Gilliam Creek, Green River, and Project Action Area



Source Parametrix 1995

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APPROXIMATE
SCALE IN FEET

0 500 1 000

N

Downstream Drainage Channels
Included in Action Area

Figure 3-4
Aerial Photograph of Proposed Wetland Mitigation Site and Action Area

Table 3-2. Actions excluded from the action area.

Excluded Action	Reason for Exclusion
Development of new off-site sources of gravel	There is no need or certainty to develop new gravel sources. Development of new sources are speculative private ventures and not reasonably foreseeable. Each of these new facilities would undergo their own ESA review prior to completing their permitting process.
Increased pollutant runoff related to transportation routes	Increased levels of pollutants sufficient to impact critical habitat or listed species are not reasonably foreseeable based on uncertainty of haul routes, scientific literature on runoff impacts, and the small increase in total traffic volume.
Redevelopment of airport properties[1] (borrow sites and acquisition areas)	No redevelopment plans presently exist nor are any such actions reasonably foreseeable at this time.
SR 509/South Access Projects	Presumed to have its own federal nexus (through Federal Highway Administration [FHWA] and Section 404).
Des Moines Creek RDF	The MPU can be constructed to meet stormwater management standards independent of the RDF. Presumed to have its own federal nexus (through Section 404).
Sound Transit Link Light Rail Facilities	Presumed to have its own federal nexus (through FTA funding).
Adjacent Public/Private Properties	Construction BMPs, and setbacks will contain construction runoff on Port property. Critical habitat is not present on adjacent properties.

[1] The use of these areas for Master Plan activities are fully considered in the BA.

Water and Fish
Resources

4. WATER AND FISH RESOURCES

Baseline watershed and fish habitat conditions in drainage areas affected by MPU improvement projects are described below. The effects of the projects on listed species are evaluated in Chapter 9. The distribution of fish species in Miller, Walker, and Des Moines creeks is shown in Figure 4-1.

Effects were evaluated in terms of criteria (no effect, may affect, beneficial, insignificant, and discountable) defined by the NMFS (1996), Washington Habitat Conservation Branch in its *A Guide to Biological Assessments* (revised March 23, 1999) and *Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale* (NMFS 1996):

> *May affect, not likely to adversely affect is the appropriate conclusion when the effects on the species or critical habitat are expected to be beneficial, discountable or insignificant. Beneficial effects have contemporaneous positive effects, without any adverse effects to the species or habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgement, a person would not (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur.*

The effects determination (Chapter 9) for each fish species is made based on the extensive mitigation measures to protect and maintain baseline conditions incorporated into the project (see Chapters 7 and 8). These mitigation measures include mitigation for potential water quality impacts (Section 7.1), increases in stormwater runoff (Section 7.2) and for impacts to stream and wetland habitat (Section 7.3). Tabulated summaries of baseline conditions for Miller Creek, Des Moines Creek, the creek estuaries, and the Green River near the Auburn Mitigation Site are presented below.

4.1 HYDROLOGIC SYSTEMS

STIA drains to Miller Creek (and its Walker Creek tributary), Des Moines Creek, and the Green River via Gilliam Creek. STIA's NPDES-Permitted stormwater outfalls are shown in Figure 4-2. STIA's NPDES-permitted IWS outfall to Puget Sound is shown in Figure 3-3.

4.1.1 Miller Creek Basin

The Miller Creek watershed drains approximately 8 mi^2 of predominantly urban area, mostly within the cities of Burien and SeaTac (see Figure 3-2). STIA facilities located in this basin include the north end of runways 16L and 16R and north air cargo facilities, an area of about 162 ac representing about 3 percent of the watershed. Flows in Miller Creek originate at Arbor, Burien, Tub, and Lora lakes, Lake Reba, and from seeps located on the west side of STIA.

The uppermost reaches of Miller Creek (above approximately river mile [RM] 4.1), extend north of SR 518. The Hermes depression, in the northwestern part of the basin, is artificially drained and piped to a tributary to Arbor Lake. This portion of the watershed drains a gently rolling plateau between the Duwamish/Green River valley and Puget Sound. Although the watershed is generally highly developed, several small bogs, depressions, and wetland lakes remain in the upper basin; this

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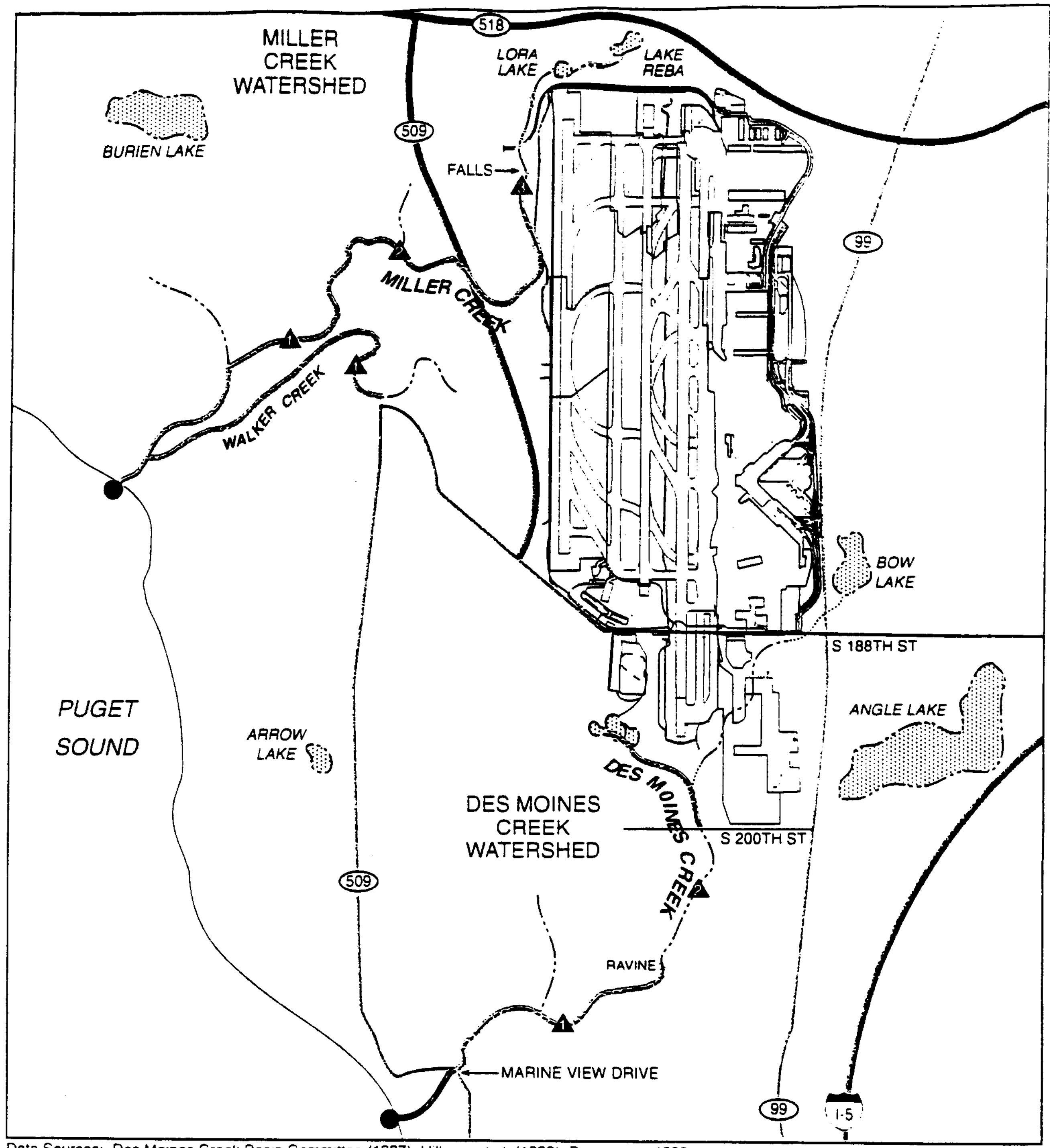

Data Sources: Des Moines Creek Basin Committee (1997); Hillman et al. (1999); Parametrix 1999a

Parametrix, Inc. Sea-Tac Airport Stormwater Management Plan/556-2912-001(48) 4/00 (K)

Figure 4-1
Current Fish Use of Des Moines Creek, Miller Creek, and Walker Creek Basins

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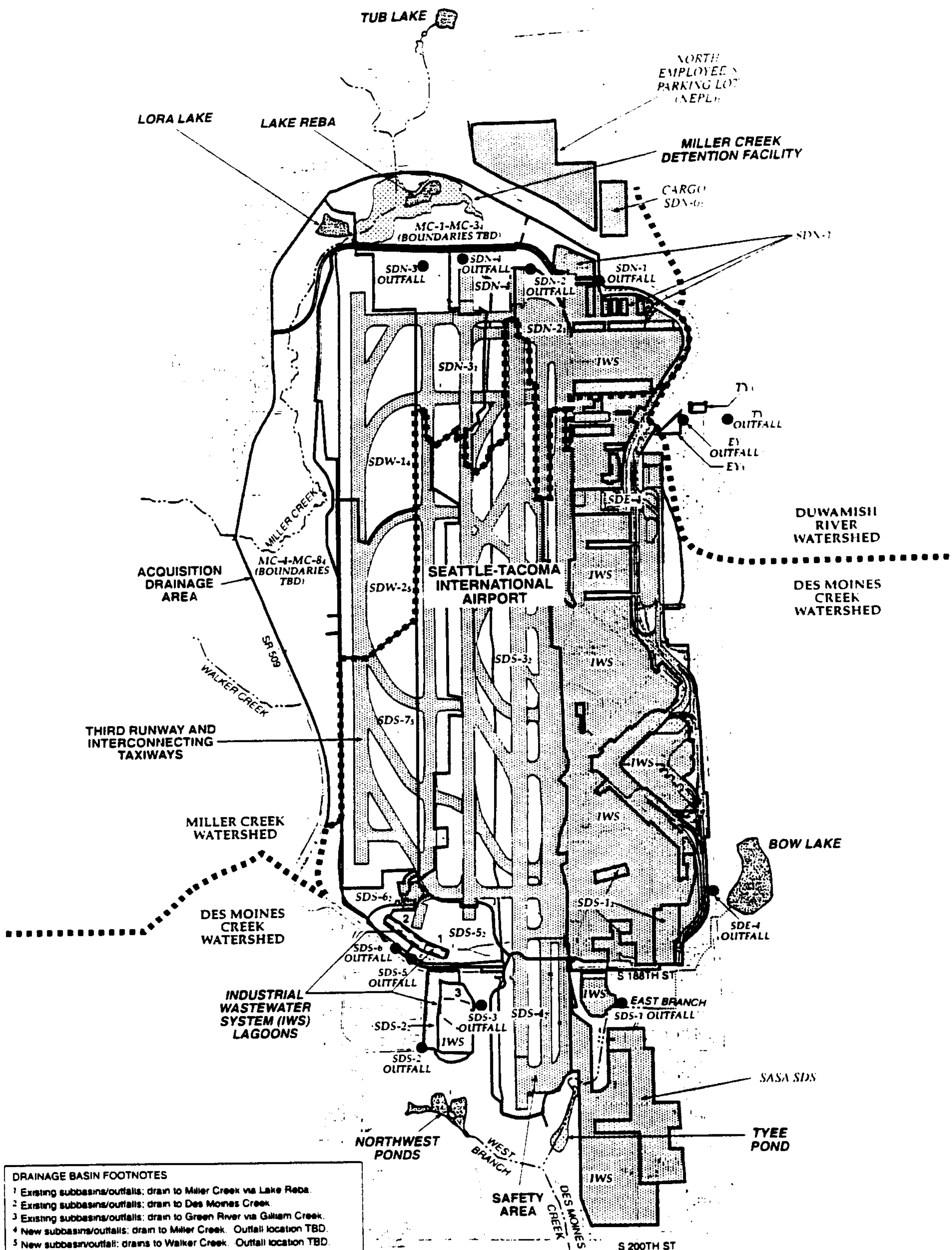

DRAINAGE BASIN FOOTNOTES

1 Existing subbasins/outfalls; drain to Miller Creek via Lake Reba.
2 Existing subbasins/outfalls; drain to Des Moines Creek.
3 Existing subbasins/outfalls; drain to Green River via Gilliam Creek.
4 New subbasins/outfalls; drain to Miller Creek. Outfall location TBD.
5 New subbasin/outfall; drains to Walker Creek. Outfall location TBD.
6 New subbasins/outfalls; drain to Des Moines Creek. Outfall location TBD.

NOTE: NPDES-Permitted outfalls indicate monitoring locations. Most stormwater must be conveyed through additional storm drainage pipes before reaching receiving waters. Existing NPDES outfalls locations may be changed during future permit renewals.

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■ ■ ■ ■ ■ Drainage Basin Divide

SeaTac Airport Drainage Basin Boundaries

SDS-2 SeaTac Airport Drainage Basin Name

Water Features

Impervious Surface Area

● NPDES-Permitted Outfall (Existing)

SCALE IN FEET 0 750 1,500

N

Figure 4-2
Future Storm Drainage System Subbasins and Existing NPDES-Permitted Outfalls

area formerly had a more extensive network of headwater wetlands that buffered the stream from winter storms and provided recharge during summer dry periods (May 1996).

In reaches downstream of 1st Avenue S. (RM 1.8), Miller Creek flows through a well-incised ravine and cuts through glacial material before entering Puget Sound via a small estuary. The outlet stream from Burien Lake enters the ravine reach at RM 1.2. A sewage treatment plant operates alongside Miller Creek at approximately RM 1.0. Walker Creek, an anadromous fish-bearing stream that originates in wetlands west of STIA and SR 509, enters Miller Creek approximately 300 ft upstream of its mouth, in a park just upstream of the Miller Creek estuary (see Section 4.1.2).

A waterfall, which drops over a hardpan lip at about RM 3.1, has been described as a complete barrier to upstream migrations of anadromous fish (Williams et al. 1975; Ames 1970). That assessment agrees with local historical anecdotes that make many references to salmon in Miller Creek up to about the waterfall location, but not beyond (see Figure 4-1). Recent spawning surveys conducted by Trout Unlimited (Batcho 1999, personal communication) have also identified this waterfall as the upper limit to coho salmon distributions in Miller Creek.

While this waterfall appears to serve as an effective migration barrier based on these reports, empirical information suggests that salmonids may be capable of leaping the waterfall. Parametrix measured hydraulic conditions of the waterfall on November 8, 1999, during the period when spawning coho salmon are present in Miller Creek. On this date, stream flow was estimated to be 12 cubic ft per second (cfs) and was below bank-full conditions. The vertical drop of 4 ft (measured from the upstream crest to the surface of the plunge pool) was within the maximum jumping height (7.3 ft) reported for coho salmon (Reiser and Peacock 1985). The plunge pool at the base of the waterfall was 5.7 ft deep and exceeded the vertical drop by more than 1.25 times, thereby providing good leaping conditions for upstream migrants (Stuart 1962). The falling water enters the plunge pool at a nearly 90-degree angle, allowing a standing wave to develop, which provides fish with additional vertical momentum to surmount the falls. Water upstream of the crest is approximately 6 inches deep, which is the minimum depth necessary for successful landing by coho salmon (Powers and Orsborn 1985). Surface velocities measured upstream of the falls crest ranged from 11 to 12 ft per second, within the limits of sustained and lower darting swimming speeds reported for coho salmon (Bell 1973).

While these observations suggest coho salmon may be physically capable of ascending the waterfall, several factors may explain why they have not been reported upstream of this location:

- Hydraulic conditions are variable during the spawning season, and are not often conducive to ascending the falls.
- Observations of spawning coho in Miller Creek are limited, and may not have occurred when coho salmon may have been present above the falls.
- Upstream habitat conditions are not favorable to the perpetuation of coho salmon capable of ascending the waterfall.
- The need to ascend the waterfall may be density dependent and coho salmon do not occur in numbers sufficient to prompt leaping into vacant habitats. Alternatively, those coho unable to successfully defend spawning areas below the falls are also unable to ascend the falls.

Sampling has found threespine stickleback (*Gasterosteus aculeatus*), pumpkinseed sunfish (*Lepomis gibbosus*), black crappie (*Pomoxis nigromaculatus*), and cutthroat trout (*O. clarki*) in Miller Creek above these falls (see Figure 4-1; Parametrix 1999a). The warmwater fish species are associated with Lora Lake and Lake Reba, and the lower velocity, fine substrate reaches of upper Miller Creek. Only coho and cutthroat were found rearing below the falls at RM 3.1 (Parametrix 1999a). However, chum salmon (*O. keta*) also spawn in lower Miller Creek (Hillman et al. 1999). During these surveys, no chinook or bull trout were observed.

Downstream from the falls, culverts under 1st Avenue S. and roads near RM 2.0 have been evaluated as impassable to fish (Williams et al. 1975; Ames 1970). However, adult coho have been found upstream of the culverts (Batcho 1999, personal communication).

The lower basin has benefited from instream habitat restoration conducted by Trout Unlimited. The goal is to increase the pool to riffle ratio of stream project segments from the original value of 13:87 calculated when work began in the 1980s, to a level approaching 50:50 (Batcho 1999, personal communication). The goal is to also improve pool quality for rearing juvenile salmonids and increase habitat complexity. Coho salmon returning to the lower basin appear to have responded favorably; recent returns number about 300 adults per year. In fully restored habitat, the expectation is that Miller Creek would support between 700 and 1,200 adult coho per year (Batcho 1999, personal communication).

Miller Creek enters Puget Sound through a private park in the City of Normandy Park. During low tide, the stream flows onto a low-gradient rocky beach composed of 3-inch-minus[17] coarse and fine gravels embedded with sand. To the north, for several hundred feet, the ordinary high water mark (OHWM) is defined by breakwater walls protecting residential property. To the south, for approximately 200 ft, the OHWM is defined by wrack[18] and LWD. The mouth of Miller Creek is affected by tidal activity, which alters stream morphology for approximately 150 ft upstream. Along this tidal channel, the stream is approximately 15 ft wide with overhanging salt marsh vegetation including Pacific silverweed (*Potentilla pacifica*), saltweed (*Atriplex patula*), and sedge (*Carex* sp.). This 15 ft by 150 ft (~ 0.05 acre) area comprises the estuarine area of Miller Creek.[19] (See Section 4.1.2 and Appendix G for further details.)

Low numbers of chum salmon redds were reported by Hillman et al. (1999), who tallied five chum redds in the lower 2.8 km (1.75 mi) of Miller Creek during the 1998-1999 spawning period. These redds were all below 1st Avenue S. Chum salmon commonly spawn in lower stream or river reaches, close to tidewater; they are less exacting in their choice of spawning material than other Pacific salmon. Because emergent fry migrate quickly to saltwater, instream habitat is less critical to their success than for species such as trout or coho, which rear for one to two years in the stream.

The confluence of Miller and Walker creeks is approximately 300 ft upstream from the mouth of Miller Creek. Upstream from the confluence, Walker Creek has a diversion pipe that draws water into a small pond impounded by a control weir. Water leaving the pond enters Miller Creek

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[17] Indicating that 95% of the gravel present would pass through a 3-inch screen.

[18] Wrack is seaweed and other marine debris that is cast up on shore.

[19] This estuary may have been larger prior to development of a private park in the vicinity.

approximately 10 ft upstream of the outfall to Puget Sound. The 3-ft-wide channel is incised approximately 1.5 ft and is tidally influenced from the confluence with Miller Creek to approximately 100 ft from the control weir. Salt marsh plants occur near its confluence with Miller Creek, and cat-tails (*Typha latifolia*) dominate the channel upstream near the control weir.

Estimates of impervious surfaces within the Miller Creek basin range from 49.4 percent based on aerial photo analysis (May 1996) to 23 percent using digitized land use data and Geographic Information systems (Parametrix 1999b). King County Surface Water Management (1987) reported an intermediate value of 40 percent[20].

Condition of Fish Habitat in Miller Creek

The Washington Department of Fisheries reported that Miller Creek had undergone extensive alteration and "total deterioration" due to heavy residential and commercial growth in the drainage in the early 1970s (Williams et al. 1975). Stream conditions necessary to adequately support spawning and rearing of salmonids "were virtually nonexistent" upstream of 1st Avenue S. (RM 1.9) due to excessive amounts of sand and silts that comprised 70 to 100 percent of the bottom substrate (Ames 1970). King County's Surface Water Management (1987) evaluation of the Miller Creek basin noted that the high level of urbanization had degraded water quality, increased the volume and rate of storm flows, promoted erosion and mass wasting processes, and destroyed riparian habitat and vegetation.[21] These factors (summarized in Table 4-1) had greatly reduced the habitat quality of streams, which in turn affect fish populations.

Miller Creek Stream surveys have been completed by Trout Unlimited (1993), Luchessa (1995), Parametrix (1999a), and Hillman et al. (1999). The 1995 survey by Luchessa was conducted as a Level I Stream Special Study using King County methodology (King County Building and Land Development 1991). Surveys agreed on Miller Creek's deteriorated habitat, particularly in the upper basin above RM 1.9. Factors contributing to loss of instream habitat included: degradation of water quality by pollutants, sediment, eutrophication of lakes and wetlands, and filling of wetlands; loss of protective streamside vegetation; loss of instream large organic debris, natural meanders, and other diversity. In addition, high water temperatures in Miller Creek during the summer constitute a water quality concern, as do high fecal coliform counts, low dissolved oxygen (DO) levels, and residues of lawn and garden chemicals, especially in the upper reaches (Parametrix 1999a).

In Miller Creek, benthic macroinvertebrate sampling near the MPU projects found benthic index of biotic integrity[22] (B-IBI) scores of 10. These scores are similar to scores observed in other urban streams subjected to hydrologic and habitat degradation (Kleindl 1995; Fore et al. 1996; Horner et al. 1996; Ecology 1999a; May et al. 1997). Studies of Puget Sound lowland streams have demonstrated that the macroinvertebrate community, as evaluated through B-IBI analysis, correlates to fish use.

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[20] These variations are due to differences in analytical methods and resolution available.

[21] Despite reported water quality degradation, Miller Creek is not on the 303(d) list of impaired waterbodies.

[22] B-IBI for Puget Sound lowland streams (Kleindl 1995) quantifies the overall biotic condition of a stream based on measurements of benthic macroinvertebrate diversity, abundance, and species composition. B-IBI scores for streams in the Puget Sound lowlands correlate with levels of urbanization (Fore et al. 1996; Horner et al. 1996) and fish use (Ecology 1999a; May et al. 1997).

Table 4-1. Environmental baseline conditions in Miller Creek, near Seattle-Tacoma International Airport.

Pathways: Indicators	Environmental Baseline: Properly Functioning	At Risk	Not Properly Functioning	Explanation
Water Quality:				
Temperature			X	Commercial, residential, and agricultural modifications to vegetation along the stream corridor have impacted ambient stream temperature. Causes of increased stream temperatures include the loss of riparian shading, impervious surfaces within the watershed, and the existing stormwater conveyance system. Daily fluctuations in water temperatures are greater in areas where riparian shading has been reduced. Stormwater systems and impervious surfaces have altered basin hydrology by conveying runoff rapidly to the stream. Runoff collected from impervious surfaces during summer may periodically contribute to temperature problems. Reduced infiltration may cause reductions in base flows, which may increase water temperatures during the summer low-flow periods.
Sediment			X	Urban developments within the watershed have altered native soils and vegetation resulting in increased sedimentation in Miller Creek. Sedimentation from agricultural runoff as well as from channel alterations occurs at Vacca Farm. Several reaches with heavy sedimentation (highly embedded substrates) are apparent. Unmaintained culverts in low-gradient reaches tend to retain small substrates and reduce the capacity of the streambed to mobilize. Historic changes such as stream channelization and the removal of LWD have increased stream degradation and fine sediment input. Historic loss of wetlands further reduces the basin's capacity to buffer sediment inputs.
Chemical and Nutrient Contamination		X		Residential development has resulted in replacement of riparian vegetation with lawns. Agricultural runoff from urban development may contain fertilizers, herbicides, pesticides, metals, oil and grease as pollutants that flow directly into the creek. Failed septic systems may also discharge nutrients and oxygen demand to the creek. The increase in nutrients could increase primary production and respiration, ultimately reducing DO, especially during summer.
Habitat Access:				
Physical Barriers			X	Several culverts may be barriers to migrations of resident and anadromous fishes at different times of the year, depending on flow conditions. The lack of LWD in the channel and alteration of stream hydrology may alter the ability of fish to pass a natural fall at approximately RM 3.0.

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Table 4-1. Environmental baseline conditions in Miller Creek, near Seattle-Tacoma International Airport (continued).

Pathways: Indicators	Environmental Baseline: Properly Functioning	At Risk	Not Properly Functioning	Explanation
Habitat Elements:				
Substrate			X	Gravel accumulations suitable for spawning by anadromous salmonids occur at several locations in the channel. Smaller accumulations suitable for resident salmonid spawning are more frequent; however, most spawning substrates are heavily embedded with silt and sand at levels greater than 30%.
Large Woody Debris			X	Historically, LWD has been cleared from the channel. The reduction or elimination of a native riparian area has impacted the recruitment of coniferous LWD. Loss of LWD has altered channel morphology resulting in reduced sinuosity, decreased pool to riffle ratio, and limits cover and habitat. Non-coniferous LWD recruitment occurs; however, it is routinely cleared from streams by homeowners.
Pool Frequency			X	Several deep pools exist. However, most are formed by modified channel features (e.g., below culverts, riprap, etc.) and lack quality habitat cover.
Off-channel habitat			X	Residential development has increased channelization and degradation, thereby eliminating opportunity for hydrologically connected seasonal habitats along stream margins. This has decreased side channel salmonid rearing habitat. Historic filling of riparian wetlands and armoring of stream banks may have decreased hydrologic connection to secondary channels.
Refugia			X	Channelization and reduction of instream structure decreases resting areas for fish. Loss of LWD and increased channel scouring reduces habitats available, especially low-velocity areas for juvenile fish. Riparian alterations, channelization, and lack of LWD result in few bank undercuts. Development to stream banks, channelization, and filling has resulted in loss of wetland and side channel habitat for rearing fish. Riparian impacts reduce overhead cover.
Channel Conditions and Dynamics:				
Width/Depth Ratio			X	Width/depth ratios vary considerably along the length of Miller Creek, but are generally low in channelized reaches and more favorable in less-developed reaches.
Streambank Condition			X	Condition of streambanks in the basin is variable. The Vacca Farm reach is channelized; however, riparian vegetation tends to stabilize these reaches with minor undercuts. Several reaches through residential neighborhoods contain large non-coniferous trees that stabilize banks with undercuts. Other areas are armored with riprap or other artificial bank structures. Lower reaches contain areas with natural banks, but most associated vegetation is relatively small.

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Table 4-1. Environmental baseline conditions in Miller Creek, near Seattle-Tacoma International Airport (continued).

Pathways: Indicators	Environmental Baseline: Properly Functioning	Environmental Baseline: At Risk	Environmental Baseline: Not Properly Functioning	Explanation
Channel Conditions and Dynamics (con't):				
Floodplain Connectivity		X		Except for the Vacca Farm area, incised streams of this nature lack a significant floodplain. Some wetlands are hydrologically connected to the channel. In the mid-basin, many residential yards are modified to drain directly to the stream banks, and stormwater is conveyed directly back to the channel. Wetlands have been filled to enlarge developable areas. Impervious surfaces are extensive and may comprise up to 49% of the basin area.
Flow/Hydrology				
Peak/Base Flows			X	Negative effects of stormwater runoff in the upper basin have been moderated through regional and STIA detention ponds. Most runoff from residences and roads in the mid and lower basin is conveyed directly to the channel, with little or no detention. Current conditions result in strong hydrographic peaks immediately following precipitation. Reduced infiltration and water withdrawals reduce summer base flows.
Drainage Network Increase			X	Impervious surfaces are extensive throughout the basin including the airport, roads, residences, and commercial development. Most runoff from impervious surfaces is conveyed through an extensive network of stormwater pipes and open drainage ditches. This increase in drainage network accentuates peak runoff rates.
Watershed Conditions:				
Road Density and Location			X	Roads, parking lots, and other impervious surfaces are extensive throughout the basin.
Disturbance History			X	Human disturbances in the basin are extensive. Residential development in the mid and lower basin have maintained some riparian areas.
Riparian Reserves			X	Riparian areas have been extensively altered. The upper basin associated with the airport has little functioning riparian area. Riparian areas are extensively altered in agricultural areas. Limited functioning riparian areas exist in residential areas, but these are fragmented and have been invaded by exotic species which dominate many locations.

Specifically, coho salmon abundance diminishes in streams with B-IBI scores of 33 or lower; these degraded stream reaches were used by resident cutthroat and not by anadromous salmon (Ecology 1999a; May et al. 1997). These findings are consistent with observations of fish use in Miller Creek and support surveys that suggest the portions of the creek adjacent to the Master Plan Projects do not currently provide high-quality habitat for coho salmon.

4.1.2 Miller Creek Estuary

A small estuary occurs where Miller Creek enters Puget Sound. Analysis of baseline conditions in the estuary (Table 4-2) indicate significant modification of this area by park development. As Miller Creek approaches the beach (Appendix G, Figure G-1), it is bordered by a private park to the south and several houses to the north. The park is mainly a grassy area with deciduous trees growing near the creek bank. The creek enters the beach about 75 ft downstream of a small footbridge and an adjacent house (Appendix G, Figure G-1).

The shoreline adjacent to Miller creek is predominantly gravel and sand with driftwood marking the high tide mark. This shoreline type continues for several hundred feet north and south of the creek where houses and cement bulkheads have been built at the high tide mark. The slope of the upper intertidal beach is moderate, dropping approximately 5 ft over a distance of 30 ft, then gentle into the water, dropping approximately 4 ft over 150 yards to mean lower low water (MLLW).

The intertidal zone at the mouth of Miller Creek is composed predominantly of mixed gravel and sand. Some cobble, boulders, and sandy areas are less present. The creek channel in the upper intertidal zone contains more cobble than adjacent areas.

The channel is vegetated with green algae (*Enteromorpha intestinalis).* The substrate has some attached barnacles, mussels, and snails. Upper intertidal areas adjacent to the stream have very little algae or other attached marine life, however amphipods and isopods are abundant under rocks and in the sand. In the middle intertidal zone, *E. intestinalis* becomes less abundant in the creek channel, while barnacles and mussels become the dominant species adjacent to the creek. In the lower intertidal zone, the creek channel is poorly defined and the substrate within and adjacent to the creek channel are similar (mixed gravel and sand). Barnacles and mussels are present, but less dense than found in the middle intertidal zone. Additionally, species of brown, red, and green algae are all sporadically present and bivalve siphons can be observed in the sandy areas.

4.1.3 Walker Creek

Walker Creek drains an approximately 2.5-mi^2 subbasin of the Miller Creek watershed. The creek originates in a 30-ac wetland (Wetland 43) located between Des Moines Memorial Drive and SR 509. The stream flows through both residential and commercial development before its confluence with Miller Creek approximately 300 ft upstream from Puget Sound. Much of the riparian areas adjacent to the creek have been eliminated or altered by adjacent development.

Walker Creek parallels Miller Creek for roughly one-half its length and they share similar effects from urbanization. KCSWM (1987) reports several problems in the Miller/Walker Creek watershed created by urbanization; these include excessive runoff from streets, parking lots, and

Table 4-2. Environmental baseline conditions in the Miller Creek estuary, near Seattle-Tacoma International Airport.

Pathways: Indicators	Environmental Baseline: Properly Functioning	Environmental Baseline: At Risk	Environmental Baseline: Not Properly Functioning	Explanation
Water Quality Elements:				
Sedimentation and Turbidity		X		Urban development in the watershed has likely altered rates of sediment deposition and turbidity in the estuary compared to natural conditions. Increased rates of sediment deposition could decrease food availability for salmon.
Dissolved Oxygen		X		Removal of riparian vegetation can increase water temperature and biological production. Especially during warm weather, these factors can reduce DO and cause stress for salmon.
Water Contamination		X		Runoff from urban development in the watershed has likely increased nutrient loading to the estuarine environment. Runoff from urban development may also contain various inorganic and organic contaminants.
Sediment Contamination		X		Urban and shoreline development increases the potential for sediment contamination in the estuaries.
Physical Habitat Elements:				
Substrate/Armoring			X	Miller Creek estuary is located within a private park and is confined on both sides with riprap and incised banks. The substrate is composed of gravels embedded with fines.
Depth/Slope		X		The inter-tidal beach is a low-gradient shallow stream section confined by a rocky bar. The reach of estuary above the mouth is a low-gradient shallow depositional area confined by armored and incised stream banks.
Tideland Condition/ Filling of Tidelands			X	Tidelands have been filled to create parkland. Natural wetlands have been filled and are now confined by the park and development.
Marsh Prevalence/ Complexity			X	Tidally influenced wetlands are very small, isolated, and dominated by exotic species. Most of the Miller Creek Estuary has been filled to create a park.
Refugia		X		A side channel in the Miller Creek estuary exists as a small drainage from an artificial pond which may provide refugia during high flows. Overhanging bank vegetation and undercut banks are present for several hundred feet above the estuary.
Physical Barriers	X			No artificial physical barriers are present. Two footbridges cross the stream near its mouth.

Table 4-2. Environmental baseline conditions in the Miller Creek estuary, near Seattle-Tacoma International Airport (continued).

Pathways: Indicators	Environmental Baseline: Properly Functioning	At Risk	Not Properly Functioning	Explanation
Current Patterns	X			Current patterns in offshore areas have not been modified by in water structures.
Salt/Fresh Water Mixing Patterns and Locations		X		The saline influence of Miller Creek Estuary is limited to a few hundred feet above the mouth of the stream. The saline influence is limited to the incised stream and its small side channel and has likely been reduced by filling of wetlands. Elevation, grade, and flow rates limit the upper extent of the saline influence of Miller Creek.
Biological Habitat Elements :				
Benthic Prey Availability	X			Filled tidelands have reduced estuarine habitat available to benthic prey. Potential diversity and abundance appear normal for the given substrate.
Forage Fish Prey Availability	X			Based on macrophyte and benthic prey availability, we presume that typical forage fish prey are present.
Marine Vegetation	X			Where substrate allows, typical green, red, and brown macrophytes are present in the intertidal zone.
Exotic Species			X	Non-native vegetation (grass and blackberry) dominate the creekside vegetation above Miller Creek's bank. No exotic marine vegetation is present.

commercial areas that has increased the volume and rate of storm flows. These increased flows have lead to mass-wasting and stream erosion, flooding, and loss of habitat. Runoff from this development has also reduced water quality and impaired fish usage.

Even though coho salmon occur in the lower reaches of Walker Creek (Batcho 1999, personal communication), the absolute upstream limit of coho use has not been documented. Coho use in Walker Creek is approximated in Figure 4-1. Hillman et al. (1999) conducted spawning surveys in Walker Creek from October 1998 to March 1999, and tallied 66 coho redds in the lower 3.6 km (2.3 mi). They also found seven chum redds up to river mile (RM) 1.35, and one potential cutthroat redd in the lower 1500 ft of the creek. During these surveys, chinook or bull trout were not observed.

While a small portion of the Walker Creek watershed (approximately 5.2 ac) will be developed for the third runway project, the project will not remove or directly alter fish habitat in Walker Creek. The runway project would fill about 0.26 ac of Wetland 44 (upslope of the defined Walker Creek channel and fish habitat). Potential indirect impacts to the creek could occur as a result of changes in water quality and hydrology.

4.1.4 Des Moines Creek

The Des Moines Creek watershed covers about 5.8 mi^2 of predominantly residential, commercial, and industrial area lying within the cities of SeaTac and Des Moines; it also includes a small area of unincorporated King County (Des Moines Creek Basin Committee 1997). STIA occupies 23 percent of the upper Des Moines Creek watershed. Baseline environmental conditions in the creek (Table 4-3) are highly modified from natural conditions by a variety of development and land-use practices.

The headwaters of the east branch (considered the mainstem by most locals) originate at Bow Lake, 3.7 RM from Puget Sound. The upper half mile of the east branch, from Bow Lake downstream to about RM 3, is conveyed through underground pipes. The west branch originates from the Northwest Ponds stormwater detention complex located at the western edge of the Tyee Valley Golf Course and joins the east branch at approximately RM 2.4. Downstream of S. 200th Street (RM 2.2), the stream flows through Des Moines Creek Park, a forested riparian wetland. The park includes an incised ravine at about RM 1.8. The ravine is a high-gradient reach in which the stream has cut to hardpan for most of the length providing little quality fish habitat. The creek is paralleled within this ravine by a paved trail and/or service road and sewer line protected in places by rock bank armoring.

Documentation of fish use in Des Moines Creek is provided in a Des Moines Creek Basin Committee report (1997) and Hillman et al. (1999), and is mapped in Figure 4-1. A variety of native salmonids use the lower 0.4 mile (below Marine View Drive), and include chum, and coho, as well as cutthroat and steelhead (*O. mykiss*) trout. Only steelhead, cutthroat, and coho are known to pass the partial migratory blockage under Marine View Drive. Coho use extends to approximately RM 1.5. The upper plateau reach supports a mixture of cutthroat and non-native warmwater fish species, particularly pumpkinseed sunfish. Largemouth bass (*Micropterus salmoides*) are found in lower numbers than pumpkinseeds in the upper creek. Warmwater fish found in the creek mainstem are presumed to be contributed by larger populations in Bow Lake,

Table 4-3. Environmental baseline conditions in Des Moines Creek, near Seattle-Tacoma International Airport.

Pathways: Indicators	Environmental Baseline: Properly Functioning	At Risk	Not Properly Functioning	Explanation
Water Quality:				
Temperature			X	Commercial and residential development in the stream corridor have impacted riparian conditions, affecting stream temperature. Daily fluctuations in water temperatures are greater in areas where riparian shading has been reduced such as the Tyee Valley Golf Course. Stormwater systems and impervious surfaces have altered basin hydrology by conveying runoff rapidly to the stream. Runoff collected from impervious surfaces during summer may periodically contribute to temperature problems. Reduced infiltration may cause reductions in base flows, which may increase water temperatures during summer, low-flow periods.
Sediment			X	Urban development within the watershed have resulted in alteration of native soils and vegetation resulting in increases in the sediment discharge and transportation in Des Moines Creek. Several reaches with heavy sedimentation (highly embedded substrates) are apparent. Historic changes such as stream channelization and removal of large woody debris (LWD) have increased stream incision and fine sediment input. Historic loss of wetlands may reduce capacity of basin to buffer sediment inputs.
Chemical Contaminant/ Nutrient		X		The Tyee Valley Golf Course may be a source of fertilizer and chemical runoff. Increases in nutrients increase biological activity in the creek, ultimately reducing DO, especially during summer. Residential and commercial development near Bow lake or parking lots south of the runway has likely increased loading of fertilizers, pesticides, metals, and organic hydrocarbons (oil and grease) to the creek.
Habitat Access:				
Physical Barriers			X	Several weirs on the Tyee Golf Course and culverts on Marine View Drive or South 200[th] Street may be barriers to resident and anadromous fish at different times of the year, depending on flow conditions.
Habitat Elements:				
Substrate			X	Gravel accumulations suitable for spawning by anadromous salmonids occur at several locations in the lower reaches of the channel. Smaller accumulations suitable for resident cutthroat trout spawning are more frequent. Most spawning substrates are heavily embedded with silt and sands.

Table 4-3. Environmental baseline conditions in Des Moines Creek, near Seattle-Tacoma International Airport (continued).

Pathways: Indicators	Environmental Baseline: Properly Functioning	At Risk	Not Properly Functioning	Explanation
Large Woody Debris			X	LWD has been cleared from the channel. The reduction or elimination of a native riparian area has impacted the recruitment of coniferous LWD. Loss of LWD has altered channel morphology resulting in reduced sinuosity, decreased pool to riffle ratio and limits to cover and habitat. Coniferous and non-coniferous LWD recruitment occur below S. 200th St. on the east bank of the stream (Parametrix 1997).
Pool Frequency			X	Des Moines Creek streambed does not meet optimal pool frequency conditions in the Tyee Valley Golf Course. Channelization, increased sediment input, alterations to the hydrograph, removal of LWD, and riparian alterations have decreased pool frequency and may have impacted the development of future pool. A high pool frequency occurs below S. 200th St. where the stream grade increases to a step/pool system formed mainly by boulders.
Pool Quality			X	The stream is channelized within the Tyee Valley Golf Course where a few deeper pools exist, especially below weirs. Quality habitat features do not exist within these pools. Boulders and some LWD form several deep pools below S. 200th St.
Off-channel habitat			X	Channelization through the Tyee Valley Golf Course has eliminated opportunities for hydrologically connected habitat along stream margins resulting in a decrease in side channel rearing habitat. Below S. 200th, the steep slope of the creek confines the channel, offering little off-channel habitat.
Refugia			X	Channelization and reduction of instream structure decreases hydraulic heterogeneity resulting in the loss of resting areas for fish. Loss of LWD and increased channel scouring reduces habitats available, especially low velocity areas for juvenile fish. Riparian alterations, channelization, and lack of LWD result in few bank undercuts. Channelization and filling has resulted in loss of wetland and side channel habitat for rearing fish. Riparian impacts also reduce overhead cover. Within the ravine south of S. 200th St., the steep slopes offer some overhanging vegetation and LWD.
Channel Condition & Dynamic:				
Width/Depth Ratio			X	Width/depth ratios vary considerably along the length of Des Moines Creek, but is generally low in channelized reaches and more favorable in less developed reaches.
Streambank Condition			X	Condition of streambanks in the basin is variable. The upper portion of the stream is largely culverted or channelized through parking lots, streets, and a golf course. Stream width is narrow, with portions of the banks containing riprap. Lower reaches (below S. 200th St.) of the stream contain areas with natural banks and forested riparian vegetation.

Table 4-3. Environmental baseline conditions in Des Moines Creek, near Seattle-Tacoma International Airport (continued).

Pathways: Indicators	Environmental Baseline: Properly Functioning	At Risk	Not Properly Functioning	Explanation
Floodplain Connectivity		X		Large wetlands are connected to the channel occur on the Tyee Valley Golf Course. Some stormwater detention exists in the upper basin associated with STIA. Wetlands have been filled to enlarge developable areas.
Flow/Hydrology:				
Peak/Base Flows			X	Impervious surfaces are extensive and may comprise up to 49% of the basin area. Little of this area receives adequate stormwater management. Return of stormwater in the upper basin has been moderated through detention ponds associated with airport runoff. Most runoff from residences and roads in the mid and lower basin is conveyed directly back to the channel, with little or no detention. Current conditions likely result in strong hydrographic peaks immediately following precipitation.
Drainage Network Increase			X	Impervious surfaces are extensive throughout the basin and include the roads, residences, commercial development, and airport facilities. Most runoff from impervious surfaces is conveyed through ditches and pipe systems to the creek without adequate stormwater management.
Watershed Conditions:				
Road Density & Location			X	Roads are extensive throughout the basin.
Disturbance History			X	Basin disturbances are extensive, however, parkland or residential development in the mid and lower basin have maintained some riparian areas.
Riparian Reserves			X	Riparian areas have been extensively altered in the upper reaches. The riparian areas upstream of S. 200th St. are extensively altered by golf course and other development. Lower reaches contain a relatively continuous riparian corridor. The width of the corridor is variable and frequently limited by residential uses and exotic species.

and possibly also the Northwest Ponds. Chinook salmon and bull trout have not been observed in Des Moines Creek.

A cascade at RM 1.5 in the ravine reach was mapped as impassible to upstream-migrating fish (Williams et al. 1975). However, recent surveys have not identified this cascade as a fish barrier (Resource Planning Associates et al. 1994). The Midway Sewage Treatment Plant is located at RM 1.1 where the ravine widens. The channel in this reach contains several aging weirs originally intended to be fish-passage structures; in their present state they may act as impediments to fish passage. Just below the treatment plant, the gradient decreases and the stream develops a floodplain that allows a more meandering channel, better habitat conditions, and well-developed riparian vegetation.

At Marine View Drive (RM 0.4), a 225-ft-long box culvert conveys the creek under the roadway, but acts as an impediment to migrating salmon and trout because of its high velocities (greater than 7 ft per second) and length (225 ft) (Des Moines Creek Basin Committee 1997). Below Marine View Drive, the stream reach through Des Moines Beach Park provides some of the most accessible and more heavily spawned fish habitat in the system. Hillman et al. (1999) found coho and chum redd densities of 26.3 and 20.0 redds/mi, respectively, during studies in this reach in 1998-1999.

Condition of Fish Habitat in Des Moines Creek

King County has estimated that the Des Moines Creek basin is 32 percent impervious surface, based on digitized land use data and Geographic Information systems (Parametrix 1999a). May (1996) reported a value of 49.1 percent, based on aerial photo analysis. Previous stream studies and habitat inventories dating back to 1974 (Des Moines Creek Basin Committee 1997) established that Des Moines Creek has been severely degraded by urbanization. Little usable salmonid habitat exists in the system upstream of S. 200th Street. Downstream of S. 200th Street, where the stream flows through a forested wetland area, a short reach harbors resident trout and pumpkinseed sunfish. Better native fish habitat exists in meanders below the Midway Treatment Plant; however, the culvert under Marine View Drive restricts migrating salmon and trout from reaching this habitat. The stream reach through Des Moines Beach Park provides the most fish use, with coho salmon, chum salmon, cutthroat trout, and steelhead observed in this reach.

Des Moines Creek is on the Washington State 303(d) list of impaired water bodies for exceeding standards for fecal coliform levels at both storm flows and base flows (Parametrix 1999a; Ecology 1998a; Des Moines Creek Basin Committee 1997). High water temperatures in summer have also been identified as a water quality concern (Parametrix 1999a; Des Moines Creek Basin Committee 1997).

Des Moines Creek enters Puget Sound through Des Moines Park located in the City of Des Moines. During low tide, the stream flows onto a low-gradient rocky beach composed of 3-inch-minus coarse and fine gravels embedded with sands. To the north, for several hundred feet, the OHWM is defined by a wrack of large woody debris. To the south for approximately 50 ft, the OHWM is defined by breakwater walls protecting residential property. Beyond the house to the south, the beach is composed of riprap protecting the Des Moines Marina.

4.1.5 Des Moines Creek Estuary

A small estuary is present where Des Moines Creek enters Puget Sound. Baseline environmental conditions (Table 4-4) in this estuary have been highly modified by park development. Before entering the beach, Des Moines Creek runs through Des Moines Beach Park consisting of lawn, roads, parking areas, etc. (Appendix G, Figure G-1). Two bridges cross the creek and the stream bank is stabilized with riprap.

The marine shoreline for about 200 ft north of Des Moines Creek is stabilized with riprap before a vegetated bluff starts and continues north. Approximately 400 ft north of Des Moines Creek some houses are protected by cement bulkheads located near the high tide mark. Immediately south of the creek, a riprap wall runs south and west across the beach to a fishing pier and the Des Moines Marina. Within the marina, the shoreline continues as riprap. The beach at the creek mouth and north of the creek has a gentle slope, dropping approximately 5 ft over 100 yards. South of the creek mouth, the riprap wall drops steeply from the high tide mark to the lower intertidal zone over a span of 25-30 ft.

The intertidal zone at the mouth of Des Moines Creek is composed of gravel and sand with some cobble and boulders. This substrate type is fairly uniform throughout the intertidal zone north of the creek. South of the creek, starting at the fishing pier, riprap covers the entire intertidal zone. *E. intestinalis* is the dominant algae in the upper intertidal zone, covering cobble and boulders about 75 ft into the Des Moines Creek channel. Lesser amounts of *E. intestinalis* are attached to rocks adjacent to the creek with barnacles sporadically present. The middle intertidal zone is dominated by barnacles and mussels, except for in the stream channel where *E. intestinalis* dominates most cobble with some presence of barnacles. The lower intertidal zone continues to have abundant numbers of barnacles and mussels with green, brown, and red algae being common. Isopods, shore crabs, and snails were more readily found in this zone and bivalve siphons were periodically observed in sandy areas. The riprap south of the creek hosts an intertidal community very different from the gradual beach to the north of the creek. Here, the majority of the intertidal zone is densely occupied by barnacles, mussels, and the red algae *Mastocarpus papillatus*. Littorina snails, and limpets are also abundant throughout this area.

4.1.6 Green River

The Green River watershed is comprised of some 482 mi^2. Development of the Green/Duwamish watershed has resulted in a variety of changes to the basin's suitability for salmonids. This development includes the diversion of Black and White rivers during the early 1900s, construction of Howard Hansen Dam (RM 64) that blocks access to significant habitat, diking of the mainstem below RM 38, forest practices, agriculture, urbanization, and industrialization in the lower Duwamish River. Of the original Green/Duwamish estuary, 97 percent has been filled; 70 percent of its original flow has been diverted to other basins, and 90 percent of the original floodplain is no longer flooded on a regular basis (USACOE 1997; USEPA 2000a). The city of Tacoma diverts flows in the upper watershed for use as a municipal water supply. The middle portion of the basin remains primarily rural; however, agriculture has increased sediments and nutrients in the river, degrading water quality as well as salmon spawning and rearing habitats. The lower reaches are becoming increasingly urbanized. The tidally influenced Duwamish Waterway has been extensively dredged and channelized for maritime use by the Port of Seattle and private industry.

Table 4-4. Environmental baseline conditions in the Des Moines Creek estuary, near Seattle-Tacoma International Airport.

Pathways: Indicators	Environmental Baseline: Properly Functioning	At Risk	Not Properly Functioning	Explanation
Water Quality Elements:				
Turbidity		X		Urban development in the watershed has likely altered sediment deposition rates and turbidity in the estuary compared to natural conditions. Increased rates of sediment deposition could decrease food availability for salmon.
Dissolved Oxygen		X		Removal of riparian vegetation can increase water temperature and biological production. Especially during warm weather, these factors can reduce DO and cause stress for salmon.
Water Contamination		X		Runoff from urban development in the watershed (including the nearby marina) has likely increased nutrient loading to the estuarine environment. Runoff from urban development also contains various inorganic and organic contaminants.
Sediment Contamination		X		Urban and shoreline development (including the nearby marina) increases the potential for sediment contamination in the estuary
Physical Habitat Elements:				
Substrate/Armoring			X	The estuary is located within the Des Moines Beach Park and is confined on both sides with riprap. The substrate is composed of gravels embedded with fines. Several pieces of woody debris and root wads are cabled within the riprap.
Depth/Slope		X		The inter-tidal beach is at approximately a 3% grade. Creek flow is dispersed over gravels and cobbles. The reach of estuary above the beach is a low-gradient shallow depositional area confined by armored banks.
Tideland Condition/ Filling of Tidelands			X	Tidelands have been filled to form the Des Moines Beach Park.
Marsh Prevalence/ Complexity			X	No vegetated wetlands are present.
Refugia			X	The saline influence of Des Moines Estuary continues a few hundred ft upstream of the riprap-confined mouth of the stream. No refugia exist within this area.
Physical Barriers				The Des Moines Estuary is confined to a narrow channel by riprap and a footbridge. A log weir confines the end of the saline influence.

Table 4-4. Environmental baseline conditions in the Des Moines Creek estuary, near Seattle-Tacoma International Airport (continued).

Pathways: Indicators	Environmental Baseline: Properly Functioning	At Risk	Not Properly Functioning	Explanation
Current Patterns			X	The nearby marina may have altered current patterns compared to natural conditions.
Salt/Fresh Water Mixing Patterns and Locations			X	The log weir at the upstream end of the estuary reduces the extent of mixing during high tides.
Biological Habitat Elements:				
Benthic Prey Availability		X		Riprap in the intertidal zone south of the creek has altered the habitat available to benthic prey in the marine environment. North of the creek, substrate conditions appear natural, and benthic prey abundance and diversity appears typical.
Forage Fish Prey Availability		X		The steep grade of the riprap south of the creek alters nearshore habitat and fish species present.
Marine Vegetation		X		The channel and the stream banks are unvegetated from the mouth to the upper extreme of the saline influence. Riprap south of the creek hosts macrophyte communities which differ from those on natural substrate.
Exotic Species		X		Vegetation adjacent to the channel consists of non-native lawn species.

Of the more than 30 fish species identified in the Green River basin, eight are anadromous salmonids (i.e., chinook salmon, coho salmon, sockeye salmon, chum salmon, pink salmon, steelhead, sea-run cutthroat trout, and bull trout) (Tacoma Public Utilities 1998). Chinook and other salmon spawn in the Green River, several hundred feet from the wetland mitigation site (Pentec Environmental 1999; Malcolm, personal communication, 1999). Baseline environmental conditions in the Green River near the wetland mitigation project (Section 4.2) are summarized in Table 4-5.

4.1.6.1 Gilliam Creek

Gilliam Creek is a small creek that discharges to the Duwamish River in the vicinity of the Auburn wetland mitigation site. This creek is a tributary to the Duwamish River and is used mainly by resident fish because of migration barriers that limit anadromous fish passage (Taylor Associates 1996 in City of Tukwila 1997). This creek, which has been impacted by development, is extensively culverted and receives stormwater runoff that causes high peak flows and low base flows. Culverts limit adult salmonid access to this tributary. The resident fishes expected to inhabit this stream and long piped sections include cutthroat trout, western brook lamprey (*Lampetra richardsoni*), carp, peamouth (*Mylocheilus caurinus*), largescale sucker (*Catostomus macrocheilus*), threespine stickleback, and sculpin.

Construction of the new water tower will occur in the basins that drain to Gilliam Creek through stormwater outfalls 012 and 013. The potential impact to Gilliam Creek could be increased turbidity and sedimentation during construction. As there will be no increase in impervious surface associated with the water tower construction nor will land use practices change, there will be no changes in hydrology or water quality after the tower is constructed.

4.2 AUBURN WETLAND MITIGATION SITE

The Auburn wetland mitigation site is a 67-ac parcel of land, located west of the Green River in the City of Auburn. The mitigation is planned to provide off-site avian habitat mitigation (see Figure 1-1) to provide in-kind replacement of wetland habitat functions (primarily for avian species) that cannot be mitigated within 10,000 ft of STIA due to wildlife attractants discussed in FAA Advisory Circular #150/5200-33 (1997b).

The site is bordered by active agricultural fields to the north and south, abandoned pastures to the west, and the Green River to the east. The area slopes to the northwest, with elevations ranging from 45 ft in the northwest corner to 52 ft along the eastern property boundary. King County is proposing to construct a trail along the Green River, east of the proposed mitigation project.

The parcel, which was farmed in the past, now supports (1) upland pasture grasses and forbs common to abandoned agricultural land in the Puget Sound basin and (2) an emergent wetland. Overall, habitat quality at the site (and the adjacent grass-dominated uplands) is low due to a dominance of invasive plant species, low plant diversity, and lack of habitat structure. Small mammals may use the area for feeding and breeding, but the site lacks cover from predation. The site may provide foraging habitat for raptors, such as northern harriers (*Circus cyaneus*) and red-tailed hawks (*Buteo jamaicensis*). Bald eagles could forage along the Green River, adjacent to the site. For most passerine bird species, the site lacks habitat structure for nesting, protection from predation, thermal cover, or perching. A narrow band of shrub vegetation along the site's southern boundary offers limited forage and perching habitat. The site is currently zoned single-family residential (R2) by the City of Auburn; the 1995 Comprehensive Plan designation is single-family (Auburn 1995).

Approximately 6 ac of emergent wetlands occur on the site (David Evans and Associates 1995; Parametrix 1996). The wetland bisects the site and directs runoff across the site. Wetland hydrology is sustained by a seasonally high groundwater table, which is at or near the ground surface during much of the rainy season. Soils have relatively low permeability. The wetland extends to the north where it physically connects to the 100-year floodplain of the Green River backwater area through a series of roadside ditches and drainage channels. During rainy periods, the wetland conveys surface water from farmland south of the site north toward the Green River.

The action areas for the Master Plan improvement projects includes the Auburn mitigation site to be directly affected by project construction, and downslope drainage ditches that could be indirectly impacted by the project. The potential indirect impacts include changes in hydrology or water quality as a result of construction activities.[23] These drainage channels connect the Auburn Mitigation Site to the Green River (see Figure 3-4).

The completed project will connect to the Green River (about 1 mile north of the site) via (1) a flood control outlet channel north of the project, which connects to (2) an existing drainage channel that flows along 277th Street and then (3) north via culverts under the road embankment, which connect to (4) existing channels that flow north to the Green River (see Figure 3-4). Rainwater and seepage runoff from the site will drain from the site to the Green River. During flood events, the Green River will back water into drainage channels and the wetland mitigation (events greater than the approximate 10-year flood). The existing farm drainage ditch between the site and South 277th Street will be enlarged to create the outlet channel for the wetland[24]. All other drainage channels will be unchanged by the project.

Adjacent areas of the Green River support chinook salmon and bull trout. Overwintering bald eagles use the Green River for foraging, and may perch in trees located 300 ft from the mitigation site.

The wetland mitigation is not expected to provide fish habitat. Due to the elevation of the mitigation site relative to the Green River, and conditions of the channel connecting it to the Green River (potential passage barriers, length, depth, duration of flow, etc.), it is unlikely that the wetland will be accessible to listed fish species. Flows in the outlet channel are expected to be intermittent, and quite slow when they occur. The wetland mitigation might provide slight beneficial indirect effects for fish in the Green River through export of organic matter and invertebrate food production. Other expected benefits to Green River fish from the mitigation site include flood storage and water quality improvement functions, though fish could access the projects during flood events greater than the 10-year flood.

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[23] This includes discharges of construction dewatering. These discharges will be made to the Green River using existing ditches and outfalls. Discharged water will meet state water quality standards, and include pre-discharge treatment for sediment removal if necessary.

[24] The Port has secured easements necessary for enlarging this ditch.

Table 4-5. Environmental baseline conditions in the Green River near the Auburn Wetland mitigation project.

Pathways: Indicators	Environmental Baseline: Properly Functioning	At Risk	Not Properly Functioning	Explanation
Water Quality:				
Temperature		X		Maximum temperature criterion are exceeded for this section of the Green River (RM 35) as listed on Ecology's 303(d) list for temperature (Caldwell 1994).
Sedimentation		X		Bank erosion and runoff may cause high levels of sedimentation within the Green River.
Chemical and Nutrients		X		This section of the Green River is at risk from elevated concentrations of nutrients and fecal coliforms.
Habitat Access:				
Physical Barriers		X		No barriers to fish access exist.
Habitat Elements:				
Substrate		X		Primarily gravel, increased levels of silt could lower the value of this reach for spawning and rearing fish.
Large Woody Debris		X		Due to clearing in riparian areas, limited sources of LWD exist.
Pool Frequency		X		Pools are present, channelization and lack of LWD lower the frequency of pools.
Pool Quality		X		Pool quality is diminished by the lack of LWD.
Off-channel Habitat		X		Limited due to diking farming of riparian areas.
Refugia			X	Lack of LWD and off-channel habitat limits the ability of rearing fish to seek refuge at this site.
Channel Condition /Dynamics:				
Width/Depth Ratio		X		This reach of the Green River appears to be incising.
Stream bank Condition		X		The stream bank on the west side is steep, arising from the OHWM and flood plain at a slope of 3:1 or greater. Banks on the east side are gentler and include an area of forested wetland.

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Table 4-5. Environmental baseline conditions in the Green River near the Auburn Wetland mitigation project (continued).

Pathways: Indicators	Environmental Baseline: Properly Functioning	At Risk	Not Properly Functioning	Explanation
Floodplain Connectivity		X		Connectivity is reduced by agricultural drainage ditches.
Flow/Hydrology:				
Peak/Base Flows		X		Natural flow regime altered by urban and reservoir developments.
Drainage Network		X		Natural drainage network altered by urban and agricultural development.
Watershed Conditions:				
Impervious Surface		X		Impervious surface lacking stormwater treatment has altered natural flow regime and contaminant loading.
Disturbance History	X			Agricultural, forestry, water management, and urban development have created significant disturbances in the watershed.
Riparian Reserves		X		Limited riparian habitat is present or preserved.

The project will require up to 440,000 cy of earth movement. The entire excavation will occur at least 200 ft from the top of the Green River bank. The existing surface water connection between the site and the Green River is more than one mile; this distance will remain unchanged. As with every STIA construction site, the erosion and sedimentation controls described in Section 7.1.3.2 will be applied during construction of the wetland and outlet channel, and construction will occur only in the dry season. In addition, the proposed project is a large depression excavation that is lower than the land between the river and the new wetland. Therefore, stormwater will be collected in the excavation. BMPs would prevent runoff with sediment from entering drainage channels that ultimately drain to the Green River.

In the vicinity of the wetland mitigation project, no woody or native vegetation would be removed, and bald eagle perch habitat would not be directly affected. In the long term, wetland and buffer vegetation planted as part of the wetland mitigation could provide additional perch habitat and the open water and emergent habitats could provide additional forage habitat for eagles.

King County Parks Department has proposed a recreational trail on land it owns adjacent to the wetland mitigation site. The trail project is independent of the wetland project, and its impacts on the environment (and listed ESA species) would be evaluated by the County when engineering and other planning documents are available.

To allow site excavation to begin during May, the shallow water table will be lowered with a dewatering system consisting of well-points and pumps. Groundwater collected by this system will be discharged to the Green River through existing surface ditches. The volume of dewatering water will be very small (2-8 cfs) compared to typical Green River flows (250-2000 cfs that occur during months when the system will operate), and therefore, unmeasurable and insignificant changes to river flows are expected. Dewatering discharges will meet water quality standards, and will be discharged through existing outfalls in a manner that will not cause bank erosion.

Species Evaluations

5. FISH SPECIES EVALUATIONS

Natural and hatchery populations of chinook salmon occur in the Green/Duwamish River watershed. Additionally, natural and hatchery produced chinook salmon from the Puyallup River watershed could pass through the action area near the Miller and Des Moines Creek mouths as they migrate to and from their ocean rearing areas. These watersheds have undergone significant modifications over the last 100 years and these changes have influenced the distribution and use of these aquatic resources by each fish species. The following section reviews the basic life history of chinook salmon and their distribution and use of the Green/Duwamish River and the Puyallup River basin watersheds.

5.1 CHINOOK SALMON

The recently completed ESA status review of Northwest chinook salmon populations defined 15 Evolutionarily Significant Units (ESUs) (each considered a species under the ESA) present in Washington, Oregon, Idaho, and California (Myers et al. 1998). Naturally spawned spring, summer/fall, and fall chinook salmon runs within the Puget Sound ESU were considered likely to become endangered in the foreseeable future (Myers et al. 1998). Available data indicated that the overall abundance of chinook salmon in the Puget Sound ESU had declined substantially from historic levels. This reduction was likely due to the effects of hatchery supplementation on genetic fitness of stocks, severely degraded spawning and rearing habitats throughout the area, as well as harvest exploitation rates exceeding 90 percent for some Puget Sound chinook stocks (Myers et al. 1998).

Following this status review, NMFS designated Puget Sound chinook as threatened in March 1999 (NMFS 1999a,b). A final ruling on critical habitat designation was made in February 2000, and includes all Puget Sound waters, estuaries, and freshwater habitats accessible to Puget Sound chinook salmon. The Duwamish hydrologic units were identified as containing critical habitat for threatened Puget Sound chinook salmon, with the Howard Hansen Dam the upstream extent of critical habitat for the Green/Duwamish River (Myers et al. 1998).

Chinook salmon from the Puget Sound region consist largely of summer and fall run stocks, with juveniles that typically migrate to the marine environment during their first year of life (Myers et al. 1998). These chinook are called "ocean-type" because they rear in freshwater a few months or less, and most of their rearing occurs in the nearshore marine environment. Generally, ocean-type chinook migrate downstream in the spring, within months after emergence, or during the summer and autumn after a brief period of rearing in fresh water (Healey 1991; Myers et al. 1998). A small portion of chinook salmon juveniles from Puget Sound migrate to the marine environment after overwintering in streams (Myers et al. 1998). These "stream-type" fish are typically progeny of spring-run chinook stocks that comprise a small and increasingly rarer component of runs in Puget Sound (Nehlsen et al. 1991). Outmigration of spring chinook begins with increasing spring river flows, typically in March, though some fish can be found emigrating in nearly any month (Williams et al. 1975).

5.1.1 General Chinook Life History

Chinook salmon in Puget Sound are commonly known as either spring-run or summer/fall-run, depending on the time at which the adults return to freshwater. Summer/fall chinook are much more abundant than spring chinook; no self-sustained runs of spring chinook presently inhabit the Duwamish/Green River (although a few spring chinook sometimes return to the Green River). Adult summer/fall chinook typically return to freshwater during July through October and primarily spawn from September through November. Juvenile summer/fall chinook typically spend only about three months in freshwater before emigrating to Puget Sound, and must have access to margin areas of streams during their fry stage.

Upon entering Puget Sound, subyearling chinook salmon smolts typically migrate near the shoreline then move offshore as they grow in size. Yearling chinook salmon, which are typically produced by spring run parents that are uncommon in the project area, probably spend less time in littoral areas of Puget Sound.

Chinook may reside in the Puget Sound region until at least November before migrating to the North Pacific Ocean (Hartt and Dell 1986). Mature chinook salmon return to their natal rivers predominately as three-, four- and five-year-olds.

Juvenile chinook salmon feed opportunistically in Puget Sound. They consume large zooplankton, such as euphausiids and large copepods, amphipods, juvenile shrimp, and larval fishes (e.g., herring and sandlance) (Miller et al. 1977; Simenstad et al. 1982; Fresh et al. 1979). In areas where riparian habitat is abundant near the Sound, terrestrial insects can be an important prey item for juveniles up to 75 mm or so. Larger chinook will typically consume larger prey and the proportion of fish in the diet increases with size.

Chinook salmon that could be present in the action area will most likely be produced from either the Green/Duwamish River (for the off-site mitigation action area) or the Puyallup River (for the STIA-MPU action area). A brief description of each of these stocks is provided below.

5.1.2 Chinook in the Green/Duwamish Rivers – Wild and Hatchery

Chinook salmon returning to the Green River have been a mixture of natural spawning and hatchery chinook salmon since approximately 1904 when the first hatchery fish returned to the Green River Hatchery on Soos Creek. Chinook salmon in the Green River consist primarily of summer/fall run fish. Historically, a spring run also occurred in the watershed. Re-routing of the White River to the Puyallup drainage in 1906 (natural and man-induced), re-routing of Lake Washington and Cedar River to the Ship Canal in 1916, construction of the Tacoma Diversion Dam in 1913 and construction of Howard Hansen Dam in 1961 eliminated access to much of the headwater habitat typically used by spring chinook salmon in this region (Grette and Salo 1986). Although spring chinook salmon are occasionally found in the Green River it does not appear that these fish constitute a self-sustained run.

Fall run chinook salmon begin entering the Duwamish River in mid-June and continue entering the river through early November, with peak entry time occurring in August. Water temperature can be exceptionally warm in the lower river during June through September due to low river flows and the lack of shade. Chinook salmon hold in the lower river (Duwamish to Kent area) until approximately mid-September, depending on temperature and flow (T. Cropp 1999, personal communication). Movement prior to this period is probably constrained by low flows, shallow water in riffles, and warm water temperatures in the lower river. Low oxygen levels in the lower river and estuary (e.g., near 14th Avenue bridge) may also inhibit upstream migration (Miller and Stauffer 1967; Salo 1969) as tagged chinook were documented to avoid areas of low DO and warm water (Miller and Stauffer 1967).

Mainstem spawning occurs between RM 24 and 61; additional spawning occurs in Soos Creek (primarily RM 0.5 to 10 and some tributaries), Newaukum Creek (RM 0-10), and Burns Creek. Most spawning reportedly occurs either below the Gorge (RM 29.6-47.0), or above the Gorge (RM 56.0-61.0, Grette and Salo 1986). However, recent helicopter surveys of the previously unsurveyed Gorge indicate significant spawning there. No chinook spawning is known to occur in Longfellow Creek or other small drainages discharging directly to Puget Sound. No chinook spawning occurs in the Green/Duwamish River within Seattle's built environment.

Peak spawning typically occurs in early October, although some chinook may spawn from mid-September through November. Most females spawn soon after reaching the spawning grounds. Until their death, females guard their redds.

Chinook fry emerge from the gravel during late winter and spring. During 1955, Dunstan (1955) captured fry upstream of Soos Creek during most of the sampling period (mid-February through April). Peak abundance of juvenile chinook in the estuary occurs during late May and early June, although chinook may be present through July (Bostick 1955; Salo 1969; Meyer et al. 1981). However, these timing estimates are undoubtedly influenced by the release of numerous hatchery chinook, which are relatively large at release and likely spend relatively little time in the estuary compared to smaller individuals. Estimated downstream survival of marked chinook salmon in 1967 (1,500 cfs) was 51 to 68 percent (Salo 1969). Survival of marked hatchery chinook decreases significantly with lower flow (Wetherall 1971), presumably because downstream migrants are more vulnerable to predators during low flows.

Estuarine habitat is a critical component in the life cycle of chinook salmon. Chinook fry and small subyearlings tend to use saltmarsh habitat where it is available, and subyearlings tend to use mudflats before moving into deeper waters (Simenstad and Eggers 1981). The length of time that ocean-type chinook spend in the estuary before migrating to the open ocean depends on whether they entered the estuary as fry (shortly after emergence) or as fingerlings which have reared in fresh water into summer. In estuaries, chinook typically feed on small crustaceans and insects. As they grow chinook tend to eat more larval and juvenile fishes, including herring and sandlance (Wydoski and Whitney 1979; Healey 1991).

Within the estuary, juvenile chinook have been observed under pier aprons and along uncovered shorelines, although greater numbers were found along the uncovered shore of the Duwamish area (Weitkamp and Farley 1976). Chinook were observed in surface waters under and along the piers and showed no reluctance to move over deeper water. Chinook were also readily captured by townet in the upper and lower Duwamish, indicating that chinook also occur offshore (Salo 1969). Chinook feed opportunistically on freshwater, marine, and terrestrial prey. Typical prey in the estuary include gammarid amphipods, calanoid copepods, insects, larval fish, mysids, and cumaceans (Parametrix 1990).

Predation by other fish is typically an important cause of mortality, but significant predation has not been identified in estuaries (Pearcy 1992). However, Salo (1969) noted that approximately seven percent of the 7,272 chinook captured in the Duwamish estuary had been attacked by river lamprey, which were especially abundant during the migration period (lamprey are anadromous and spawn during spring). Lamprey marks were also recently observed on four percent of the salmon captured in the Government Locks (Warner and Fresh 1999). The impact of river lamprey on chinook is unknown because some attacked fish may have been killed.

Many juvenile chinook appear to follow the nearshore environment as they emigrate into Elliott Bay and Puget Sound. Extensive sampling of inner and outer Elliott Bay by townet during June and July 1966, indicated chinook were more abundant in the inner bay, but numerous chinook were also captured in the outer bay during early June (Salo 1969). Sampling of juvenile salmon at Pier 91 indicated chinook were present in low numbers from April through early July (Weitkamp and Campbell 1980).

5.1.3 Puyallup River Basin Chinook Salmon

Three runs of chinook salmon inhabit the Puyallup River Basin. These runs include a spring run in the White River tributary, a summer/fall run in the White River tributary, and a fall run in the Puyallup River (WDF et al. 1993). Puyallup River fall run chinook salmon were listed as a stock of special concern by Nehlsen et al. (1991) and spring chinook are considered to be nearing extinction (Salo and Jagielo 1983). WDFW recently listed the status of the White River summer/fall run chinook salmon as unknown due to inconsistent spawner survey data (WDF et al. 1993). Chinook salmon of the Puyallup River basin exhibit primarily ocean-type life history strategies; smolts migrate to the ocean within the first year, mature at ages 3 and 4, and have coastally oriented ocean migration patterns (Myers et al. 1998). Spawning by chinook in the basin occurs either upstream of the City of Puyallup/MASCA wastewater treatment outfall or in tributaries below the outfall. Sampling in the Puyallup River estuary indicated that chinook smolts are present near the mouth of the Puyallup River from mid-April to June. Details of life history timing for spring, summer/fall, and fall run chinook salmon in the Puyallup River basin are discussed below.

Adult migration timing of White River spring chinook is unique among south Puget Sound chinook stocks due to early river entry by adults. Spring chinook enter the Puyallup River from late May through mid-October, and spawn in the White River primarily in September. White River chinook arriving at the adult fish trap at Buckley on or before August 15 are considered spring chinook, while those arriving later are considered summer/fall chinook. Major spawning and holding areas for spring chinook include the lower White River, lower Clearwater River, lower Greenwater River, West Fork White River and Huckleberry Creek (Warren 1994; WDF et al. 1993). Although supplementation occurs at the Muckleshoot Fish Hatchery, the stocked fish are of native origin and spring chinook are considered a native run (WDF et al. 1993). Current efforts by the U.S. Forest Service, Tribes, and WDFW are focussed on rebuilding the population and providing acclimation sites throughout the upper White River watershed. Adults returning to the hydropower facility at Buckley are transported above Mud Mountain Dam to maintain a natural spawning population in the upper White River watershed. Recent escapements of spring chinook to the White River have been chronically depressed, averaging about 100 fish annually (ranged from 10 to 500 between 1978 and 1991; WDF et al. 1993). A second feature of White River spring chinook unique among Puget Sound chinook is that fry overwinter within the river. Outmigration by yearling spring chinook smolts occurs from March through August (Williams et al. 1975).

The summer/fall run of chinook salmon in the White River is considered distinct from the spring run based upon run timing, and distinct from the Puyallup River fall run based upon the geographic distribution of spawners. Summer/fall run chinook are captured in the Buckley trap from August through October, peaking in late August and early September (Salo and Jagielo 1983). Spawning occurs from late September through October in the lower White River, lower Clearwater River, and lower Greenwater River (WDF et al. 1993). Juvenile outmigration occurs within the first year, and juveniles are captured in the Puyallup River estuary from April through June (Shreffler et al. 1990). The summer/fall chinook stock is considered wild, and the stock status is unknown due to inconsistent spawner counts (WDF et al. 1993).

Puyallup River fall chinook salmon are considered distinct from other chinook runs based on their geographic spawning distribution which occurs in the Puyallup River upstream of Sumner, and in tributaries including the Carbon River, South Prairie Creek, Wilkeson Creek, Voight Creek, and Clarks Creek (WDF et al. 1993). Fall chinook spawn primarily from September through October, with most natural production occurring in South Prairie Creek. Non-native chinook releases into the Puyallup River have been made, with the origin of most introductions since the late 1960s from Green River chinook. Status of the fall run chinook in the Puyallup River is unknown due to inconsistent spawner survey data (WDF et al. 1993). Fall chinook smolt outmigrate during the first year and are common estuarine residents of the Lincoln Avenue wetland, located near the mouth of the Puyallup River. Smolts may spend up to 43 days in the estuary from April through June (Shreffler et al. 1990).

5.1.4 Critical Habitat

As part of their responsibilities under the ESA, the NMFS designated critical habitat for the Puget Sound chinook ESU (NMFS 2000). Critical habitat for this ESU includes all marine, estuarine, and river reaches accessible to listed chinook salmon in Puget Sound. NMFS further identified the marine areas of the Puget Sound as including the (1) South Sound, (2) Hood Canal, and (3) North Sound[25] (NMFS 2000). Major river basins stated by NMFS (2000) as known to support this ESU include the Nooksack, Skagit, Stillaguamish, Snohomish, Green/Duwamish, Puyallup, Nisqually, Skokomish, Dungeness, Cedar, and Elwha Rivers. Finally, major bays and estuarine/marine areas providing critical habitat to this ESU include the South Sound, Hood Canal, Elliott Bay, Possession Sound, Admiralty Inlet, Saratoga Passage, Rosario Strait, Strait of Georgia, Haro Strait, and the Strait of Juan De Fuca.

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[25]NMFS has identified the limits of the North Sound as extending to the international boundary at the outer extent of the Strait of Georgia, Haro Strait, and the Strait of Juan De Fuca to a straight line extending north from the west end of Freshwater Bay, inclusive (NMFS 2000).

Equally important, NMFS (2000) included a description of habitat types essential to chinook as including:

- Juvenile rearing areas
- Juvenile migration corridors
- Areas for growth and development to adulthood
- Adult migration corridors
- Spawning areas

Within these areas, essential features of critical habitat include adequate:

- Substrate
- Water quality
- Water quantity
- Water temperature
- Water velocity
- Cover/shelter
- Food
- Riparian vegetation
- Space
- Safe passage conditions

5.1.4.1 Critical Habitat in Miller Creek

While portions of Miller Creek might appear to fall within the strict application of the above definition of critical habitat[26], there appears to be no critical habitat present in Miller Creek upstream of the estuary. This determination is based, in part, on NMFS' further definition of accessible reaches as *"those within the historical range of the ESUs that can still be occupied by any life stage of salmon or steelhead"* (p. 7777, NMFS 2000). Available data (reviewed below) does not support the historical usage of Miller Creek by chinook salmon. Additionally, examinations of these creeks has found a lack of specific physical features preferred by chinook salmon for spawning, rearing, and migrating.

[26] Based on the lack of physical barriers that could restrict accessibility of this water body to the various life stages of chinook salmon.

Potential Historical and Current Use of Miller Creek by Chinook Salmon

Williams et al. (1975) state that "coho and chum salmon are the only species that ascend Miller, Bow Lake, and Des Moines Creeks." Documentation of exclusive coho and chum salmon spawning in Miller Creek in 1980 (Egan 1982) and 1998 (Hillman et al. 1999) corroborates Williams et al. (1975), as do the personal observations of local volunteers (Batcho 1999, personal communication). The lack of chinook use of Miller Creek is also supported by habitat surveys conducted in 1993-94 (Luchessa 1995), 1996 (Aquatic Resource Consultants 1996), and 1999 (Hillman et al. 1999; Parametrix 1999, unpublished field data). These surveys found a general lack of clean, unembedded gravel of a suitable size for chinook, and a general lack of pools and instream cover. Although chinook may use small streams, they typically do not occur in many small streams used by coho (Meehan and Bjornn 1991) because coho prey upon juvenile chinook (Myers et al. 1998). The lack of refugia in Miller Creek would tend to accentuate this predator/prey relationship, further precluding them from the stream.

Additional impediments to the historical use of Miller Creek is creek morphology. Fall chinook generally spawn in gradients less than three percent (Cramer et al. 1999). Miller Creek exceeds this slope at approximately RM 0.8 (Parametrix unpublished field data), and while upstream areas are below this grade, their size and flow are much smaller than those located downstream. The culvert beneath 1st Avenue South (RM 1.8) may present sheet flow that is too shallow to allow chinook passage. Whether the natural 4-ft falls at RM 3.1 were historically a barrier to chinook is unknown, but flow depths and/or substrate size both above and below RM 3.1 are not suitable for chinook.

In Puget Sound, no stream systems smaller than 3 miles in length are reported to support chinook salmon (Williams et al. 1975) (see summary of salmon use of small streams presented in Table 5-1). Two streams of lengths similar to Miller and Des Moines Creeks (Dogfish Creek 3.5 miles and Gorst Creek 3.9 miles) support or were suspected of supporting chinook salmon. These creeks occur in the Water Resource Inventory Area (WRIA) 15-Kitsap Basin, in Kitsap County.

Table 5-1. Summary of salmon use in small Puget Sound drainages greater than 3 miles in length[1].

WRIA		Stream			Salmon Use
		Number	Name	Length (miles)	
05	Stillaguamish River	0009	South Douglas Slough	4.7	Unknown
		0445		4.2	Unknown
06	Whidbey-Camano Island	0011		3.4	Unknown
		0029		4.05	Coho, Chum
		0037		4.1	Unknown
07	Snohomish River	0001	Tulalip Creek	5.5	Coho, Chum
		0005	Mission Creek	6.1	Coho, Chum
09	Duwamish River	0371	Miller Creek	4.8	Coho, Chum
		0377	Des Moines Creek	3.45	Coho, Chum
10	Puyallup River	0006	Hylebos	9.0	Coho, Chum
		0017	Wapato	13.8	Coho, Chum

Table 5-1. Summary of salmon use in small Puget Sound drainages greater than 3 miles in length (continued).

WRIA		Stream Number	Stream Name	Length (miles)	Salmon Use
11	Nisqually River	0324	McAllister/Medicine	7	Chinook[2], Coho, Chum
		0327			
12	Tacoma Basin	007	Chamber Creek	18.6	Chinook, Coho, Chum, Sockeye
13	Budd Inlet	0006	Woodland Creek	11.0	Coho, Chum
		0012	Woodard Creek	7.5	Coho, Chum
		0026	Indian Creek	3.3	None
		0133		3.6	Coho, Chum
		0138	McLane Creek	5.6	Coho, Chum
14	Shelton Basin	0001	Perry Creek	4.5	Coho, Chum
		0009	Schneider Creek	5.3	Coho, Chum
		0012	Kennedy Creek	9.6	Chinook, Coho, Chum
		0020	Skookum Creek	9.0	Chinook, Coho, Chum
		0029	Mill Creek	16.0	Chinook, Coho, Chum
		0035	Goldsborough Creek	14.0	Chinook, Coho, Chum
		0049	Johns Creek	8.3	Chinook, Coho, Chum
		0051	Cranberry Creek	9.4	Chinook, Coho, Chum
		0057	Deer Creek	8.5	Chinook, Coho, Chum
		0067	Malaney Creek	2.9	Coho, Chum
		0069	Campbell Creek	4.5	Coho, Chum
		0094	Sherwood Creek	18.3	Chinook, Coho, Chum
15	Kitsap Basin, draining to Puget Sound	0002	Coulter Creek	8.0	Chinook, Coho, Chum
		0015	Rocky Creek/un-named creek	8.0[2]	Chinook, Coho, Chum
		0048	Minten Creek	6.3	Chinook, Coho, Chum
		0056	Burley Creek	5.2	Chinook, Coho, Chum
		0060	Purdy Creek	3.5	Coho, Chum
		0099	Cresent Creek	3.1	Coho, Chum
		0107	Olalla Creek	4.2	Coho, Chum
		0185	Curley Creek/ Salmonberry Creek	27.7	Chinook, Coho, Chum
		0203	Blackjack Creek	6.9	Coho, Chum
		0216	Gorst Creek	3.9[3]	Chinook, Coho, Chum
		0229	Chico Creek	6.0	Coho, Chum
		0249	Clear Creek	3.2	Coho, Chum
		0255	Barker Creek	3.1	Coho, Chum
		0285	Dog Fish Creek	3.5	Chinook, Coho, Chum
		0299	Grovers Creek	5.1	Coho, Chum

1 Includes drainages supporting streams greater than 3 miles in length in WRIAs 05-15. No streams less than 3 miles in length are reported to be used by chinook salmon.

2 Chinook are seen in this creek but it is reported to have no fisheries value due to lack of spawning gravel.

3 This drainage includes several tributaries, Alexander Lake, and Heins Lake.

Chinook use in these creeks may be due to natural watershed conditions that differ from those observed in Miller and Des Moines Creeks. The streams occur near Bremerton, an area that receives about 30 percent more rainfall than STIA. This greater precipitation increases runoff and stream flows, and may create more favorable habitat conditions for chinook than would occur at STIA where rainfall is less. For example, streamflow in Dogfish Creek averages about 8.9 cfs (Williams et al. 1975), while flows at the mouths of Miller and Des Moines creeks average about 5.5 cfs (Parametrix 1996; King County DNR 1997). In addition to greater runoff, Williams et al. (1975) report that Dogfish Creek and other streams within the area have very stable stream flows. This stable stream flow may result from relatively gentle topography and greater infiltration of runoff through gravelly soils (USDA 1980). These creeks also contain at their mouths substantial estuaries and tideflat habitat that Miller and Des Moines creeks lack. These more extensive estuarine habitats may be conducive to out-migrating juvenile salmon.

Chinook Spawning Areas

Miller Creek, water depths, substrate conditions (size and depth) may be too shallow or small to meet the behavioral requirements of spawning chinook. Chinook are generally mainstem river or larger tributary (2-3 meters wide, Healey 1991) spawners with redds[27] as much as 12 ft long and 1 ft deep (Scott and Crossman 1973). The physical size of these redds would make them difficult to establish in a small creek such as Miller Creek, providing no suitable chinook spawning habitat. While chinook are reported to spawn in water depths as shallow as 5 cm, typical water depths are greater than 30 cm (Healey 1991). As reviewed above, chinook salmon use of small streams draining directly to Puget Sound is limited (Williams et al. 1975). For example, of the 151 streams that drain directly to Puget Sound, only 17 are reported to be used by chinook salmon (Table 5-1).

In addition to the small size of the creeks, sediment size and depth may not be suitable for chinook spawning. Healey (1991) reports chinook redds are typically covered with 10-33 cm of gravel that range in size from 2.5 to 15 cm (Gallager and Gard 1999). For Miller, Des Moines, and Walker creeks, these habitat conditions are generally not present in any substantial amount. Sediment depths are frequently less than 18 cm depth, and often contain a high percentage of fine sediment (Hillman et al. 1999; KCSWM 1987) that limits their suitability for use in spawning.

Juvenile Rearing Areas

Juvenile chinook require areas of available food and refuge from predators during their freshwater rearing stage. These areas are characterized by the presence of somewhat slow moving water (<0.2 m/s) where they can find food (aquatic and terrestrial insects, such as chironomids, and other invertebrates) and subsurface cover (cobble, cut bank, woody debris) and overhead cover (grasses, shrubs, overhanging bank, etc.) that provide refuge from predators. Refuges from predators, such as overhead and submerged vegetation, woody debris, overhanging banks, may reduce predation rates on juveniles holding in a stream. Such cover is significantly lacking in Miller Creek.

[27] A salmon spawning area.

Migrating Juveniles and Adults

Use of Miller and Des Moines creeks by outmigrating juveniles and returning adults produced by adjacent river systems is not expected based on the substantial lack of physical features used by chinook salmon in spawning and rearing streams. Juvenile and sub-adult chinook are not known to re-enter freshwater while migrating to and from natal streams and ocean rearing areas prior to reaching their natal streams (e.g., Dawley et al. 1986; Weitkamp 2000, personal communication). While straying to non-natal streams can occur, absence of the features noted above would not attract adult chinook to these creeks. Similarly, juvenile chinook produced in other stream systems migrating through the Puget Sound to ocean rearing areas would not be expected in Miller Creek above the mean higher high water line.

Critical Habitat in Miller and Des Moines Creeks

Based on the summary provided in this section, the best available scientific information indicates that Miller Creek presently does not provide suitable spawning habitat for chinook salmon, nor does information suggest that this creek historically supported a chinook salmon population. Given these considerations, the freshwater portion of Miller Creek does not fall within the defined range of chinook salmon critical habitat. Consequently, critical habitat in Miller Creek is limited to the estuarine area as defined by the zone of tidal influence at the mouth of Miller Creek. This determination is based on the findings that chinook juvenile rearing areas, chinook juvenile migration corridors, areas for chinook growth and development to adulthood, adult chinook migration corridors, and chinook spawning areas are not present in either of these creek.

5.1.4.2 Critical Habitat in Des Moines Creek

As discussed in section 5.1.4.1, Des Moines Creek also appears to lack suitable spawning habitat, and would historically not be used by chinook salmon.

The assessment of Williams et al. (1975) regarding the lack of chinook use of Des Moines Creek was presented in the previous sections is also applicable to the analysis of chinook use of Des Moines Creek. Potential habitat limitations for chinook in Miller Creek also apply to Des Moines Creek (Des Moines Creek Basin Committee 1997).

Currently few anadromous fish are able to pass the culvert beneath Marine View Drive, which limits most salmon production to the creek's lower 0.4 mile. The most recent assessment of current fish use in Des Moines Creek also indicates a lack of historical use by chinook (Des Moines Creek Basin Committee 1997). The estuarine boundary for marine rearing by chinook off Des Moines Creek that establishes the boundary of chinook critical habitat would be similar to that described for Miller Creek.

Based on the summary provided in this section and section 5.1.4.1, the best available scientific information indicates that Des Moines Creek presently does not provide suitable spawning habitat for chinook salmon, nor does information suggest that this creek historically supported a chinook salmon population. Given these considerations, the freshwater portion of Des Moines Creek does not fall within the defined range of chinook salmon critical habitat. Therefore, critical habitat is limited to the estuarine area as defined by the zone of tidal influence at the mouth of Des Moines Creek.

5.1.4.3 Critical Habitat Near the Auburn Mitigation Site and Gilliam Creek

The extensive culverting of Gilliam Creek and the lack of spawning gravel makes it very unlikely that adult chinook salmon will use this tributary of the Duwamish River for spawning or juvenile rearing. This creek discharges to that part of the Duwamish River used by returning adults and outmigrating juveniles for migration. During the winter and spring months, juvenile salmon could be rearing the area where Gilliam Creek discharges to the Duwamish River.

5.1.4.4 Critical Habitat Near the IWS Outfall

The IWS outfall is located in Puget Sound 1,800 ft offshore and in 170 ft of water. This area is critical habitat and represents a migration corridor for returning adult chinook salmon. No juvenile chinook will be present at this depth.

5.1.4.5 Evaluation Approach

The lack of use of the Miller and Des Moines Creek basins by chinook salmon presented here indicates that the only chinook critical habitat present in either basin is located at the estuarine mouths of each creek. Only these areas, then, provide essential habitat for juvenile migration, growth, and development to adulthood, and adult migration. Within these habitat areas, implementation of the MPU could potentially impact substrate, water quality, water quantity, food, and safe passage conditions. Consequently, the evaluations following this section will examine the actions associated with implementing the MPU, determine their potential to impact only these specific essential features in the estuarine/marine areas of Miller and Des Moines Creeks, identify any necessary mitigation for these impacts, and then determine their effect on chinook salmon. Since project construction will not directly alter these habitats, the effects analysis addresses indirect effects of the action to chinook salmon and their identified critical habitat.

5.2 BULL TROUT

5.2.1 Status and Distribution

The USFWS (1998a), identified five distinct population segments (DPSs) of bull trout in the coterminous U.S., including the Coastal-Puget Sound bull trout DPS sub-populations (USFWS 1998b; 1999b). On 1 November 1999, bull trout were listed as threatened throughout their range in the coterminous U.S. (USFWS 1999a).

Bull trout life histories may be complex and include resident (non-migratory), adfluvial (lake dwelling), fluvial (migratory stream and river dwelling), and anadromous fish (saltwater migratory) strategies. The Coastal-Puget Sound population segment of bull trout is unique because it is thought to contain the only anadromous forms within the coterminous U.S. (USFWS 1998b). However, little specific information exists about anadromous life strategies for bull trout (Rieman and

McIntyre 1993). The status of the migratory (fluvial, adfluvial, and anadromous) forms are of greatest concern throughout most of their range. Land development, farming, forestry, and other land uses have degraded the quality of river habitats for bull trout. Consequently, migratory bull trout populations have declined and resident bull trout are thought to compose most of the remaining populations in many areas (Leary et al. 1991; Williams and Mullan 1992). Bull trout commonly are distributed sporadically, and are associated with cool water and complex habitats, including headwater reaches of streams (USFWS 1998b). The decline of bull trout has been attributed to habitat degradation, blockage of migratory corridors by dams, poor water quality, the introduction of non-native species, and the effects of past fisheries management practices (USFWS 1998a).

Bull trout spawn in late summer and early fall (Bjornn 1991). Puget Sound stocks typically initiate spawning in late October or early November as water temperature falls below 7-8° C. Spawning habitat almost invariably consists of very clean gravel, often in areas of groundwater upwelling or cold spring inflow (Goetz 1994). Egg incubation temperatures needed for survival have been shown to range from 2-4°C (Willamette National Forest 1989). Bull trout eggs require approximately 100-145 days to hatch, followed by an additional 65-90 days of yolk sac absorption during alevin incubation. Thus, in-gravel incubation spans more than six months. Hatching occurs in winter or late spring and fry emergence occurs from early April through May (Rieman and McIntyre 1993).

Generally, for their first 1 to 2 years, bull trout juveniles rear near their natal tributary and exhibit a preference for cool water temperatures (Bjornn 1991). Resident forms of bull trout spend their entire lives in small streams, while migratory forms live in tributary streams for several years before migrating to larger rivers (fluvial form) or lakes (adfluvial form). Migratory individuals typically move downstream in the summer and often congregate in large, low-velocity pools to feed (Bjornn 1991). Anadromous bull trout usually remain in freshwater 2 or 3 years before migrating to salt water in spring (Wydoski and Whitney 1979).

Bull trout life histories are plastic (i.e., variable and changeable between generations), and juveniles may develop a life history strategy that differs from their parents. The shift between resident and migratory life forms may depend on environmental conditions. For example, resident forms may increase within a population when survival of migratory forms is low (Rieman and McIntyre 1993). Char[28] are generally longer-lived than salmon, and bull trout up to 12 years old have been identified in Washington (Brown 1992).

In Washington State, bull trout and Dolly Varden, two closely related char species, coexist and are managed as a single species. Separate inventories are not maintained by the WDFW due to the considerable biological similarities in life history and habitat requirements that exist between the two species. Although historic reports of char may have specified either bull trout or Dolly Varden,

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[28] For purposes of fisheries management, the WDFW does not differentiate between Dolly Varden (*Salvelinus malma*) and bull trout, and when necessary for the purposes of the ESA, considers the State's native char populations to be predominantly bull trout.

methodologies for reliably distinguishing between the two have only recently been developed and have not yet been widely applied (WDFW 1998).

Bull trout have not been reported in either Miller or Des Moines creeks. The nearest record of a native char, presumably a bull trout, to either Des Moines or Miller Creek was the pre-1980 capture of a single specimen from Puget Sound, midway between the tip of Three Tree Point and the Vashon Island shore (Miller and Borton 1980). This fish likely originated from the Green or Puyallup rivers, where anadromous bull trout are known to exist (Warner and Fresh 1999). (See Section 9.4 for additional discussion of bull trout use of these creeks.)

Bull trout are found in a variety of habitats, including lakes, reservoirs, large rivers, and small streams, but they primarily inhabit cold streams (Rieman and McIntyre 1995). More so than any other Puget Sound salmonid, clean, cold waters are critical for maintaining healthy bull trout populations. Spawning does not peak in the fall until water temperatures drop below 7°C (WDFW 1997; Wydoski and Whitney 1979), and summer daily maximum temperatures in the 12° to 14°C range are often cited as the preferred range for freshwater rearing (Sexauer and James 1997). Habitat components that influence bull trout distribution and abundance include temperature, cover, channel form and stability, valley form, spawning and rearing substrates and migratory corridors (Rieman and McIntyre 1995; USFWS 1998b). As noted, migratory bull trout move between multiple habitats during their life cycle, while the non-migratory form maintains a relatively small home range, typically completing their life cycle in small headwater streams (Rieman et al. 1997).

Water temperatures in short-run streams such as Miller and Des Moines creeks in lowland Puget Sound commonly exceed 4° C during the winter, and are unsuitably warm for reproduction of this species. A 6- to 7-month period of incubation also requires a sediment-free redd environment – conditions which are commonly absent in urbanized streams, and which are absent in Miller and Des Moines Creeks (Hillman et al. 1999). Further, there are no known bull trout populations reproducing in short, low-elevation streams draining directly to Puget Sound (Kraemer 2000 personal communications; Hendrick 2000 personal communication). Spawning occurs in headwater areas in generally pristine habitat.

Bull trout fry are often found in shallow, backwater areas of streams that contain woody debris. Fry are bottom dwellers and may occupy interstitial spaces in the streambed (Brown 1992). Nearshore marine waters are presumably used by anadromous bull trout; however, specific temporal and spatial uses of these areas have not been well-described. After entering marine waters, anadromous char in Puget Sound feed mainly on fish including smelt, herring, and juvenile salmonids (Brown 1992). As bull trout mature, they tend to rely less on invertebrates as their primary prey and may feed exclusively on fish (Bjornn 1991).

5.2.2 Anadromy in Bull Trout

Bull trout are considered optionally anadromous, and the survival of the species is not dependent upon whether they can migrate to sea or not, in contrast to obligate anadromous species like pink and chum salmon (Pauley 1991). Nonetheless, the anadromous life-history form is important to the long-term persistence of bull trout and the metapopulation structure. Anadromous fish are generally larger and more fecund than their freshwater counterparts and, play an important role in facilitating gene flow among subpopulations that are geographically remote.

Most information on anadromous char in north Puget Sound was obtained by C. Kraemer, WDFW, and remains unpublished. Kraemer has captured numerous char in marine and tidally influenced waters; primarily from Skagit Bay and Port Susan at the mouth of the Stillaguamish (Kraemer 1994). Kraemer has identified Dolly Varden and bull trout in these samples.

Research by Kraemer (1994) suggests that anadromous juveniles enter the nearshore environment in the spring, April through June (see Juvenile Movements), and spend most of the summer feeding and rearing. These anadromous char experience rapid growth, ranging from 25 to 40 mm per month, during their marine feeding period (WDFW 1997). Feeding observations and stomach content analysis indicate that while in Skagit Bay and Port Susan, native char feed extensively on fish, including surf smelt *(Hypomesus pretiosus)*, Pacific herring *(Clupea pallasi)*, Pacific sand lance *(Ammodytes hexapterus)*, pink and chum salmon smolts, and a number of invertebrates (WDFW 1997). Although limited research has been performed on anadromous bull trout, data by Kraemer suggest that the distribution of bull trout and Dolly Varden overlaps with the distribution of smelt and herring, particularly the spawning beaches of these forage fish (WDFW 1997).

Sub-adult char return to their lower (20 to 25 mi) river of origin and its tributaries in late summer and early fall (WDFW 1997). Most of these fish range from 250 to 350 mm in length. After overwintering in fresh water, some fish reenter marine waters as early as late February. Most anadromous char appear to reach maturity after their second migration to marine waters. Many of these fish return to fresh water from late May through early July to begin their spawning migration to upstream areas (WDFW 1997). Movement during summer and fall low flow period appears to be concentrated to periods of low light, just after dawn or before sunset (WDFW 1997).

Information on the extent and distribution of migrating char is limited. Anadromous char from the Skagit River have been documented on the east side of Camano Island, as far as 25 miles from the mouth of the river (WDFW 1997). Information on adult char returning to the Sauk basin suggests that spawning migrations extend as far as 120 mi upstream and these fish climb to an elevation of 3170 ft (Kraemer 1994). Kraemer showed through a radio-tagging study on the Skykomish River that upstream migrating adults generally moved about 1.5 to 2.0 mi per day, and ranged up to 9 mi (WDFW 1997). It appears that adult anadromous bull trout may be more temperature tolerant than earlier life stages. Kraemer has found migrating and staging char in Puget Sound tributaries (e.g. Stillaguamish River) having water temperatures between 20° and 24°C (WDFW 1997).

5.2.3 Bull Trout in the Green/Duwamish River

Bull trout may occur within the Green/Duwamish basin; however, information documenting their presence is meager. Suckley and Cooper (1890 in USFWS 1998b) suggested that char were once common in the Duwamish as early as June. In creel counts spanning 33 years, only four char were taken by over 35,500 anglers (USFWS 1998b). In 1980 one "Dolly Varden trout" or char was captured by Parametrix biologists during a juvenile salmonid study on the lower Duwamish River (Parametrix 1982). More recently, a char was taken by an angler in 1994 and positively identified as a bull trout through genetic analysis (USFWS 1998b). The furthest upstream record of char is from one harvested near RM 40 (USFWS 1998b). No char have been documented in the upper basin where Plum Creek Timber Company has performed presence/absence surveys (WDFW 1998). No spawning populations have been recorded within the basin (WDFW 1998). Consequently, the occasional char observed within the basin may be straying from neighboring sub-populations (WDFW 1998). It is, however, possible that viable populations of bull trout inhabited the Green-Duwamish basin historically.

Distinct populations of bull trout occur in the neighboring drainages of the Cedar and Puyallup rivers. These drainage were historically tributary to the Duwamish River. Re-routing of the White River to the Puyallup drainage in 1906 (natural and man-induced), re-routing of Lake Washington and Cedar River to the Lake Washington Ship Canal in 1916, construction of the Tacoma Diversion Dam in 1913 and construction of Howard Hansen Dam in 1961 eliminated access to much of the headwater habitat (Grette and Salo 1986) that would typically be used by bull trout.

The status of the Green/Duwamish bull trout sub-population is listed as "depressed" (USFWS 1998b). Water quality within the basin exceeds temperature standards under Section 303(d) of the Clean Water Act (USFWS 1998b). Current water temperature standards may not be sufficient to protect bull trout due to their need for cold water habitats (USFWS 1998b). Other factors that may affect the abundance of bull trout in the Green/Duwamish basin include agriculture and grazing practices, urbanization, competition and hybridization with brook trout, and migratory barriers at the City of Tacoma's water diversion (RM 61) and at Howard Hanson Dam (RM 64) (USFWS 1998b).

5.2.4 <u>Critical Habitat</u>

The designation of critical habitat for listed species is required under the ESA and is generally determined at the time of the listing. The critical habitat designation for bull trout was deemed "not determinable" by the USFWS (1999a; 64 FR 58927), due to the meager understanding of the biological needs of the species. A critical habitat designation is normally expected within two years of the proposed rule (USFWS 1998a). Since critical habitat has not been designated, it cannot be determined if critical habitat for bull trout will occur.

5.2.4.1 Presence in Miller Creek, Des Moines Creek, and the Green River

Anadromous bull trout are known to make feeding forays into lower river mouths to feed on loose salmon eggs during mass spawning of certain salmon species, notably pink, chum, and sockeye. Dense aggregations of spawning chum, for example, often results in redd superimposition and liberation of eggs deposited by previous spawners.

Surveyors of Miller and Des Moines creeks have not seen bull trout in and among chum salmon (Hillman et al. 1999; Batcho 1999, personal communication). Bull trout feeding forays into these creeks or any similar small tributaries of Puget Sound has not been documented (Kraemer 2000 personal communication; Hendrick 2000 personal communication). Therefore, it is highly unlikely bull trout use either Miller or Des Moines creeks as forage habitat. The Green River basin may have historically supported healthy populations of char and likely included resident, migratory, and anadromous populations.

5.2.4.2 Reproduction Potential in Miller and Des Moines Creeks

Habitat conditions presented in Miller Creek, Walker Creek, and Des Moines Creek are unlikely to support the reproduction of bull trout. The suitability of these basins to have historically supported bull trout, or to provide bull trout reproduction under restored conditions is highly unlikely, also because of unsuitable habitat conditions. Specific reasons why bull trout would not successfully rear or incubate in the creeks are discussed below.

The Miller Creek and Des Moines Creek basins are small, and occur at low elevations. Because of flow and temperature conditions in small Puget Sound streams, even under restored conditions, they would be expected to warm above the thermal tolerances of bull trout. The likelihood of bull trout populations to inhabit Miller or Des Moines creeks in the future is very low because of an unfavorable temperature regime in the creeks. Although mature adult anadromous char are found migrating and staging in Puget Sound tributary rivers at stream temperatures of 20 to 24° C (Kraemer 1994), published data consistently indicate juvenile preference for cooler waters. Throughout Washington, bull trout are seldom found in temperatures exceeding 18° C (Brown 1992). The stream temperatures in Miller and Des Moines creek are known to exceed optimal levels during portions of the summer months, and these suboptimal temperatures would continue regardless of riparian enhancement planned as part of the project. Juveniles of anadromous bull trout populations rear for several (two or more) years instream prior to migrating to the ocean, and would be unable to tolerate the existing thermal maxima, even under improved shading expected by restored riparian zones. Summer distributions of juvenile bull trout are limited to areas of groundwater discharge in cold, headwater areas (Goetz 1994; Willamette National Forest 1989), presumably due to the thermal moderation these localized environments provide during warm conditions (Rieman and McIntyre 1993).

Bull trout could not spawn successfully (produce viable fry) in Miller or Des Moines creeks since water temperatures during the putative egg incubation period (roughly 225 days after spawning) would exceed the thermal maximum observed for this species (ca. 8° C; Willamette National Forest 1989; Kraemer 1994).

5.2.4.3 Presence in Miller Creek, Des Moines Creek Estuaries

Anadromous phases of bull trout originating from other Puget Sound basins could potentially inhabit nearshore marine areas at the outlets to these basins. A variety of prey items are available to bull trout in the near shore area.

Adult bull trout feed on herring, sand lance, and surf smelt in the nearshore zone of Puget Sound, particularly near the spawning beaches of these baitfishes (Kraemer 1994). There is a large herring spawning area in Quartermaster Harbor, about 6 miles from Miller and Des Moines creeks, and both surf smelt and sand lance spawning beaches are located within a mile or two north and south of Miller and Des Moines creeks.

Newly-emerged fry of chum and pink salmon make immediate migrations to the marine rearing environment (Scott and Crossman 1973). These small salmonid species, as well as out migrating coho, are also known to be a prey item for bull trout in the marine area (Brown 1992; Kraemer 1994). Chum fry emergence from Miller and Des Moines creeks could also bring bull trout to the estuaries, however, this behavior has not been documented in southern Puget Sound (WDFW 2000, personal communication).

Anadromous adult and subadult bull trout are very unlikely to move from the estuaries of Miller and Des Moines creeks into the creeks themselves. Lack of physical features (i.e., deep pools and large woody debris) would discourage the use of these creeks for overwintering by these life stages. Lack of suitable spawning habitat and stream temperatures would prevent spawning and rearing by bull trout. Finally, anadromous adult and subadult bull trout are very unlikely to move into these creeks to feed. These phases of bull trout respond to large amounts of prey items[29] which would typically not be produced in either creek.

5.3 ESSENTIAL FISH HABITAT

In addition to the above two listed species, a number of commercially managed species could be affected by the proposed MPU Improvements. Specifically the Magnuson-Stevens Act requires the evaluation of proposed projects with a federal nexus to evaluate impacts on habitat of commercially managed fish populations. Essential fish habitat (EFH) has been defined for the purposes of the Magnuson-Stevens Act as "*those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity*" (NMFS 2000). NMFS has further added the following interpretations to clarify this definition:

- "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate;
- "Substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities;
- "Necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and
- "Spawning, breeding, feeding, or growth to maturity" covers the full life cycle of a species.

This section presents the essential fish habitat present in the Action Area for three main groups of coastal pelagic species (CPS) fishery, West Coast groundfish, and Pacific coast salmon.

5.3.1 Coastal Pelagic Species Fishery

The CPS fishery includes four finfish [Pacific sardine (*Sardinops sagax*), Pacific (chub) mackerel (*Scomber japonicus*), northern anchovy (*Engraulis mordax*), and jack mackerel (*Trachurus*

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[29] An example would be large amounts of chum eggs resuspended into the water column by spawning females during large spawning efforts as has been observed in coastal streams of Washington State (Kraemer 2000 personal communication). Such large spawning efforts by chum salmon have not been observed in either Miller or Des Moines creeks.

symmetricus)] and the invertebrate, market squid (*Loligo opalescens*) (NMFS 2000). CPS finfish are pelagic (in the water column near the surface and thus not associated with particular substrate), because they generally occur above the thermocline in the upper mixed layer. For the purposes of defining EFH, NMFS has treated the four CPS finfish as a single species complex, because of similarities in their life histories and similarities in their habitat requirements (NMFS 2000). Market squid are also treated in this same complex because they are similarly fished above spawning aggregations.

NMFS (2000) has defined the east-west geographic boundary of EFH for each individual CPS finfish and market squid as all marine and estuarine waters from the shoreline along the coasts of California, Oregon, and Washington offshore to the limits of the exclusive economic zone and above the thermocline where sea surface temperatures range between 10°C to 26°C. The southern extent of EFH for CPS finfish is the United States-Mexico maritime boundary. The northern boundary of the range of CPS finfish is more dynamic and variable due to the seasonal cooling of the sea surface temperature. The northern EFH boundary is, therefore, the position of the 10°C isotherm which varies both seasonally and annually.

Primarily present in the coastal areas of Washington State, three of the four vertebrates (Northern anchovy, Pacific sardine, and Pacific (chum) mackerel) have been observed in Puget Sound and thus have some EFH in the action area (DeLacey et al. 1972) (Table 5-2). Jack mackerel have not been reported in the Puget Sound, and therefore do not have any EFH in the action area (DeLacey et al. 1972) (Table 5-2). EFH for these organisms in the Action area (Northern anchovy, Pacific sardine, and Pacific (chum) mackerel, and market squid) will include water and substrate necessary to the life cycle of these species.

Table 5-2. Summary of distribution and essential fish habitat for Pacific CPS in the coastal waters of Washington State and in the MPU Improvements Action Area (adapted from NMFS 1998).

Common Name	Lifestage	Present in Coastal Waters of Washington State?	Present in Action Area[1]?
Northern anchovy	Eggs/Larvae/Juveniles	Yes	Unlikely
	Adults	Yes	Yes
Pacific sardine	Eggs/Larvae/Juveniles	Yes (restricted to seasonally warm thermocline.)	Unlikely
	Adults	Yes (restricted to seasonally warm thermocline.)	Yes
Pacific (chub) mackerel	Eggs/Larvae/Juveniles	Yes (restricted to seasonally warm thermocline.)	Unlikely
	Adults	Yes (restricted to seasonally warm thermocline.)	Yes
Jack mackerel	Eggs/Larvae/Juveniles	No	No
	Adults	Yes	No
Market squid	Eggs/Larvae/Juveniles	information not available	Yes
	Adults	Yes	Yes

[1] As determined from DeLacey et al. 1972.

5.3.2 West Coast Groundfish

In contrast to the coastal pelagic species discussed above, the West Coast groundfish make up a much more diverse set of organisms. West Coast groundfish that could have EFH in the Action area were identified by comparing NMFS' review of West Coast groundfish (Casillas et al. 1998) with the distribution of these fish as presented in Hart (1973) and Delacey et al. (1972) (Table 5-3).

These species will have essential fish habitat in the Action area (both at the mouths of Miller and Des Moines Creeks as well as the Midway Sewer outfall) that include water and substrate necessary to the life cycle of these species.

5.3.3 Pacific Coast Salmon

NMFS has not yet designated EFH for Pacific Coast Salmonids, or for chinook. Therefore, we cannot evaluate EFH for Pacific Coast Salmon beyond the analysis presented for chinook salmon critical habitat.

Table 5-3. West Coast groundfish present in Puget Sound and potentially present in the Action Area (taken from Casillas et al. 1998 and Hart 1973).

Spiny Dogfish	Black Rockfish	Redbanded Rockfish	Dover Sole
Big Skate	Blue Rockfish	Redstripe Rockfish	English Sole
California Skate	Bocaccio	Rosy Rockfish	Flathead Sole
Longnose Skate	Brown Rockfish	Sharpchin Rockfish	Pacific Sanddab
Ratfish	Canary Rockfish	Splitnose Rockfish	Petrale Sole
Lingcod	China Rockfish	Stripetail Rockfish	Rex Sole
Cabezon	Copper Rockfish	Tiger Rockfish	Rock Sole
Kelp Greenling	Dark blotched Rockfish	Yelloweye Rockfish	Sand Sole
Pacific Cod	Pacific Ocean Perch	Yellowtail Rockfish	Starry Flounder
Pacific Whiting (Hake)	Greenstriped Rockfish	Arrowtooth Flounder	
Sablefish	Quillback Rockfish	Butter Sole	

Wildlife

6. WILDLIFE SPECIES EVALUATIONS

In 1995, Shapiro (1995) prepared a BA addressing bald eagles and peregrine falcons as part of the STIA MPU FEIS that received concurrence from the USFWS on December 6, 1995 (Appendix A). Other than addition of new off-site and on-site wetland and riparian mitigation, the project design has not significantly changed since the services concurred with the conclusions of this BA. Nor has bald eagle use of the project area changed since concurrence on the BA was made. Consequently, previous conclusions regarding the effects of MPU improvements on bald eagles have not changed.

6.1 BALD EAGLE STATUS AND DISTRIBUTION

The continental U.S. population of bald eagles has recovered dramatically since its lows in the 1960s. Although eagle populations once numbered between 250,000 and 500,000, human development and the use of the pesticide DDT reduced the population to a low of about 400 pairs by the early 1960s. With the banning of DDT in 1972, and active recovery efforts, the number of breeding pairs reached approximately 6,000 by 1998. Because of this recovery, the bald eagle has been proposed for de-listing, an action that could happen as soon as July 2000.

Recovery has been especially dramatic in Washington State where there are now over 600 nesting pairs, 300 in Puget Sound alone. Bald eagle nesting territories are now found along shorelines in much of the Puget Sound Region and along the inland shorelines of Lake Washington.

Washington State also supports the largest wintering population of bald eagles in the continental U.S. (eagles nesting in Washington typically winter in British Columbia and southeast Alaska where winter runs of salmon occur). During the overwintering period, a few thousand birds can be found throughout the state where waterfowl and fish congregate, including along the shorelines of Puget Sound.

6.1.1 <u>Effects Analysis</u>

Construction projects can affect bald eagles in three primary ways: loss of habitat, loss of foraging opportunities, and disturbance (Bottorff et al. 1987, Stalmaster 1987; Mathisen 1968). Each of these elements is addressed below for both the nesting and wintering bald eagle activity periods at the specific locations where bald eagles may be present.

6.1.1.1 Master Plan Development at STIA

The bald eagle nest site nearest to the Miller and Des Moines creeks evaluation area (No. 611) is located south of Seahurst Park, approximately 2.5 miles west of STIA. A second nesting territory is found 1 to 3 mi southeast of various STIA construction projects at Angle Lake. While the Angle Lake territory is currently occupied, the nest has been inactive for a number of years (Negri 1999, personal communication). Shapiro (1995) conducted behavioral observation surveys of both territorial and wintering eagles in the vicinity of nest No. 611 during the winter of 1994-95. Their observations showed that all foraging perches discovered in their study area occurred along the shoreline of Puget Sound, and all foraging flights occurred over Puget Sound and not over STIA.

Noise disturbance associated with construction activities in the Miller and Des Moines creek evaluation areas is not expected to affect nesting eagles because the nearest active nest (No. 611) occurs over 2 mi away from the construction projects, beyond the quarter and half mile distances at which the bald eagle recovery plan (USFWS 1986) regulates construction noise activities. The nearest inactive nest, associated with the Angle Lake territory, is 1 to 3 mi away from the various construction sites, also beyond the zone where noise activities are regulated.

Because major construction is planned outside the overwintering period for bald eagles (October 31 to March 31), increases in ambient noise levels at the site will not disturb overwintering eagles. Planting at the wetland mitigation site may occur during the overwintering period for bald eagles. During planting, noise levels at the wetland mitigation site will exceed ambient levels because trucks and other vehicles will deliver and distribute plant materials to the site. The change in noise levels that will occur at potential eagle perch trees (greater than 300 ft west of the planting activities) is unknown.

This BA is in agreement with the Shapiro (1995) report in that construction activities associated with this evaluation area are not expected to significantly impact nesting or wintering bald eagles, or their prey, because the eagles confined their activities to the vicinity of Puget Sound; thus, the loss of habitat associated with activities in this evaluation area would not affect eagle foraging or perching behavior.

Since the MPU improvement projects in the Miller and Des Moines creeks evaluation area could indirectly affect bald eagles as a result of increased aircraft activity, Shapiro (1995) assessed the potential for increased disturbance of the nesting pair at nest No. 611 by noise from approaching and departing aircraft. They concluded that the potential effects would not be significant based on the following:

- Future flight paths associated with the new runway are not expected to be significantly different from current approach and departure zones (Port of Seattle 1994).
- Eagle-aircraft collision is very unlikely due to the eagles' relatively slow flight and high visual acuity, which allows them to avoid collisions (Olendorff et al. 1981).
- Perching bald eagles generally do not react to commercial jets, according to a study conducted at the Bellingham Airport by Fleischner and Weisberg (1986).
- The ongoing transition to quieter Stage 3 aircraft (to be fully completed by year 2020), will result in a reduction in aircraft noise below current levels.

6.1.1.2 Off-site Wetland Mitigation

The Auburn wetland mitigation site occurs adjacent to the Green River, a fish-bearing river that provides foraging habitat for bald eagles. According to WDFW, the nearest known nest site (the Green River Bald Eagle Territory) occurs nearly 3 mi to the east, near Big Soos Creek. This nest location is beyond the quarter and half mile distances at which the bald eagle recovery plan (USFWS 1986) regulates construction noise activities. The nearest defined territorial boundary of this pair is over 2 mi away; therefore, construction activities would not affect nesting bald eagles, or their territories.

Winter use of the area by bald eagles is expected between the October 31 to March 31 wintering period. This use, however, would not coincide with most wetland construction activities, which will occur between April and October. Consequently, wetland construction activities do not have the potential to disturb wintering eagles. Some landscaping construction mobilization demobilization may occur during the winter months, but this will occur over 200 ft from the Green River, and would be unlikely to significantly affect wintering eagles. Once built, the constructed wetland is anticipated to provide habitat to waterfowl (eagle prey), and the project may provide a benefit to wintering eagles.

Other potential projects in the vicinity of the off-site wetland mitigation project in Auburn could affect bald eagle use of riparian areas near the Green River. These include a proposed trail, improvements to 277th Street, and development of private property to commercial or residential uses (these projects are presumed to be associated with federal actions associated with federal funding, wetland impacts, and/or floodplain alterations and should not be considered in cumulative impacts analysis in the BA). While it is unlikely the trail project would remove perching or forage habitat, it may result in disturbance to eagles using the riparian area of the Green River. The wetland mitigation project could provide new forage and perch areas for bald eagles, and partially mitigate for the potential disturbance impacts the project may have. The trail project is proposed on county property in the riparian buffer of the Green River. Development of the trail project could reduce the restoration potential of the riparian area; in particular, the trail could restrict the ability of a restored riparian buffer to deliver wood to the Green River channel.

6.1.2 Determination

The construction and operation of the STIA MPU projects (Miller and Des Moines creeks evaluation area) is not expected to adversely impact local bald eagles (Shapiro 1995). This report agrees with previous assessments, that the project "may affect," but is "not likely to adversely affect" bald eagles in the vicinity of Miller and Des Moines creeks.

Because the nearest active bald eagle nest is beyond one-half mile of the Auburn wetland mitigation site, wetland construction activities associated with this site will have no effect on breeding bald eagles. Because wetland landscaping and construction mobilization activities could occur during the bald eagle wintering period, but more than 200 ft from the Green River, activities "may affect," but are "not likely to adversely affect" wintering eagles. Eventually, the wetland may offer a beneficial effect to wintering eagles by providing additional foraging opportunities.

The overall determination for the STIA MPU improvements project is "may affect," but is "not likely to adversely affect" bald eagles.

6.2 MARBLED MURRELET STATUS AND DISTRIBUTION

Marbled murrelets are marine birds that forage in near-shore environments from Northern California through Alaska. In response to declines in their population in the southern portion (California, Oregon, and Washington) of their range, they were listed as threatened under ESA 1992 (FWS 1992), and critical habitat designated in 1996 (FWS 1996). The decline in marbled murrelets has been mostly attributed to the loss of nesting habitat for the species (Ralph and Miller 1995) and the critical habitat designation for the species is limited to specific nesting areas.

Marbled murrelets typically nest in the canopy of old-growth forests where there are at least some trees greater than 32 inches diameter breast high and/or 200 years of age. Stands of large trees infected with mistletoe (mistletoe brooms of greater than 1 square ft of surface area) are also occasionally used by nesting murrelets (Ralph and Miller 1995). Marbled murrelets forage on a wide variety of small fish and invertebrate prey in water up to about 260 ft deep. They typically forage about 0.2 to 1.2 miles from shore (FWS 1996).

Critical habitat for marbled murrelets is limited to the nesting habitat areas designated by Fish and Wildlife Service (1996). The nearest designated critical habitat to STIA is approximately 30 miles west in the Olympic Mountains, about 35 miles east in the Cascade Mountains, and about 45 miles southwest in the Black Hills. The critical habitat designation does not include the marine areas (including Puget Sound) where murrelets forage. The U.S. Fish and Wildlife Service (1996) determined water quality and habitat conditions in marine foraging areas do not require special management consideration or protection beyond that provided by existing federal laws and regulations (including the Clean Water Act and the Coastal Zone Management Act).

Murrelets generally forage for small fish and invertebrates in nearshore waters. They are opportunistic feeders and will consume most available prey species, which may include Pacific sandlance (*Ammodytes hexapterus*), Pacific herring (*Clupea harengus*), and surf-smelt (*Hypomesus pretiosus*) (Burkett 1995; Strachan et al. 1995). Invertebrate prey commonly used by murrelets includes euphausiids, mysids, and gammarid amphipods (Nelson 1997).

Within Puget Sound, marbled murrelet abundance is relatively low (Speich and Wahl 1995). Speich et al. (1992) estimated the southern Puget Sound spring/summer population at 480 (compared to four times that for northern Puget Sound). Winter estimates were approximately the same (>400) but birds tended to be more concentrated, especially in the vicinity of Hood Canal. There are no estimates of marbled murrelet use in Puget Sound in the vicinity of STIA, although there are anecdotal observations showing that they occasionally occur in low numbers.

Abundance of murrelets in marine foraging areas may be related to the availability of nesting habitat in the surrounding area (Ralph and Miller 1995). In the case of Puget Sound, there is little nesting habitat available nearby, and most nesting stands occur considerable distances (10 to 40 miles) inland (Hamer 1995). According to Hamer (1995) no nesting stands are known to occur in the Puget Trough, and only a few (17) have been located in the South Cascades. Nesting is also suspected in the Bald Hills area near the town of Rainier (Nysewander 2000, personal communication).

Since the early 1990s, WDFW has been conducting seabird surveys in South Puget Sound and has found low concentrations in the Tacoma Narrows and Nisqually delta region throughout the year (Nysewander 2000, personal communication). During these surveys, marbled murrelets have not been observed in the region of STIA. The closest WDFW sightings are from Quartermaster Harbor 5 miles southwest of the mouth of Miller Creek. Although WDFW is aware of one or more sightings near STIA, they suspect that the occurrences are rare (Nysewander 2000, personal communication).

Observations by others (Rainier Audubon Society, Thias Block, personal communication) show that marbled murrelets periodically use Puget Sound, near the mouth of Des Moines Creek during the winter months (Table 6-1). The Seattle Audubon Society's Christmas Bird Count (located north of the action area for the STIA MPU) periodically reports marbled murrelet within their count area (including an observation in January 2000). The Tacoma Audubon Society's count area, located south of the action area of the STIA MPU also reports marbled murrelets. These observations are consistent with other findings that report marbled murrelets occurring in southern Puget Sound during the winter (Speich et al. 1992). At this time, an influx of birds from British Columbia, or birds avoiding harsher winter storm conditions in northern Puget Sound (Speich and Wahl 1995) occurs. These non-breeding birds are likely to follow the shoreline and open water areas, and are unlikely to cross STIA or its approach/departure zones.

Table 6-1. Marbled murrelet observations reported near the mouth of Des Moines Creek.[30]

Survey	Date	Observation
Christmas Bird Count	1990	1
	1992	2
	1995	1
Other Observations	April 23, 1988	3 pair
	April 19, 1989	2 pair
	May 6, 1989	6 birds
	July 24, 1990	1 pair

There are very few records of forested stands occupied by marbled murrelets occurring in the Cascades due east of STIA (DNR 1996). A small concentration occurs in the headwaters of the Nisqually River (southeast of STIA), but most occupied stands have been found in the North Cascades in the headwaters of the Skagit, Sauk, and Stillaguamish rivers (Northeast of STIA) (Hamer 1995).

Breeding pairs have not been observed in the action area since 1990. Their absence since 1990 may be due to a loss (i.e. logging) of their nest sites. Because forage habitat for murrelets in the action area is more than the reported 18 to 25 mile (30 to 40 km) maximum distance (Nelson 1997) the birds travel from nesting and activity sites, it is concluded that the action area does not provide forage habitat for breeding murrelets.

6.2.1 Effects Analysis

Implementation of STIA MPU projects will not affect critical habitat for marbled murrelets because old growth forest areas designated as critical habitat do not occur in the action area. No critical habitat occurs within 30 miles of the action area.

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[30] Personal data provided by Thias Bock of the Rainier Audubon Society, April 2000.

The project could potentially affect marbled murrelets by:

- Disturbing birds in marine habitat during construction.
- Altering nearshore foraging habitat from changes in sediment and/or water quality caused by changes in airport runoff to Miller and Des Moines creeks, and
- Affecting the chance of aircraft-bird strikes if murrelets traveled between inland nesting areas and marine foraging sites.

The Auburn wetland mitigation site is too far from murrelet nesting (in the Cascades) and foraging areas (in Puget Sound) for activities at this site to affect either nesting or foraging birds. Potential disturbance to traveling birds during wetland construction will be avoided given that murrelets travel between foraging and nesting sites during the early dawn hours (Nelson and Hamer 1995) when construction equipment would not be operating.

The nearest STIA-associated construction activity to marine waters (potential murrelet foraging habitat) is nearly 1.5 miles. This distance is five times the distance at which the USFWS regulates construction activities for other threatened bird species (i.e., bald eagles). Consequently, it is highly unlikely that foraging murrelets would be affected construction activities.

If activities at STIA affected the type and abundance of marbled murrelet prey in Puget Sound near the mouth of Miller or Des Moines Creeks, birds using the area could be affected. Changes in hydrology or sediment transport in Miller Creek, caused by airport runoff, could affect sedimentation patterns or rates could affect benthic organisms and other prey species. Changes in water chemistry in the creek caused by airport runoff could also affect benthic organisms and other murrelet prey species.

The potential effects of STIA MPU projects on the Miller and Des Moines Creek estuaries, including benthic organisms and fish are discussed in detail in Sections 7 and 9 where effects on chinook salmon and bull trout are evaluated. These evaluations have determined that within the estuaries and creek mouths and near the IWS outfall, organisms exposed to runoff will not be affected by toxicity. Further, significant increases in sedimentation, turbidity, or temperatures would not be expected. Since murrelets forage in open water areas off shore from the creek estuaries that listed fish species may use, their exposure to airport runoff is further ameliorated by the significant dilution of creek runoff in Puget Sound waters. Thus, MPU-induced changes to the nearshore foraging zone used by murrelets would not occur, and no changes to the environmental baseline for the species are anticipated.

Stormwater quality and hydrology mitigation implemented as part of the STIA MPU projects should improve water quality and hydrologic conditions in Miller and Des Moines creeks. Improved conditions are expected due to:

- Improved stormwater quality and quantity treatment of runoff from new development compared to the existing baseline,

- Retrofitting of existing airport facilities to upgrade water quality and quantity treatment of runoff to King County standards,
- Implementation of improved Ecology BMPs for construction and operation, and
- Mitigation activities in Miller and Des Moines creeks (see Chapter 7) to improve instream habitat for fish and invertebrates.

Improvements in creek water quality would likely provide a slight benefit to the nearshore areas where marbled murrelets forage, but would at a minimum, maintain existing conditions for foraging murrelets.

The STIA MPU will affect air traffic, which in turn could affect the potential for marbled murrelet collisions with aircraft, if breeding marbled murrelets were present in the action area. It is currently unknown what flight routes marbled murrelets take, or what altitudes they fly when traveling near Puget Sound and nesting habitat (Hamer 1999, personal communication). However, it is generally thought that they follow river valleys and fly at altitudes up to 500 ft (Hamer 1999, personal communication). It is not known whether they avoid flying over highly urbanized areas found in the vicinity of STIA. Nevertheless, crossing airport flight paths could make them vulnerable to aircraft flying at altitudes less than 500 ft. This potential zone of intercept could occur in approximately 3 to 5 miles from the end of the runways (assuming a 50:1 take off and landing glide slopes).

The potential for a marbled murrelet strike is extremely remote at best for the following reasons:

- The presence of breeding marbled murrelet pairs in the marine waters near STIA has not been observed since 1990. Breeding marbled murrelets are not expected in the action area because there is no nearby suitable nesting habitat for them.
- No marbled murrelets have been reported to have been struck by aircraft at STIA (Table 6-2). Bird-aircraft strikes are of significant safety concern to the Port and FAA; however, the general infrequency of strikes (about 22 per year) relative to the total number of birds near the airport demonstrate there is a low probability any single bird would be subject to a strike. The low numbers of marbled murrelets in the area make the probability that aircraft would strike marbled murrelets exceedingly low. This strike potential is further reduced by the fact that in the immediate vicinity of the airport, where most aircraft-bird strikes occur, marbled murrelets habitat (nesting or foraging) is not present.
- There is no evidence of marbled murrelet flight routes that cross the aircraft approach/departure zones; plus there are no recent reports of murrelets near STIA during the breeding season. Should breeding marbled murrelets occur near STIA during the breeding season, they may be more likely to follow local river courses to inland nest sites.
- The rapid flight of marbled murrelets makes them less susceptible to bird-aircraft strike than slower flying birds (Grettenberger 2000 personal communication).

Table 6-2. Birds and Other Wildlife Subject to Strikes with Aircraft at the Seattle-Tacoma International Airport[1]

Species	Year																			Total
	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	
Birds																				
Common loon												1								1
Canada goose							1					1					1(7)		1	4
Northern shoveler																2				2
Gadwall																1				1
Mallard		3							1			1		1		2		1	2(4)	11
Wigeon (species unknown)																1				1
Canvasback									1											1
Ruddy duck														1						1
Hooded merganser													1		1					2
Greater scaup																			1	1
Duck (species unknown)		1		1					1						2					5
Western gull																1	1		3	5
Glaucous-winged gull												1					1	2(3)	1	5
California gull							1													1
Gull (species unknown)		1			1	1	4					1	1		1	1		2(7-8)		13
Common tern							1													1
Great blue heron					1										1		1			3
Green heron							1													1
Semipalmated plover												1								1
Killdeer			2	1	2						1	2	1	2	1	1	1			14
Long-billed dowitcher												1							1	2
Dowitcher (species unknown)												1								1
Western sandpiper	1										1		1	1(6)				1(7-10)		5
Common snipe											1		1							2
Horned lark													1							1
Cooper's hawk														1						1
Red-tailed hawk			1						3			2					2		1	9

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Table 6-2. Birds and Other Wildlife Subject to Strikes with Aircraft at the Seattle-Tacoma International Airport[1] (continued).

Species	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Total
Swainson's hawk								1												1
Merlin											2									2
American kestrel											1	4				1(2)	1	3	3	13
Small hawk (species unknown)																	1		1	2
Common barn owl			4				1		1		1	3	2		2	1		1		16
Short-eared owl			1									1	3							5
Snowy owl			1															1		2
Great horned owl									1											1
Belted kingfisher											1									1
Band-tailed pigeon	1				1								1		1(7)					4
Common nighthawk									1	1										2
Northern flicker										1									1	2
Black swift												1								1
Barn swallow												2		1						3
Cliff swallow													1							1
Bank swallow								5	1	2		2	2			1				13
Northern rough-winged swallow												1								1
Swallow (species unknown)				1		1						1					1		1	5
American robin					1							1						1		3
Varied thrush											1									1
European starling		1	2	1	1		1	2			1	2	3(5)			2(33)	2	1(30)	2(3)	21
Cedar waxwing																1			1	2
Western meadowlark					1			1				3	1	1			1		1	9
Savannah sparrow														1						1
House sparrow														1						1
Song sparrow											3									3
Sparrow (species unknown)		1	2			1						1	1		1(2)				1	8
Spotted towhee																			1	1

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Table 6-2. Birds and Other Wildlife Subject to Strikes with Aircraft at the Seattle-Tacoma International Airport[1] (continued).

Species	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	Total
Unknown small bird		1								2			1		1	4(5)	4	3	3(4)	19
Unknown large bird																		1		1
Unknown bird	3		1				1	3				1	1	2(3)	3(5)	3(4)	3	10(11)	2	33
Other Wildlife																				
Coyote									1					1(2)						2
Raccoon										1										1
Total	5	8	14	4	8	3	11	12	11	7	13	35	22(24)	13(17)	14(23)	22(56)	20(26)	27 (69-73)	27 (31)	276 (380-384)

[1] Values shown under each year are the number of strikes in that given year. Numbers in parentheses indicate the number of individuals struck in a given year. Information on the numbers of individuals struck is only available for 1991-1997.

6.2.2 Determination

Based on the rarity of marbled murrelets in marine waters near STIA, the distance between STIA and Puget Sound, the water quality protection incorporated into the STIA MPU, and the remote probability of an aircraft striking a marbled murrelet, we conclude that the project will have "no effect" on the marbled murrelet or its critical habitat. If unforeseeable and significant changes in water quality, hydrology, or sedimentation were to occur at the creek estuaries, a determination of "may effect," or "not likely to adversely affect" marbled murrelets may be appropriate.

Water Resource
Impacts and Mitigation

7. WATER RESOURCE IMPACTS AND MITIGATION

Potential project impacts to water resources and their associated habitats are summarized in this section. The analysis includes impacts to water quality, hydrologic (flow) conditions, and to wetland and stream habitats. Mitigation incorporated into the action to reduce or eliminate these potential impacts is also discussed.

The analysis of the potential indirect impacts of stormwater on listed species, critical habitat, and essential fish habitat is based on the *Preliminary Comprehensive Stormwater Management Plan* (SMP) *for Seattle-Tacoma International Airport Master Plan Improvements* (Parametrix 1999b) for STIA. King County stormwater management experts are completing a technical review of the plan through an agreement with the Department of Ecology. The purpose of this review is to determine if the proposed SMP is consistent with applicable standards, and that the stormwater design standards identified in the SMP mitigate potential stormwater impacts of MPU projects. Upon completion of this review, and evaluation of any recommendations by the County, some stormwater management facilities may change from descriptions presented here (i.e., the size and storage capacity of detention facilities may be modified). The King County review will identify any needed changes in modeling and design of stormwater facilities to meet the performance standards that protect aquatic habitat in Miller, Des Moines, and Walker creeks from stormwater runoff impacts. Subsequent to this review, a revised SMP will incorporate the changes identified by King County. This independent review and subsequent design modifications assure that the current findings of this biological assessment regarding stormwater are valid. This is because the impacts evaluated here are those associated with the performance standards, and not the specifics of the system designed to achieve them.

7.1 WATER QUALITY IMPACTS AND MITIGATION

Water quality in Miller and Des Moines creeks could potentially be affected by projects described in the MPU; these projects include construction activities and increases in impervious surface that could lead to additional sediments and contaminants in stormwater runoff. STIA operations could further impact water quality in each creek because of: (1) conventional pollutants associated with urban type development, (2) ground and aircraft de-icing activities, and (3) discharge of effluent from the IWS system. Additional water quality impacts could include hydrologic impacts (e.g., increased peak and reduced base flows) and as well as impacts on wetland function resulting from wetlands filling and stream relocations.

The following sections describe the protective measures that will be undertaken to prevent water quality impacts. Water quality protection is covered by the Federal Water Pollution Control Act (33 U.S.C. § 1251, et seq.), also known as the Clean Water Act, and the Washington Water Pollution Control Act (RCW 90.48). The Clean Water Act is designed to protect the "chemical, physical, and biological integrity of the Nation's waters (U.S.EPA 1993)." The Clean Water Act is implemented through Section 401, Section 402 (the National Pollutant Discharge Elimination System [NPDES]) and Section 404 (addressing fill and the waters of the United States). The NPDES system is administered in Washington by Ecology.

The Port's compliance with the Clean Water Act. and in turn. protection of STIA's receiving waters, is demonstrated through compliance with its NPDES Permit (Ecology 1998b). As stated in the Fact Sheet (Ecology 1998c) for the Port's NPDES Permit. "compliance with the effluent limitations and other conditions in this permit constitutes compliance with the Federal Water Pollution Control Act. . .and the Washington Water Pollution Control Act (RCW 90.48)."

Specifically, the NPDES Permit requires the following measures:

- Effluent limitations based on the more stringent of either technology- or water quality-based limits.

- A stormwater pollution prevention plan (SWPPP) that identifies source control and treatment best management practices (BMPs) to "identify, reduce, eliminate, and or prevent the discharge of stormwater pollutants; to prevent violations of water quality, ground water quality, or sediment management standards; and to prevent adverse water quality impacts on the beneficial uses of the receiving water. . .(Ecology 1998b)."

- Routine water quality and toxicity monitoring for STIA stormwater outfalls and IWS discharge, and reporting of these results to Ecology.

- Evaluation of pollution sources and BMP effectiveness via self-inspection and monitoring results, to identify where and when additional BMPs are necessary to accomplish the SWPPP objectives.

Source controls and treatment facilities are implemented throughout STIA based on the activities undertaken at the airport, the anticipated water quality impacts associated with each activity, and the required and recommended BMPs. This infrastructure is continually updated via an adaptive management process by which (1) BMPs are implemented, (2) monitoring and inspections demonstrate BMP effectiveness or necessary changes, (3) BMP improvements are made when necessary, and (4) follow-up sampling demonstrates that the improvements are effective. Ecology reviews and approves this process annually to ensure that the Port's discharges are compliant with the Clean Water Act, and that the discharge conditions are protective of the receiving waters. Numerous BMP improvements have been implemented through this process (see Table 7-1) and follow-up monitoring has confirmed their efficacy.

The BMPs described in Table 7-1 are examples of how the Port has performed ongoing monitoring and implemented BMPs, to reduce and/or eliminate identified or potential water quality impacts. The Master Plan Updates are extensions of existing activities at STIA, and potential water quality impacts associated with these activities are expected to be similar to existing potential impacts. Although water quality BMPs are proposed for the Master Plan Updates in compliance with minimum requirements, BMPs in excess of the minimum requirements are proposed herein based on the Port's stormwater monitoring and management experience with these activities. Furthermore, the adaptive management process described above will continue to be used for new, existing, and redeveloped areas at STIA, to identify additional BMPs where necessary.

Table 7-1. Best management practices implemented at STIA as a result of monitoring and adaptive management (Port of Seattle 1997, 1998a, 1999a).

BMP	Results
Containment and diversion of the following areas to sanitary sewer or IWS: certain loading docks, trash handling areas, ramp areas subject to aircraft de-icing or servicing, and washing areas.	Prevent discharge of industrial or sanitary pollutants to the storm drain system (SDS) and surface waters.
Snowmelt areas to divert meltwater from collected snow to the IWS after ground de-icing compounds have been applied.	Elimination of a source of biochemical oxygen demand (BOD) to SDS and surface waters.
Elimination of urea as a ground de-icer.	Elimination of a source of ammonia.
Elimination of glycols as ground de-icers.	Elimination of glycol discharges to SDS and surface waters.
Implementation of a decant station.	Reduce petroleum and suspended solids pollution in SDS and surface waters.
Store chemicals and hazardous materials in the IWS area only.	Prevent spills to the SDS and surface waters.
Divert subbasin SDN-2 to IWS.	Eliminate glycol discharges to SDS and surface waters.
Catch basin inserts[a] in Taxi Yard catch basins.	Reduce petroleum and suspended solids pollution in SDS and surface waters.
Remove runway skid marks.	Reduce source of suspended solids and other pollutants to SDS and receiving waters.
Coating for targeted rooftops in SDN-1 (to be implemented in 2000-2001).	Eliminate source of toxicity in SDS and surface waters.

[a] Catch basin inserts are specially designed fabric inserts, placed in stormwater catchbasins. The fabric is designed to trap fine sediment, petroleum products, and other pollutants generated from parking lots and roads.

Complementing the general protection afforded the aquatic community by the Clean Water Act described above, the direct and indirect effects of the chemicals discharged to the environment from the MPU improvement operations are also evaluated in this section. Specific toxicity values have been identified for chinook salmon and bull trout from the scientific literature that will correspond with adverse effects on these species. Potential impacts resulting from chemicals discharged from MPU improvement operations were then evaluated by comparing the predicted concentrations for specific time spans to these adverse effect concentrations. These comparisons were made in areas where specific life-stages of both fishes could be present and for relevant exposure conditions (e.g., the amount of time each life-stage would expected to be present).

The first part of this section evaluates water quality impacts during construction of the MPU improvements, followed by water quality impacts expected during their operation.

7.1.1 Construction Impacts

7.1.1.1 Construction Runoff

The primary potential water quality impacts resulting from construction activities (including excavation and transport of fill) are increased turbidity and sedimentation in the receiving environments due to stormwater runoff from disturbed construction sites. Erosion and sedimentation typically occur when rainfall and stormwater runoff erode soil and deposit eroded materials downslope or downstream of the construction area. Erosion and sedimentation can result from a variety of potential actions associated with construction of MPU projects, including:

- Vegetation removal that exposes soil to rainfall and runoff,
- Grading, filling, and excavation that exposes soil to rainfall,
- Tracking soils onto impervious surfaces that are subsequently washed by rainfall,
- Excavation that oversteepens slopes and causes slope failures,
- Construction in streams or drainage courses where moving water is present,
- Constructed slopes that collect and concentrate stormwater, causing erosion, and
- Failure to protect drainage channels from erosive flow.

These construction actions could directly and indirectly affect chinook salmon and bull trout at the mouths of Miller and Des Moines creeks. Direct effects could result from increases in suspended solids in the water column. Indirect effects could result in deposition of sediment in areas where prey species of these fish may be present.

The MPU projects will meet the turbidity standard for Class AA waters[31]. This standard (WAC 173-201A-030) states that turbidity may not exceed 5 Nephelometric Turbidity Units (NTU) over background when background is 50 NTU or less, or register more than a 10 percent increase in turbidity when background exceeds 50 NTU. As a numerical standard, this pollution limit is protective of aquatic life (Ecology 1999b). Data from Des Moines Creek (Herrera 1995, 1996, 1997) demonstrated that when turbidity was 5 NTU or less, median total suspended solids (TSS) was 1.6 mg/L. Thus, if turbidity standards are met, TSS increases may be 1.6 mg/L[32]. This small increase in baseline TSS is orders of magnitude less than the acute and chronic TSS thresholds of 1,000 and 250 mg/L, respectively (King County DNR 1999a).

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[31] Washington surface waters are classified as Class AA (extraordinary), Class A (excellent), Class B (good), Class C (fair), or Lake Class. Class designation is based largely on characteristic uses of the waters. As defined by WAC 173-201A-030, Class AA waters shall "markedly and uniformly exceed the requirements for all or substantially all" of the following characteristic uses: water supply; stock watering; fish and shellfish migration, rearing, spawning, and harvesting; wildlife habitat; recreation; and commerce and navigation.

[32] Turbidity is a measure of the physical concentration and the light scattering properties of the suspended sediments. As the adverse effect of suspended solids to fish is related solely to it's physical characteristics, the appropriate measure for determining effects is the amount of suspended solids, measured as mg/L.

These actions could also result in a potential increase in sedimentation downstream of the MPU construction sites. Sediment could leave the construction area, move downstream as suspended sediment, and settle in critical habitat at the mouth of Miller or Des Moines creeks in areas where epibenthic[33] and infaunal[34] organisms are present. Chinook salmon and bull trout could be indirectly impacted by effects of increased sedimentation on these organisms as they are potential prey for juvenile chinook and the baitfish which are prey for bull trout present in the creek mouths.

Increased sedimentation can stress benthic organisms by interfering with their filter feeding and breathing (ventilating). In this evaluation, we define sedimentation (sediment deposition) as the settling of solids at the sediment-water interface which can cover and subsequently smother epibenthic and infaunal species. Increases in sedimentation rates have been documented in Canada and the U.S. (Turk et al. 1980; Lemly 1982) as causing mortality to aquatic organisms.

No state criterion or federal standard is currently available to gauge the impacts of sedimentation on benthic organisms. However, King County DNR (1999b) has evaluated the impacts of sedimentation on epibenthic and infaunal organisms in the Duwamish River and Elliott Bay. In that study, effects of sedimentation on aquatic life were evaluated using chronic effects[35] data from the scientific literature (King County DNR 1999c). Data used in this study were considered relevant when they addressed situations applicable to the habitats similar to Miller and Des Moines creeks (i.e., if they applied to rivers and estuaries with sandy silted bottoms).

Using these studies, King County derived effects criteria for sedimentation by following the California water quality marine standards process (Klapow and Lewis 1979) and U.S. Environmental Protection Agency (EPA) water quality criteria process (Stephan et al. 1985). The derived effects thresholds were defined as the lowest sedimentation rates expected to protect 95, 90, 85, and 75 percent of the exposed aquatic species. Initial work conducted by Parametrix (1977) has identified the chronic effect threshold for sediment settling as 21 mm/month (Table 7-2). This sediment settling rate is higher than rates observed in the open ocean (1 mm/year) and the 11 mm/month seen in a deltaic influenced estuary (Zedler and Onuf 1984). Thresholds providing other levels of ecological protection from the chronic effects of sedimentation are reported in Table 7-2.

Table 7-2. Chronic effects thresholds for sedimentation.

Species Protected (%)	Chronic Effect Threshold (mm/month)
95	21
90	37
85	47
75	60

Source: Parametrix 1977

[33] Invertebrates living just at or just above the sediment/water column interface
[34] Invertebrates living in sediment (i.e., benthic).
[35] Chronic effects are reductions in growth and reproduction in the invertebrate population, and not acute mortality.

As described above, the proposed stormwater construction sediment controls described in Section 7.1.2 will limit turbidity to levels (<5 NTUs) that are several orders of magnitude less than chronic thresholds of TSS. Further, such low TSS levels result in potential sedimentation rates that will be much lower than the chronic thresholds listed in Table 7-2. Consequently, sedimentation from MPU improvements is not expected to adversely impact food availability to juvenile chinook salmon and bull trout, nor directly impact these fish through increased TSS levels.

Sediment can also impact fish directly either by clogging and abrading fish gills or by settling in streams to cement in spawning gravel. Achieving the turbidity levels of less than 5 NTUs will prevent the fish gill impacts from occurring. Fouling of chinook or bull trout redds will not occur as no spawning by chinook or bull trout takes place in Des Moines or Miller creeks.

7.1.1.2 Other Potential Construction Impacts

In addition to sedimentation, several other potential water quality impacts could occur during construction. Standard sediment and erosion control practices to minimize sedimentation may result in other potential water quality impacts including solar heating of the stored runoff which could affect stream temperatures when water is finally discharged. Advanced stormwater treatment systems that use flocculation agents could potentially add chemicals to stormwater runoff. Some MPU project elements include in-water construction (e.g., Miller Creek Relocation, Vacca Farm restoration, 154th Street bridge replacement, and culvert replacement on the Tyee Golf Course) that could cause a direct increase of sediments to Miller and Des Moines creeks.

Sediment ponds store stormwater runoff for treatment, either by settling or chemical flocculation. However, temperature effects from retained construction stormwater are unlikely because significant storms that would result in several days of water storage during warm weather are rare. The Port has observed that little or no runoff occurs from embankment construction areas occurs during smaller, summer-season storms that occur when temperature impacts are of greatest concern. For example, in 1998 and 1999, the construction sites did not generate sufficient runoff to store water and operate the flocculation treatment system until mid-November, a time when significant temperature impacts would not occur due to the cool air temperatures (Table 7-3), lack of solar radiation, cool creek water, and high stream flows. During the spring of 1999, stormwater runoff quantities had decreased to the point where the plant discontinued operation by early April (thus no water was retained), prior to the time when warm temperatures and increased solar radiation levels could increase the temperature of stored stormwater runoff (see Table 7-3).

Since Autumn 1997, the Port has used advanced stormwater treatment systems to treat runoff from construction sites, including the NEPL, and the 1998 and 1999 phases of the third runway embankment. Since implementation of these systems, water quality monitoring at construction sites (Port of Seattle 1998b, 1999b, 2000) has demonstrated that stormwater discharges comply with turbidity standards. The Port will continue to use advanced construction stormwater treatment where necessary and appropriate. Construction TESC BMPs and advanced stormwater treatment systems are described in Section 7.1.2 and Appendix D.

Table 7-3. Temperature ranges for the warmest months when extended storage of stormwater at the Seattle Tacoma International Airport is expected.

Parameter	November	April
Average Maximum	49.6°F	58.2°F
Average Minimum	38.1°F	40.1°F
Average	43.9°F	49.2°F
Highest	65°F	77°F
Lowest	23°F	30°F
Number of clear days	3	3
Partly cloudy days	4	7

Source: WSU (1968).

The potential water quality impacts from the advanced stormwater treatment BMPs used to control turbidity include changes to pH and the toxicity of treatment compounds. This BMP has been used safely for more than three years at STIA and several construction sites (e.g., several WSDOT projects and Microsoft construction sites in Redmond) with Ecology's review and approval (Ecology 1998a). The draft Ecology Stormwater Manual Update includes a BMP for Construction Stormwater Chemical Treatment (Ecology 1999b). For its treatment regimes, the Port has used both organic polymers, such as CatFloc, and inorganic compounds such as alum. Aquatic bioassay testing of treatment system effluent has demonstrated that the effluent is not toxic (Port of Seattle 1998c). Aquatic toxicity testing of the polymer compounds themselves has demonstrated that effective treatment concentrations are several orders of magnitude below toxic concentrations (Calgon 1997).

Mitigation actions and beneficial habitat restoration are proposed in areas where standing or moving water is present at some time during the year. Sedimentation impacts from proposed in-stream work, such as the Miller Creek relocation project, would be mitigated by erosion control BMPs and adjusting construction seasons to avoid work during wet months. Upon completion of the relocation project, potential turbidity would be reduced by gradually reintroducing the stream into the new channel. Additional in-water mitigation measures are not required because the relocated portion of the Creek is not critical habitat for chinook salmon or bull trout, and listed fish would not be present. A detailed discussion of the Miller Creek relocation is found in Section 7.3.2.1.

A sewer line that crosses Miller Creek would be relocated (see Figure 3-1 and Table 3-1) such that the sewer line does not occur in stream habitat used by listed species, and listed species do not occur within about 3.5 miles from the sewer line project. Potential project effects are the same as the Miller Creek relocation, because the proposed sewer line replacement occurs in the channel relocation area. The pipe section under the proposed new alignment of Miller Creek (approximately 100 linear ft) would be installed prior to new channel construction. New channel construction would then occur, and flow would be gradually diverted into the new channel. Finally, once the old channel is no longer active, installation of the new sewer line would be continued under the former channel. No construction would occur across active stream channels, and as with every STIA construction site, the erosion and sedimentation controls described in Section 7.1.2 would be applied.

Wetland construction and restoration work. (e.g., Tyee Valley Golf Course. Miller Creek Buffer. Vacca Farm, and the Auburn wetland mitigation site) would take place in the summer months (when these areas are typically dry and runoff is unlikely) and erosion control BMPs would protect the creek from construction runoff. Since sedimentation would be controlled using the BMPs described in Section 7.1.2, no off-site sedimentation would occur.

Base flow impacts from construction activities would be negligible because the embankment construction sites are generally unpaved and will remain pervious. The material proposed for the embankment fill is typically more permeable than the till soils over which the embankment will be constructed, and due to its permeability, will infiltrate greater amounts of water than till soil.

During construction, stormwater treatment facilities will detain stormwater runoff for water quality treatment. Release from these facilities will be at or below baseline conditions for the site.

7.1.2 Construction Mitigation

Sedimentation from MPU construction sites will not affect critical habitat because significant amounts of sediment will not be discharged from these sites. Construction erosion control measures will meet Ecology's water quality standards, which are protective of the critical habitat, as discussed above. To ensure that these measures will be applied, the Port has implemented the following protection measures by:

- Funding independent third-party oversight of construction erosion control and stormwater management and compliance,
- Writing and implementing construction SWPPPs and monitoring plans for individual MPU improvement project activities,
- Fully applying conventional BMPs,
- Providing advanced construction stormwater treatment where necessary,
- Supervising contractor erosion control compliance with a full-time erosion control and stormwater engineer,
- Monitoring construction stormwater runoff whenever it rains, and
- Additionally monitoring construction stormwater runoff when rainfall exceeds 0.5 inch in a 24-hour period.

The BMPs listed in Table 7-4 will be applied as specified in the Stormwater Management Manual for Puget Sound (The Ecology Manual) or the King County Surface Water Design Manual (King County DNR 1998). Detailed information on erosion and sediment control for the third runway embankment construction is provided in Appendix D.

Table 7-4. Summary of the Ecology Manual BMPs generally applicable to Master Plan construction sites.

Category	Applicable BMPs
Temporary cover practices	Temporary seeding, straw mulch, bonded fiber matrices, and clear plastic covering
Permanent cover practices	Preserving natural vegetation, buffer zones, permanent seeding and planting
Structural erosion control BMPs	Stabilized construction entrance, tire wash, construction road, stabilization, dust control, interceptor dike and swale, and check dams
Sediment retention	Filter fence, storm drain inlet protection, and sedimentation basins

A Construction Spill Control and Countermeasures Plan containing the following elements will be implemented on each site:

- Spill control measures, including designated fueling areas,
- Secondary containment of spillable substances,
- Use of drip pans and pads,
- Contractor education,
- Labeling and proper storage of spillable substances,
- Designated spill containment procedures, and
- Proper notification and cleanup procedures.

Advanced stormwater treatment systems may be used to treat construction runoff when conventional BMPs do not remove sufficient turbidity to meet state water quality standards. The treatment process is described in Appendix D.

Data from the 1999-2000 wet season (Table 7-5 and Appendix D) demonstrate that the Port's advanced stormwater treatment system is highly effective at producing clear water. Between November 8, 1999, and March 4, 2000, a total of 164 batches of construction site runoff were treated. The average batch size was approximately 70,000 gallons.

Table 7-5. Summary of third runway embankment advanced construction stormwater treatment plant performance results from November 8, 1999 to March 4, 2000.

Number of batches treated	164
Percentage of treated batches meeting water quality standard for turbidity	100%
Average post-treatment turbidity (NTU)	2.7
Average Miller Creek turbidity on days when discharge occurred (NTU)	12.6

Source: Port of Seattle (2000).

All discharged treated stormwater met the Washington Water Quality Standard (WAC 173-201A) for turbidity, which requires that discharges not increase receiving water turbidity by more than 5

NTUs. On average, the site discharge was 9.9 NTUs less than that of Miller Creek, meaning that the construction discharge typically made the stream clearer.

When applied, advanced treatment would consist of Ecology-approved alum or polymer flocculation systems. All chemical treatment facilities would operate in accordance with the conditions of BMP C250, Construction Stormwater Treatment, as it appears in the Ecology Stormwater Manual. The draft Manual (Ecology 1999b) provides criteria for polymer product use:

- Polymer-treated stormwater discharged from construction sites must be nontoxic to aquatic organisms.
- A primary coagulant, flocculent-aid, or any combination thereof must be approved by EPA for potable water use.
- Petroleum-based polymers are prohibited.
- Prior to authorization for field use, jar tests must demonstrate that the turbidity reduction necessary to meet the receiving water criteria can be achieved. Test conditions including, but not limited to, raw water quality and jar test procedures, should be indicative of field conditions.
- Prior to authorization for field use, the polymer-treated stormwater must be tested for aquatic toxicity. Applicable procedures defined in Chapter 173-205 WAC, Whole Effluent Toxicity Testing and Limits, will be used. Testing will use (a) stormwater from the construction site at which the polymer is proposed for use or (b) a water solution using soil from the proposed site.
- Testing must show that the dosage at which the polymer becomes toxic is at least twice the anticipated operational dose.
- The approval of a proposed coagulant or flocculent-aid will be conditional, subject to the full-scale bioassay monitoring of treated stormwater required by Ecology. The Port will use only polymer products that have been evaluated and are currently approved for use.

7.1.3 Impacts of Operation

Operation of the airport after implementation of the MPU projects could impact water quality in Miller and Des Moines creeks as well as waters of the Puget Sound at the IWS outfall. (For a complete description of the physical layout and treatment systems used in the IWS, please see the recent *Preliminary Comprehensive Stormwater Management Plan for Seattle-Tacoma International Airport Master Plan Improvements* (Parametrix 1999b). Water quality impacts to each creek could result from the discharge of pollutants typically present in urban stormwater, as well as from the anti-icing and de-icing chemicals used in airport operations to these creeks. Additional water quality impacts on the listed species could occur in the water column to which the IWS discharges. As discussed below (Section 7.1.4.3), stormwater collected in the IWS is first treated and then directly discharged to Puget Sound.

Pollutants can affect several elements that are considered to be essential features of critical habitat, including substrate, water quality, water temperature, and food. As noted earlier, sediment can clog and abrade fish gills, and settle in streams and estuaries, fouling redds and invertebrate (food) habitat. Metals and hydrocarbons can cause lethal and sublethal toxic effects to fish and their food base. Nutrients and oxygen-consuming materials can reduce DO and alter food chain dynamics. Temperature increases can cause stress or mortality.

As described in Sections 5.1.4 and 5.2.4, potentially affected critical habitat is located at the mouths of Miller and Des Moines creeks and in the vicinity of the IWS outfall. Therefore, potential water quality impacts are related to stormwater runoff from the MPU and its potential impact to the estuarine and nearshore environment at the mouths of the creeks and in the water column in the vicinity of the outfall. If stormwater runoff quality from the MPU projects is likely to improve due to proposed mitigation or other beneficial actions, there would be no negative effect on the critical habitat or listed species.

The STIA MPU improvements are not expected to negatively affect existing water quality during operation for the following reasons:

- Runoff sampled from the existing airport runways was not found to be toxic to aquatic organisms.
- Existing urban and residential land with higher pollutant concentrations than runways and with little or no water quality treatment, will be replaced with runways that include treatment BMPs.
- Other existing water quality impacts, such as agricultural activity and golf course management, will be removed from airport land in the Miller Creek watershed.
- Many existing airport support areas, such as roadways and parking lots, will be retrofitted with water quality BMPs.
- Proposed beneficial habitat enhancements will provide water quality benefits to the streams.
- The quality of STIA runway stormwater is comparable to or better than regional urban stormwater, and BMPs to be implemented are known to be effective at removing pollutants in urban runoff.
- The MPU will include stormwater quality BMPs in compliance with The Ecology Manual.

As discussed in Section 7.1 above, the Port is compliant with its NPDES Permit. The permit engenders a continuous adaptive management process by which BMPs are implemented, monitoring and inspection occurs, and follow-up actions are taken where needed to eliminate actual or potential impacts.

The following sections describe the existing water quality conditions (including de-icing), the STIA drainage system, current and proposed BMPs (including the IWS and source controls), existing treatment BMPs, and expected water quality benefits from other Port-proposed enhancement actions. Mitigation for new potential water quality effects is presented in Section 8.

7.1.3.1 Determining Water Quality Impacts on Chinook Salmon and Bull Trout

A variety of analysis techniques and weight-of-evidence evaluations are necessary to determine potential water quality impacts on listed species, if any, attributable to airport operations after implementation of the MPU projects. These approaches are needed because it impossible to continuously measure or predict all concentrations in water where listed species could be exposed or to observe all their responses to these concentrations. These approaches are based on the best available scientific techniques used by regulatory agencies, such as EPA, to establish criteria protective of aquatic resources. Water quality criteria themselves were not used in this evaluation as they have been developed to protect 95 percent of all aquatic species, and may not be specifically protective of listed species (Stephan et al. 1985).

Stormwater Chemical Concentrations

Effects of chemicals in stormwater generated by the STIA operations were predicted using measured chemical concentrations in existing discharges and then mathematically modeling exposure concentrations where chinook salmon and bull trout are present in the Action Area. For several years, a NPDES monitoring program of stormwater chemical concentrations of Port outfalls has been completed for compliance with NPDES regulations. This Port program provided a data source for chemical concentrations in stormwater discharged to Miller and Des Moines creeks as well as from the Industrial Wastewater Treatment Plant (IWTP). Specific discharge locations where chemical concentrations have been measured are presented in Figure 7-1.

No critical habitat was present at the discharge locations where direct measurements of stormwater chemical concentrations were made; thus, it was necessary to use mathematical models to predict concentrations at actual points of exposure, such as the mouths of Miller and Des Moines creeks and the IWS outfall. The predicted concentrations were developed by combining the distributions of measured stormwater chemicals with the predicted dilutions based on rainfall and daily stormwater discharge volume (see Appendix F for a detailed description of the modeling procedures used). Predicted concentrations were developed using a conservative approach. Specifically, the upper 95th percentile value of measured chemical concentrations[36] was chosen to represent the input values used to predict whether water quality impacts will occur.

Development of Toxicity Thresholds

An additional requirement in determining water quality impacts is identifying appropriate thresholds for chemical toxicity. Appropriate toxicity data are often unavailable for the specific combinations of listed species and chemicals of potential concern. In many cases toxicity data are only available for a standard test species that may not represent the sensitivity of listed species. Because of the time and costs associated with testing all species of interest, extrapolation among different species is frequently used to assess toxicity values in the absence of the full suite of toxicity parameters (King County DNR 1999a).

The relevance of interspecies extrapolation was investigated by comparing the response of various salmonid species with common test organisms [rainbow trout (*O. mykiss*) and fathead minnow (*Pimephales promelas*)] (see Appendix E for a complete description of this investigation). This comparison established rainbow trout to be an acceptable surrogate for the other tested salmonid species (coho salmon, chinook salmon, brown trout, brook trout, and lake trout) for both organic

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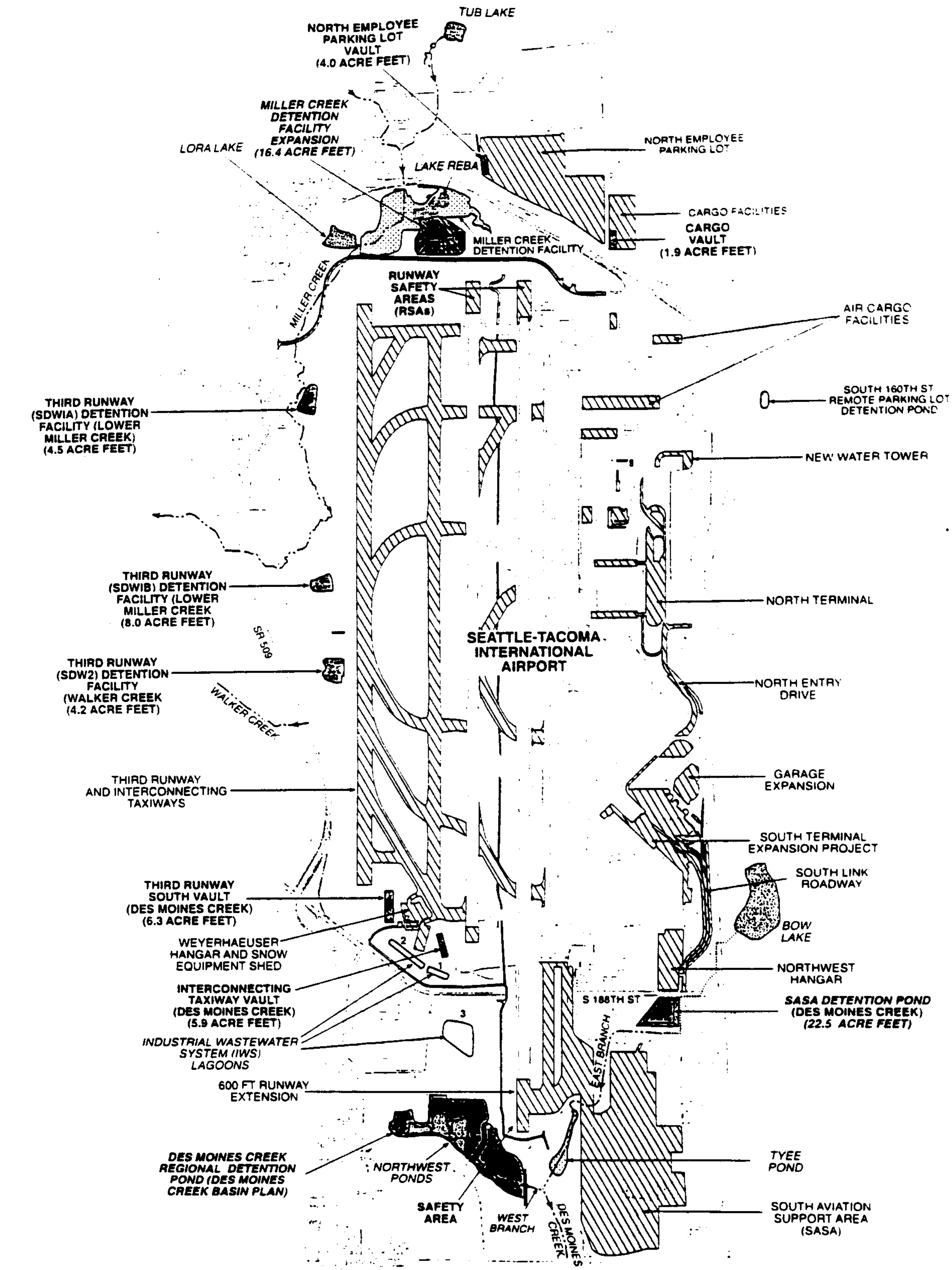
[36] The 95 percent upper confidence limit of a sample mean is the value which below 95 percent of all sample means would fall if the measurements were repeated numerous times using the same methods. This value is always higher than the mean value.



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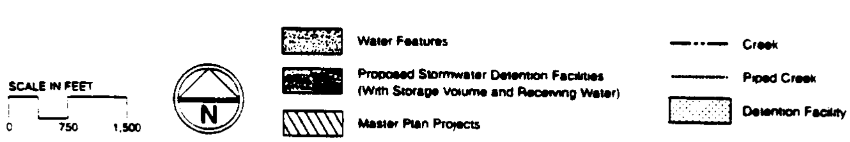

Figure 7-1
Master Plan Update Improvements and Proposed Detention Facilities

and inorganic chemicals[37]. A similar comparison of fathead minnow response to toxicants with salmonids indicated an acceptable predictive relationship for organics, but not for metals. Fortunately, having available the salmonid toxicity data for the metals of concern in STIA stormwater avoided any need to extrapolate outside of the genus *Oncorhynchus*[38].

Chinook salmon and rainbow trout toxicity values were used without modification to represent toxicity thresholds for chinook salmon and bull trout, a use supported by the 1:1 relationship demonstrated in Appendix E when such data were available. Fathead minnow data were transformed using the regression relationship developed in Appendix E to represent toxicity thresholds for one group of organic compounds (Types I, II, and IV propylene glycol based de-icing and anti-icing compounds).

<u>**Determining Water Quality Impacts**</u>

Impacts of chemicals in stormwater on listed species were then determined by comparing modeled exposure concentrations to the identified toxicity thresholds. Additional corroborative evidence was developed by collecting and testing the toxicity of stormwater to fathead minnows and *Daphnia pulex*, a freshwater invertebrate representative of the prey items of juvenile chinook.

7.1.3.2 Characterization of STIA Stormwater Quality

The Port has monitored stormwater quality from its outfalls since 1995. The data show the efficacy of BMPs implemented by the Port over a number of years. For example, airport runoff is, for most parameters measured, cleaner than runoff from other urban areas. Copper and zinc concentrations have dropped significantly at outfall SDS -1 since new BMPs re-routed runoff from aircraft service areas in this subbasin from the SDS to the IWS in June 1997 (Port of Seattle 1998a).

The parameters in Table 7-6 (total petroleum hydrocarbon [TPH], fecal coliforms, BOD, TSS, turbidity, and total recoverable copper, lead, and zinc) plus ethylene glycol and propylene glycol are the stormwater monitoring parameters currently required by the STIA NPDES Permit (FOG and ammonia, also listed in the table, were formerly required). Ecology and the Port have determined these parameters to be the significant chemicals most likely to be discharged to surface waters by airport activities (Ecology 1998c). Ethylene glycol and propylene glycol, potassium acetate (KA), and calcium magnesium acetate (CMA) are de-icing chemicals used at STIA.

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[37] No toxicity data were found for bull trout, but lake trout is from the same genus (*Salvelinus*) and Suter et al. (1983) has established that species from the same genus have very similar responses to the same toxicants (see Appendix E for a further discussion).

[38] The genus *Oncorhynchus* inclus the five Pacific salmon species (chinook, coho, chum, pink, and sockeye), golden trout, cutthroat trout, and Gila trout (Robins, et al. 1991).

Table 7-6. Seattle-Tacoma International Airport runoff quality (1995-1998) compared to regional and national urban stormwater quality studies [a,b].

(1) Pollutant	(2) Units	(3) STIA: RW/TW (median)	(4) STIA: All Data (median)	(5) Bellevue: Sturtevant Creek[c] (log-normal median)	(6) Bellevue: BURP[e] (mean, median)	(7) King County: Metro(1982) (mean)	(8) NURP[h]: USEPA (1983) (median)	(9) Portland NPDES[i]	(10) Freeway Runoff (mean)
FOG	mg/L	0.5	1.1	3.7	2.5	7.8	–	–	30[f]
TPH	mg/L	0.3	0.5	3.7	–	–	–	6.5	–
Fecal coliforms	mpn/ 100 ml	1	30	201	980	–	1000 to 21000	–	–
BOD	mg/L	8.2	6.4	–	6.6	–	9	20	–
TSS	mg/L	4.8	16.0	82.3	50	–	100	119	106[g]
Turbidity	mg/L	5.4	10.0	29.4	19	–	–	–	–
NH3[d]	mg/L	0.04	0.1	0.58	0.17	–	–	–	–
Cu (TR)	µg/L	37	30	10.4		20	34	39	43[g]
Pb (TR)	µg/L	3	5	26.3	170	210	144	36	466[g]
Zn (TR)	µg/L	54	74	161.4	120	110	160	253	638[g]

Source: Port of Seattle 1999a

[a] "–" indicates no data available, reported, or applicable.

[b] Column 3 indicates median pollutant concentrations in STIA runway/taxiway runoff (RW/TW) (SOS-3 subbasin data). Column 4 indicates median pollutant concentrations in airport wide runoff. Columns 5-9 indicate pollutant concentrations observed in urban and highway runoff in representative regional and national studies.

[c] From Bellevue (1996) Sturtevant Creek, downstream site.

[d] Ammonia values are expressed as total ammonia, not as ammonia-nitrogen.

[e] Bellevue Urban Runoff Program from Pitt and Bissonnette (1984). For turbidity, Cu, Pb, and Zn data reported as mean of grab samples.

[f] Highway runoff in England (see Booth and Horner 1995).

[g] Highway runoff from Interstate 5 freeway in Seattle with 57,000 automobiles per day, 43 to 54 storm samples in 1980-81 (Chui et al. 1982).

[h] National Urban Runoff Program.

[i] City of Portland 1993. NPDES Part 2 Municipal Application, data from NW Yeon Blvd (Portland 1993).

Pollutant Abbreviations

FOG = Fats, oil, grease
TPH = Total petroleum hydrocarbons
BOD = Biochemical oxygen demand
TSS = Total suspended solids
Cu = Copper
Pb = Lead
Zn = Zinc
TR = Total Recoverable

Ground De-Icing

During winter months, potassium acetate (KA) and calcium magnesium acetate (CMA) are applied as runway and taxiway de-icers. In solution, these chemicals dissociate into potassium, calcium, magnesium, and acetate, all of which occur naturally in the environment. The presence of added calcium and magnesium causes an increase in hardness in runoff waters; this, in turn, reduces bioavailability of metals (Rand and Petrocelli 1985). Acetate is a weak acid that is readily biodegradable through processes that consume DO, potentially increasing the biological oxygen demand of surface waters. Environmental monitoring at Halifax International Airport, where KA and CMA were used, showed increases in BOD associated with rises in acetate levels, but the absence of any other discernable impact (ADI Nolan Davis Inc. 1994).

DO monitoring in winter 1998-1999 (Cosmopolitan Engineering Group 1999) demonstrated the following:

- DO concentrations in the Northwest Ponds, Lake Reba, and Miller and Des Moines creeks fluctuate in the absence of de-icing activities.
- There was no discernable change in DO concentrations in the receiving water bodies following ground anti-icing and de-icing events in December 1998 and February 1999.
- During de-icing events, DO in the Des Moines Creek basin remained above 8.0 mg/L (60-100 percent saturation) at the Tyee Valley Golf Course Weir. It remained above 10 mg/L, and often above 12 mg/L, (90-110 percent saturation) in Des Moines Creek at the Wastewater Treatment Plant, where salmon are present (Des Moines Creek Basin Committee 1997).
- During and following de-icing events in the Miller Creek basin, DO remained above 8 mg/L, and often above 10 mg/L, (60-100 percent saturation) at the Miller Creek Detention Facility outlet. DO remained above 10 mg/L, and often above 12 mg/L, (100 percent saturation) at downstream reaches where salmon are present.

Because DO levels naturally fluctuate in rivers and streams, Alabaster and Lloyd (1980) concluded that it is somewhat inappropriate to have criteria based on a single minimum value that should never be violated. However, criteria have been developed by EPA (USEPA 1986) and state standards have been established (WAC 173-201A-030). The studies used to develop the DO criteria by EPA indicate DO concentrations around 8 mg/L would not affect salmonid survival (Duodoroff and Shumway 1970), growth (JRB Associates 1984), or swimming speed (Davis et al. 1963; Jones 1971). Given that DO concentrations in Des Moines and Miller Creeks remained above 8 mg/L in the upper reaches, and above 10 mg/L downstream of the STIA where salmon are present, ground de-icing activities are unlikely to affect listed species or critical habitat.

Sand

Sand may be applied to road surfaces to enhance traction when icing conditions occur[39]. Sand particles are much larger than the design particle size for retention of water quality treatment BMPs; thus, after passing through catch basins, detention facilities, and treatment BMPs, all sand particles would be captured before they could reach the streams. Other particles present in applied sands (i.e., clay-sized particles and smaller) may be partially removed by treatment BMPs. Particles not removed may be discharged to streams or the IWS. To maintain the efficiency of existing and new BMPs for sediment, the Port will continue to clean catch basins after sand application.

Aircraft De-Icing

Aircraft anti-icing and de-icing fluids[40] (ADAFs) are a potential source of BOD and toxicity. Aircraft anti-icing and de-icing fluids consist of either ethylene glycol or propylene glycol mixed with constituents that include water, buffers, wetting agents, and oxidation inhibitors (this discussion distinguishes *glycols* from *de-icing fluids*, which include glycols and the other constituents). The exact type and quantity of these constituents in de-icing fluids varies, is considered proprietary by the manufacturers, and is therefore unknown.

Aircraft deicing and anti-icing fluids are categorized into four classes: Type I, Type II, Type III, and Type IV (USEPA 2000b). Type I is the most commonly used fluid and is used primarily for aircraft deicing. These types of fluids, containing either ethylene glycol or propylene glycol, water, and additives, remove accumulated ice and snow from aircraft surfaces (USEPA 2000b). Types II, III, and IV were developed for anti-icing and form a protective anti-icing film on aircraft surfaces to prevent the accumulation of ice and snow. Anti-icing fluids are composed of either ethylene glycol or propylene glycol, a small amount of thickener, water, and additives (USEPA 2000b).

The Port of Seattle collects annual records for Ecology of amounts and types of anti-icing and de-icing fluid used at STIA using a reporting period spanning April 1st – March 31st. For the period of April 1, 1998 through March 31, 1999, tenants at STIA used predominantly propylene glycol based Type I fluids followed by ethylene glycol Type I fluids and then Type II and Type IV fluids, both propylene glycol-based (Table 7-7). To evaluate the impacts of ADAFs on listed species present in the Action Area, we based the percentages of different ADAF formulations applied on the actual percentages recorded by STIA for when aircraft de-icing and anti-icing is necessary for passenger safety. Over the last year, Type II fluids have been phased out at STIA in favor of Type IV fluids. While a few tenants still possess some Type II anti-icing fluids, the Port has indicated that those tenants plan to completely discontinue their use at STIA.

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[39] Because of potential damage to aircraft, sand is only applied to roads.

[40] Anti-icing fluids are applied to aircraft prior to take-off to limit or prevent icing once airborne. De-icing fluids are applied to aircraft on the ground to remove ice build-up prior to takeoff (U.S. EPA 2000b).

Table 7-7. Relative usage of aircraft de-icing / anti-icing fluids for April 1, 1998 – March 31, 1999.

	Type I (EG)	Type I (PG)	Type II (PG)	Type IV (PG)
Percent of total ADAFs used	4.1%	94.8%	0.8%	0.2%

EG: ethylene glycol based
PG: propylene glycol based

While aquatic toxicity data (Table 7-8) for ADAF have been available since the mid 1990s, data collected using a specific ADAF are quickly outdated because manufacturers continue to develop less toxic additives (USEPA 2000b). In addition to the toxicity data, the USEPA (2000b) cites the USFWS Classification System in rating Type I ADAFs as "relatively harmless" and rating Type II/IV ADAFs as "slightly toxic" to "relatively harmless." Furthermore, the Type IV propylene glycol-based fluid that was evaluated, showed levels of toxicity similar to Type I (PG) fluids from the same manufacturer, indicating that additives in Type IV (PG) fluid "may not significantly impact aquatic toxicity" (USEPA 2000b).

Table 7-8. ADAF aquatic toxicity data provided by fluid manufacturers to the EPA.

Species	Duration and Endpoint	Type I (EG) Conc. mg/L	Type I (PG) Conc. mg/L	Type IV (EG) Conc. mg/L	Type IV (PG) Conc. mg/L
Fathead Minnow (*Pimephales promelas*)	96-h LC50	22,000	1,250	370	1,400*
Rainbow Trout (*Oncorhynchus mykiss*)	96-h LC50	17,000	NA	380	NA
Water Flea (*Daphnia magna*)	48-h EC50	44,000	NA	NA	NA
Water Flea (*Daphnia magna*)	48-h LC50	NA	750	630	975

Source: USEPA (2000b)
*Data provided by ARCO Chemical Company
EG - Ethylene Glycol
PG - Propylene Glycol
NA – Not Available

Because ADAFs are a mixture of glycols, water, and additives, de-icing fluid levels in runoff can only be estimated by the measured glycol concentrations. Although glycol content varies by formulation, a typical Type I fluid is approximately 90 percent glycol, while Type II and Type IV fluids are generally about 65 percent glycol. De-icing fluid additives, which are suspected to be responsible for most measurable ADAF toxicity, constitute no more than 2 percent (by weight) of ADAFs (USEPA 2000b). Levels of ethylene glycol, propylene glycol, and total glycols have been monitored in both the SDS and the IWS. By fractionating measured glycol levels according to the percentages by which de-icing fluids were applied and the approximate glycol content of those fluids, we estimated whole de-icing fluid concentrations at different locations where chinook salmon and bull trout (Table 7-9) could be exposed. We used the following equation:

$$\textit{Estimated Concentration of ADAF} =$$

$$\textit{(Measured Glycol Type)} * \textit{(\% of Glycol Type Used at STIA)} * \left(\frac{1}{\textit{\% Glycol in ADAF Type}}\right)$$

Table 7-9. Estimated maximum ADAF concentrations (mg/L) in the IWS Outfall Discharge and at the mouth of Miller and Des Moines creeks.

ADAF type	Max. ADAF Conc., IWS Discharge at 0.5 meters from end of pipe[1]	Max. ADAF Conc., Mouth of Miller Creek	Max. ADAF conc., Miller Creek Falls	Max. ADAF Conc., Mouth of Des Moines Creek	Max. ADAF conc., Des Moines Creek Ravine
Type I (EG)	44.4	4.22	3.56	5.89	27.7
Type I (PG)	55.8	5.83	4.84	13.41	58.8
Type II (PG)	0.65	0.07	0.06	0.16	0.7
Type IV (PG)	0.16	0.02	0.01	0.04	0.2

[1] Effluent concentrations for the IWS system are calculated at 0.5 meter from the end of pipe, because this is where plume velocities are less than 1.0 m/s, the continuous swimming speed of adult chinook salmon (Groot et al. 1995).

EG: ethylene glycol

PG: propylene glycol

As described in Table 7-9, ADAF Types I (EG), II (PG), and IV (PG) make up a small percentage of de-icing fluids used at STIA; likewise, they account for a very small amount of glycols detected in the IWS discharge and at the mouths of Miller and Des Moines creeks. Applying the relationship between fathead minnow toxicity and toxicity for salmonids presented in Appendix E, the equivalent salmonid LC50 value for Type 1 (PG) would be 415.3 mg/L and for Type IV (PG) (i.e., the predominant ADAF used) would be 460.5 mg/L. The maximum concentration of all four types of anti-icing and de-icing fluids used at STIA are at least seven times below their relevant toxicity thresholds (USEPA 2000b). As these maximum concentrations will only occur very rarely and they are already well below the adverse effect concentration, ADAFs in STIA stormwater will not adversely affect chinook salmon or bull trout.

Copper and Zinc in Miller Creek, Des Moines Creek, and IWS Effluent

Environmental baseline conditions in Miller and Des Moines creeks are generally considered "at risk" or "not functioning properly" (see Tables 4-1 to 4-4). This "at risk" condition was found to exist at the mouth and within the general run of each creek. This evaluation is based mainly on the degraded habitat characteristics of each creek. Potentially contributing to the impact of these creeks are stormwater constituents typically present in urban stormwater (U.S.EPA 1983) and constituents present in stormwater runoff generated by airport operations.

As common constituents in urban stormwater, copper and zinc (U.S.EPA 1983) are generated by urban land-uses and activities, in addition to STIA, that are present in these drainages. Copper and zinc have been detected in all STIA stormwater samples required by the Port's NPDES Permit (Port of Seattle 1999a). Copper and zinc have also been detected in all samples collected in Des Moines Creek (and neighboring Massey, McSorley, and Barnes creeks) by the City of Des Moines (Herrera 1997), and in all samples upstream and downstream of STIA outfalls in the Stream Effects Study (Port of Seattle 1997). Copper and zinc are not routinely monitored in IWS Effluent; however, of three samples taken between 1995 and 1997, copper was detected in one sample and zinc in three (Kennedy/Jenks 1998).

The copper and zinc concentrations in stormwater will be either unchanged from existing baseline conditions or lower than stormwater currently discharged, because the MPU improvements will result in a greater volume and percentage of stormwater runoff undergoing water quality treatment and detention compared to the environmental baseline. This will be accomplished by retrofitting areas currently lacking treatment as well as detaining and treating all stormwater associated with new impervious surfaces. Additionally, copper and zinc in stormwater discharged to Miller and Des Moines creeks will be reduced through the collection and routing of stormwater to the IWS system (evaluated above) from areas that currently discharge to these creeks. Therefore, the proposed actions will not increase the exposure of chinook salmon or bull trout to copper or zinc at the mouths of Miller or Des Moines creeks. Similarly, in the unlikely event that either adult chinook salmon or bull trout strayed into these creeks, the proposed action will not increase their exposure to zinc and copper.

Ongoing investigations have identified that conditions (such as the amount of dissolved organic carbon) in each creek reduce the bioavailability of copper to fish[41] (Parametrix 1999c). Consequently it is not possible to calculate the total copper and zinc levels that will be present at the creek estuary or in the freshwater lengths of Miller or Des Moines creeks.

However, it is possible to evaluate the impacts of copper and zinc from STIA operations to these portions of the creeks using two complimentary approaches. First, the improvements and retrofitting of stormwater control facilities associated with the MPU improvements will maintain or reduce the amount of copper and zinc contributed to these basins. This will serve to maintain or improve existing environmental baseline conditions for chinook salmon and bull trout potentially occurring in the creek estuaries. Second, even without knowledge of the contributions of other point and non-point sources of copper and zinc, it is possible to model the contribution of STIA operations to copper and zinc at the mouths of Miller and Des Moines creeks, and to compare these values with the relevant toxicity thresholds.

To complete this second evaluation, copper and zinc concentrations were predicted using a mathematical model for the areas where listed fish could be exposed to them (the mouths of Miller and Des Moines creeks as well as the IWS outfall). (See Appendix F for a complete description of the modeling approach.) The model used the hydrologic flow data from Miller and Des Moines creeks over the last 49 years and water quality data to produce a cumulative distribution of predicted copper and zinc concentrations that would occur during a 49 year period (Table 7-10).

Similarly, the maximum potential flow of IWS effluent to the Midway Sewer District outfall was used to predict the concentration of copper and zinc in effluent discharged to the Puget Sound (Table 7-11). In contrast to Miller and Des Moines creeks, it is possible to calculate concentrations for copper and zinc near the IWS outfall where listed species may occur because of the likelihood that Puget Sound background concentrations are significantly lower than the concentrations of the effluent. Effluent concentrations were predicted at 0.5 meters and 10.8 meters from the point of discharge from the terminal 5" port at the end of the diffuser. These distances were chosen based on a plume velocity of 1.0 m/s (the maintenance swimming speed for an average sized adult chinook salmon [Groot et al. 1995]) and the acute mixing zone boundary.

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[41] Dissolved organic carbon can bind with divalent metals, such as copper, reducing their bioavailability and therefore their toxicity to aquatic organisms such as fish. The U.S. EPA (1994) has identified procedures for investigating and determining the effect of dissolved organic carbon on metals toxicity for use in setting thresholds that will be protective of aquatic organisms.

Table 7-10. Predicted amount of time in 49 years that copper and zinc will be at or greater than specific concentrations at the mouths of Miller and Des Moines creeks.

Location in the Action Area	Copper, mg/L	Zinc, mg/L	Exceedence (Percent)[1]	Exceedence (Days)[2]
Mouth of Miller Creek	0.045	0.234	0.001%	0.2 days
	0.022	0.113	0.01%	2 days
	0.013	0.064	0.1%	18 days
	0.007	0.035	1%	179 days
Mouth of Des Moines Creek	0.024	0.060	0.001%	0.2 days
	0.020	0.049	0.01%	2 days
	0.018	0.043	0.%	18 days
	0.010	0.024	1%	179 days

1 Percent of time in 49 years copper or zinc exceeds reported concentrations
2 Number of days copper or zinc concentrations exceeds reported concentrations during 49 years, not all of which will be contiguous over this time period.

Table 7-11. Predicted concentrations of copper and zinc in the vicinity of the IWS outfall.

Location in the Action Area	Distance from Diffuser Port	Copper, mg/L	Zinc, mg/L
IWS Outfall	0.5 meters	0.030	0.103
	10.8 meters	0.002	0.007

These predicted copper and zinc concentrations were then compared with the acute toxicity thresholds for chinook salmon and bull trout (Table 7-12, from USEPA 1985, 1987). Data for both copper and zinc were available for chinook from these sources. No specific toxicity data was available for bull trout, thus brook trout (*Salvelinus fontinalis*) was used as a surrogate species based on the relationships developed in Suter et al. 1983 and Appendix E.

Table 7-12. Copper toxicity values for chinook salmon and brook trout .

Listed or Surrogate Species	LC50 Toxicity Value[a]	
	Copper, mg/L	Zinc, mg/L
Chinook salmon	0.042	0.446
Brook Trout	0.110	2.100

Source: USEPA (1985, 1987)

a LC50 toxicity values are based on 96 hours of continuous exposure. It is unlikely either salmon or bull trout would remain the vicinity of the IWS outfall for 96 consecutive hours.

Comparisons of these toxicity thresholds to the predicted amounts for zinc at the IWS outfall indicates that these concentrations are 4 to 64 times below the LC50 value for chinook and 20 to 300 times below the LC50 value for bull trout for the time periods assessed. Similarly, copper concentrations in the vicinity of the outfall are between 1.4 and 21 times below the chinook LC50 and 4 to 55 times below the bull trout LC50. The active foraging behavior of the adult chinook and bull trout that could be present in the vicinity of the marine outfall will further reduce their exposure to these chemicals. None of these predicted concentrations at the mouths of Miller and Des Moines creeks for these exposure periods (distributed over 49 years) will result in any significant adverse effects on chinook salmon or bull trout. This conclusion is based on these observations:

- Zinc concentrations in each of the three exposure locations (the mouths of Miller and Des Moines creeks) are always below the adverse affects level. Concentrations for exposure durations relevant to the toxicity tests used to develop these toxicity values (96 hours or more) are significantly below these values. Similarly, zinc concentrations 10 meters or more from the outfall diffuser are also significantly below the zinc toxicity values for chinook salmon and brook trout[42].
- Copper concentrations at the mouths of Miller and Des Moines creeks are always below the brook trout copper toxicity value. Exposure durations for copper concentrations at or near the copper toxicity value at the mouths of Miller and Des Moines creeks are for such short durations (0.2 to 2 non-contiguous days spread over 49 years) that they will not pose adverse effects to chinook salmon. Copper concentrations for exposure durations relevant to the toxicity tests used to develop these toxicity values (96 hours or more) are significantly below these values. This conclusion is supported by copper toxicity data provided by G. Chapman (unpublished data).
- Copper concentrations at the Midway Sewer District Outfall 10 meters or more from the diffuser ports are significantly below the toxicity values.
- Bioavailable concentrations of copper and zinc in Miller and Des Moines creeks will likely be much less than those presented here. Preliminary experimental evidence has demonstrated a significant reduction in copper and zinc bioavailablility when mixed with receiving waters from these creeks.

Industrial Wastewater System Emergency Discharge Impacts

Areas subject to industrial pollution, including petroleum products or application of aircraft anti- and de-icing chemicals (glycols), drain to the IWS. When ground de-icing chemicals (acetate compounds) are applied, snow is removed from runways and placed in snowmelt areas that also drain to the IWS, thus preventing these de-icing chemicals from reaching the creeks.

Water collected in the IWS is treated to remove petroleum products, trash, and particulates (the treatment process is described in Section 7.1.4.3). Treated effluent is discharged directly to Puget Sound via an outfall located 1,800 ft offshore, at a depth between 156 and 178 ft below mean sea level (permitted by the Port's NPDES permit). Therefore, areas subject to industrial activities do not result in stormwater quality impacts to Miller Creek or Des Moines Creek.

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[42] The surrogate species for bull trout (see Appendix E for a discussion of the use of surrogate species in toxicity test value development).

If during extreme precipitation events the storage capacity of IWS storage is exceeded, untreated water would be released to Des Moines Creek. This has occurred only once (for several hours) under the current configuration of the IWS, during an extreme rain-on-snow event in December 1996-January 1997. No petroleum hydrocarbons were detected downstream of the release, although elevated BOD and glycols were detected.

Such storage exceedances of IWS would become less frequent with the proposed expansions of this system. Lagoon 3 will be enlarged in 2000-2001, providing additional storage to account for the increase in IWS area. The total lagoon storage (Lagoons 1, 2, and 3) will be increased from approximately 29.5 million gallons to approximately 81.4 million gallons (Lagoon 3 at overflow elevation will have a capacity of 76.5 million gallons; the normal volumes of Lagoons 1 and 2 are 1.64 and 3.27 million gallons, respectively).

The IWS was designed with the storage capacity necessary to hold the 25-year, 1- through 7-day storms from a 424 acre service area and a discharge rate of 4MGD[43]. Runoff was calculated using the StormShed hydrologic model (Engenious Systems 1997) and rainfall for the 1- through 7-day 25-year storms (Port of Seattle 1998a). The analysis (Table 7-13) shows that the total lagoon storage will provide excess capacity for the 25-year storms. The cumulative amount of storage necessary increases up to and then decreases beyond the 5-day storm runoff volume, demonstrating that the storage is adequate for multiple-day storms.

Table 7-13. Cumulative runoff volume, treatment volume, and required storage volume for the IWS under future conditions for 1- through 7-day 25-year storms.

Storm	Cumulative Runoff Volume (gal)	Cumulative Treated Volume (gal)	Stored Volume (gal)
24-h 25 y	36,427,600	4,000,000	32,427,600
2-d 25 y	50,265,600	8,000,000	42,265,600
3-d 25-y	58,269,200	12,000,000	46,269,200
4-d 25-y	66,347,600	16,000,000	50,347,600
5-d 25-y	72,107,200	20,000,000	52,107,200
6-d 25-y	75,548,000	24,000,000	51,548,000
7-d 25-y	77,866,800	28,000,000	49,866,800

If a release becomes necessary, operational procedures will minimize the impact on Des Moines Creek. Initial runoff from each storm (which flushes most of the pollutant load from the ground surfaces) flows to Lagoons 1 and 2. Any release of untreated water would occur from Lagoon 3, in which pollutants would be more dilute, especially under the extreme events in which overflow would occur. Although an overflow spillway is provided to meet dam safety requirements, overflows from Lagoon 3 would be released from a bypass pipe at mid-depth to avoid discharge

43 The 424 acre service area includes the area of existing IWS service, and new service area to meet MPU treatment standards.

from the lagoon surface (preventing release of floating petroleum product) or from the lagoon bottom (preventing entrainment and discharge of accumulated sediment).

7.1.3.3 Toxicity Testing

The effect of stormwater runoff on critical habitat downstream of the Port discharge points can also be assessed with knowledge of stormwater toxicity. Bioassay screening tests (Parametrix 1999c) in Miller Creek and Des Moines Creek downstream of STIA stormwater outfalls demonstrated no toxicity to either fathead minnows or the invertebrate, *Daphnia pulex* (Table 7-14). For all tests, there was 100 percent survival in the undiluted stormwater (100 percent sample water). No Observed Effect Concentrations (NOEC) of 100 percent sample water, and Lowest Observed Effect Concentrations (LOEC) of >100 percent sample water, meaning that the highest concentrations at which no effect was observed was pure stormwater (100 percent), and that the stormwater was thus non-toxic to the exposed test organisms.

Table 7-14. Summary of bioassay results.

Sample	Percent Survival 100% Sample Water	NOEC[1]	LOEC[2]
Miller Creek downstream of STIA (8th Ave. S)	100	100	>100
Miller Creek downstream of STIA (SR 518)	100	100	>100
Lake Reba	100	100	>100
Walker Creek downstream of STIA	100	100	>100
Northwest Ponds Inlet Channel (upstream of STIA)	100	100	>100
STIA Outfall SDS-3	100	100	>100
Des Moines Creek W Branch (downstream of STIA)	100	100	>100
Des Moines Creek E Branch (downstream of STIA)	100	100	>100

Source: Parametrix (1999c)

1 No observed effect concentration
2 Lowest observed effect concentration

In addition to instream samples, WET testing was performed on effluent from STIA SDS outfalls, to satisfy NPDES Permit requirements (Port of Seattle, in press; Table 7-15 and Figure 7-1). The tests used standard protocols and sensitive species (the freshwater crustacean, *Daphnia pulex*, and the freshwater fish, *Pimephales promelas*). The invertebrate *Daphnia pulex* is more sensitive than salmonids to the types of pollutants expected to cause toxicity in STIA stormwater (e.g., copper[44]) (USEPA 1985). The WET test results are conservative because they represent conditions before dilution in the receiving waters, and flow-through facilities such as Lake Reba, where physical, chemical, and biological processes will capture or transform dissolved pollutants (see Section 7.1.4.5).

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[44] For example, *Daphnia pulex* is five times more sensitive to copper at an adjusted hardness of 50 ppm than is chinook salmon.

Of the four outfalls tested, three met the WET performance standards, demonstrating an overall lack of toxicity in samples consisting of 100 percent stormwater from Port discharges. The runoff from the three outfalls in which no toxicity was measured are the most representative of runoff expected from airport activities included in the MPU. Subbasins SDS-3 and SDN-4 represent approximately 77 percent of the runway/taxiway drainage area and generates runoff similar to that expected from new air field development. SDE-4 is the largest and most representative of the SDS subbasins which contain airfield and support (hangers, terminal, cargo, etc.) facilities.

Table 7-15. Results of Port of Seattle WET testing for stormwater outfalls.

Basin	Sample Date	Species	Duration	NOEC[1] (%)	LOEC[2] (%)	LC50[3] (%)	% Survival in 100% Sample[4]
SDN1	11/13/98	*D. pulex*[5]	48 hours	100	>100	>100	80
	1/14/99	*D. pulex*	48 hours	100	>100	85.20	30
	3/24/99	*D. pulex*	48 hours	50	100	74.00	10
	11/13/98	*P. promelas*[6]	96 hours	50	100	89	40
	1/14/99	*P. promelas*	96 hours	100	>100	>100	78
	3/24/99	*P. promelas*	96 hours	50	100	>100	63
SDN4	11/13/98	*D. pulex*	48 hours	100	>100	>100	75
	1/14/99	*D. pulex*	48 hours	100	>100	>100	100
	11/13/98	*P. promelas*	96 hours	100	>100	>100	100
	1/14/99	*P. promelas*	96 hours	100	>100	>100	100
SDS3	11/13/98	*D. pulex*	48 hours	100	>100	>100	90
	1/14/99	*D. pulex*	48 hours	100	>100	>100	80
	11/13/98	*P. promelas*	96 hours	100	>100	>100	98
	1/14/99	*P. promelas*	96 hours	100	>100	>100	95
SDE4	11/19/98	*D. pulex*	48 hours	100	>100	>100	90
	2/23/99	*D. pulex*	48 hours	100	>100	>100	95
	3/24/99	*D. pulex*	48 hours	100	>100	>100	95
	7/2/99	*D. pulex*	48 hours	100	>100	>100	100
	11/19/98	*P. promelas*	96 hours	100	>100	>100	100
	2/23/99	*P. promelas*	96 hours	25	50	>100	63
	3/24/99	*P. promelas*	96 hours	100	>100	>100	98

1 NOEC = No Observed Effect Concentration, the highest tested concentration at which no adverse effects are observed on the aquatic test organisms.
2 LOEC = Lowest Observed Effect Concentration, the lowest concentration that results in statistically significant adverse effects.
3 LC50 = Estimated concentration that would be lethal to 50 percent of the test organisms during the test period.
4 Represents end-of-pipe concentration before dilution in receiving waters.
5 Waterflea
6 Fathead minnow

For the one outfall demonstrating toxicity (SDN-1), the source of toxicity has been identified as galvanized rooftops that leach zinc. These rooftops are a very limited area of the SDS (approximately 2 ac, or about 0.5 percent of the SDS), and are not representative of MPU improvement projects which will not use zinc-treated roofing materials. Furthermore, the toxicity observed in SDN-1 does not result in instream toxicity, as demonstrated by the results of the instream toxicity screening (see Table 7-14). The lack of toxicity is likely the result of runoff flowing through vegetated drainage channels and Lake Reba, where physical, chemical, and biological processes would remove dissolved pollutants (see Section 7.1.4.5). Furthermore, the runoff would be diluted before it reached Miller Creek. The Port is taking measures to reduce or eliminate leaching from the SDN-1 rooftops through the application of coatings to reduce or eliminate leaching (Port of Seattle, In Press). The Port will perform follow-up monitoring to confirm that toxicity has been eliminated. All future rooftops will be constructed with materials that do not leach zinc.

Toxicity testing of the other outfalls and creeks demonstrates that STIA runoff is unlikely to contribute stormwater discharges with potential toxicity to fish in critical habitat. The above observations are consistent with May et al. (1997) comprehensive study of Puget Sound streams (including Miller and Des Moines creek), which concluded that chemical water quality does not represent the critical factor to biota in urban streams. Rather, they found streambed and bank stability (altered by changes in runoff volume) were determined to be the "most significant problems" in Puget Sound urban streams.

7.1.4 Mitigation During Operation

7.1.4.1 Water Quality Treatment BMPs

All new MPU PGIS in SDS subbasins will receive water quality treatment to meet or exceed the requirements of the Ecology Manual as discussed above. Where existing developed areas do not have BMPs consistent with the Ecology Manual, these areas will be retrofitted with water quality treatment BMP to the maximum extent practicable. Treatment BMPs include bioswales, filter strips, and wet vaults.

The primary water quality BMPs for existing and proposed PGIS will be filter strips and bioswales. In these facilities, water quality treatment occurs as runoff from impervious surfaces sheet flows over broad, shallow-sloped grassy areas (filter strips), or is directed through grass-vegetated swales (bioswales). Flow velocity is slowed by the gentle slopes, the size of these facilities and by grass, all of which enhance the settling of particulates. Vegetation also mechanically traps particles. Some water infiltrates into the ground as it flows over the vegetated area, further filtering out particles. Removal of metals and organic compounds is also significant, as these pollutants bind to trapped particles and/or the organic material in the soil and vegetation. In areas where adequate space is not available, treatment may also be provided by wet vaults, which remove particulates and other sorbed pollutants by settling.

Filter strips and bioswales have proven effective for most pollutants in runoff from STIA, as demonstrated by pollutant concentration data and toxicity testing at STIA outfalls. As required by the Port's NPDES Permit, ongoing monitoring will demonstrate the effectiveness of BMPs, and where necessary, will indicate where additional levels of protection may be necessary. The Port's NPDES Permit provides appropriate and effective mechanisms for monitoring BMP performance and improving BMPs when necessary.

The King County Manual (King County DNR 1998) requires that high-vehicle-use areas[45] (i.e., road intersections with high vehicle counts) have oil control treatment. The upper and lower Terminal Drives appear to meet the high-use definition, and will be retrofitted with oil control treatment or runoff will be diverted to the IWS. The IWS meets or exceeds the requirements for oil control treatment.

7.1.4.2 Source Control

Source identification and controls are used throughout STIA (Table 7-16). Source controls include passive measures (such as warning signs on catch basins and education of airport and tenant employees), and active measures (such as sweeping near and cleaning of catch basins). Source identification is also an important part of source control. As required by its NPDES Permit, if elevated pollution levels or toxicity are noted, the Port updates its Stormwater Pollution Prevention Plan to eliminate or provide treatment for the source.

Source control BMPs are reviewed and approved by Ecology and meet or exceed the requirements of the King County and Ecology Manuals. As discussed in Section 7.1, the Port's monitoring and inspection results are used to confirm the performance of source controls, and to identify additional source controls where necessary.

7.1.4.3 Industrial Wastewater System

The IWS collects stormwater from the terminal, air cargo, hangars, maintenance, and parking areas. Stormwater from these areas may be contaminated by accidental fuel spill, de-icing chemicals, and washwater from cleaning of aircraft or ground support vehicles. The IWS system prevents runoff and pollutants from reaching Miller or Des Moines creeks, and the critical habitat located near their mouths at Puget Sound. The IWS consists of collection piping, two primary storage lagoons (Lagoons 1 and 2), a third lagoon for additional storage (Lagoon 3), and an Industrial Wastewater Treatment Plant (IWTP).

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[45] The *King County Surface Water Management Manual* (King County DNR 1998) defines high-use sites as any one of the following:

- commercial or industrial site subject to average daily traffic count equal to or greater than 100 vehicles per 1,000 square feet of gross built area, or
- commercial or industrial site subject to petroleum storage and transfer in excess of 1,500 gallons per year, or
- commercial or industrial site subject to use, storage, or maintenance of a fleet of 25 or more diesel vehicles that are over 10 tons gross vehicle weight, or
- a road intersection with average daily traffic of 25,000 vehicles or more on the main roadway and 15,000 vehicles or more on any intersecting roadway.

Table 7-16. Seattle-Tacoma International Airport source control BMPs (as approved by Ecology).

Activity	BMPs
Aircraft servicing	Restrict to IWS areas or block drains Store glycol in IWS areas Confine parking of lavatory waste trucks to IWS Identify and connect problem SDS areas to IWS Restrictions for fueling on taxiway Alpha Monitor SDS outfalls during de-icing
Aircraft Movement Area (AMA) anti-icing/de-icing	Minimize de-icing chemical use Use calcium magnesium acetate (CMA)/sand mixture for roadways
Snow storage	Operate pump stations to divert snowmelt to IWS
Spill control	Implement spill plan
Vehicle washing and maintenance	Prohibit vehicle washing in SDS areas Place signs in key locations Clean sumps in Taxi Yard annually Sweep Taxi Yard and control litter Maintain catch basin inserts
AMA maintenance	Sweep pavement frequently Inspect catch basin sumps annually and clean as needed Store and dispose of sediments properly Construct secondary containment for used engine fluids
Inappropriate connections and discharges	Inspect outfalls for evidence of illicit connections
Temporary storage of surplus and used materials	Store liquids in approved secondary containment or IWS areas only Control entry of surplus materials
Landscape management (in developed areas)	Use environmentally benign chemicals only when necessary. If landscape chemicals are used: • Follow proper cleaning/disposal procedures • Apply during dry periods • Restrict use near waterways • Incorporate BMPs into contractor specifications • Follow Ecology guidelines for herbicide application • Apply herbicides/pesticides according to instructions • Fertilize shrubs and trees by hand • Avoid catch basin grates when applying fertilizer or pesticides Implement Integrated Pest Management Plan as appropriate Give priority to biological methods of pest management Conduct regular weeding and pruning Trim ivy-covered areas by hand (do not use herbicides) Do not use beauty bark in drainageways

Table 7-16. Seattle-Tacoma International Airport source control BMPs (continued).

Activity	BMPs
Tenant activities in SDS areas	Monitor and educate tenants on source and spill control De-ice aircraft according to established procedures Encourage drip pans beneath fueling trucks if leakage is observed Sweep around dumpsters Store liquids in secondary containment Do not store used fluids or hazardous waste in SDS areas Do not maintain vehicles or equipment in SDS areas Inspect catch basin grates Require tenant water pollution control plans Enforce tenant compliance with Port SWPPP Require tenant spill control plans
Other operational BMPs	Evaluate operations and revise standard operating procedures to minimize pollution Designate a SWPPP implementation monitor Conduct regular inspections of SWPPP elements Assemble pollution prevention team Conduct SDS outfall monitoring Sign catch basins ("dump no waste – drains to salmon stream") Establish packing material source control

The IWS lagoons detain industrial wastewater, settle solids, and equalize flows to the IWTP. The IWTP treats collected water by flash-mixing aluminum chloride into the influent water to flocculate particulates and oils, using dissolved air flotation to carry the floc to the surface, and by employing a skimmer to remove the floated contaminants. Treated water flows in a pipe approximately 2.0 miles to join with the Midway Sewer District effluent pipe for direct discharge into Puget Sound via a 200 ft long diffuser located 1,800 ft offshore at a depth between 156 and 178 ft below mean sea level. The discharge is permitted by the Port's NPDES Permit (Ecology 1998b). IWTP effluent is monitored continuously for flow, weekly for pH, TSS, and oil/grease, and monthly for BOD, glycols, and TPH.

As demonstrated in the monthly Discharge Monitoring Reports (DMRs) submitted to Ecology, effluent water quality limitations, established in the Port's NPDES Permit, have been met since November 1996 (Ecology 1998c). Prior to November 1996, for the 1994-1996 permit cycle, IWS discharges exceeded interim effluent limitations on 35 instances. In response to these exceedances, the Port implemented source control and operational BMPs in the IWS, and, as stated by Ecology (1998c), "The performance of the IWTP has improved greatly due to the IWTP performance evaluation and the [BMP] improvements… The Port has been in compliance with the interim effluent limitations at Outfall 001 [the IWS marine outfall] since November 1996."

As required by its NPDES Permit, the Port has performed an analysis and determination of all known available and reasonable methods of treatment (AKART) for handling of IWS flows (Kennedy/Jenks 1998). For discharge during periods when effluent BOD levels are a concern, the Port has determined that the recommended AKART alternative is to discharge Industrial Wastewater Treatment Plant (IWTP) treated effluent to the King County Department of Natural Resources (DNR) East Division Reclamation Plant at Renton (EDRPR). This alternative would eliminate or reduce IWS discharge to Puget Sound. IWS flows would continue to be treated by the

IWTP to remove oil and grease and TSS before flowing to the EDRPR. The Port is negotiating with King County DNR to determine pretreatment standards, flow limits and timing, conveyance from the IWTP to the EDRPR, permitting, monitoring, and fees (Feldman 1999). The Port's NPDES Permit requires that the AKART recommendation must be fully implemented by June 2004. It has been submitted to Ecology for concurrence.

IWTP sludge is treated off-site by a private contractor in a fully-permitted facility. The treatment process uses thermal desorption to produce a neutral solids product.

7.1.4.4 Retrofitting

Water quality BMPs applied to new and existing developed areas are presented in Figure 7-2, described in detail in the *Preliminary Comprehensive Stormwater Management Plan for Seattle-Tacoma International Airport Master Plan Improvements* (Parametrix 1999b) and summarized in Table 7-17. Currently, most of STIA's existing PGIS (260.6 ac) are effectively treated with approved BMPs. All new PGIS (122.7 ac) will be effectively treated using approved BMPs. BMPs will be implemented in areas to be redeveloped and, where practicable[46], BMPs will be retrofitted into existing developed areas not to be otherwise redeveloped (108.7 ac of redeveloped and retrofitted area).

Approximately 80 acres of area will be examined for retrofitting using new or innovative BMPs such as catch basin inserts to provide some degree of treatment.

After redevelopment and retrofitting with stormwater management facilities, the ratio of total treated PGIS to new MPU PGIS is at least 1.89. Thus, the BMP implementation plan exceeds the Stormwater Effects Guidance document criteria (WSDOT 1999; Appendix C) for No Effect; based on this guidance, the project would not be expected to significantly increase the concentration of pollutants entering the Miller, Walker, or Des Moines creek systems[47] and thus will not change baseline water quality conditions. Upon completion of the MPU, approximately 86 percent of STIA's PGIS will be treated. Based on proven performance of current BMPs and the Port's current compliance with its NPDES permit, water quality treatment is projected to be protective of the receiving waters.

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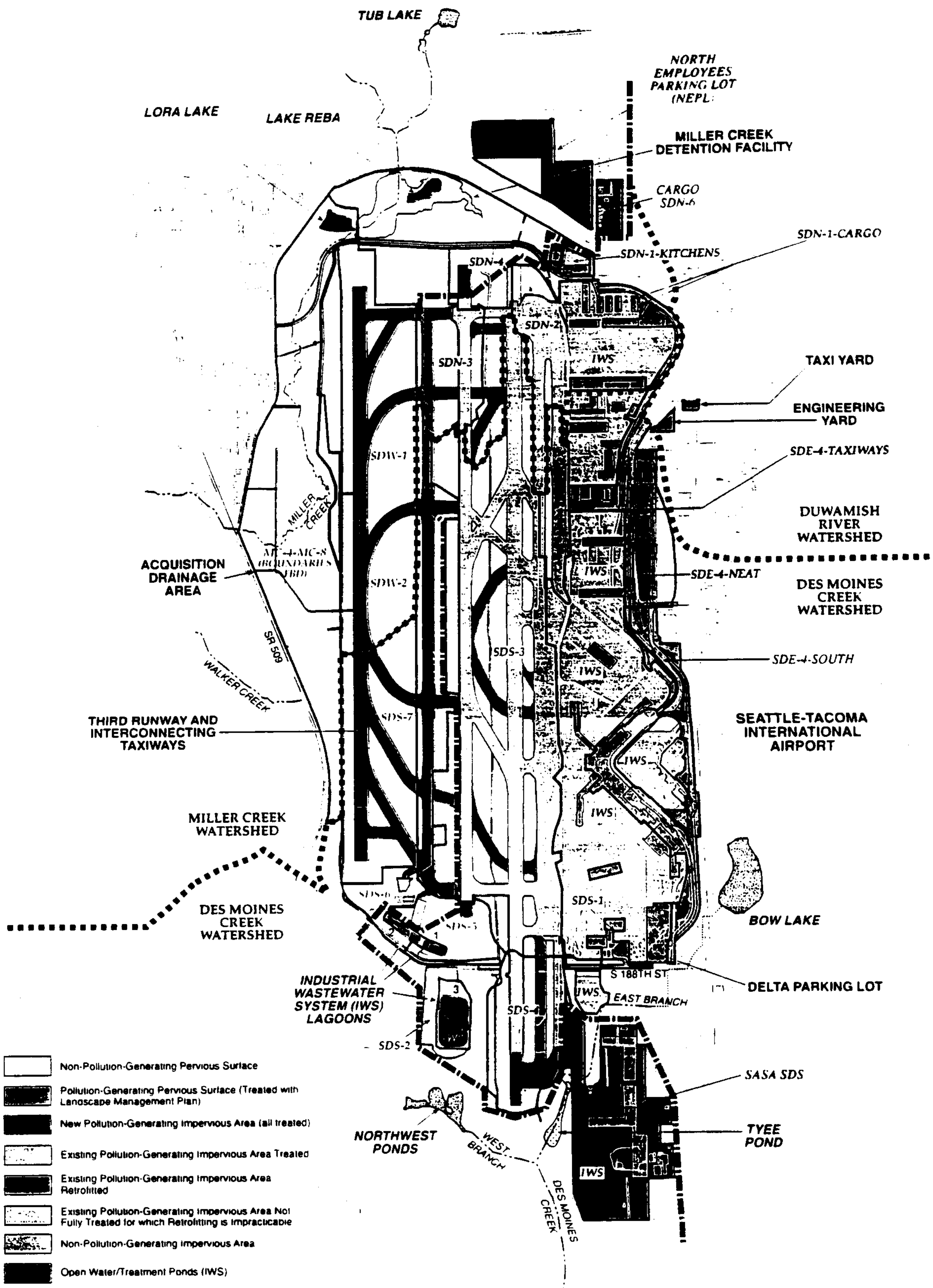
[46] It is not currently practicable to retrofit the stormwater management system for all of STIA. Retrofitting of certain areas not otherwise being redeveloped would require demolition and reconstruction of roadways and taxiways resulting in unacceptable operational impacts at unreasonable cost. If these areas undergo redevelopment in the future, water quality treatment BMPs would be added at that time.

[47] The WSDOT criteria are valid for the PGIS at STIA because the airport generates the same types of stormwater pollutants that are found on roadways (due to the use of de-icing materials, and the generation of metals and oil and grease). Analysis of STIA's stormwater runoff demonstrates that its water quality is equal to or better than the quality of road runoff. The project also proposes treatment BMPs that are the same as those used for road projects, and there treatment efficiency would also be the same.



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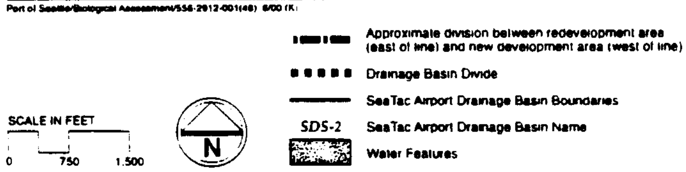

Figure 7-2
Water Quality Treatment for New and Retrofitted Surfaces

Table 7-17. Estimated water quality treatment of pollution-generating impervious surfaces (PGIS).

Description	Area (ac)
New MPU projects PGIS (all treated)	122.7
Existing PGIS (not anticipated to be redeveloped) already treated	260.6
Existing PGIS to be redeveloped or retrofitted with treatment	108.7
Existing PGIS where conventional retrofitting is not practicable	80
Total	**492.2**

7.1.4.5 Other Water Quality Mitigation

<u>**Pollutant Removal in Lake Reba**</u>

Lake Reba, a stormwater facility constructed by the Port in 1973, collects and detains stormwater from the north end of STIA and discharges it to Miller Creek. In addition to stormwater detention provided by live storage (volume that drains dry between storms), Lake Reba has a permanent pool that allows the facility to act as a wetpond. Wetponds function by settling solids and allowing a variety of physical, chemical, and biological mechanisms to capture or transform dissolved pollutants (Horner et al. 1994). Pollutants such as heavy metals and nutrients that adsorb to particulates are removed as well.

Pollutant removal efficiency in a wetpool is a function of the wetpond's volume relative to the design storm runoff volume. Lake Reba characteristics are described in Table 7-18. The design storm runoff volume is based on a mean annual storm of 0.5 inch, as specified by the King County Manual (King County DNR 1998).

Table 7-18. Characteristics of the Lake Reba stormwater facility.

Lake Reba Characteristics	Value
Impervious drainage area	51.2 ac
Pervious drainage area	67.8 ac
Design storm runoff[1]	2.63 ac-ft
Pond dead storage volume	4.0 ac-ft
Ratio: dead storage volume to design runoff	1.5

[1] Design storm runoff calculated according to the following equation, per the King County Surface Water Design Manual: *Design runoff = [0.9*(Impervious Area) + 0.25*(Pervious Grass Area)]*(design storm depth/12).*

With a ratio of dead storage volume to design runoff volume of approximately 1.5, pollutant removal efficiency can be estimated (Horner et al. 1994). Estimated pollutant removal rates are reported in Table 7-19.

Table 7-19. Estimated pollutant removal efficiency in Lake Reba.

Pollutant	Removal Efficiency (%)
Total Suspended Solids	60
Total Copper	33
Total Zinc	33
Total Lead	42
Total Phosphorus	58

Source: Horner et al. 1994

Snowmelt Facility

The Port uses a snowmelt facility to store melting snow after de-icing chemicals have been applied to the runways and taxiways. The facility drains to a pump station that diverts meltwater to the IWS. This BMP reduces the amount of BOD in runoff reaching Miller and Des Moines creeks.

Aircraft Anti-Icing and De-Icing Within IWS

Aircraft anti-icing and de-icing is performed only within areas draining to the IWS and conforms to the operational source control BMPs for airports as identified by Ecology (1999b). This BMP minimizes glycols in stormwater runoff to Miller and Des Moines creeks. As discussed above, glycol concentrations in stormwater outfalls are significantly below toxic concentrations.

Enhancement of Wetland Water Quality Functions

Existing degraded wetlands in the Miller Creek and Des Moines Creek basins will be enhanced to restore their natural water quality functions (Parametrix 1999a)[48]. As described in Mitsch and Gosselink (1993), the restored wetlands will benefit water quality by:

- Increasing settling and mechanical trapping of particulates,
- Removing metals and other toxics that bind to particulates,
- Reducing and binding metals in humic material, and
- Biologically removing and uptaking nutrients.

Additionally, some restored wetlands will displace existing cultivated land and golf course, removing pollution sources from those activities.

[48] No natural wetlands will receive untreated stormwater from MPU projects.

Miller Creek Buffer Enhancement

Riparian buffers along approximately 6,500 linear ft of Miller Creek will be enhanced (Parametrix 1999a). Native trees, understory plants, and ground cover will replace lawns, agricultural areas, golf course, and other areas to restore buffer quality and continuity. As described in Committee on Protection and Management of Pacific Northwest Anadromous Salmonids (CPMPNAS) (1996) and Forman and Gordon (1986), enhanced buffers will:

- Increase biofiltration of runoff flowing into the creek from riparian areas,
- Reduce erosion from areas directly adjacent to the creek, and
- Shade the creek, to reduce stream temperatures to increase DO.

Additionally, restored buffers will replace existing residential lawns and cultivated land, removing pollution sources from these activities.

Miller Creek Stream Channel Restoration and Enhancement

Approximately 1,500 ft of the Miller Creek channel will be restored and enhanced by repairing and revegetating eroding and hardened streambanks and by installing LWD in the channel. These restoration activities will provide water quality benefits to Miller Creek by reducing channel erosion and downstream sedimentation.

7.2 HYDROLOGIC IMPACTS AND MITIGATION

The listed species evaluated here could be impacted from increasing the impervious area and filling wetlands. These actions could increase peak flows and reduce base flows in Miller and Des Moines creeks, and thus affect habitat quality at the mouths of these creeks. Actions associated with the MPU improvements affecting the hydrology of Miller and Des Moines basins are discussed in the following sections, along with associated mitigation measures that compensate for these actions.

7.2.1 Flow Impacts

The activities associated with implementing the MPU improvements will include adding new impervious surfaces (new runways, taxiways, parking, and roadways) and filling wetlands. These actions, if unmitigated, could change the hydrologic flow regime of Miller and Des Moines creeks, including increased peak-flow magnitude and frequency, increased peak-flow duration, and lower summer base flows. Wetland filling could decrease flood water storage in the watershed, also leading to increased flooding. The potential effects of high-flow impacts in the stream are increased erosion and sedimentation, habitat damage from scouring flows, and impaired habitat use during high-flow period. Base flow impacts could reduce the discharge of water at the mouths of these creeks and lower base flow volumes are subject to other water quality impacts, such as high stream temperature and low DO.

Potential impacts in critical habitat present in the estuaries of Miller and Des Moines creeks include increased sedimentation in these estuaries caused by high-flow erosion in the upper watershed and potential changes in the estuarine hydrology. However, with flow mitigation, it is unlikely that the critical habitat at the mouths of these creeks could be affected by hydrologic changes when flows in the creeks relative to the influence of tides are considered. Proposed peak-flow mitigation reduces peak flows from existing levels in both creeks, which will reduce bank and channel erosion as well as sedimentation in estuaries. Base flow changes will be mitigated as described below; however, it is unlikely that predicted minor baseflow changes would adversely influence the hydrology of critical habitat.

In addition to new impervious areas, other proposed actions could alter hydrology in the creeks, including removal of septic tanks, peat excavation at the Vacca Farm site, and removing existing water withdrawals. These actions and their impacts are discussed below. Additional detail on hydrology and stormwater management are provided in the *Preliminary Comprehensive Stormwater Management Plan for Seattle-Tacoma International Airport Master Plan Improvements* (Parametrix 1999b), which addresses mitigation of flow impacts on the drainage basins. The plan includes modeling conducted to estimate the impacts of the project on the Miller and Des Moines creeks systems. The Hydologic Simulation Program – FORTRAN (HSPF) model was used for this purpose. Details of the model application are discussed in the *Preliminary Comprehensive Stormwater Management Plan for Seattle-Tacoma International Airport Master Plan Improvements* (Parametrix 1999b). This document discusses the results of HSPF modeling and flow mitigation design.

7.2.1.1 Impervious Area

In the Miller Creek basin, MPU improvement projects will result in a net increase of 59 ac[49] of impervious surface area (Table 7-20), increasing the overall impervious area in the basin by about 1 percent above the existing baseline (about 23 percent of impervious surface) (FAA 1997b). This includes a net increase of 3.6 ac of impervious surface in the Walker Creek subbasin of Miller Creek. In the Des Moines Creek basin, MPU improvement projects will add an additional 120 ac of new impervious surface area (Table 7-20) draining to the creek, increasing the overall basin total by approximately 3 to 3.5 percent (FAA 1997b).

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

[49] The net change in impervious area includes a reduction of 51.8 ac of impervious surfaces (streets, driveways, and rooftops) that will result when existing houses and streets are removed in the acquisition area. Demolition in these areas is ongoing and is expected to be completed by 2002.

Table 7-20. Summary of Miller and Des Moines Creek drainage areas at STIA and change in impervious area between 1994 baseline and 2004 future conditions (acres).

		1994 Baseline			2004 Future Conditions			Increase in Impervious Area
Subbasin[1]	Master Plan Update Improvements	Perv.	Imperv.	Total	Perv.	Imperv.	Total	
Miller Creek								
SDN-1	Air cargo facilities	13.7	44.1	57.9	13.7	44.2	57.9	0.1
SDN-2	Air cargo facilities	5.5	2.0	7.5	5.3	2.2	7.5	0.2
SDN-3	Taxiways, 154th/156th St. Reloc., N. safety fill	69.4	20.3	89.7	62.0	27.6	89.7	7.3
SDN-4	Taxiways, 154th/156th St. Reloc., N. safety fill	39.4	6.0	45.4	29.0	16.4	45.4	10.4
SDW-1	Third runway	147.2	16.5	163.7	116.4	47.2	163.7	30.8
SDW-2	Third runway	39.3	5.3	44.6	35.1	9.5	44.6	4.2
NEPL	NEPL	42.3	0.0	42.3	0.0	42.3	42.3	42.3
CARGO	Air cargo facilities	7.4	0.7	8.1	0.0	8.1	8.1	7.4
Other STIA Basins		284.5	194.4	478.9	303.4	175.5	478.9	-18.9
Des Moines Creek								
SDE-4	N. terminal, S. terminal, garage, air cargo	49.6	109.4	159.0	39.3	119.7	159.0	10.3
SDS-1	S. terminal, Northwest hanger	1.5	16.3	17.7	1.4	16.4	17.7	0.1
SDS-2		8.1	1.0	9.1	8.1	1.0	9.1	0.0
SDS-3	Taxiways	228.2	184.9	413.1	178.9	234.1	413.1	49.2
SDS-4	Safety area expansion, SASA taxiways	45.1	19.5	64.6	32.1	32.5	64.6	13.0
SDS-5	Snow equipment shed, Weyerhaeuser	32.1	0.4	32.5	28.3	4.2	32.5	3.8
SDS-6	Snow equipment shed, Weyerhaeuser	12.5	4.3	16.7	13.5	3.2	16.7	-1.1
SDS-7	Third runway	80.5	10.7	91.3	55.1	36.2	91.3	25.4
SASA[2]	SASA roofs and parking	29.6	4.6	34.3	0.0	34.3	34.3	29.6
Other STIA Basins		343.3	411.0	754.3	346.8	407.6	754.3	-3.5

Table 7-20. Summary of Miller and Des Moines Creek drainage areas at STIA and change in impervious area between 1994 baseline and 2004 future conditions (acres) (continued).

		1994 Baseline			2004 Future Conditions			Increase in
Subbasin[1]	Master Plan Update Improvements	Perv.	Imperv.	Total	Perv.	Imperv.	Total	Impervious Area
IWS System								
IWS primary drainage		45.2	320.0	365.2	29.9	335.4	365.2	15.4
SASA IWS		53.1	5.3	58.4	0.1	58.3	58.4	53.0
Totals								
SDS		1479.2	1051.4	2530.6	1268.4	1262.2	2530.6	210.6
IWS		98.3	325.3	423.6	30.0	393.7	423.6	68.4
TOTAL		1577.5	1376.7	2954.2	1298.4	1655.9	2954.2	279.0

[1] No changes in baseline conditions of subbasins draining to Gilliam Creek (Outfalls 012 and 013) will occur.
[2] Includes the SASA footprint and SDS-4 expansion area.
Perv. = Pervious surface
Imperv. = Impervious surface

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7.2.1.2 Wetland Fill

The potential impacts to the hydrology of Miller, Des Moines, and Walker creeks from filling 18.33 ac of wetlands are the loss of stormwater storage, ground water recharge, and groundwater discharge. These functions are discussed below, and all wetland hydrologic functions are accounted for in the HSPF model that assesses runoff impacts by various input parameters and calibration.

Stormwater Storage

Most wetlands filled by the project provide limited ability to store stormwater because the wetlands do not occur in closed basins or basins with restricted outlets that would allow water to pond during storms and release slowly following storms. Most wetlands occur on moderate to gentle slopes and are free-draining (seldom, if ever, ponding water). Flood storage functions are provided by riparian wetlands located in the 100-year floodplain of Miller Creek. Approximately 9,600 cy of flood storage would be filled at Vacca Farm, and approximately 10,000 cy of new floodplain will be excavated adjacent to the creek. All flood storage, including that provided by wetlands, is accounted for in the calibration of the HSPF model; design of stormwater detention facilities using this model will assure that flow mitigation is provided for impacted wetlands.

Groundwater Discharge

Several wetlands are sites of groundwater discharge, and thereby provide base-flow support to streams during all or portions of the year. Where fill occurs in these wetlands, the project has been designed to allow these discharge functions to continue. For example, the Third Runway embankment is designed with an internal drainage system that will collect water that currently infiltrates on the airfield and discharges in wetlands near 12th Avenue South. The drainage system will also collect water that infiltrates into the new embankment, and discharge it to wetlands and Miller Creek. Drainage systems associated with retaining walls constructed to reduce wetland impacts will also convey groundwater downslope to wetlands and either creek. Groundwater discharge effects on base flow are accounted for in the calibration of the HSPF model.

Groundwater Recharge

Most wetlands affected by fill are unlikely to have significant groundwater recharge functions, because most of these wetlands occur on till soils, where layers of till restrict groundwater recharge. These low permeabilities result in poor drainage conditions, which in combination with topography and surface drainage features, promote the development of wetlands. Other wetlands occur in areas of known groundwater discharge (i.e., wetlands formed by local groundwater discharges), and thus cannot recharge groundwater. However, the HSPF model is based on the premise that all wetlands infiltrate (with an infiltrative capacity of 2.5 times that of till); thus the model conservatively accounts for potential impacts to groundwater recharge as a result of filling these wetlands. Overall, development of impervious surfaces from master plan projects could reduce groundwater recharge and eventual groundwater discharge to streams; these functions are accounted for in the HSPF model, and mitigation for these effects are included in the activities discussed in Section 7.3.2.

7.2.2 Indirect Hydrologic Impacts/ Impact Avoidance

Where feasible and practical, direct and indirect impacts the hydrologic functions of wetlands (baseflow, groundwater discharge, and stormwater storage) have been avoided (see Hart Crowser 199a, Hart Crowser 1999b, Parametrix 1999a, and Parametrix 1999e for a detailed hydrologic and wetland impact analysis). For example, within the three borrow areas, direct and indirect impacts to hydrologic functions of wetlands were avoided or minimized by protecting several wetlands and their upslope watersheds from excavation. Wetlands located downslope of excavation or fill areas will continue to receive ground and surface water from upslope areas because BMPs for water quality, site grading, and other surface water management features will allow clean water to continue to discharge to them. Additionally, rainwater will continue to infiltrate on the borrow sites because no impervious surface will be added, and this water will be available to recharge downslope wetlands and Des Moines Creek.

7.2.3 Stormflow Mitigation

As part of the MPU improvement, the Port will construct stormwater conveyance, detention, and water quality treatment facilities to manage runoff from both newly developed project areas and existing airport areas, as described below. Additional detail on the proposed stormwater controls is provided in the *Preliminary Comprehensive Stormwater Management Plan for Seattle-Tacoma International Airport Master Plan Improvements* (Parametrix 1999b). This plan was prepared to analyze and describe stormwater management for projects associated with the STIA MPU improvements. The stormwater management facilities will mitigate the impacts of new construction on Miller, Walker, and Des Moines creeks, as required by current stormwater regulations and mitigation goals identified during the environmental review process. The facilities will also mitigate stormwater impacts from current development by reducing the magnitude and duration of peak flows and by improving base flows.

The overall goals of the Stormwater Management Plan are to design MPU improvements to meet local and state stormwater regulatory requirements for stormwater management, and to provide additional stormwater management to protect Miller and Des Moines creeks from increased stormwater runoff and decreased baseflows. To achieve these goals, the following specific objectives have been identified:

- Design the MPU improvements in accordance with applicable stormwater regulations and the conditions of approval for the MPU Final Supplemental Environmental Impact Statement (FSEIS) (FAA 1997b). By meeting or exceeding regulations, the Port will implement flow control standards that are protective of the receiving water environment, and which are designed to prevent changes from the base condition.
- Prevent increased flood peaks in Miller and Des Moines creeks during the 2-, 10-, and 100-year 24 hour runoff events by meeting enhanced Level 1 stormwater discharge criteria for onsite facilities (measured upstream of regional detention facilities). Preventing increased flood peaks will prevent increased erosion and sedimentation, habitat damage from scouring flows, and impaired habitat use that may occur as a result of elevated peak flows.

- Match the magnitude and duration of erosive flows to the pre-developed condition up to the 50-year event. This will occur by retrofitting to Level 2 stormwater discharge criteria for all airport runoff, as measured in Miller Creek downstream of the existing Miller Creek Detention Facility and in Des Moines downstream of the proposed STIA-Des Moines Creek retrofit facilities (comprised of on-site vaults or the Des Moines Creek RDF). Preventing increases in erosive flow duration will prevent increased duration of streambed-mobilizing, habitat-damaging flows.
- Work with King County and the local jurisdictions to implement the recommendations of the Des Moines Creek Basin Plan. This will promote consistency among the activities being implemented in the basin to maximize the protective and mitigative benefits, and to ensure that projects are implemented where needed most.
- Support a basin planning process for the Miller Creek basin.

To mitigate stormwater runoff impacts on Miller and Des Moines creeks, the flow control standards adopted by the Port will comply with the approved MPU FEIS (FAA 1996), the Governors Certificate (Locke 1997), the King County Surface Water Design Manual (King County DNR 1998), and the Ecology Manual.

7.2.3.1 Flow Control Retrofitting for Existing Airport Areas: Level 2

To protect instream and estuarine habitat, the redevelopment provisions of Ecology's stormwater manual that require retrofitting of stormwater detention to existing airport areas will be implemented. The Port has committed to achieving streamflows that maintain or reduce existing peak flow magnitude and duration in Miller and Des Moines creeks. The Level 2 flow control standard, as defined by the King County Manual, requires matching post-developed flow durations to pre-developed flow durations[50], for all flow magnitudes between 50 percent of the 2-year event and the full 50-year event.

The pre-developed condition for the Level 2 standard will be based on a *target watershed flow regime*[51]. The target flow regime is the range of flows the channel can convey while maintaining a stable sediment transport regime (i.e., net equilibrium between downcutting and aggradation over the length of the stream). In the Des Moines Creek basin, the target flow regime was determined in a study by the University of Washington (King County CIP Design Team 1999). The flow regime determined for Des Moines Creek coincides with a target flow regime that would occur with an effective watershed impervious area of 10 percent. In studies of several Puget Sound streams, Booth and Jackson (1997) identified an approximately 10 percent impervious area threshold above which stream channel instability and habitat degradation occur. Based on the agreement between the King County CIP Design Team (1999) analysis and Booth and Jackson (1997), a target

[50] Flow duration control refers to limiting the duration of geomorphically significant flows (i.e., those flows which initiate bedload movement) to baseline (pre-MPU conditions).

[51] For areas upstream of the MCDF or the Des Moines Creek RDF. For areas west of the airport and downstream of the MCDF, pre-developed conditions are equal to 1994, as stipulated by Ecology in the original (1998) Section 401 Certification.

watershed flow regime in the Miller Creek watershed was defined as the flow regime resulting from the watershed development with 10 percent impervious surface.

The net result of flow retrofitting in the watersheds will be to replicate a flow regime that would occur at a watershed imperviousness of 10 percent, downstream of the Miller Creek Detention Facility and the STIA-Des Moines Creek retrofit facilities, *before flow impacts and controls for the MPUs are considered*. That is, even though the Miller Creek watershed has an existing impervious area of about 24-49 percent and the Des Moines Creek watershed a 36-49 percent imperviousness, the flows in both streams would be reduced to a level corresponding to approximately 10 percent impervious area in each basin[52] (for the basin upstream of the MCDF and Des Moines Creek RDF).

7.2.3.2 Flow Control for New Development

Level 2 flow controls would be provided for new development to prevent increases in peak flows beyond existing peak flow or the target watershed flow regime, whichever is lower. These flow controls would exceed standards that are normally required by local regulations and would mitigate stormwater impacts from MPU improvement areas.

In the Des Moines Creek Basin, the Des Moines Creek Basin Planning Committee proposes to construct a RDF south of the airport in the vicinity of the northwest ponds. The purpose of this facility is to reduce existing watershed impacts from existing impervious surfaces, and to return flows to the target flow regime.

The Port proposes to construct detention vaults in the Des Moines Creek Basin meeting the Level 2 standard. However, when the RDF is constructed, vaults meeting this standard will no longer be needed[53]. Therefore, at a minimum, stormwater detention from MPU development improvements in the Des Moines Creek Basin will be designed to an "enhanced Level 1 standard" when the RDF is completed[54] (Table 7-21). The pre-developed condition for the enhanced Level 1 standard will be 1994 base conditions.

7.2.3.3 Pond and Vault Construction and Operation

The feasibility of proposed stormwater ponds and vaults is demonstrated by the recent construction of similar facilities at STIA, including the NEPL Vault (1997) and the Interconnecting Taxiways Vault (1998). Only the SASA detention pond will displace wetlands, a 0.06 ac shrub wetland. All other on-site detention facilities will be constructed in non-wetland areas. The primary discharge from the detention facilities is predicted to be surface discharge (not infiltration).

enough to absorb solar radiation and cause significant temperature increases in Miller, Des Moines, or Walker Creeks. For example, in the third runway north pond, following a 2-year storm, 81 percent of the water will drain within 24 hours, and 98 percent within 48 hours. Storms of this

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[52] The HSPF model was calibrated with recorded flow data and actual basin land use prior to simulation of adding Level 2 flow control retrofits. The calibration accounts for flows attributable to each type of land use, based on existing conditions. Flows for other land use and hydrologic control conditions (such as 10 percent impervious surfaces and the Level 2 flow control retrofit) were then simulated using the HSPF model.

[53] The RDF will provide the LEVEL 2 flow control for the Des Moines Creek Basin.

[54] The Level 1 flow control standard is defined by the King County Manual, and require detention of post-developed 2- and 10-year peak flows to their pre-developed conditions. The enhanced Level 1 standard for this project is defined as controlling the developed 2-, 10-, and 100-year peak flows to pre-project conditions.

Table 7-21. Summary of proposed stormwater detention storage required for Master Plan Update improvements.[1]

	Master Plan Update improvements	Detention Standard	New Storage	Role of Regional Facility Achieving in Level 2 Stormwater Standard
Miller Creek Watershed				
Miller Creek Detention Facility (MCDF)	Air cargo, taxiway, (SDN-1, SDN-2, SDN-3, and SDN-4)	Enhanced Level 1	16.4 acre-ft of new storage added to MCDF (will not affect wetlands)	The expanded MCDF achieves Level 2 flow control for all STIA drainage entering pond (including new Master Plan projects).
Miller Creek tributary (upstream of MCDF)	The NEPL and 24th Street development	Enhanced Level 1	4.0 acre-ft, the NEPL vault (built 1998); 1.9 acre-ft, 24th Street development vault	The expanded MCDF achieves Level 2 flow control for all STIA drainage entering pond (including new MPU improvements).
Lower Miller Creek	Third runway	Level 2 based on 1994 land use	13.0 acre-ft, third runway north pond	MCDF does not provide adequate Level 2 flow control in this area.
Walker Creek	Third runway	Level 2 based on 1994 land use	6.6 acre-ft, third runway middle vault or pond	No regional detention facilities planned for Walker Creek.
Subtotal			**41.9 acre-ft**	
Des Moines Creek Watershed				
East branch of Des Moines Creek	Air cargo and terminal (SDS-1 and SDE-4)	Enhanced Level 1	None	Detention need eliminated by routing stormwater areas to IWS, as required by SWPPP.
East branch of Des Moines Creek	The SASA	Enhanced Level 1	22.5 acre-ft, the SASA detention pond	The SASA pond volume includes replacement of the existing 18.5 acre-ft Tyee Pond. Level 2 flow control to be provided by new Des Moines Creek RDF.
West branch of Des Moines Creek	Taxiway (SDS-3)	Enhanced Level 1	5.9 acre-ft, Taxiway vault (built 1998)	Level 2 flow control to be provided by new Des Moines Creek RDF (or on-site storage if RDF not constructed).
West branch of Des Moines Creek	Third runway (SDS-3)	Enhanced Level 1	6.3 acre-ft, Third runway south vault	Level 2 benefits provided by new Des Moines Creek RDF (or on-site storage if RDF not constructed)
Subtotal			**34.7 acre-ft**	
TOTAL			**76.6 acre-ft**	

[1] Construction of a new water tower in subbasins draining to Gilliam Creek would not add impervious surface and would not require new storage facilities.

magnitude are very rare during warm months (in August, on average, a 1.8-inch storm will occur Detention facilities will consist of dry ponds with live storage[55] and will not include wet ponds with dead storage[56]; therefore, water is not expected to remain in stormwater detention ponds long only once in 20 years, a time when the average monthly temperature is 67.7°F) (NOAA 1997). This assessment is supported by data on temperature of stormwater runoff and adjacent receiving waters. Data collected by the Port during a storm on June 24, 1996, and several storms during early September 1996 show temperature of runoff from stormwater outfalls was typically found to be at or below the mean daily air temperature (Port of Seattle 1997). For most outfalls, temperatures of stormwater runoff were found to be below that of the receiving water, and below the water quality standard of 16° C.

7.2.3.4 Net Result of Hydrologic Mitigation

The net result of flow controls for the MPU improvements will be to reduce flows in Miller Creek and Des Moines Creek to a stable flow regime downstream of STIA discharges (Table 7-22). In all 41.9 acre-ft of new storage volume will be provided in the Miller Creek watershed, and 34.7 acre-ft of storage will be provided in the Des Moines Creek watershed (see Table 7-20)[57]. Level 2 facilities will retrofit existing flows to the target watershed flow regime before new development is considered. Enhanced Level 1 facilities will then maintain flows at or below the target watershed flow regime. The net effect of flow controls for Miller, Walker, and Des Moines creeks (Figure 7-3) will be to maintain flows below existing conditions, or the target watershed flow regimes following Master Plan construction and flow mitigation, whichever is less. The target flow regime will achieve the level of flow control required by regulations, and will reduce flows in the stream channels, thereby reducing erosion and improving channel stability.

Table 7-22. Existing and future peak flow estimates for Miller and Des Moines creeks (all values are cfs).

		Miller Creek			Des Moines Creek			
Return Period (years)	Condition	Below Miller Creek Detention Facility	At SR-509	Near Mouth	West Branch	East Branch	At S. 200th	At Mouth
2	Existing	55	82	177	84	63	151	206
	Future	46	74	168	24	59	53	133
	Change	-9	-8	-9	-60	-4	-98	-73
10	Existing	70	126	279	145	92	248	302
	Future	60	117	266	67	85	103	201

[55] *Live storage* is that volume of stormwater stored in a detention facility that drains following the storm. Live storage is used for hydrologic benefit to reduce flow peaks and durations.

[56] *Dead storage* is the volume of water retained in a stormwater facility in a permanent pool. Dead storage is used for water quality benefits by settling out particulates and providing other pollutant removal processes.

[57] The SMP is under revision by the Port and by King County. The detension volumes shown are subject to increase and decrease. However, the flow protection standard will not be charged, therefore, the Project Stormwater mitigation will protect the baseline condition.

Table 7-22. **Existing and future peak flow estimates for Miller and Des Moines creeks (all values are cfs) (continued).**

Return Period (years)	Condition	Miller Creek: Below Miller Creek Detention Facility	Miller Creek: At SR-509	Miller Creek: Near Mouth	Des Moines Creek: West Branch	Des Moines Creek: East Branch	Des Moines Creek: At S. 200th	Des Moines Creek: At Mouth
	Change	-10	-9	-13	-78	-7	-145	-101
100	Existing	88	187	430	219	133	377	413
	Future	76	181	412	206	122	213	302
	Change	-12	-6	-18	-13	-11	-164	-111

7.2.4 Base Flow Impacts

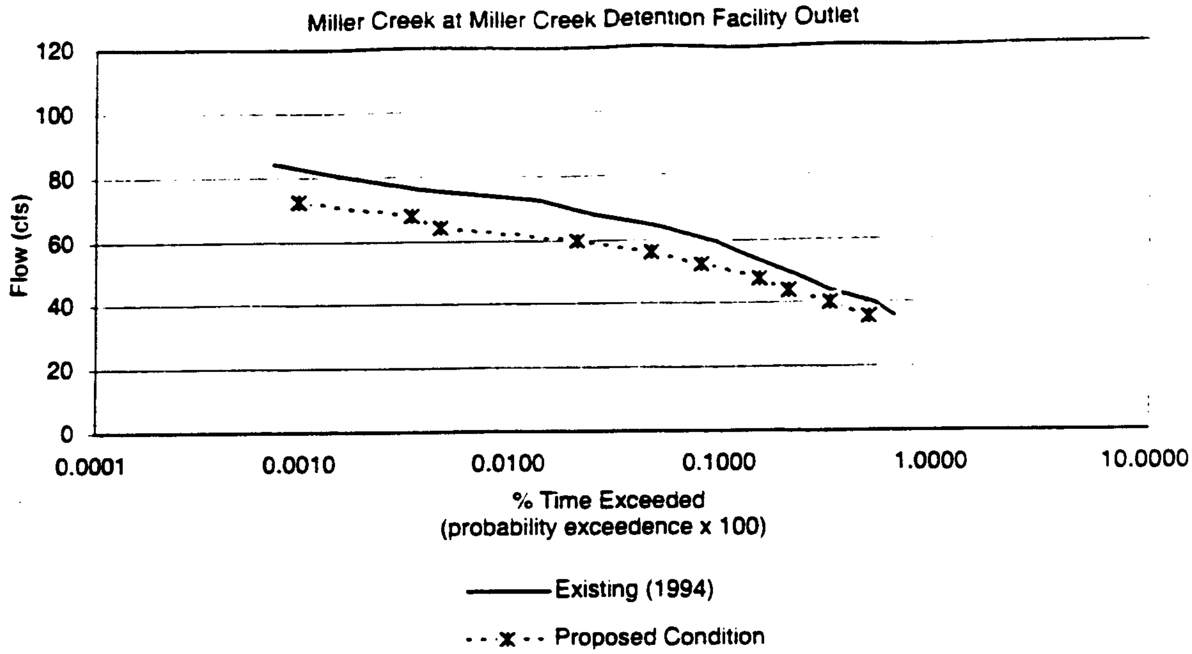
Hydrologic modeling has also demonstrated a potential base flow impact due to the MPU (Parametrix 1999b). The reduction in base flow has been estimated to be 0.04 cfs during the 1 in 10-year low flow in Miller Creek, primarily due to new impervious surfaces. In Des Moines Creek, the potential impact is 0.13 cfs. If base flow impacts are large enough, the wetted stream area of the creeks could be reduced and adversely affect critical habitat. However, base flow impacts estimated for Miller and Des Moines creeks are insignificant and would not measurably change the wetted area of critical habitat. For example, in the creeks, the estimated drop in water surface elevation from a 0.05 cfs base flow reduction on Miller Creek is approximately 0.01 ft, a change that does not significantly reduce aquatic habitat areas. Critical habitat for chinook salmon does not extend upstream of the wetted area of the tidal influence, and flow changes would not affect the wetted area of critical habitat which is controlled by tidal influence. Other actions associated with the MPU, including the removal of existing septic tanks and the restoration of Vacca Farm, have potential impacts that are described below. However, several MPU actions, such as removing existing water withdrawals, will mitigate potential Miller Creek base flow impacts.

7.2.4.1 Septic Tanks

Septic tanks will be removed from acquired residential properties in the Miller Creek watershed, thereby eliminating a documented pollutant source (Des Moines Creek Basin Committee 1997). Septic tank runoff is not a natural component of baseflow and the influence of septic systems on baseflow, if any, includes the deleterious effect on water quality. The potential flow from septic systems to Miller Creek is estimated as described below.

The following conditions are used in the estimate:

- Approximately 380 septic tanks are to be removed in the acquisition area. (The figure of 380 is used, though a substantial number of septic tanks may be abandoned or unused);
- It is presumed that an average of 3 persons use each system;
- The daily wastewater flow is 100 gallons per capita per day (gpcd) (Lindenburg 1997); and
- All water entering septic systems is lost as evapotranspiration or baseflow because losses to the deep aquifer were not estimated (making these estimates conservative).



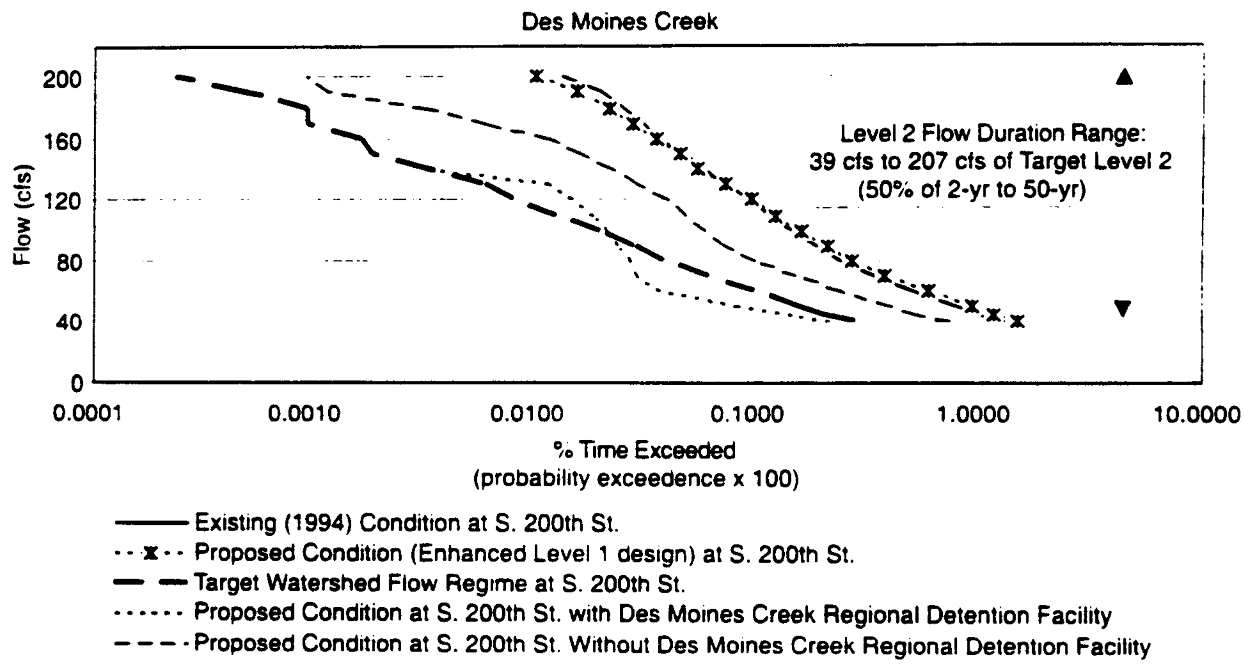
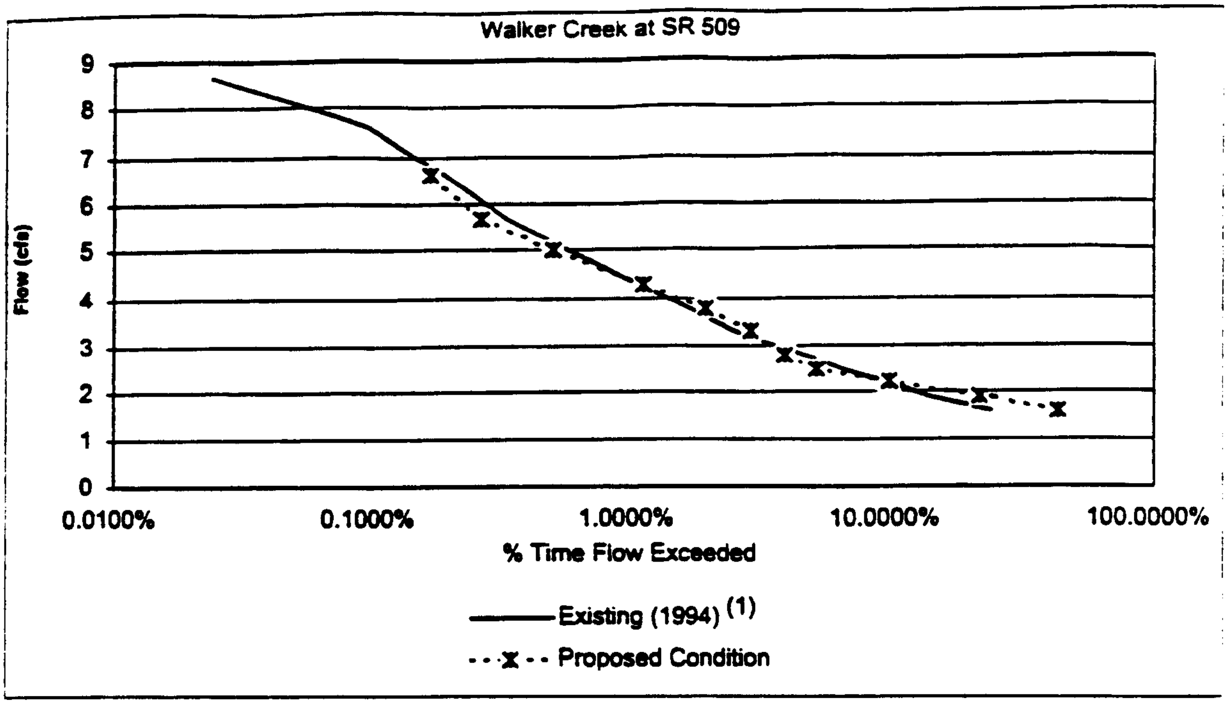


Figure 7-3
Flow Duration Curves for Level 2 Discharge Standard in Miller Creek, Des Moines Creek, and Walker Creek



(1) Target flows for the 3rd runway detention ponds are based on runoff produced from 1994 land use conditions and are not required to be retrofit to "predeveloped" (10% EIA) conditions.

Figure 7-3
(Continued)

Based on the above conditions, the average daily flow to septic systems is (380 systems) x (3 persons/system) x (100 gpcd) x (1 cf/7.48 gal) x (1 d/86400 sec) = 0.18 cfs. However, during the dry months and low flow periods, evapotranspiration prevents much of this flow from reaching the stream. Assuming that each septic system drainfield is 50 ft by 50 ft. and average evaporation (not including transpiration) is 5 inches per month during August (Linsley and Franzini 1979), the loss to evaporation would be (380 systems) x (50 ft x 50 ft) x (5 in/month) x (1 mo/30 d) x (1 d/86400 sec) x (1 ft/12 in) = 0.15 cfs. After losses to evapotranspiration (and neglecting other losses, such as deep aquifer recharge), the wastewater flow balance that may reach the stream during low flows is about 0.03 cfs. Considering the beneficial effects of removing the water quality impacts they create, the removal of septic tanks and their effect on base flow is negligible and would not adversely affect the chinook critical habitat located at the estuaries of Miller and Des Moines creeks.

7.2.4.2 Effects of Peat Removal at Vacca Farm

Peat soils are often identified as having the ability to store water during wet periods and then release it slowly during dry periods, thereby augmenting base flows of associated creeks. Excavation of peat soils during construction could alter hydrology and potentially affect base flow in Miller Creek. An estimate of baseflow impacts is described here.

The peat soil at the Vacca Farm site is identified as "Rifle" peat, a fibrous, woody peat. It forms in depressions on top of glacial outwash soils such as the Vashon advance outwash, a medium dense sand soil series mapped in the vicinity of the Miller Creek valley. The Soil Conservation Service estimates the permeability of similar peat soils to be on the order of 0.63 to 2 inches per hour (moderate permeability). An estimate of field capacity (the soil water content after gravity drainage from the peat has ceased), based on the Soil Conservation Service data, is 0.4 (relatively high soil water retention). In comparison, the underlying dense sand in the outwash material has a permeability estimated at less than 1.4 inches per hour, and an available water capacity of about 0.1. The total porosity of the peat is assumed to be 0.8 (relatively high, thus a conservative assumption of greater maximum water storage).

The quantity of peat removed that could potentially provide water storage is about 10,000 cy. Therefore, the peat could store (10,000 cy) x (27 cf/cy) x (0.8 - 0.4) = 108,000 cubic ft of water. If the release rate to the creek were uniform during the drier months (May-September), the average daily flow would be on the order of (108,000 cubic ft)/(160 days x 24 hours x 60 minutes x 60 seconds) = 0.008 cfs. This estimate is high because it neglects evapotranspiration which reduces the amount of water actually available to release as stream flow. Furthermore, the timing of the release of water stored in the peat is not likely to be uniform throughout the summer–most release would occur during late spring and early summer (May and June), prior to minimum stream flows. Thus, the potential impact on baseflows from peat removal is likely considerably less than 0.008 cfs; this is unlikely to affect instream or critical habitat for chinook at the creek mouths.

7.2.4.3 Retired Water Uses

Existing water rights along Miller Creek give property owners the right to withdraw water from Miller Creek for domestic personal use, lawn and yard watering, and commercial irrigation. After acquiring these rights through property purchase, the Port proposes to cease the exercise of these rights, as part of the mitigation for the MPU improvements.

Water rights for 17 domestic users and 6 commercial irrigation users will be obtained during property acquisition. As discussed below, eliminating these withdrawals is more than sufficient to mitigate for base flow impacts from MPU improvements (estimated to be approximately 0.04 cfs). The average rate of withdrawal from Miller Creek by the property owners during low-flow periods as calculated by:

- Fifty percent of the 17 domestic users are withdrawing at a 0.01 cfs rate at any given time during the critical low-flow period in August.
- The commercial irrigation users apply 0.008 cfs per acre on 5.2 ac (the amount of farm area known to be irrigated). This rate is the amount needed to apply 24 inches of total water during the 4-month irrigation season, and is typical of agricultural applications.

Based on these conditions, the estimated total quantity of water used by the identified water rights holders and the commercial irrigation users is 0.13 cfs. Of this amount, 0.09 cfs is from the domestic users and 0.04 cfs is from the commercial irrigation users. These calculations are provided in further detail in Appendix H, and believed to be conservative because during field studies potential withdrawls on property without water rights were observed.

7.2.5 Base Flow Mitigation

While hydrologic modeling shows potential decreases in baseflow due to Master Plan development projects, the Port has proposed mitigation in each watershed to compensate for potential reductions in base flows in Miller and Des Moines creeks. On Miller Creek, the Port will acquire and cease exercise of water right permits, certificates, and claims associated with properties that are being acquired. On Des Moines Creek, the Des Moines Creek Basin Committee or Port will implement flow augment using an existing well.

Further improvements to base flows in both streams can be achieved by infiltrating stormwater at the detention facilities. Because site conditions must be favorable for infiltration to be feasible, the Port will evaluate infiltration during the project design phase. Infiltration will be incorporated into constructed facilities when geologic conditions permit.

7.2.5.1 Miller Creek

The reduction in Miller Creek baseflow due to project impacts is estimated to be 0.04 cfs (see Appendix H). Baseflow reductions due to septic system removal would be on the order of 0.03 cfs. Removal of peat soils from Vacca Farm is estimated to result in a maximum baseflow reduction of

0.008 cfs. The sum of baseflow impacts (0.09 cfs) will be mitigated by ceasing water withdrawals of approximately 0.13 cfs from the stream.

7.2.5.2 Des Moines Creek

The reduction in Des Moines Creek baseflow, before mitigation, is estimated to be 0.13 cfs (see Appendix H). As discussed below, this impact will be mitigated by augmenting stream flow with up to 0.8 cfs by pumping from deep groundwater.

To address the concerns over base flows on Des Moines Creek, the Des Moines Creek Basin Committee has proposed to implement a recommendation of the Des Moines Creek Basin Plan to augment the stream flow with water pumped from a well. This project would provide supplemental water to that stream during critical summer months. The Port, as an active participant in the Basin Plan, would provide the groundwater well and associated water rights for the flow augmentation project. The Port owns the water rights to accomplish flow augmentation of Des Moines Creek, as reported in the *Preliminary Comprehensive Stormwater Management Plan for Seattle-Tacoma International Airport Master Plan Improvements* (Parametrix 1999b). This well is capable of producing adequate water to meet the recommended augmentation flow rates of the *Des Moines Creek Basin Plan* (Des Moines Creek Basin Committee 1997), with a flow rate of 0.8 cfs.

7.3 WETLAND AND STREAM HABITAT IMPACTS AND CONSERVATION MEASURES

There are no direct impacts to chinook critical habitat resulting from stream relocation or wetland fill. However, to mitigate project impacts to these habitats, a variety of in-basin and out-of-basin conservation measures are planned. These habitat impacts and associated conservation measures are discussed in this section.

7.3.1 Wetland and Stream Habitat Impacts

7.3.1.1 Direct Impacts to Stream Habitat

Direct impacts to stream habitat by the MPU project improvements include the filling of approximately 980 ft of Miller Creek (Figures 7-4 and 7-5) to accommodate the Third Runway embankment and the relocation of S. 154th Street. The existing stream channel influences the flow pattern in receiving waters, the amount of aquatic habitat available to macroinvertebrates, and detritus transport to the creek. The channel section to be filled also supports resident fish; however, this portion of Miller Creek does not contain critical habitat for any listed species. Only resident cutthroat trout and threespine stickleback are known to occur in this portion of Miller Creek.

This portion of Miller Creek has been modified to support agricultural activities, and existing conditions are degraded (*Wetland Functional Assessment and Impact Analysis*, Parametrix 1999e). The section of Miller Creek affected is an artificial (i.e., constructed ditch) stream channel adjacent to the Vacca Farm site. The natural creek was moved to its present location and constructed as a straight channel to improve drainage in the area for farming. The existing channel lacks significant variation in streambed substrate, channel configuration, instream fish habitat and riparian vegetation. Ditching of this section of the Miller Creek channel has resulted in less available macroinvertebrate habitat, reduced detritus transport to the creek, and reduced fish habitat compared to more natural channel reaches located downstream of the impact area. Direct impacts from filling

980 ft of the stream channel would be a loss of surface water conveyance, and existing macroinvertebrate habitat and fish habitat.

No direct impacts to the Walker Creek channel or fish habitat would occur. The headwaters of Walker Creek in Wetland 43 will not be impacted by the project. The proposed project will fill 0.26 ac of Wetland 44 (see Figure 7-5, and also see Section 4.1.1). With the exception of the culvert replacement on the Tyee Valley Golf Course, crossing Des Moines Creek, no new culverts would be added to Miller, Des Moines, or Walker creeks. A culvert over Des Moines Creek will be replaced, but this culvert does not occur in stream habitat used by listed species, which are limited to reaches of the stream approximately 2.5 miles downstream for the project.

Temporary construction impacts to stream and riparian habitat will be mitigated by implementing the TESC BMPs.

7.3.1.2 Conservation Measures for Direct Impacts

Any impacts resulting from the filling of a reach of Miller Creek will be mitigated through conservation measures designed to improve function in this reach of the creek relative to existing conditions. Conservation measures include: (1) relocating the ditched reach of Miller Creek in a new channel with a more natural, complex stream morphology and substrate, and (2) establishing a native forested riparian zone to provide particulate trapping and sediment retention, optimal buffer stream temperatures, adequate shade for the stream, and a source of detritus and coarse woody debris to the downstream reaches (see Section 7.3.2.1 below). The net effect of relocating a reach of Miller Creek will be an overall improvement in water quality and macroinvertebrate and fish habitat in the relocated reach and downstream portions of Miller Creek.

7.3.1.3 Direct Impacts to Wetland Habitat

The proposed MPU construction projects will result in direct permanent impacts (filling) to 18.33 ac of wetlands (about 9.08 ac of Category II wetlands, 7.24 ac of Category III wetlands, and 2.01 ac of Category IV wetlands) (Figure 7-5 and 7-6) and temporary construction impacts to 2.17 ac of wetlands (Table 7-23 and Table 7-24) (Parametrix 1999a). Temporary impacts during construction include removal of wetland vegetation (native and non-native), potential sedimentation, and temporary use of wetland areas for construction stormwater management.

Direct impacts to wetland functions due to the proposed MPU projects were evaluated by assessing the level of functions performed by the existing wetlands, and therefore the functions that would be lost due to filling 18.33 ac of wetlands. Impacts were evaluated for the nine functions typically performed by wetlands (*Wetland Functional Assessment and Impact Analysis*, Parametrix 1999e) by classifying wetlands into hydrogeomorphic and habitat groups, and identifying wetland attributes that are recognized as indicators of wetland functions for western Washington wetlands.

Based on the presence of these indicators and professional judgement, each wetland was rated using a "high," "medium," or "low" ranking.

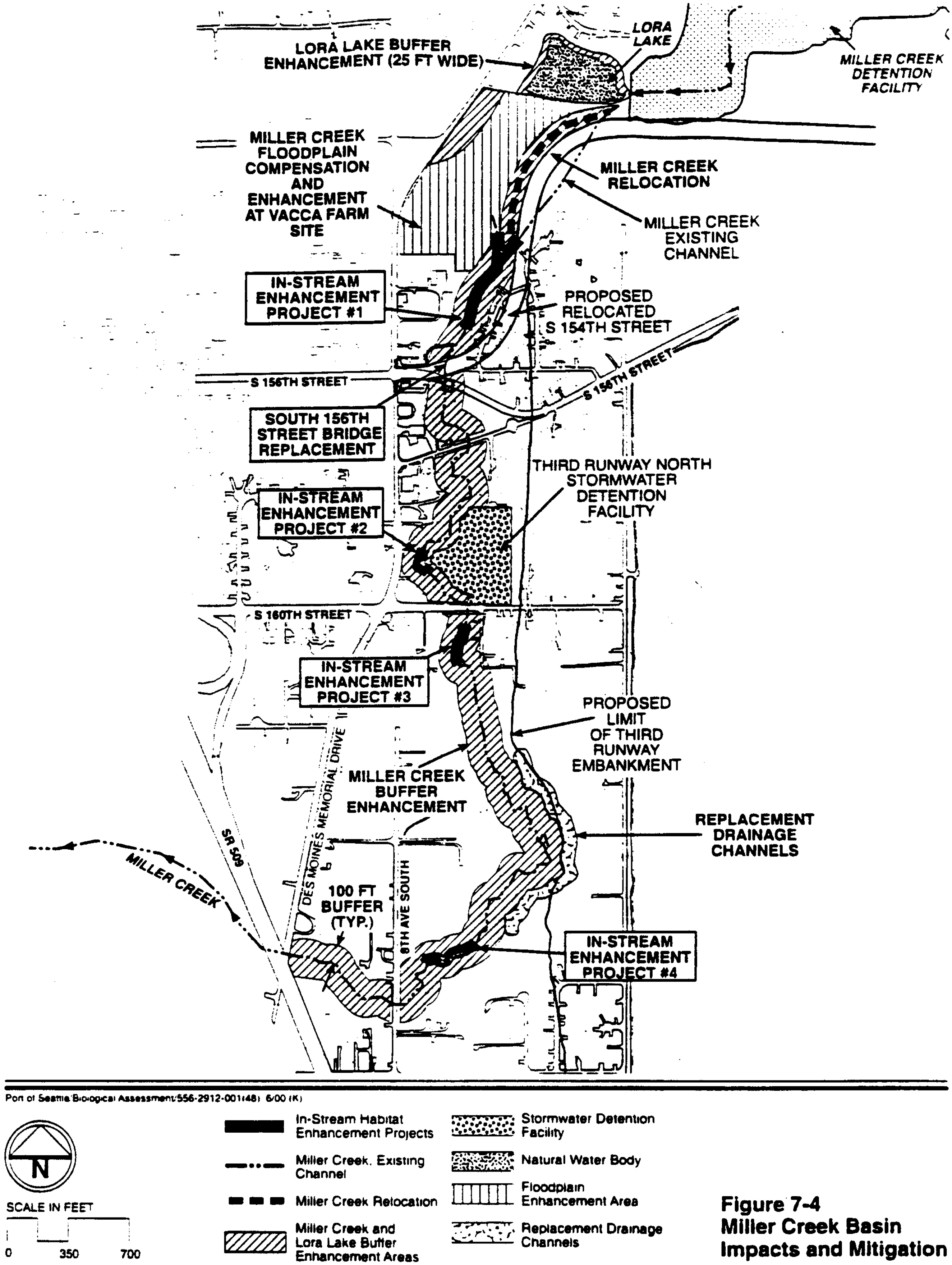


Figure 7-4
Miller Creek Basin Impacts and Mitigation

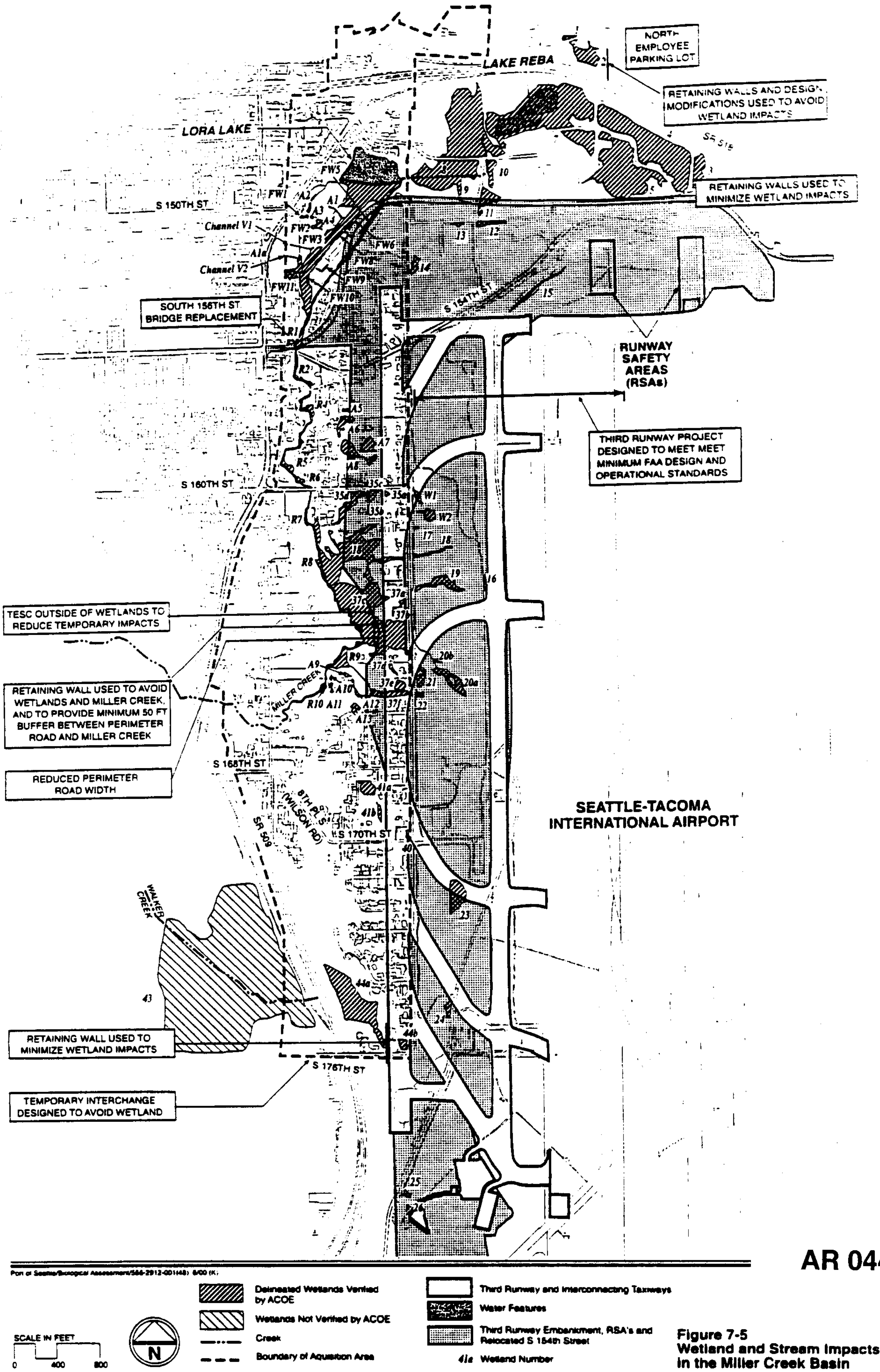


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Figure 7-5
Wetland and Stream Impacts in the Miller Creek Basin

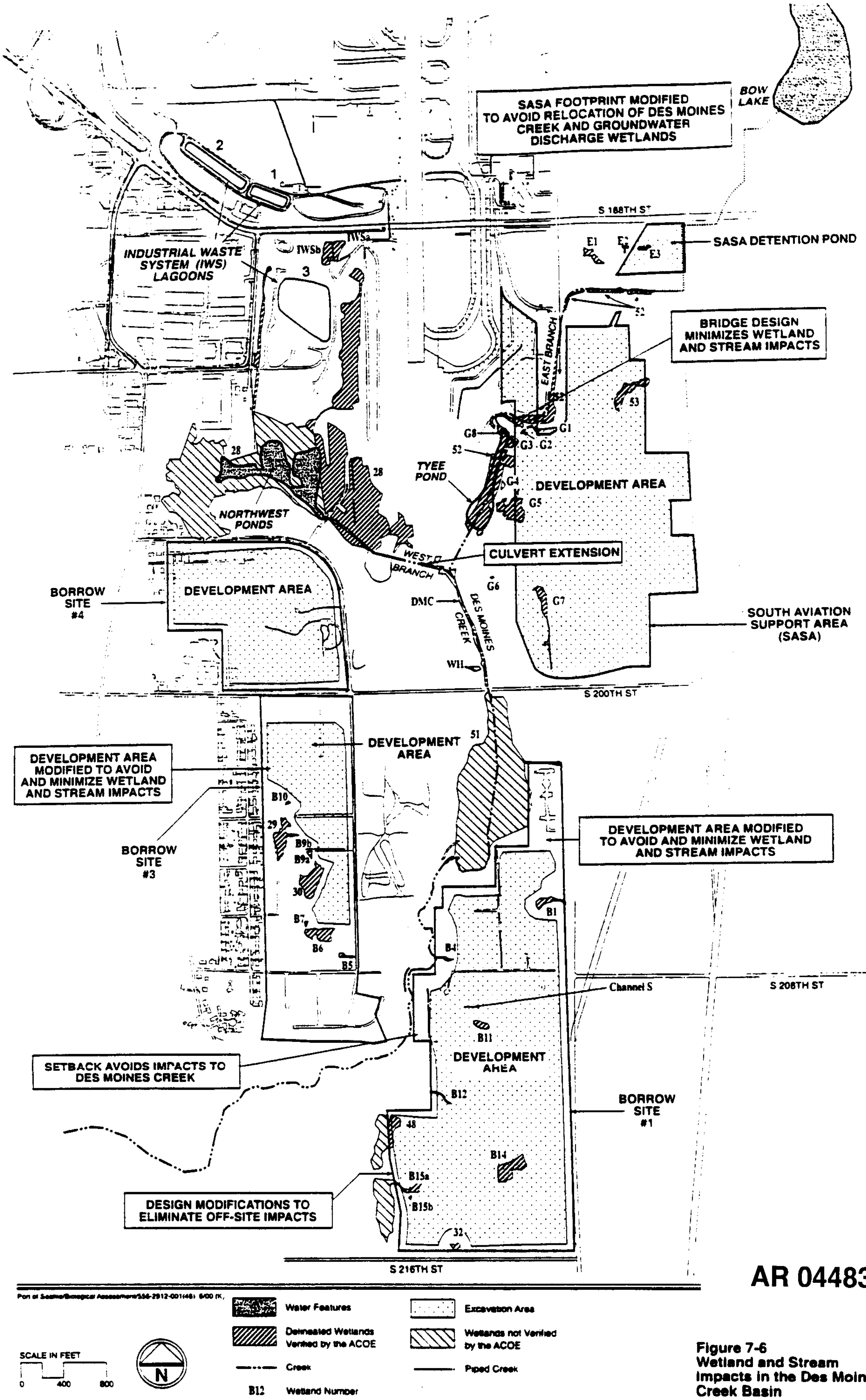

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Figure 7-6
Wetland and Stream Impacts in the Des Moines Creek Basin

Table 7-23. Summary of permanent wetland impacts by project and wetland category [a] (in acres).

Project	Category II	Category III	Category IV	Total
RSA	0.00	0.14	0.00	0.14
Third Runway	8.10	4.87	0.97	13.94
Borrow Area 1	0.28	1.17	0.00	1.45
The SASA	0.65	1.15	0.98	2.79
Mitigation	0.00	0.02[b]	0.00	0.02
TOTAL	9.03	7.35	1.95	18.33

[a] Wetland categories are per Ecology (1993). Category I wetlands are the highest-quality wetlands. Category II wetlands are high-quality wetlands, while Category III and IV wetlands are considered moderate- and low-quality wetlands, respectively. These wetland categories are generalizations, and do not necessarily reflect the performance of the wetlands in providing specific functions.

[b] Impacts result from a permanent access road crossing an emergent wetland at the Auburn mitigation project.

Table 7-24. Summary of temporary construction impacts to wetlands in the proposed Seattle-Tacoma International Airport Master Plan Update improvement area.

					Vegetation Type Impacted		
Wetland	Rating	HGM[a] Class	Vegetation Types	Total	Forest	Shrub	Emergent
Runway Safety Areas							
3	II	Slope	Forested	0.05	0.05	0.00	0.00
4	II	Slope	Forested	0.10	0.10	0.00	0.00
5	III	Slope	Shrub	0.10	0.05	0.05	0.00
Third Runway							
9	III	Slope	Forested/Emergent	0.03	0.01	0.00	0.02
11	III	Slope	Forested/Emergent	0.13	0.10	0.00	0.03
18	II	Slope	Forested/Shrub/Emergent	0.36	0.18	0.07	0.11
37	II	Slope	Forested/Emergent/Shrub	0.71	0.50	0.10	0.11
44	II	Slope	Forested	0.30	0.20	0.10	0.00
A1	II	Depression, Riparian	Forested/Shrub/Emergent	0.05	0.01	0.01	0.03
A12	III	Slope	Shrub	0.03	0.00	0.03	0.00
A13	III	Slope	Forested	0.01	0.01	0.00	0.00
Borrow Site 1 Wetlands							
48	II	Slope	Forested	0.10	0.10	0.00	0.00
B15	III	Slope	Shrub	0.10	0.00	0.10	0.00
South Aviation Support Area							
52	II	Slope	Forest/Shrub/Emergent	0.10	0.00	0.05	0.05
TOTAL				**2.17**	**1.31**	**0.51**	**0.35**

[a] Hydrogeomorphic classification system used to evaluate wetland functions (Parametrix 1999e).

With respect to biological functions, wildlife use of the study area and its associated wetlands is largely limited to species that tolerate human disturbance. This pattern of wildlife use is a result of area fragmentation by urban development. In addition, for many wetlands on the project site, habitat and faunal diversity is limited because the wetlands are too small[58] to meet habitat requirements for many wildlife populations. However, when compared to other urban wetlands, some of the larger wetlands in the project area that support native shrub and forest vegetation provide moderate to high function for songbirds, amphibians, and small mammals. Several wetland areas that are riparian to Miller Creek or Walker Creek are presumed to support fish habitat in the adjacent streams. These wetlands provide shade, detrital inputs, invertebrates, woody debris, and groundwater discharge to the creeks. However, many of the existing wetlands function at a low level to support macroinvertebrate and fish habitat because they are dominated by herbaceous, non-native vegetation and are a source of nutrient and/or pollutant input to the streams.

The riparian wetlands located on groundwater seeps adjacent to Miller and Des Moines creeks provide base flow support functions and may help reduce stream temperatures during summer months. Many of the wetlands have limited stormwater storage capacity due to their small size, lack of direct connections to the streams, or owing to topographic conditions that limit stormwater detention. The existing groundwater recharge function is also limited because most wetlands appear to be underlain by relatively compact soils that limit groundwater infiltration rates. Wetlands within the project area that occur on relatively flat areas and receive runoff from urban areas do function to improve water quality.

7.3.1.4 Conservation Measures for Direct Wetland Impacts

A major focus of the MPU project design was to avoid and minimize direct impacts to the biological and physical functions of on-site wetlands. Unavoidable direct impacts to wetlands will be mitigated by a combination of wetland restoration and enhancement actions as detailed in the *Draft Natural Resource Mitigation Plan* (Parametrix 1999a). These combined conservation measures will result in the restoration and functional enhancement of a total of 19.67 ac of in-basin wetlands, as well as enhancement of 28.39 ac of riparian and wetland buffers. In addition, to mitigate for avian habitat that cannot be replaced in-basin due to wildlife hazards to aircraft operations, a total of 40.56 ac of restored or enhanced wetlands, and 15 ac of buffer enhancement will be created at the Auburn mitigation site.

7.3.1.5 Indirect Wetland and Stream Impacts

Potential indirect impacts due to filling of wetlands by the MPU project include changes in hydrology to downslope wetlands and streams, reduction in the amount of wildlife habitat available for wetland species, and changes in water quality through removal of wetland area. No direct impacts occur to listed species, because all wetland impacts occur in portions of the Miller and Des Moines creek basins that do not contain critical habitat for these species. The project design

[58] For example, of over 90 wetlands, totaling more than 170 ac, about 68 wetlands are ½ ac in size or less, and only about 13 are greater than 1 ac in size.

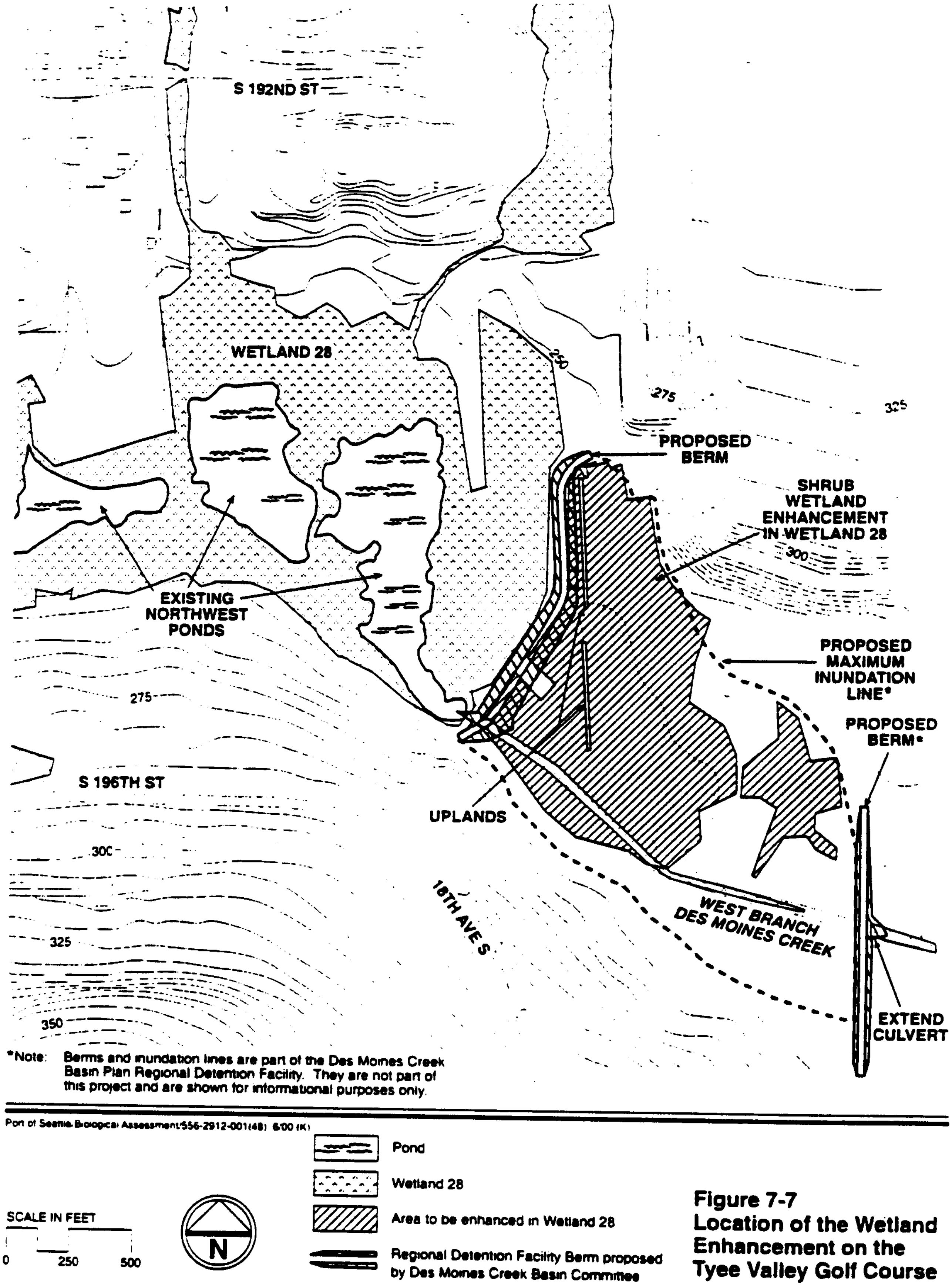
(including the mitigation design) contains actions directed at avoiding and minimizing impacts to aquatic systems from filling wetlands. Due to the mitigation actions included in the project, the project is not expected to adversely affect hydrology, water quality, or wildlife habitat in downslope wetlands or adjacent streams.

Indirect impacts to hydrology include changed hydrology in wetlands downslope of filled wetlands, as well as impacts to base flow in streams adjacent to filled wetlands. These potential impacts are mitigated through project design, as explained in Appendix B to the Wetland Functional Assessment and Impact Analysis (Parametrix 1999e; see pages 10-13; 24-26; and Figure 9). For example, the fill for the third runway and embankment includes a drainage layer to be placed atop the existing soil surface that will function as an underdrain. This drainage layer will convey groundwater under the embankment fill to downslope wetlands. After the embankment is constructed, groundwater that currently surfaces in some of the wetlands that will be filled will surface in wetlands downslope of the embankment. The drainage layer will also collect groundwater that infiltrates into the embankment, and either allow it to infiltrate into the existing soil or flow downslope to the wetlands and Miller Creek. It is anticipated that Section 404 permit conditions will require monitoring the hydrology of downslope wetlands to determine that sufficient hydrology is present to maintain the areas as wetland. Indirect impacts to the hydrology of wetlands adjacent to the fill are not expected to be significant and will not significantly alter their hydrologic function.

Some wildlife species are likely to avoid wetland areas during construction. Indirect impacts resulting from noise and human disturbance are expected to be minor because most wetlands are already subject to aircraft noise, traffic noise, and human disturbances, and because the wildlife species present in these wetlands are tolerant of these activities. Removal of human activities and structures from the acquisition area (i.e., about 30 ac of Miller Creek buffer) would provide new habitat for some species. In addition, the restoration and enhancement of wetlands and buffers will increase the amount and quality of wildlife habitat in the project area by increasing habitat patch sizes, providing corridors between habitat patches (e.g., the Miller Creek riparian buffer), re-establishing native forested, shrub, and emergent vegetation, and adding LWD and habitat complexity to streams.

7.3.2 Wetland and Stream Habitat Mitigation

Compensatory mitigation for unavoidable impacts to wetlands is a part of the MPU project. Mitigation includes actions in the Miller and Des Moines creek basins, as well as out-of-basin mitigation at the Auburn mitigation site. Following the recommended preference for on-site in-basin mitigation, several on-site mitigation elements are proposed to compensate for the MPU improvement projects' potential impact to stream, wetlands, and aquatic habitat in-basin. In-basin mitigation is directed toward restoring all impacted wetland and stream functions except avian habitat (Figure 7-7, and see Figure 7-4). In-basin mitigation establishes 48.06 ac of on-site wetland enhancement and stream buffering that will be protected in perpetuity from future development. These actions include grading to establish wetland hydrology, removing invasive non-native species, planting native wetland vegetation, and installing LWD. Mitigation actions also include removing certain existing land use conditions (e.g., paved surfaces, artificial landscaping and attendant nutrient and pesticide inputs, septic systems, and channel riprap) that degrade on-site



*Note: Berms and inundation lines are part of the Des Moines Creek Basin Plan Regional Detention Facility. They are not part of this project and are shown for informational purposes only.

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Figure 7-7
Location of the Wetland Enhancement on the Tyee Valley Golf Course

wetland and aquatic habitat. In-basin mitigation to compensate for potential impacts to the hydrology and aquatic habitat of Miller and Des Moines creeks also includes creating significant stormwater management facilities, restoring riparian buffers, restoring segments of the Miller Creek channel, replacing drainage channel functions, establishing watershed rehabilitation trust funds, and improving stream base flows.

Mitigation for wildlife habitat (bird and small mammals) is provided out-of-basin and consists of creating a large, high-quality wetland system in the city of Auburn at the mitigation site. At this location the mitigation complies with the FAA Advisory Circular 150/5200-33 regarding wildlife attractants near airports (FAA 1997a).

Specific mitigation actions that are a part of the MPU project have the potential to impact stream habitat. Potential impacts of specific mitigation actions, as well as steps taken to avoid, minimize, and mitigate for these potential impacts are discussed below. The mitigation actions are designed to replace and improve aquatic system functions impacted by the MPU project; therefore, the project is expected to have a net beneficial effect on wetland and aquatic systems.

7.3.2.1 Miller Creek Relocation

Approximately 980 ft of Miller Creek, south of Lora Lake, will be filled to accommodate the embankment for the third runway and the associated relocation of S. 154th Street (see Figures 3-1 and 7-4). To compensate for this impact, a new stream channel will be constructed approximately 200 ft west of the existing channel, through the Vacca Farm site. Relocating the creek will increase the channel length to approximately 1,080 ft and provide fish habitat features that are currently lacking in the creek segment that is to be filled.

The creek relocation does not occur in stream habitat used by listed species, and listed species are limited to stream reaches located approximately 3.5 miles downstream of the project. As with other development projects, potential indirect effects of the project are changes in stream hydrology or water quality during construction, which could affect the Miller Creek estuary and nearshore marine habitats. Section 7.1.2 describes the extensive TESC measures implemented and shown to be effective by the Port. Construction adjacent to the Miller Creek relocation will use these measures to prevent impacts to water quality in the creek.

The Miller Creek Relocation project will be constructed during the dry season to further reduce impacts. It is expected that the work can be completed within one working season.

7.3.2.2 Miller Creek Riparian Corridor Buffer Enhancement

Downstream of the floodplain and buffer enhancement areas at the Vacca Farm site, a 100-ft buffer will be established along the west side of approximately 6,500 linear ft of Miller Creek (within the acquisition area) (see Figure 7-5). Buffer averaging will be used on the east side of the creek, where a minimum 50-ft buffer will be established. Where the embankment design allows, buffers will be increased so that the average buffer width is 100 ft. The buffer enhancement will improve creek habitat, as well as eliminate sources of yard chemicals, untreated stormwater runoff, and sewage which currently degrade water quality in Miller Creek. The 100-ft buffer will enhance water quality and aquatic habitat. This buffer enhancement project will protect about 24 ac of riparian habitat along Miller Creek.

The planting approach along the length of the buffer will vary depending upon the existing buffer condition. In sections of the buffer that are primarily lawn, areas will be planted with native trees and shrubs. Areas that contain some native and some non-native vegetation will be enhanced by either inter-planting native species to produce a continuous tree canopy or underplanting native shrubs beneath an existing canopy that lacks understory vegetation. Some areas that contain invasive species (such as Himalayan blackberry and Japanese knotweed) will be cleared, graded, and also inter-planted with native woody vegetation.

The proposed buffers (100 ft typical) will protect non-listed salmon habitat in Miller Creek, as summarized in Table 7-25. While the summary in the table indicates that 100-ft buffers protect riparian functions critical to salmon using urban streams, any future development in the acquisition area would be subject to additional environmental review by the Port, City of SeaTac, and other agencies. Larger buffers could be established at this time if they were determined necessary to mitigate environmental impacts of development specifically within the vicinity of the stream.

7.3.2.3 Tyee Valley Golf Course Wetland Enhancement

To improve water quality and riparian habitat within the Des Moines Creek basin, approximately 4.5 ac of emergent wetland area, located within the existing and active Tyee Valley Golf Course, would be restored to a native shrub vegetation community. The enhancement would convert the existing turf wetland to a native shrub wetland community. Planting a native shrub community on the golf course would reduce chemical runoff reaching aquatic environments and fish populations in Des Moines Creek, increase nutrient removal and recycling in the riparian zone, and decrease wildlife attractants within 10,000 ft of the airfield (as required by the FAA).

The enhancement actions would be compatible with plans to construct a RDF on the golf course (King County CIP Design Team 1999). Shrub communities planned for the wetland would be tolerant of the planned hydrologic regime of the final RDF design (see King County CIP Design Team 1999). The wetland restoration actions proposed for the Tyee Golf Course, however, do not depend on construction of the proposed King County RDF. The wetland restoration could be fully implemented with or without RDF construction. A seasonally high groundwater table that is present during the winter months would maintain the hydrology within the wetland with or without the presence of the RDF. Soils in these wetland areas are typically saturated to the surface during the late fall, winter, and early spring months.

7.3.2.4 Watershed Basin Trust Funds

Watershed trust funds established to enhance aquatic habitat in Miller and Des Moines creeks would provide $150,000 for restoration projects in each basin for projects complying with the FAA advisory circular on wildlife attractants near airports. Examples of projects eligible for trust fund monies will be defined by the Des Moines Creek Basin Plan (Des Moines Creek Basin Committee 1997), the Stream Survey Report for Miller Creek (FAA 1996), or other projects that meet the key criteria used to evaluate proposals. Requests for monies must be made by King County; the cities of SeaTac, Des Moines, Burien, and Normandy Park; special districts; tribal governments; non-profit organizations; or combinations of such governments through inter-local agreements.

Table 7-25. **Summary of functions and effectiveness of 100-ft riparian buffers along Miller Creek.**

Function	Explanation	Limitation in urban setting	100-ft buffer effective?
Wood Production	Large conifers fall into creek channels. Logs, root wads, and other woody debris creates habitat complexity in stream and controls geomorphic processes (i.e., sorts gravel, stabilizes channel, etc.).	Hazard trees within buffers are sometimes removed to protect property; however, some could be cut to fall into the stream. Woody debris can block culverts and must be removed.	Yes, management actions may enhance delivery of wood compared to natural settings.
Shade	At the small-scale, shade derived from vegetation blocks solar radiation from warming water.	Dense shrubs within 25 to 50 ft of small streams are able to provide this function.	Yes
	At larger scales, mature forest vegetation and topography (i.e., ravines, canyons) may create a thermal corridor that maintains a cool air mass along a riparian corridor.	The existing urban setting lacks room for thermal protection at this scale. Road crossings and other disturbances can break the thermal barrier.	Variable
Water Quality	Physical, chemical, and biochemical processes in buffers remove nutrients or other chemical pollutants from runoff or interflow prior to discharge to the stream.	In urban setting, most runoff is collected from impervious surfaces and routes to creeks via pipes. Treatment BMPs are used to replace water quality functions of buffers. Runoff and interflow from non-impervious surfaces may be improved by buffers.	Yes
Sediment Production	Naturally meandering stream cuts new channels and delivers spawning gravels.	Buffer size must accommodate historically active floodplain.	Yes
Food Production	Leaves fall in stream and provide food for aquatic insects which fish eat. Terrestrial insects that fall into the stream are a source of food for fish.	Dense shrubs within 25 to 50 ft of small streams are able to provide this function.	Yes
Wildlife Corridor	Intact riparian buffers allow wildlife to move along stream corridor.	Streets and development typically fragment buffers. Large mammals that rely on corridors are absent from urban settings. These areas support opportunistic birds and wildlife typical of urban settings.	Yes,-Limited to species adapted to urban environments.

7.3.2.5 Off-Site Avian Habitat Mitigation

Off-site mitigation is proposed because FAA regulations prohibit the siting of potential wildlife attractants (including wetland mitigation) within 10,000 ft of active runways. Des Moines and Miller creek watersheds are almost totally within the 10,000-ft exclusion area for wildlife habitat mitigation, and the portions of the watersheds that are more than 10,000 ft from existing runways were found unsuitable for mitigation due to their small size, developed nature, forested condition, or the lack of hydrologic conditions necessary to support wetlands. Therefore, off-site mitigation is proposed in the nearby Green River watershed.

To mitigate for the loss of wildlife habitat on-site, the Port intends to construct an approximately 36-ac wetland mitigation area on a 67-ac parcel in the city of Auburn (Figure 3-4). This wetland mitigation area would replace lost wetland functions by providing a diverse wetland habitat. Approximately 40.56 ac of wetland (including forested, shrub, emergent and open water) would be created at the Auburn site. Upland buffers totaling about 15 ac would protect the wetland mitigation and provide territorial habitat for a variety of wildlife species.

The Auburn mitigation site is at least 200 ft west of the Green River, is bordered on the east by a strip of land adjacent to the Green River that is owned by King County and is the proposed location of a recreational trail. Mitigation activities will involve grading to establish hydrology, removing non-native species and planting native species. Construction will occur during the dry season and BMP sediment and erosion control measures will be implemented during construction. In addition, any timing restrictions for construction activities, or any other limitations to be specified in future permits would be observed. All mitigation actions will be monitored according to monitoring plans presented in the *Draft Natural Resource Mitigation Plan* (Parametrix 1999a). Any additional monitoring required will also be conducted to comply with permit conditions.

Conservation Measures and Mitigation Actions

8. CONSERVATION MEASURES AND MITIGATION ACTIONS

Although chinook salmon and bull trout are not known to occur in the Miller Creek and Des Moines Creek basins, a variety of conservation measures and mitigation actions have been incorporated into the proposed construction and operational phases of the project to protect, enhance, and restore stream and riparian habitats in the respective watersheds. These actions will also ensure protection of chinook critical habitat located near the mouth of Miller and Des Moines creeks.

This section summarizes actions incorporated into the MPU improvement projects to mitigate adverse impacts to wetlands, streams, floodplains, and drainage channels. Mitigation activities address three categories of impacts: (1) water quality; (2) changes in hydrology as a result of new impervious surface; and (3) habitat modification. These mitigation actions are summarized below and described in detail in Chapter 7 and in the *Draft Natural Resource Mitigation Plan* (Parametrix 1999a). Conservation measures also include BMPs designed to protect aquatic resources during the project construction. These measures will ensure that no habitat degradation occurs, including potential downstream effects in estuarine areas that could be used by chinook salmon and anadromous bull trout.

8.1 WATER QUALITY MITIGATION

Water quality conservation and mitigation activities include pollutant source control, water quality treatment (including the IWS), and off-site enhancements of wetland and stream water quality functions. These actions are listed in Table 8-1 below and described in Section 7.1.4. As described in Section 7.1.4.4, stormwater treatment is designed to serve 189 percent of the new impervious surface associated with the project. At this level of treatment, the potential inefficiencies of BMPs are compensated for and no significant water quality degradation would occur (Appendix C).

Table 8-1. Summary of Master Plan water quality mitigation activities and benefits.

Water Quality Mitigation Activity	Water Quality Benefits
Conventional water quality treatment BMPs (bioswales, filter strips, wet vaults, infiltration)	Remove particulates and metals and other toxics that bind to particulates.
IWS	Contains and treats industrial stormwater; prevents industrial stormwater discharge to Miller and Des Moines creeks.
Pollutant removal in Lake Reba and Northwest Ponds	Removes particulates and metals and other toxics that bind to particulates.
Source controls	Presented in Table 7-16.
Construction erosion control and advanced stormwater treatment	Prevents sedimentation impacts in receiving waters.
Snowmelt facility	Reduces BOD reaching receiving waters.
Aircraft de-icing and anti-icing only within IWS	Minimize glycols in runoff reaching Miller and Des Moines creeks.

Table 8-1. Summary of Master Plan water quality mitigation activities and benefits (continued).

Water Quality Mitigation Activity	Water Quality Benefits
Enhancement of wetland water quality functions (Miller Creek and Tyee Valley Golf Course wetland restoration)	Conversion of farmland and golf course to shrub wetlands will remove potential sources of pollutants; restored wetlands will enhance water quality through removal of particulates and other contaminants.
Miller Creek buffer enhancement	Enhanced buffers will increase biofiltration of runoff flowing into the creek from riparian areas, reduce erosion and sediment supply, shade the creek to reduce stream temperatures and increase DO capacity.
Miller Creek stream channel restoration and enhancement	Reduced scour, erosion, and sediment supply.
Level 2 hydrologic controls	Reduced scour, erosion, and sediment supply.

8.2 STORMWATER QUANTITY AND IMPERVIOUS SURFACE MITIGATION

To protect Miller and Des Moines creeks from increased stormwater runoff, the Port will design MPU development improvements to match peak flows to pre-developed conditions, and retrofit existing airport areas to control the duration of erosive flow rates in the streams to pre-developed conditions. The Port will also implement measures to prevent or mitigate for effects on baseflows in both streams. The actions are listed in Table 8-2 below and described in Section 7.2.2.

Table 8-2. Summary of Master Plan Update improvements related to mitigation of hydrologic effects of increased impervious surfaces.

Action	Hydrologic Benefits
Provide Level 1 flow controls	Prevents increases in peak flows up to the 100-year event.
Retrofit to Level 2 flow controls for Miller, Walker, and Des Moines creeks.	Retrofits the airport such that the duration and peak of erosive flows match a pre-development condition of 10 percent impervious (the Target Watershed Flow Regime identified in the Des Moines Creek Basin Plan).
Eliminate use of surface water rights on Miller Creek.	Increases baseflows.
Support the Des Moines Creek Basin Committee's flow augmentation project.	Increases baseflows during late summer low flows.
Where feasible, incorporate infiltration into stormwater management facilities.	Increases baseflows.

Figure 7-2 illustrates existing hydrologic conditions and the proposed runoff conditions after development and implementation of peak stormwater flow controls. The figure shows that for Miller, Des Moines, and Walker creeks, post-project hydrology will match or be improved over existing baseline.

The flow-duration curves are a statistical representation of all flows expected to occur at a location in the watershed. The curve statistics are developed from the HSPF hydrologic model of the systems. Each point on the curve describes the probability of flow occurring at any hour during the 48 years of simulation. Therefore, if the curve in the future condition is the same as the existing condition, the probability of a given peak flow rate occurring is the same for both conditions. The range, duration, and frequency of flows will also remain the same as existing conditions.

The flow-duration curves show that the effect of 169.3 ac of impervious surface on peak flows can be mitigated in detention facilities. For example, the curves shown for Des Moines Creek under existing and proposed conditions with enhanced Level 1 design are virtually identical, indicating peak flows will not change. In addition, construction of the RDF will further mitigate peak flows to an "idealized" Des Moines Creek peak flow regime determined for King County (facilitators of the Des Moines Creek Basin Plan) by the University of Washington. The "idealized flow" curve represents optimal hydrologic conditions given the current channel morphology, as shown by the "proposed condition with RDF." The "target flow regime" curve that closely follows the RDF curve is a simulated flow-duration curve that characterizes the watershed at approximately 10 percent impervious (the basin is currently 32 percent effective impervious area). Therefore, the proposed peak flows with the RDF actually significantly reduce the existing flows and the effect of existing impervious area on creek hydrology.

In the Miller Creek basin, the existing Miller Creek Detention Facility (MCDF) already provides peak flow mitigation for existing development. This is demonstrated by the fact that existing peak flows for larger, less frequent storms are below the target watershed curve (simulating the basin at 10 percent impervious) for Miller Creek. However, to match the target flow regime for smaller storms, which result in flows exceeding the target flow regime, additional detention will be provided through expansion of the MCDF into adjacent upland areas. The results of the detention expansion, shown by the "proposed condition" flow curve, demonstrates that flows will be further reduced, even with the addition of impervious areas.

Airport activities, and stormwater runoff (quality and quantity) characteristics are similar to those associated with highway projects in that it will be a linear strip of pavement built upon an earthen embankment. BMPs will typically consist of stormwater detention vaults and grassy filter strips and swales, which are used for many highway projects. Ground de-icing for runways, taxiways and highways uses similar methods and chemicals (acetate compounds). The absence of toxicity from STIA stormwater runoff demonstrates that existing BMPs are effective at protecting critical habitat located 2.5 to 3.0 miles from STIA.

A peer review process by King County (in process) of the Port's studies is expected to result in some modifications to the current plan and ultimate concurrence that the plan mitigates stormwater impacts for the proposed master plan projects in a manner that protects listed fish and the aquatic habitat of Miller, Des Moines, and Walker creeks. In addition, the proposed mitigation improves existing conditions by removing existing impacting uses and by retrofitting portions of the airport that are not included in the Master Plan.

8.3 HABITAT MODIFICATION

Conservation measures to protect fish, riparian, and wetland habitat (Tables 8-3, 8-4, and 8-5) are described in Section 7.3. These actions would compensate for project-related impacts to habitat functions and enhance existing habitat through a variety of actions focused on Miller and Des Moines creeks.

Table 8-3. **Summary of on- and off-site compensatory mitigation for watershed, wetland, and stream impacts at Seattle-Tacoma International Airport.**

Description of Impact	Mitigation Action	Explanation/Comment
On-Site Mitigation[a]		
Permanent Impacts		
Fill approximately 980 linear ft of Miller Creek channel to accommodate third runway embankment.	Relocate approximately 1,080 ft of Miller Creek channel.	Channel relocation will enhance aquatic habitat by providing stream buffers, instream habitat features, and by increasing channel length by approximately 100 ft.
		Plant approximately 3.8 ac of buffer around the channel relocation project with native trees and shrubs. (This buffer extends into the floodplain area.)
Fill 1,290 linear ft of drainage channels to accommodate third runway embankment.	Create new drainage channel and establish protective buffers.	Create approximately 1,290 ft of new drainage channel(s) with associated buffer habitat.
Fill approximately 5.24 acre-ft of Miller Creek floodplain to accommodate third runway embankment and S. 154th Street relocation.	Replace lost floodplain.	Excavate approximately 9,600 cy (to achieve storage of 5.94 acre-ft) from the Vacca Farm site, providing an excess of 0.7 acre-ft of floodwater storage.
Impact approximately 18.33 ac of wetland during construction of the third runway embankment and other construction-related projects.	Restore Vacca Farm to historic floodplain shrub wetland.	Approximately 11 ac of prior converted wetland and farmed wetland will be planted with native trees, shrubs, and emergent species. Restoration of the area will stabilize soils, improve water quality, and enhance Miller Creek habitat. It will reduce wildlife habitat attractants and conform to FAA mandates regarding wildlife attractants for airport safety.
	Establish 50-ft buffer between the floodplain enhancement area and Des Moines Memorial Drive.	The buffer will be established and enhanced by planting native upland trees and shrubs to provide approximately 1.89 ac of upland buffer.
	Restore wetlands on the Tyee Valley Golf Course.	Plant approximately 4.5 ac of historic peat wetlands on the Tyee Valley Golf Course with native shrub communities. This enhancement will be coordinated with Des Moines Creek Basin Committee planned RDF. The enhancement and RDF will improve hydrologic functions of the watershed, reduce wildlife attractants near the airfield, and restore a peat wetland.
Temporary Impacts		
Construct temporary stormwater management ponds and other construction projects, which may impact up to 2.17 ac of wetland.	Restore wetland areas after construction is complete.	Temporarily filled or disturbed wetlands will be restored. Restoration will include establishing pre-disturbance topography and planting with native shrub vegetation.

Table 8-3. Summary of on- and off-site compensatory mitigation for watershed, wetland, and stream impacts at Seattle-Tacoma International Airport (continued).

Description of Impact	Mitigation Action	Explanation/Comment
Indirect and Cumulative Impacts		
Fill wetlands near Miller Creek that may reduce aquatic habitat value of the creek.	Establish and enhance buffers along Miller Creek corridor between S. 156th Street and Des Moines Memorial Drive.	Establish a 100-ft buffer on the west side of Miller Creek and a 100-ft average (50-ft minimum) buffer on the east side of the creek. These buffers will provide approximately 24 ac of riparian buffer habitat.
	Establish a 25-ft buffer around Lora Lake.	Approximately 0.60 ac of buffer around Lora Lake will be converted from lawn to native shrub vegetation.
Additional development in the watersheds could result in additional cumulative impacts.	Participate in developing and implementing Miller Creek and Des Moines Creek basin plans.	These planning processes will identify effective, long-term solutions to restore additional fish habitat to Miller and Des Moines creeks. The Port will contribute both staffing resources and funds, and with other cooperating jurisdictions, will continue to plan and implement appropriate watershed restoration projects.
The runway fill may eliminate water sources that contribute to remaining wetlands downslope of the runway.	Design internal drainage and conveyance channels.	Subsurface and surface conveyance channels will continue to collect and distribute groundwater currently surfacing near 12th Avenue S. to Miller Creek and associated wetlands.
	Monitor wetlands adjacent to the third runway embankment.	Wetlands subject to potential indirect impacts will be monitored to determine whether unmitigated indirect impacts have occurred. If significant new wetland impacts are verified, corrective actions will be implemented.
Off-Site Mitigation		
Permanent Impacts		
Loss of approximately 18.33 ac of wetland wildlife (avian) habitat	Replace habitat function off-site at an overall ratio of 2:1	Due to conflicts with avian habitat and aviation safety concerns, new wetlands habitat will be created at a 67-ac site in Auburn, Washington. This wetland creation will increase overall avian and other wildlife use and diversity in an area that will not compromise aviation safety.

[a] All mitigation areas (including, but not limited to, streams, wetlands, buffers, and floodplains) located within 10,000 ft of a runway shall be subject to the provisions of the Port's Wildlife Hazard Management Plan (Port of Seattle 1999c) for the management of wildlife and wildlife attractant areas.

8.3.1 Avoidance of Potential Failure of the Mechanically Stabilized Earth Walls

Inclusion of mechanically stabilized earth (MSE) walls in the MPU improvement projects to retain the third runway embankment prevents the need for any further relocations of Miller Creek, as well as reducing impacts on the functions of the adjacent wetlands. This section presents information related to the stability of wall and the potential for impacts related to MSE wall failure.

Table 8-4. In-basin mitigation credit for proposed fill of 18.33 ac of wetland at Seattle-Tacoma International Airport.

In-Basin Mitigation	Mitigation Acreage	Mitigation Credit [a] (Acres)
Wetland Restoration - Credit Ratios 1:1		
Vacca Farm	6.13	6.13
Wetland Enhancement - Credit Ratios 1:2		
Vacca Farm (Farmed Wetland, Other Wetlands)	4.87	2.44
Wetlands in Miller Creek Buffer	4.17	2.09
Tyee Valley Golf Course Wetlands	4.50	2.25
Buffer Enhancement – Credit Ratios 1:5		
Miller Creek Upland	24.00	4.80
Vacca Farm	3.79	0.76
Lora Lake	0.60	0.12
Other Actions (no credit assigned)		
Miller Creek Channel Replacement		
Miller Creek In-Stream Enhancement Projects		
Miller Creek Drainage Channel Replacement		
Trust Fund of $300,000 for Miller and Des Moines Creek Basins		
Total In-Basin Mitigation	**48.06**	**18.58**

[a] Washington State Department of Ecology 11/30/99 draft Compensatory Wetland Mitigation Banks guidelines (WAC 173-700). These draft guidelines were used since they provide the credit ratios for buffer enhancement.

Table 8-5. Out-of-basin mitigation for proposed fill of 18.33 ac of wetland at Sea-Tac Airport.

Out-of-Basin Mitigation	Mitigation Acreage	Mitigation Credit [a] (Acres)
Wetland Creation - Credit Ratios 1:1		
Auburn Wetland Creation	34.56	34.56
Wetland Enhancement - Credit Ratios 1:2		
Auburn Wetland Enhancement	6.00	3.00
Buffer Enhancement - Credit Ratios 1:5		
Auburn Upland Buffers	15.00	3.00
Total Out-of-Basin Mitigation	**55.56**	**40.56**

[a] Washington State Department of Ecology 11/30/99 Draft Compensatory Wetland Mitigation Banks guidelines (WAC 173-700). These draft guidelines were used since they provide the credit ratios for buffer enhancement.

There are a number of design and construction measures that are being used to prevent failure to the proposed MSE walls located greater than 70 ft from Miller Creek. No MSE wall that has been designed and constructed with the techniques described herein has ever catastrophically failed. Design of the MSE walls includes analyses to verify adequate factors of safety for each of several potential failure mechanisms which can generically be categorized as internal stability; sliding; overturning; global stability; compound stability; and bearing capacity. Each potential failure mode is evaluated for both static and seismic conditions. In addition to checking that adequate factors of safety exist for each of these potential failure modes, the design approach utilized by the Port also includes verification of acceptable deformations for the walls and their foundations. Mechanically stabilized earth (MSE) is more stable under seismic conditions than unreinforced fill soils, and the Port of Seattle is going beyond conventional standards of care to prevent the risk of off-site impacts.

Design of the Third Runway MSE walls will generally conform to criteria in the current specifications developed by the American Association of State Highway and Transportation Officials (AASHTO). The AASHTO criteria are the same engineering methods used for design and construction of highway bridges and other important structures where performance is essential to protect public safety and well-being. The AASHTO standards are regularly updated to incorporate improvements in engineering practices, based on the engineering evaluations of walls subject to earthquakes at Kobe, Japan, Northridge California and other seismic events.

Consistent with the AASHTO standards, the Third Runway MSE walls are being designed for a large earthquake with a nominal 475-year return period. However, the Port's design will exceed the AASHTO criteria in several important ways. The Port has used a site-specific probabilistic seismic hazard assessment (PSHA) to select the peak horizontal ground acceleration used in the design (0.36g) which is about 10-percent higher than the AASHTO default level of earthquake acceleration. Design will use the same minimum factors of safety specified by AASHTO; and maximum allowable stress in the reinforcing will be much lower (i.e. safer) than are used in design of some bridges and other types of structures. Finally, the Port's design incorporates a separate finite-difference analysis step to verify acceptable levels of stress and deformations in the MSE walls, which goes above and beyond the AASHTO criteria.

In addition to the seismic design provisions outlined above, the Port has taken a number of steps to avoid risk of instability or other adverse off-site impacts from the MSE walls, in several other important ways. These include:

- Completion of detailed explorations and in-situ tests to thoroughly and completely identify conditions in the subgrade soils that will support the MSE walls;
- Replacement or improvement of subgrade soils to support the MSE walls;
- Development of construction quality control specifications by a subconsultant firm that specializes in MSE walls, and who has successfully completed more than 10 MSE walls exceeding 90 ft in height; and
- Use of select soil materials for construction to provide good drainage behind and below the walls;

- Continued use of independent technical reviews for design and construction plans. by outside experts.

In addition to the measures described above to prevent catastrophic failures. the Port's construction plans include a number of measures to avoid the risk of wetland impacts due to minor structural damages which could occur due to sizable earthquakes, and to enable long-term maintenance should it be needed. These include construction of a permanent restricted-access road along the base of the walls; construction of temporary and permanent runoff controls. and protection and maintenance of wetland buffers to prevent temporary (construction-related) and permanent offsite impacts related to wall construction.

Effects Determination for
Threatened Aquatic Species

9. EFFECTS DETERMINATION FOR LISTED SPECIES

The following subsections present a detailed description of the effects of the proposed Master Plan Development projects on pathways and indicators of chinook salmon and bull trout. The effects of the projects are evaluated based on criteria (no effect, may effect, beneficial, insignificant, and discountable) defined by the NMFS, Washington Habitat Conservation Branch in: *A Guide to Biological Assessments* (NMFS 1999b) and *Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale* (NMFS 1996):

The analysis of effects is summarized for key project actions according to how they may affect pathways and indicators of properly functioning salmon habitat. These actions are:

- Effects of constructing projects in uplands. This analysis considers effects of soil disturbance and stormwater management on construction sites as the primary pathway that could affect salmon habitat. This analysis also considers the significance of altering or eliminating wetland and stream habitat, and the new mitigation created in both the Miller and Des Moines Creek basins. Significant pathways of these actions are direct alteration of habitat and construction impacts (including stormwater runoff).
- Effects of constructing projects in the Green River Watershed. The off-site wetland habitat mitigation in Auburn and new water tower construction are the only actions in the Green River Watershed. Construction of the new water tower will result in no change in impervious surface or land use types. Consequently, potential pathways affecting salmon habitat are only construction impacts (dewatering and stormwater runoff).
- Effects of operation. This analysis considers operational effects of Master Plan projects and mitigation on salmon habitat. The primary pathways affecting habitat are the habitat benefits derived from mitigation, the effects of stormwater runoff (quality and quantity) on habitat at the mouths of Miller and Des Moines creeks, and potential spill of hazardous materials.
- Effects of groundwater removal as mitigation for potential impacts to baseflow in Des Moines Creek.

Finally, a summary of the effects determination for essential fish habitat, marbled murrelet, and bald eagle is included in this section.

9.1 EFFECTS ANALYSIS FOR CHINOOK SALMON

9.1.1 Direct Effects

9.1.1.1 Miller, Walker, and Des Moines Creek Basins

Chinook salmon have not been documented to occur in the Miller Creek or the Des Moines Creek basins upstream of their confluence with Puget Sound. Therefore, construction and operation of

MPU project are not expected to directly effect the freshwater life stages or critical habitat of chinook salmon. Although results of the action are intended to improve habitat conditions for salmonids in the Miller Creek and Des Moines Creek basins (through increased stormwater management and habitat restoration), future use of the streams by chinook (i.e., through straying from other basins) is unlikely and not expected. The overall characteristics of these basins, including spawning substrate accumulations and particle sizes, stream width, and hydraulic conditions appear inadequate to support chinook on a long-term basis, even under restored conditions. Therefore, since chinook salmon do not occur in these basins, construction and operation of the project will have no effect on freshwater stages of chinook salmon in the portions of the Miller Creek or Des Moines Creek basins located upstream of the estuarine boundary. As chinook do not occur within 1.5 miles of the project area, all of the potential direct impacts on chinook in the freshwater environment are discountable.

In the unlikely event that adult chinook salmon should stray into Miller and Des Moines creeks, construction and operation impacts on water quality and creek habitat "are not likely to adversely affect" this fish. Without appropriate spawning conditions, these strays will not spawn and thus juvenile chinook will not be exposed to any minor changes in water quality or improvements to creek habitat or buffers (Tables 9-1 and 9-2).

9.1.1.2 Miller and Des Moines Creek Estuaries

No direct modification of habitat in the Miller or Des Moines creek estuaries or nearshore habitat will occur.

9.1.1.3 Offshore IWS Outfall

No modification or construction of the IWS outfall will occur. Indirect impacts resulting from operation are described in Section 9.1.2.

9.1.1.4 Auburn Wetland Mitigation

No modification of habitat in the Green River will occur, and use of erosion control BMPs will assure water quality impacts to the river will not occur. Discharge of construction dewatering will occur through existing outfalls and discharges will meet water quality standards protective of fish.

9.1.2 <u>Indirect Effects</u>

Potential indirect effects related to the project include:

- Effects of altered hydrology and sediment transport on small estuaries and nearshore habitat potentially used by chinook salmon at the mouths of Miller and Des Moines creeks. Changes in stream hydrology that will occur as a result of the project are insignificant and discountable; therefore, there will be no detectable hydrologic effects on the estuaries.

Table 9-1. **Effects of Master Plan Update improvement projects for Seattle-Tacoma International Airport on relevant indicators in Miller Creek.**

Pathways: Indicators	Effects of the Action(s) Restore[1]	Maintain[1]	Degrade[1]	Explanation
Water Quality:				
Temperature	X			Restoration of riparian areas will increase shading along stream corridor, buffering both daily and seasonal extremes in water temperatures. Stormwater detention and wetland restoration will help reduce runoff peaks, increase base flows, and reduce daily temperature fluctuations.
Sediment	X			During construction, water quality treatment of runoff and construction BMPs will prevent significant changes in sedimentation. Restoration of wetlands, creek buffers, and stream habitat will reduce sedimentation generated from upslope areas. Increase in woody debris and pool formation will increase sediment buffering capacity in the channel.
Chemical and Nutrients	X			Runoff from airport facilities will be treated using BMPs, including retrofitting, to prevent degradation of water quality. Purchase of residential properties will eliminate sources of nutrients including septic and fertilizer runoff. Wetland restoration and buffer enhancement will restore the natural function of these systems to protect water quality.
Habitat Access:[2]				
Physical Barriers		X		No new barriers will be constructed. Footbridges and abutments will be removed.
Habitat Elements:				
Substrate	X			Water quality treatment will reduce fine sediments entering the channel.
Large Woody Debris	X			LWD will be added to the stream to meet goals of 80 pieces per mile. Long-term natural recruitment of LWD from 100-ft buffers will occur through natural processes.
Pool Frequency	X			Increasing LWD in channel, removing channelization and stream restoration projects will all contribute to increased pool formation.
Pool Quality	X			Increasing LWD to the channel will encourage formation of larger and deeper pools at a greater frequency than currently exists. LWD as cover will also increase pool quality.
Off-channel Habitat	X			Elimination of channelization, restoration of riparian zone, and increase of LWD to channel will promote side channel formation.
Refugia	X			Promotion of side channel formation, wetland restoration, and increasing pool frequency will provide greater areas of high quality rearing and holding habitats for salmonids.

Table 9-1. Effects of Master Plan Update improvement projects for Seattle-Tacoma International Airport on relevant indicators in Miller Creek (continued).

Pathways: Indicators	Effects of the Action(s) Restore[1]	Maintain[1]	Degrade[1]	Explanation
Channel Condition & Dynamics:				
Width/Depth Ratio	X			Increasing LWD to the channel will promote pool and riffle formation, decreasing the overall width to depth ratio of the channel.
Streambank Condition	X			Restoration of riparian zones will reduce erosion along exposed stream banks. Elimination of channelized reaches and planting with riparian vegetation will promote formation of bank undercuts.
Floodplain Connectivity	X			Elimination of channelization and restoration of wetlands will increase linkage of floodplains to the main channel. Potential for overbank flows in mainstem Miller Creek.
Flow/Hydrology[2]:				
Peak/Base Flows	X			Stormwater detention, standards, elimination of impervious surfaces that lack stormwater management, restoration of wetlands, and promotion of side channels will serve to restore a more natural runoff regime. Base flows are expected to increase through wetland restoration, dampening of stormwater returns, and elimination of withdrawals for irrigation.
Drainage Network Increase		X		Incorporation of stormwater detention will keep runoff rates below existing and mitigate potential impacts of increasing drainage network. The subsurface drainage system incorporated into the embankment will maintain baseflow to downslope wetlands and mitigate impacts of wetland fill.
Watershed Conditions:				
Road Density & Location		X		Stormwater mitigation will eliminate impacts of new impervious surfaces.
Disturbance History		X		Residential impervious surfaces removed will be exchanged with new surfaces associated with the airport facilities. Disturbance-related impacts near the creek will decrease.
Riparian Reserves	X			The riparian width and continuity will increase. Canopy density and shading will increase. Natural woody debris recruitment will increase through time as riparian areas mature. Establishment of native plant species will be promoted.

[1] For the purposes of this checklist "restore" means to change the function of an "at risk" indicator to "properly functioning," or to change the function of a "not properly functioning" indicator to "at risk" or "properly functioning" (i.e., it does not apply to "properly functioning" indicators); "maintain" means that the function of an indicator does not change (i.e., it applies to all indicators regardless of functional level); "degrade" means to change the function of an indicator for the worse (i.e., it applies to all indicators regardless of functional level).

[2] Implementation of the trust fund for restoration in Miller Creek may increase or restore some of these characteristics.

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Table 9-2. Effects of Master Plan Update improvement projects for Seattle-Tacoma International Airport on relevant indicators in Des Moines Creek.

Pathways: Indicators	Effects of the Action(s) Restore[1]	Maintain[1]	Degrade[1]	Explanation
Water Quality:				
Temperature	X			Stormwater detention and wetland restoration near Northwest Ponds will help reduce runoff peaks, increase base flows, and reduce temperature fluctuations. Dead storage in detention ponds will not occur.
Sediment		X		During construction water quality treatment of runoff using construction BMP's will prevent sedimentation and restoration of wetlands will also reduce sediment runoff to the creek. During operation, water quality treatment BMPs and retrofitting will prevent increases in sediment runoff.
				Three on-site borrow areas will be operated only during the summer construction season to reduce the potential of sediment runoff. Use of TESC measures (berms, silt fencing, haybales, biofilteration swales, ponds, etc.) will be installed and maintained throughout the year.
				Temporary haul roads used to transport fill from excavation sites to the runway construction sites will be filled with biofiltration swales, detention/sedimentation ponds, filter strips, and other appropriate BMP required to protect water quality.
Chemical and Nutrients	X			Closing the Tyee Valley Golf Course will reduce sources of nutrients. Runoff from airport facilities will be treated using BMPs for water quality, IWS, and retrofitting.
Habitat Access[2]:				
Physical Barriers		X		No change in culverts or other physical barriers are planned.
Habitat Elements[2]:				
Substrate		X		Substrate in the creek will not be changed. A reduction in the amount of sediment transport may result from improved stormwater detention.
Large Woody Debris		X		LWD will be maintained as part of the proposed action.
Pool Frequency		X		A change in pool frequency is not expected to occur as part of the proposed action.
Pool Quality		X		A change in pool quality is not expected to occur as part of the proposed action.
Off-channel Habitat		X		No significant change in this condition will occur.

Table 9-2. Effects of Master Plan Update improvement projects for Seattle-Tacoma International Airport on relevant indicators in Des Moines Creek (continued).

Pathways: Indicators	Effects of the Action(s) Restore[1]	Maintain[1]	Degrade[1]	Explanation
Refugia		X		No change in refugia anticipated to occur as part of the proposed action.
Channel Condition & Dynamic:				
Width/Depth Ratio		X		Width/Depth ratio is not anticipated to change as a result of the proposed action.
Streambank Condition	X			Restoration of riparian wetlands in the golf course area will improve streambank conditions.
Floodplain Connectivity	X			Restoration of wetlands at the Tyee Valley Golf Course will improve linkage of floodplains to the creek, including export of organic matter from the floodplains to the creek.
Flow/Hydrology:				
Peak/Base Flows	X			Stormwater detention, floodplain restoration, and wetland restoration will help restore more natural runoff patterns. Hydrographic peaks will be reduced, returning precipitation to the channel over a longer period. Base flows are expected to increase through wetland restoration, flow augmentation, and dampening of stormwater returns.
Drainage Network Increase		X		New stormwater detention facilities associated with the runway and other projects will maintain the function of existing drainage network.
Watershed Conditions:				
Road Density & Location		X		The amount of road density and location will not significantly be changed as part of the proposed action. The hydrologic impacts of new roads is mitigated through stormwater detention.
Disturbance History		X		The project is located in an area that has historically been subjected to commercial and residential uses and activities. However, in-basin mitigation actions, will decrease the amount of disturbance and increase protection of the creek.
Riparian Reserves	X	X		Riparian areas on the golf course will improve. Riparian areas near Borrow Areas 1 and 3 will be preserved by buffers ranging from 150 ft to 200 ft.

[1] For the purposes of this checklist: "restore" means to change the function of an "at risk" indicator to "properly functioning," or to change the function of a "not properly functioning" indicator to "at risk" or "properly functioning" (i.e., it does not apply to "properly functioning" indicators); "maintain" means that the function of an indicator does not change (i.e., it applies to all indicators regardless of functional level); "degrade" means to change the function of an indicator for the worse (i.e., it applies to all indicators regardless of functional level).
[2] Implementation of the trust fund for restoration in Des Moines Creek may increase or restore some of these characteristics.

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- Effects of altered water quality on small estuaries and nearshore habitat potentially used by chinook salmon at the mouths of Miller and Des Moines creeks. Chinook salmon currently use the lower reaches of area rivers (i.e., Green, Puyallup) where detailed studies show lower water quality than that found in Miller or Des Moines creeks. BMPs and other mitigations detailed earlier will maintain the current suitability of the lower reaches of these creeks and their estuaries for chinook salmon.
- Effects from increased rates of discharge of treated stormwater from the Midway Sewer District marine outfall. Increased discharge rates could potentially increase the exposure of marine organisms to treated stormwater. The outfall discharge point is between 156 and 178 ft deep and 1800 ft offshore (MLLW). Predicted concentrations of stormwater constituents discharged from the IWS outfall will be below adverse effects concentrations for adult chinook salmon.

9.1.2.1 Miller, Walker, and Des Moines Creeks

As stated earlier for construction impacts, in the unlikely event that chinook salmon adults stray into either Miller or Des Moines creeks, the effects of the MPU projects are "not likely to adversely affect" these fish. This analysis is based on the effects of these actions which will either restore or maintain the relevant pathways of exposure (see Tables 9-1 and 9-2).

No effect on listed species would occur from groundwater withdrawals for baseflow augmentation. The Des Moines Creek Basin Plan (Des Moines Creek Basin Committee 1997) describes the well as extending to a depth of 600 ft below the surface and is cased to almost 200 ft. Water drawn from the well would almost certainly have no effect on flow levels in the Creek. Groundwater sources which the well draws upon are below sea level and are on their way to discharge directly to Puget Sound or potentially other deep wells in the general vicinity. Water quality samples from the existing well show that the well water is suitable for use in augmenting flow in the Creek during summer months. Given that the well is currently used for irrigation, no change in baseline is anticipated.

9.1.2.2 Miller and Des Moines Creek Estuaries

Downstream indirect effects of project construction were evaluated for chinook and their identified critical habitat at the outlets of Miller and Des Moines creeks. This analysis considers the effects of soil disturbance and stormwater management during construction and operation as the primary pathway that could affect chinook salmon and their critical habitat downstream of the construction area (Table 9-3).

Determining the effects of MPU construction involved identifying baseline conditions and considering the effects of construction relative to these conditions. This "matrix of pathways and indicators" has been modified from the standard table recommended by USFWS and NMFS to address pathways specific to estuarine and nearshore environments.

Table 9-3. Effects of operation of Mater Plan Update improvements (including mitigation) on critical habitat at the mouths of Miller Creek and Des Moines Creek.

Pathways: Indicators	Effects of the Action(s): Restore	Maintain	Degrade	Explanation
Water Quality:				
Temperature		X		The in-basin mitigation will improve riparian conditions in Miller and Des Moines creeks, which will enhance water temperatures by providing increased shade. The temperature of stormwater runoff from the airport may vary from that found in Miller or Des Moines creeks. During most of the year, runoff is generated during cool weather and when stream flows are great enough so no significant change in stream temperature occurs. Large storm events during late summer warm weather periods (when the streams are most vulnerable to temperature impacts from stormwater due to low base flow) are unlikely.
Sedimentation	X	X		All new MPU project PGIS will be served by BMPs in compliance with the Ecology Manual. Runoff treatment BMPs will also be retrofitted into existing airport areas where practicable. Water quality treatment BMPs are designed to remove 80 percent of suspended sediments from flows up to the design flow. Habitat mitigation activities will improve water quality in the receiving streams. Mitigation restoration of stream banks, plowed farmland, and riparian areas will reduce sediment supply from erosion. Restored and enhanced wetlands and stream buffers will increase biofiltration of runoff and streamflows. Airport-wide compliance with Level 2 flow control standards will reduce the existing duration of erosive flows, in turn reducing sedimentation impacts.
Metals, nutrients, petroleum products		X		All new Master Plan Project PGIS will be constructed with water quality treatment BMPs Runoff treatment BMPs will also be retrofitted into existing airport areas where practicable. Total treated PGIS will equal 189 percent of new PGIS, exceeding WSDOT's ESA guidance criterion for No Effect. In addition to sediments, runoff treatment BMPs will remove significant amounts of nutrients and other contaminants. The Port will continue to comply with its NPDES Permit, which requires that an effective SWPPP be maintained and implemented. Project areas subject to industrial pollution or at significant risk of spills will be diverted to the IWS, which collects and treats runoff from these areas and discharges to a deep outfall in Puget Sound. Project areas outside the IWS will be at no greater risk of spills than existing land uses; if spills occur in these project areas, the Port is prepared to respond immediately with a spill control and countermeasures plan. Whole effluent testing has historically demonstrated little or no toxicity in STIA stormwater runoff. If toxicity is identified in STIA stormwater, the Port will trace and eliminate the source. The current AKART analysis is evaluating the diversion of water currently treated and discharged by the IWS to the King County Wastewater Treatment System

Table 9-3. Effects of operation of Mater Plan Update improvements (including mitigation) on Critical Habitat at the mouths of Miller Creek and Des Moines Creek (continued).

Pathways:	Effects of the Action(s)			
Indicators	Restore	Maintain	Degrade	Explanation
Anti-icing and De-icing Chemicals		X		All aircraft anti icing and de-icing occurs within the IWS drainage area. After ground de-icing compounds have been applied, snow will be collected and melted in a facility that drains to the IWS. Glycol concentrations in stormwater effluent are significantly below toxic levels. Monitoring following ground de-icing demonstrates that DO remains at levels above the 8 mg/L criterion for impairment of salmonids (Cosmopolitan 1999; Des Moines Creek Basin Committee 1997).
Habitat Access:				
Physical Barriers	X			Stream restoration and enhancement projects will improve fish access to floodplains and in-channel habitat.
Habitat Elements:				
Substrate	X			Bank stabilization, riparian restoration, improved stormwater management will reduce sediment sources that can degrade substrates. In-stream enhancement projects will provide limited areas of improved substrates.
Large Woody Debris	X			Buffer and stream enhancement projects will increase the amount of woody debris in the channel to meet WDFW recommendations.
Pool Frequency	X			Stream enhancement projects will increase pool frequency.
Pool Quality		X		Stream enhancement project will maintain pool quality.
Off-channel Habitat	X			Restored wetlands and floodplain mitigation will improve the connection between channel and off-channel habitat.
Refugia	X			Restored wetlands and floodplain mitigation will improve the availability of the floodplain as refuge habitat during high flows.
Channel Condition /Dynamics				
Width/Depth Ratio	X			Enhancement projects will improve the width-to-depth ratio of the channel.
Streambank Condition		X		Enhancement projects will stabilize stream channels with vegetation.
Floodplain Connectivity		X		Floodplain connectivity will be maintained.

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Table 9-3. Effects of operation of Mater Plan Update improvements (including mitigation) on Critical Habitat at the mouths of Miller Creek and Des Moines Creek (continued).

Pathways:	Effects of the Action(s)			
Indicators	Restore	Maintain	Degrade	Explanation
Flow/ Hydrology				
Peak/Base Flows		X		Although new impervious surfaces will be added, all new project areas will be constructed with flow control facilities meeting the Level 2 standard. Additionally, flow controls for existing airport areas will be upgraded to the Level 2 standard. Complete coverage with Level 2 facilities will improve runoff hydrology from STIA. To improve base flows in Des Moines Creek, the Port will work with King County to ensure that the flow augmentation project is implemented as soon as possible
Drainage Network		X		A section of Miller Creek will be relocated; the new channel will be constructed with an improved riparian corridor, which will benefit this reach and the downstream system by reducing sediment supply and low-flow water temperatures. The Des Moines Creek Regional Detention Facility, if constructed, will take place in the Northwest Ponds, improving the downstream flow regime. All other changes to the drainage network will consist only of changes to existing piped or channeled systems tributary to the streams and will not affect the downstream system. The potential impact of increased stormwater drainage systems is mitigated through detention facilities. No basin transfers will take place.
Watershed Conditions:				
Impervious Surface		X		Addition of new impervious surfaces coupled with construction of new stormwater detention facilities for new and retrofitted paved areas will result in improved runoff hydrology from STIA.
Disturbance History		X		Development of MPU improvements occurs on property that has been previously developed.
Riparian Reserves		X		Riparian areas along Miller Creek will be preserved and enhanced.

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Construction of the third runway embankment and other MPU projects has been planned and designed to meet TESC BMPs requirements as necessary to prevent water quality degradation in fish habitat and other surface waters. The project also meets state water quality standards (WAC 173-201A) and Ecology (1992) test management practices. Specifically, water quality standards state that discharges shall result in no increases in turbidity in the receiving stream more than 5 NTUs above background (upstream) conditions when background is 50 NTU or less or register more than a 10 percent increase in turbidity when background exceeds 50 NTU. For the Third Runway embankment, the planned construction methods are designed to meet these standards, including advanced stormwater treatment, are described in Appendix D and Section 7.1.3.2. These methods will be adapted to other construction projects at STIA as appropriate and necessary.

Construction of the NEPL in the summer and fall of 1997 demonstrated that full implementation of standard TESC BMPs alone were inadequate to allow discharges to meet the state water quality standards. Therefore, in Autumn 1997, advanced stormwater treatment systems were implemented to treat NEPL construction runoff. Following implementation of these systems, all stormwater discharges remained in compliance with water quality standards identified to be protective of chinook and their critical habitat. These treatment systems were later implemented on other projects, including the 1998 and 1999 embankment construction phases. During the 1998-1999 wet season (a period of record rainfall at STIA) construction stormwater discharges remained in compliance with standards. The successful application of these methods on large construction projects over more than two years provides reasonable assurance that future construction stormwater discharges will comply with water quality standards, and that sedimentation or turbidity impacts to downstream surface waters will not occur, and that chinook salmon or their habitat will not be significantly altered.

Since there is no known natural production of chinook in Miller or Des Moines creeks, any juvenile chinook found near the mouths of the creeks would likely be from natural production in adjacent river systems (i.e., Green and Puyallup Rivers). Studies of juvenile chinook behavior in estuarine and marine environments have generally found that chinook fry and presmolts remain near their natal rivers and initially do not migrate far in the nearshore environment (Argue et al. 1985; Fisher and Pearcy 1990; Healey 1980a, 1982; Levy and Northcote 1982). Thus, very few juvenile chinook would be expected in very shallow water near the mouths of Miller and Des Moines Creeks, even if chinook populations were to fully recover in nearby river systems. Older juvenile chinook migrating past the two creeks would be expected to be in deeper water (Argue et al. 1985; Healey 1980a, 1980b; Dawley et al. 1986; Weitkamp and Schadt 1982).

As discussed in Section 7.1.4.1, water quality treatment BMPs for STIA will serve all new PGIS and will be retrofitted for existing PGIS where practicable. Treatment will be provided for PGIS totaling 189% of the new project PGIS, exceeding WSDOT's ESA guidance criteria for No Effect (Appendix C). Other source control and off-site mitigation activities will also protect and improve water quality (see Section 7.1.4).

BMPs will minimize any impacts of aircraft de-icing and anti-icing chemicals applied at STIA. Tenants at STIA use a variety of different formulations, with propylene glycol-based Type I fluids being the predominate type, followed by ethylene glycol Type I fluids and then Type II and Type IV fluids, both propylene glycol based. Application of these formulations can result in detectable concentrations of ethylene and propylene glycols (and, presumably, associated ADAF additives for each formulation) in stormwater discharged to Miller and Des Moines creeks, as well as to the IWS outfall. Comparisons of predicted ADAF formulations at all three potential exposure locations indicates that maximum concentrations of all four types of anti-icing and de-icing fluids used at STIA are present at concentrations of at least seven times below their relevant toxicity thresholds.

Observations following ground anti-icing and de-icing in December 1998 and February 1999 demonstrated that DO[59] in the streams remained above 8.0 mg/L (Cosmopolitan 1999), a level above which no impairment to salmonids is expected (Des Moines Creek Basin Committee 1997).

Current water quality in highly urbanized chinook-bearing rivers such as the Green/Duwamish, as well as its estuary and Elliott Bay, is adequate to sustain salmonids, including chinook. Amphipods in the Duwamish Estuary pose no survival risk to salmon smolts (King County DNR 1999c). Current water quality in Des Moines Creek is adequate to support salmonid uses (Des Moines Creek Basin Committee 1997). Since instream water quality after MPU is expected to be at or better than present conditions (see Tables 9-1 and 9-3), estuarine contamination greater than that seen in the lower Duwamish and Elliott Bay is unlikely. Since studies have not been conducted on the benthos and sediment quality offshore of Miller and Des Moines creeks, additional assessment of chinook rearing habitat quality would be speculative.

9.1.2.3 Offshore IWS Outfall

BMPs will also minimize effects of ground anti-icing and de-icing chemicals applied at STIA. Snow in contact with de-icing compounds is collected so it melts in facilities draining to the IWS. This practice minimizes de-icing compounds in runoff reaching Miller, Walker, and Des Moines creeks.

Older juvenile (e.g., > 90-100 mm Total Length) or adult chinook can be present in deeper water offshore of Miller and Des Moines creeks. Effects on offshore water quality, benthic deep-water habitat, and overall deep water rearing conditions are not expected to be measurable after implementation of the MPU improvement projects. Thus, direct or indirect effects on potential fish and invertebrate chinook prey are unlikely.

Treated discharge from the IWS joins output from the Midway Wastewater Treatment Plant and is discharged to Puget Sound at a depth of between 156 and 178 ft (MLLW) at 1,800 ft offshore. While it is unlikely, adult chinook and bull trout could forage for bait fish at this depth. In contrast, juvenile chinook fry and pre-smolts rear and forage in shallow water (< 3 m) (Dawley et al. 1986; Stober and Salo 1970; Weitkamp et al. 1981). MacDonald et al. (1987) noted that juvenile chinook were rarely seen deeper than two meters; when found in deeper water, very few were seen near the bottom. Thus, no direct or indirect effects on juvenile chinook are expected from the deepwater outfall.

9.1.2.4 New Water Tower and Auburn Wetland Mitigation

Construction of the wetland mitigation area and the new water tower are the only MPU improvement actions in the Green River watershed. Project activities at this site include construction dewatering facilities, access roads, creating or enhancing wetland habitat for wildlife,

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[59] Low DO is the primary potential environmental impact of de-icing compounds on receiving waters.

and constructing the water tower. Potential pathways affecting salmon habitat for this project are construction impacts that include dewatering, erosion, and stormwater runoff from unpaved temporary access roads (Table 9-4).

Adherence to BMPs for construction stormwater management and erosion control will ensure no direct impacts to freshwater stages of chinook salmon in the Green River occur and that downstream habitats will be protected. Construction BMPs similar to those described above for MPU projects construction, including advanced stormwater treatment when necessary, will be implemented for the wetland mitigation construction. Discharge of construction dewatering will meet state water quality standards and NPDES construction permit requirements. Dewatering discharge will be at rates low enough to prevent bank or other erosion. Dewatering may occur during two construction seasons between May and September. No change in runoff will result from the new water tower construction as this action will not change impervious surface draining to Gilliam Creek through outfalls 012 and 013, and no change in water quality will occur because land use type will not change. While adult salmon are present in the Green River within the range of these months, they would not be affected because discharges would meet water quality standards and would be minor relative to the large baseflows of the Green River. Therefore, no downstream effects are expected to result from the project. Nearshore marine habitats several miles downstream of the project will not be affected.

9.1.2.5 FAA Tower and Other Navigation Aids

STIA projects implemented by FAA to improve or relocate navigation facilities and aids (e.g., TRACON[60], ASR, ASDE, or other NAVAIDS) (see Table 3-1) are not located in wetlands and streams. These projects will be constructed using all stormwater quality and water quantity mitigation identified for other STIA projects, including TESC to meet NPDES requirements[61] and NMFS stormwater guidelines for "may affect" but is "not likely to adversely affect."

The Airport Traffic Control Tower currently under construction on a site previously developed with paved surfaces, and buildings, will not change baseline water quality conditions in Des Moines Creek. The site is located 2.5 miles north of the creek, and over 5 stream miles from the mouth of the Des Moines Creek where chinook salmon could occur. The project includes extensive TESC BMPs to assure water quality standards are met. These include:

- Use of water trucks, wash down, and sweeping to control dust,
- Use of straw bales and filter socks at all existing stormwater catch basins,
- Covering of stockpiled construction materials, and
- Completion of all work in accordance with the existing NPDES permit.

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[60] As a future federal action that is not a part of the STIA MPU improvements, the effects of constructing and operating the TRACON facility will be determined in consultation with the Services when this project goes forward in the future.

[61] Approved by the Department of Ecology on March 3, 2000.

Table 9-4. Effects of constructing wetland habitat mitigation adjacent to the Green River and constructing the new water tower.

Pathways:	Effects of the Action(s)			
Indicators	Restore	Maintain	Degrade	Explanation
Water Quality:				
Temperature		X		No change to baseline condition.
Sedimentation		X		During construction, the Port will apply construction erosion control measures in excess of minimum requirements, by (1) implementing a construction SWPPPs and monitoring plans, (2) fully applying conventional BMPs, (3) providing advanced stormwater treatment if necessary, (4) funding independent third party oversight of construction erosion control and stormwater management and compliance. These actions will minimize erosion and will trap mobilized settleable sediment on-site, preventing it from reaching the streams. Dewatering water is anticipated to have low solids concentration and low turbidity. For dewatering discharge, water quality standards will be met and discharge will be controlled so as not to cause erosion. Furthermore, project runoff and dewatering discharge will be insignificant relative to flow in the Green River. Once constructed, the wetland will act as a sediment trap and provide minor water quality benefits for this parameter. Given the timing, nature and location of the project, the risk of ecologically significant discharges of sediment is low. With no increase in impervious surface, construction of the new water tower will not increase sedimentation.
Chemical and Nutrients	X			During construction, the Port will implement a spill control and countermeasures plan to minimize the potential of spills or spilled pollutants reaching surface waters. Fertilizers may be used during planting operations, but limited temporary applications in small quantities to enhance plant growth and prevent excess nutrients in runoff. Once constructed, the wetland will trap sediment, as well as chemicals and nutrients that absorb to sediment, providing a water quality benefit. Certain weeds such as reed canarygrass (*Phalaris arundinacae*), Japanese knotweed (*Polygonum cuspidatum*), or Himalayan blackberry (*Rubus discolor*) may require control on mitigation sites to enhance the survival of native vegetation. Control could include the use of herbicides, but herbicide applications would not be made at any location where standing water is present. Herbicide applications would be made by a licensed herbicide applicator to properly apply the herbicides in areas specified by a wetland ecologist. If herbicides are used to control invasive plants, their use will be temporary and applied according to EPA application rates and recommendations. Several potential herbicides may be used. According to the 1999 Water Quality Permit to WSDA from Ecology, Rodeo® (glyphosate with a surfactant) or 2,4-D amine (under certain circumstances) are two herbicides that have approved for use in aquatic environments, including wetlands. Rodeo® is a herbicide with short environmental persistence and is non toxic to fish (Bluegill and trout) and aquatic invertebrates (*Daphnia*) at required application rates. Other herbicides such as Garlon® may be used in

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Table 9-4. Effects of constructing wetland habitat mitigation adjacent to the Green River and constructing the new water tower (continued).

Pathways: Indicators	Effects of the Action(s): Restore	Maintain	Degrade	Explanation
				upland areas to control additional noxious weeds such as Himalayan blackberry. Due to the low toxicity, the relatively small areas where herbicides may be applied, the application in terrestrial areas during the dry summer months, and short residence time, adverse affect on listed salmon or the aquatic environment would not occur.
Habitat Access:				
Physical Barriers		X		No change to baseline condition. The project will not establish new barriers affecting fish access.
Habitat Elements:				
Substrate		X		No change to baseline condition.
Large Woody Debris		X		No change to baseline condition.
Pool Frequency		X		No change to baseline condition.
Pool Quality		X		No change to baseline condition.
Off-channel Habitat	X			The project will support off-channel habitat in downstream drainage channels.
Refugia	X			The project will support value of downstream ditches as refugia.
Channel Condition /Dynamics				
Width/Depth Ratio		X		No change to baseline condition.
Stream Bank Condition		X		No change to baseline condition.
Floodplain Connectivity	X			The wetland mitigation will be connected to the 100-year floodplain.

Table 9-4. Effects of constructing wetland habitat mitigation adjacent to the Green River and constructing the new water tower (continued).

Pathways:	Effects of the Action(s)			
Indicators	Restore	Maintain	Degrade	Explanation
Flow/Hydrology				
Peak/Base Flows		X		No change to baseline condition.
Drainage Network		X		No change to baseline condition.
Watershed Conditions				
Impervious Surface		X		Impervious surface lacking stormwater treatment has altered natural flow regime. No change to baseline condition.
Disturbance History	X			Agriculture and urban development have created significant disturbances in the watershed. The project will preserve 67 ac of land from potential future development.
Riparian Reserves	X			Limited riparian habitat is present or preserved. The project will result in restoration and preservation of 67 ac of riparian wetland and upland habitat. The project will support off-channel riparian habitat that occurs downstream in drainage channels connected to the Green River.

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Since no new impervious surface will be created, baseline runoff and water quality conditions will not change. However, the 2.5-acre site is part of the STIA-MPU are that will be retrofitted with water quality and water quantity BMPs (to occur in conjunction with redevelopment of larger portions of the northeast area of the airfield). Implementation of construction BMPs and no change in impervious surface assures that the project will have "no effect" on chinook salmon that may occur in creek estuaries more than 5 miles from the project site.

9.1.3 Inter-related and Interdependent

As explained in Section 3.2, the projects included in the MPU Actions (see Table 3-1 and Section 3.1) include all inter-related and interdependent actions associated with the Master Plan Update. Therefore, all effects from interdependent and inter-related actions have been discussed above. Environmental mitigation, utility improvements, transportation improvements, etc. needed to permit or support MPU actions have been described and evaluated above. MPU projects associated with the proposed action are necessary to accommodate existing and future air transportation needs of the region. These needs are largely generated by past and ongoing economic growth in the Puget Sound region, including the increased use of air travel by the public. Airport expansion is largely reactive and not anticipated to induce growth and generate cumulative impacts that would not already occur for other socio-economic reasons.

9.1.4 Cumulative Effects

Under ESA, cumulative effects are those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation [50 CFR 402.02]. For the STIA MPU action areas, these actions could include development of residential and commercial properties on private or airport property, improvement of local transportation systems, development of property for local government infrastructure, installation of the fuel hydrant system[62], etc. Projects that receive federal funding or require federal permits are not considered in this section since they must be reviewed independently under ESA. Since it is unlikely that significant projects will be developed near chinook salmon habitat (i.e., the small estuaries at the mouths of Miller or Des Moines creeks), the potential pathways affecting chinook salmon are indirect through changes in stormwater hydrology and water quality in the upper portions of the watersheds.

Cumulative direct and indirect impacts to chinook salmon freshwater habitat will not occur from other development projects in the basins because freshwater habitat for the species does not occur in the Miller and Des Moines creek watersheds. Since future development (including potential redevelopment of borrow or acquisition areas) will comply with existing or emerging standards required to protect and improve the environment (stream habitat, water quality, stormwater quantity) for salmon species, habitat in these creeks should improve. These standards should protect water quality, stream hydrologic conditions, stream habitat conditions, riparian buffers, and

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[62] The fuel hydrant system is an underground piped fuel distribution system designed to transport aviation fuel from storage facilities to aircraft gates and is intended to replace the use of refueling trucks.

wetlands. Protection of habitat and water quality in the streams will eliminate significant downstream effects to estuarine areas at the creek outlets.

Other potential projects in the vicinity of the off-site wetland mitigation project in Auburn could affect chinook critical habitat in the Green River. These include a proposed trail, improvements to 277[th] Street, and development of private property to commercial or residential uses (these projects are presumed to be associated with federal actions associated with federal funding, wetland impacts, and/or floodplain alterations and should not be considered in cumulative impacts analysis in the BA). The trail project is proposed on county property in the riparian buffer of the Green River. Development of the trail project could reduce the restoration potential of the riparian area; in particular, the trail could restrict the ability of a restored riparian buffer to deliver wood to the Green River channel.

9.1.5 Determination

When the potential direct, indirect, and cumulative effects of the proposed STIA MPU improvements are considered, relative to all life stages of chinook salmon or their habitats in both freshwater and nearshore marine environments, in the Miller Creek, Des Moines Creek, and Green River basins, we conclude that the projects "may affect," but are "not likely to adversely affect" this species.

9.2 EFFECTS ANALYSIS FOR BULL TROUT

The effects analysis for bull trout presented here incorporates the same analysis for chinook salmon presented in Section 9.1. The analysis is summarized below.

9.2.1 Direct Effects

Bull trout are not known to occur in small creeks, such as Miller and Des Moines creeks, that drain directly to Puget Sound. They have not been found in recent creek evaluations (Batcho personal communication 1999; Des Moines Creek Basin Committee 1997). Bull trout do not reproduce or rear in these creeks on a year-round basis (Section 5.2.1 and below). Therefore, construction and operational phases of the proposed action will have no direct effects on juvenile freshwater-rearing phases of bull trout in Miller or Des Moines creeks.

9.2.2 Indirect Effects

9.2.2.1 Miller, Walker, and Des Moines Creeks

Based on evaluation of the potential for bull trout to stray or forage in Miller or Des Moines creeks (Section 5.2), the potential for indirect impacts to bull trout in the freshwater portions of the creeks is discountable. Bull trout have not been observed in these or other similar sized creeks that drain directly to Puget Sound.

9.2.2.2 Miller and Des Moines Creek Estuaries

Estuarine areas at the outlets of Miller and Des Moines creeks could potentially be used by anadromous phases of bull trout. Improvements and protection of water quality and stream habitat conditions in the streams will eliminate significant downstream effects of the projects that might occur in estuarine areas at the creek outlets.

Proposed stormwater detention facilities and base flow mitigation will prevent the potential of altered hydrology and sediment transport processes to impact the estuaries and nearshore habitat potentially used by bull trout at the mouths of Miller and Des Moines creeks. Significant changes in stream hydrology will not occur as a result of the project: therefore, there will be no hydrologic effects on the estuaries.

As discussed in Section 9.1, strict adherence to BMPs will protect these nearshore waters from downstream water quality effects during project construction phases. Stormwater treatment and riparian restoration associated with the project will improve the quality of waters discharged from Miller and Des Moines creeks. If stormwater facilities are properly maintained, no downstream effects on marine habitats are expected during project operation. Thus, the projects would not impair the potential use of the nearshore marine area by adult bull trout. We conclude that construction and operation of the project is unlikely to adversely affect bull trout that may seasonally inhabit nearshore marine waters near the outlets of Miller and Des Moines creeks as well as any adults that may stray in these creeks on an extremely infrequent basis. BMPs and other mitigations detailed earlier will maintain the current suitability of the lower reaches of these creeks and their estuaries for bull trout.

9.2.2.3 Offshore IWS Outfall

Effects from increased discharge rates of treated stormwater from the IWS outfall could potentially increase the exposure of marine organisms to treated stormwater generated by MPU projects. The outfall discharge point is between 156 and 178 ft deep and 1,800 ft offshore (MLLW). Since bull trout are not expected to forage this deep, no direct or indirect effects on bull trout are expected.

9.2.2.4 Auburn Wetland Mitigation

Potential indirect effects on habitat for bull trout in the Green River near the Auburn wetland mitigation and water tower construction projects are the same as discussed for chinook salmon. Construction and operation is unlikely to adversely effect the species or its habitat.

9.2.2.5 FAA Tower and Other Navigation Aids

As explained for chinook salmon in Section 9.1.2.5, the Airport Traffic Control Tower project will not alter baseline water quality or quantity conditions in Des Moines Creek or in the creek estuary, located over 5 miles away, where bull trout could occur. For this reason, and as a result of the extensive TESC BMPs and compliance with the existing NPDES permit, the project will have "no effect" on bull trout.

9.2.3 Cumulative Effects

Cumulative effects of projects near STIA are unlikely to effect bull trout because the species does not occur in the affected watersheds, and is unlikely to occur there in the future. Any indirect impacts associated with other projects planned in these basins will comply with existing or emerging development standards required to protect habitat for fish species. These standards will protect water quality, stream hydrologic conditions, stream habitat conditions, riparian buffers, and wetlands. With existing and emerging regulations, habitat and water quality conditions in the Miller Creek and Des Moines Creek watersheds are likely to improve or remain at their current condition, whether or not other development in the watershed occurs. No indirect or cumulative effects on bull trout are expected to result from operation of the mitigation site near the Green River.

9.2.4 Determination

Based on consideration of the various life histories and associated habitat requirements of bull trout in both freshwater and marine environments, the potential direct, indirect, interdependent inter-related, and cumulative effects of the construction and operation of the STIA Master Plan Improvement projects "may affect," but are "not likely to adversely affect" for the action area evaluated.

9.3 DETERMINATION OF EFFECTS ON ESSENTIAL FISH HABITAT

This determination of the effects of the MPU projects on EFH is made pursuant to section 305(b)(2) of the Magnuson-Stevens Act. Under this act, Federal agencies are required to consult with NMFS regarding any of their actions authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken that may "adversely affect" EFH. "Adverse effect" means any impact which reduces the quality and/or quantity of EFH, which can include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey, reduction in species' fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

Cumulative impacts are incremental impacts, occurring within a watershed or marine ecosystem context, that may result from individually minor but collectively significant actions. The assessment of cumulative impacts is intended in a generic sense to examine actions occurring within the watershed or marine ecosystem that adversely affect the ecological structure or function of EFH. The assessment should specifically consider the habitat variables that control or limit a managed species' use of a habitat. It should also consider the effects of all impacts that affect either the quantity or quality of EFH.

For any Federal action that may adversely affect EFH (except those activities covered by a General Concurrence) Federal agencies must provide NMFS with a written assessment of the effects of that action on EFH. Federal agencies may incorporate an EFH Assessment into documents prepared for other purposes such as Section 7 Biological Assessments.

An EFH assessment must contain:

- A description of the proposed action;
- An analysis of the effects, including cumulative effects, of the proposed action on EFH, the managed species, and associated species, such as major prey species, including affected life history stages;
- The Federal agency's views regarding the effects of the action on EFH; and
- Proposed mitigation, if applicable.

The earlier chapters of this document present a detailed description of the proposed action and the relevant environmental impacts associated with the MPU projects. The following sections present the analysis of effects and a determination of these effects on EFH identified under the Magnuson-Stevens Act.

9.3.1 Direct Effects

Essential fish habitat for the CPS fishery and West Coast groundfish[63] is not known to be present in small creeks, such as Miller and Des Moines creeks, as all lifestages of these fishes present in the Action Area reside in marine waters. EFH for these species will be found in the estuaries of Miller and Des Moines creeks as well as the general location of the IWS outfall.

As discussed in Section 9.1, strict adherence to BMPs will protect these nearshore waters from downstream water quality effects during project construction phases. Stormwater treatment and riparian restoration associated with the project will improve the quality of waters discharged from Miller and Des Moines Creeks. No downstream effects on EFH are expected during project operation if stormwater facilities are properly maintained. Thus, the projects would not impair potential use of EFH by these commercially managed fish. We conclude that construction and operation of the project is not likely to directly adversely any EFH in the Action Area.

9.3.2 Cumulative and Indirect Effects

Potential indirect impacts of STIA Master Plan Improvements to ESA listed species are discussed extensively elsewhere in the BA and include:

- Effects of altered hydrology and sediment transport on EFH present at the mouths of Miller and Des Moines creeks. Changes in stream hydrology will not occur as a result of the project; therefore, there will be no hydrologic effects on EFH in the estuaries.

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[63] As identified in Section 5.3.3, NMFS has not yet identified EFH for Pacific Coast Salmon. Therefore, Pacific Coast Salmon were not evaluated beyond that conducted for chinook salmon.

- Effects of altered water quality on EFH present at the mouths of Miller and Des Moines creeks. BMPs and other mitigations detailed earlier will not reduce the quality or quantity of EFH present in the estuaries of Miller and Des Moines creeks.

- Effects from increased rates of discharge of treated stormwater from the Midway Sewer District marine outfall. Increased discharge rates could potentially reduce the quality of EFH in this locality. The rapid levels of dilution achieved after discharge of effluent from this outfall will reduce chemical concentrations below any level that will reduce quality or quantity of EFH in the vicinity of the outfall.

Cumulative effects associated with the project are unlikely to affect EFH. Any cumulative or indirect impacts associated with other projects planned in these basins will comply with existing or emerging development standards required to protect habitat for fish species. These standards will protect water quality, stream hydrologic conditions, stream habitat conditions, riparian buffers, and wetlands. With existing and emerging regulations, habitat and water quality conditions in the Miller Creek and Des Moines Creek watersheds are likely to improve or remain at their current condition, whether or not other development in the watershed occurs.

9.3.3 Determination

Based on consideration of the essential fish habitat requirements of coastal pelagic species fishery and West Coast groundfish, the potential direct, indirect, and cumulative effects of the construction and operation of the STIA Master Plan Improvement projects are "not likely to adversely affect" any identified EFH for the action area evaluated.

9.4 MARBLED MURRELETS

Overall, marbled murrelet abundance is relatively low in the Puget Sound. There are no estimates of marbled murrelet use in Puget Sound in the vicinity of STIA, although there are anecdotal observations showing that they occasionally occur in low numbers. The closest WDFW reported sightings of marbled murrelets in the STIA project area are from Quartermaster Harbor 5 miles southwest of the mouth of Miller Creek. Although WDFW is aware of other sightings near the mouth of Des Moines Creek, WDFW suspects that the occurrences are very rare. The primary activity that would bring marbled murrelets to the project area would be foraging for small fish in nearshore waters.

9.4.1 Direct Effects

Implementation of STIA MPU projects could potentially affect marbled murrelets in three ways: (1) disturbance of marine birds during construction, (2) alteration of nearshore foraging habitat from increased changes in sediment and/or water quality from changes in airport runoff to Miller and Des Moines creeks, and (3) increased chance of bird strike to breeding marbled murrelets traveling between inland nesting areas and marine foraging sites. The Auburn wetland mitigation site is too far from murrelet nesting (in the Cascades) and foraging areas (in Puget Sound) for activities at this site to affect these nesting and foraging birds. Potential disturbance to traveling birds during wetland construction will be avoided given that murrelets travel between foraging and nesting sites during the early dawn hours when construction equipment would not be operating.

The nearest any STIA-associated construction activity is to marine waters (potential marbled murrelet foraging habitat) is nearly 1.5 miles. This is five times the distance at which the USFWS regulates construction activities for other sensitive threatened species (i.e., bald eagles). Consequently, it is highly unlikely that foraging marbled murrelets would be directly affected by construction activities. Degradation of the nearshore foraging zone is also unlikely. Changes in creek water quality would likely be insignificant in the nearshore areas where marbled murrelets forage, but these improvements should maintain existing conditions for foraging murrelets.

9.4.2 Indirect and Cumulative Effects

The potential for a marbled murrelet strike from increased aircraft activity is extremely remote. The presence of marbled murrelets in the marine waters near STIA is very low. No marbled murrelets have been reported to have been struck by aircraft at STIA. While bird-aircraft strikes are of significant safety concern to the Port and FAA, their relative frequency suggest the probability of including individuals from the small population of marbled murrelets is insignificant. There is no evidence of murrelet flight routes that would cross the aircraft approach/departure zones. There is better evidence that these birds follow river courses to inland nest sites.

9.4.3 Determination

Based on the rarity of marbled murrelets in marine waters near STIA, the lack of breeding pairs in the action area, the distance between STIA and Puget Sound, the water quality benefits to be derived from the MPU project improvements, and the remote probability of an aircraft striking a murrelet, we conclude that under the range of normally expected circumstances, the project will have "no effect"[64] on the marbled murrelet or its critical habitat. In certain unlikely circumstances, the project "may affect" the species, but will not adversely affect this species or its critical habitat.

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[64] This "no effect" determination is consistent with "may effect, not likely to adversely affect" determination made for listed fish species because, as shown in Section 7, sedimentation and hydrologic conditions at the creek mouths will not change from baseline conditions. Implementation of construction BMPs, operational BMPs, retrofitting, and other mitigation would improve water quality in the estuaries. The potential short term impacts to water quality (i.e. during infrequent storm events) that may effect listed fish species, would have "no effect" on marbled murrelets who forage several hundred feet offshore (U.S.FWS 1996). In this location, the tremendous dilution of creek water with Puget Sound would result in no change to baseline conditions in murrelet foraging habitat. Murrelets have not been observed in the action area during the breeding season since 1990, and thus, it is very unlikey breeding birds traveling to nest sites would cross the air port where they could be subject to airstrike. Wintering birds are very unlikely to fly east across flight paths as they do not visit nest sites, and move north-south along shore.

9.5 BALD EAGLE

As was presented in Section 6.1, the Shapiro BA (1995), which the USFWS concurred with December 6, 1995, concluded that the MPU projects as described then were "not likely to adversely" bald eagles in the Action Area (presented in Appendix B). The current design of the MPU projects is unchanged from that evaluated in 1995, other than the addition of new off-site and on-site wetland and riparian mitigation. Similarly, bald eagle use of the project area is unchanged since 1995. Therefore these earlier conclusions concerning the effect of MPU improvements on bald eagles are still relevant. The following sections evaluate the changes in the project since 1995 and determine what the effect of the all projects will be on bald eagles.

9.5.1 Direct Effects

The evaluation presented in Section 6.1 found that there are not direct effects on bald eagles in the project area essentially due to lack of exposure of bald eagles to MPU construction activities or future STIA operations. This evaluation was based on the physical distance of bald eagle nests from the project area or the timing of when construction activities will take place relative to the use of this area by overwintering bald eagles. Similar conclusions were reached about the Auburn Wetland mitigation site concerning the distance of inactive and active nesting sites as well as the presence of overwintering bald eagles. Once the Auburn Wetland mitigation site has been completed, it is likely to have a beneficial effect on bald eagles by providing improved habitat for bald eagle prey.

9.5.2 Indirect and Cumulative Effects

Increased future aircraft activities will not indirectly effect bald eagles in the action area based on the analysis presented in Section 6.1. Current flight patterns, coupled with the increasing use of quieter engines, will either maintain or improve the existing baseline environment currently used by bald eagles.

9.5.3 Determination

The implementation of the MPU projects is not expected to adversely impact local bald eagles (Shapiro 1995). This report agrees with previous assessments, that the project "may affect, not likely to adversely affect" bald eagles in the vicinity of Miller and Des Moines creeks. The overall determination for the MPU improvements project is "may affect," but is "not likely to adversely affect" bald eagles.

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APPENDIX A

AGENCY CORRESPONDENCE

United States Department of the Interior

FISH AND WILDLIFE SERVICE
North Pacific Coast Ecoregion
Western Washington Office
3704 Griffin Lane SE, Suite 102
Olympia, Washington 98501-2192
(360) 753-9440 FAX: (360) 753-9008

December 6, 1995

Julia Lisa Tims,
Wildlife Ecologist
Shapiro and Associates, Inc.
1201 Third Avenue, Suite 1700
Seattle, Washington 98101

FWS Reference: 1-3-96-I-29

Dear Ms. Tims:

This letter is in response to letters dated October 19, 1995, and November 22, 1995, transmitting the Biological Assessment in regard to the proposed construction of a new parallel runway and associated facilities at the Seattle-Tacoma International Airport as part of its Master Plan Update. The proposed new parallel runway site is located within the City of SeaTac, in King County, Washington.

Sufficient information was provided to determine the effects of this project and to conclude whether this project is likely to adversely affect the peregrine falcon and bald eagle. However, regulations implementing 50 CFR§ 402.13 of the Endangered Species Act of 1973, as amended (Act), stipulate that the U.S. Fish and Wildlife Service (Service) concurrence may be provided only to the involved federal agency which, in this case, is the Federal Aviation Administration (FAA).

To expedite the environmental review process, you may consider this project to be in compliance with the requirement of Section 7(a)(2) of the Act if the FAA agrees with your finding of "not likely to adversely affect" the peregrine falcon and bald eagle. To conclude the consultation process, we request a copy of the FAA Determination of Effect for our records. Please use the Service's reference number (1-3-96-I-29) when transmitting the correspondence requested.

This project should be reanalyzed if new information reveals that the action may affect listed species or critical habitat in a manner or to an extent not considered in this consultation; if the action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this consultation; and/or if a new species is listed or critical habitat is designated that may be affected by this project.

Your interest in endangered species is appreciated. If you have further questions about this letter or your responsibilities under the Act, please contact Jeff Haas at (360) 753-6045 or Jim Michaels of my staff at the letterhead phone/address.

Sincerely,

David C. Frederick
Supervisor

jh/jkp
SE/FAA/1-3-96-I-29

c: WDFW (Region 4) Thompson

December 14, 1995

Mr. David Frederick
U.S. Fish and Wildlife Ser
North Pacific Coast Ecoreg:
Western Washington Office
3704 Griffin Lane S.E., Suite 102
Olympia, WA 98501-2192

(Reference Number 1-3-96-I-29)

Dear Mr. Frederick:

This is in response to your letter of December 6, 1995, to Shapiro and Associates, requesting a copy of our Determination of Effect regarding the recently identified bald eagle nest near Angle Lake.

Enclosed is a copy of the Addendum to the Biological Assessment for Bald Eagles and Peregrine Falcons prepared for the Sea-Tac Airport Master Plan Update. The FAA, in cooperation with the Port of Seattle, has determined that the proposed action is "not likely to adversely affect" the recently identified bald eagle nest near Angle Lake.

Thank you for your expeditious review and concurrence with this determination.

Sincerely,

ORIGINAL SIGNED BY DENNIS OSSENKOP

Dennis Ossenkop
Environmental Protection Specialist

cc: Barbara Hinkle, Port of Seattle
Mary Vigilante, Synergy Consultants, Inc.
Julia Tims, Shapiro and Associates, Inc.

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FILE: SEATAC

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
HABITAT PROGRAM/OLYMPIA FIELD OFFICE
510 Desmond Drive SE/Suite 103
LACEY, WASHINGTON 98503

September 9, 1999

Shanon Harris
Parametrix, Inc.
5808 Lake Washington Blvd. N.E., Suite 200
Kirkland, Washington 98033-7350

Re: Species List Request for Seattle-Tacoma International Airport Master Plan Update

Dear Ms. Harris:

The National Marine Fisheries Service (NMFS) has received your May 27, 1999 letter requesting a list of threatened and endangered species that could occur in the vicinity of the Seattle-Tacoma International Airport. Enclosed is a statewide list of those anadromous fish species that are listed as threatened or endangered, those that are proposed for listing, and those that are candidates for listing under the Endangered Species Act (ESA). This inventory only includes those anadromous species under NMFS' jurisdiction. The U.S. Fish and Wildlife Service should be consulted regarding the presence of species falling under their jurisdiction.

Please note that our agency does not have site specific information for listed species, which may be available from local, state or tribal biologists. To expedite future species list requests, the NMFS intends to make the attached tables available at a convenient website: www.nwr.noaa.gov.

Presently, Puget Sound chinook (*O. tshawytscha*), is listed as threatened and may occur near the project area. Proposed critical habitat for chinook may include the project area (March 9, 1998; 63 FR 11482). Puget Sound coho salmon (*O. kisutch*) is a candidate species for listing and may also occur near the project area.

Thank you for your inquiry for information pertaining to federally listed threatened and endangered species. Should you require additional information, please contact DeeAnn Kirkpatrick at (206) 526-4452.

Sincerely,

Matthew W. Longenbaugh
Western Washington Team Leader

Enclosure

AR 044904

ESA STATUS - WASHINGTON STATE ANADROMOUS SALMONIDS - APRIL 1999

Species	(E=endangered, T=threatened, Date is for FR publication)		
	Listed	Proposed	Candidate
Coho (Oncorhynchus kisutch)	None	None	1) Puget Snd/St. of Georgia (7/95) 2) SW WA/L. Col. R. (7/95)
Steelhead (O. mykiss)	1) Upper Col. R. (E - 8/97) 2) Snake R. (T - 8/97) 3) Lower Col. R. (T - 3/98) 4) Middle Col. R. (T - 3/99)	None	None
Chum (O. keta)	1) Hood Canal Summer (T-3/99) 2) Columbia River (T-3/99)	None	None
Chinook (O. tshawytscha)	1) Snake R. fall (T - 4/92) 2) Snake R. spg/smmr (T - 4/92) 3) Upper Col. R. Spring (E - 3/99) 4) Puget Sound (T - 3/99) 5) Lower Col. R. (T-3/99)	None	None
Sockeye (O. nerka)	1) Snake R. (E - 11/91) 2) Ozette Lake (T - 3/99)	None	None
Pink (O. gorbuscha)	None	None	None
Sea-run Cutthroat (O. clarki clarki)	None	1) SW Wash/Col River (T-4/99)	None

NOTE: Listing rules announced on 3/24-25/99 will become effective 60 days after Federal Register publishing.

AR 044905

United States Department of the Interior

FISH AND WILDLIFE SERVICE
North Pacific Coast Ecoregion
Western Washington Office
510 Desmond Drive SE, Suite 102
Lacey, Washington 98503
Phone: (360) 753-9440 Fax: (360) 753-9518

JUN 2 3 1999

Dear Species List Requester:

You have requested a list of listed and proposed threatened and endangered species, candidate species, and species of concern (Attachment A) that may be present within the area of your proposed project. This response fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act of 1973, as amended (Act). We have also enclosed a copy of the requirements for Federal agency compliance under the Act (Attachment B).

Should the Federal agency determine that a listed species is likely to be affected (adversely or beneficially) by the project, you should request section 7 consultation through this office. If the Federal agency determines that the proposed action is "not likely to adversely affect" a listed species, you should request Service concurrence with that determination through the informal consultation process. Even if there is a "no effect" situation, we would appreciate receiving a copy for our information.

Both listed and proposed species may occur in the vicinity of the project. Therefore, pursuant to the regulations implementing the Act, impacts to both listed and proposed species must be considered by the Federal agency in a Biological Assessment (BA) (Attachment B for more information on preparing BAs). Formal conference with the Service is required by the Act if the federal agency determines that the proposed action is likely to jeopardize the continued existence of a proposed species, or result in the destruction or adverse modification of proposed critical habitat. The results of the BA will determine if conferencing is required. If the species is ultimately listed, your agency may be required to reinitiate consultation.

Species of concern are those species whose conservation standing is of concern to the Service, but for which further status information is still needed. Conservation measures for species of concern are voluntary, but recommended. Protection provided to these species now may preclude possible listing in the future.

There may be other Federally listed species that may occur in the vicinity of your project which are under the jurisdiction of the National Marine Fisheries Service (NMFS). Please contact NMFS at (360) 753-9530 to request a species list.

In addition, please be advised that Federal and state regulations may require permits in areas where wetlands are identified. You should contact the Seattle District of the U.S. Army Corps of Engineers for Federal permit requirements and the Washington State Department of Ecology for State permit requirements.

Your interest in endangered species is appreciated. If you have additional questions regarding your responsibilities under the Act, please contact Bobbi Barrera at (360) 753-6048, or John Grettenberger of this office, at the letterhead phone/address.

Sincerely,

Gerry A. Jackson
Supervisor

BB/JKO
Enclosure(s)

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AR 044907

ATTACHMENT A

June 9, 1999

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES, CANDIDATE SPECIES AND SPECIES OF CONCERN WHICH MAY OCCUR WITHIN THE VICINITY OF THE PROPOSED SEATTLE-TACOMA INTERNATIONAL AIRPORT MASTER PLAN UPDATE IN KING COUNTY, WASHINGTON

(T22N R04E S04,05,09;T23N R04E S20,21,28,29,32,33)

FWS REF: 1-3-99-SP-0744

LISTED

Bald eagle (*Haliaeetus leucocephalus*) - There is one bald eagle nesting territory located in the vicinity of the project at T23N R04E S34. Nesting activities occur from January 1 through August 15.

Wintering bald eagles may occur in the vicinity of the project. Wintering activities occur from October 31 through March 31.

Major concerns that should be addressed in your biological assessment of the project impacts to listed species are:

1. Level of use of the project area by listed species.
2. Effect of the project on listed species' primary food stocks, prey species, and foraging areas in all areas influenced by the project.
3. Impacts from project construction (i.e., habitat loss, increased noise levels, increased human activity) which may result in disturbance to listed species and/or their avoidance of the project area.

PROPOSED

Bull trout (*Salvelinus confluentus*) - Coastal/Puget Sound population may occur in the vicinity of the project.

CANDIDATE

None.

SPECIES OF CONCERN

The following species of concern may occur in the vicinity of the project:

Long-eared myotis (*Myotis evotis*)
Long-legged myotis (*Myotis volans*)
Pacific lamprey (*Lampetra tridentata*)
Pacific Townsend's big-eared bat (*Corynorhinus townsendii townsendii*)
River lamprey (*Lampetra ayresi*)

letter5

ATTACHMENT B

FEDERAL AGENCIES' RESPONSIBILITIES UNDER SECTIONS 7(a) AND 7(c) OF THE ENDANGERED SPECIES ACT OF 1973, AS AMENDED

SECTION 7(a) - Consultation/Conference

Requires:

1. Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species;

2. Consultation with FWS when a federal action may affect a listed endangered or threatened species to ensure that any action authorized, funded, or carried out by a federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The process is initiated by the federal agency after it has determined if its action may affect (adversely or beneficially) a listed species; and

3. Conference with FWS when a federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or an adverse modification of proposed critical habitat.

SECTION 7(c) - Biological Assessment for Construction Projects *

Requires federal agencies or their designees to prepare a Biological Assessment (BA) for construction projects only. The purpose of the BA is to identify any proposed and/or listed species which is/are likely to be affected by a construction project. The process is initiated by a federal agency in requesting a list of proposed and listed threatened and endangered species (list attached). The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the species list, please verify the accuracy of the list with the Service. No irreversible commitment of resources is to be made during the BA process which would result in violation of the requirements under Section 7(a) of the Act. Planning, design, and administrative actions may be taken; however, no construction may begin.

To complete the BA, your agency or its designee should: (1) conduct an onsite inspection of the area to be affected by the proposal, which may include a detailed survey of the area to determine if the species is present and whether suitable habitat exists for either expanding the existing population or potential reintroduction of the species; (2) review literature and scientific data to determine species distribution, habitat needs, and other biological requirements; (3) interview experts including those within the FWS, National Marine Fisheries Service, state conservation department, universities, and others who may have data not yet published in scientific literature; (4) review and analyze the effects of the proposal on the species in terms of individuals and populations, including consideration of cumulative effects of the proposal on the species and its habitat; (5) analyze alternative actions that may provide conservation measures; and (6) prepare a report documenting the results, including a discussion of study methods used, any problems encountered, and other relevant information. Upon completion, the report should be forwarded to our Endangered Species Division, 510 Desmond Drive SE, Suite 102, Lacey, WA 98503-1273.

______* "Construction project" means any major federal action which significantly affects the quality of the human environment (requiring an EIS), designed primarily to result in the building or erection of human-made structures such as dams, buildings, roads, pipelines, channels, and the like. This includes federal action such as permits, grants, licenses, or other forms of federal authorization or approval which may result in construction.

Appendix B

APPENDIX B

1995 BIOLOGICAL ASSESSMENT
APPENDIX K FROM
SEA-TAC AIRPORT MASTER PLAN UPDATE FINAL EIS

Appendix K
Sea-Tac Airport Master Plan Update Final EIS

BIOLOGICAL ASSESSMENT

Prepared for:

Port of Seattle
and
Federal Aviation Administration

Prepared by:
Shapiro and Associates, Inc.
1201 Third Avenue, Suite 1700
Seattle, Washington 98101

April 1995

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AR 044915

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(1) INTRODUCTION

The Port of Seattle (POS) has proposed construction of a new parallel runway and associated facilities at the Seattle-Tacoma International Airport (Airport) as part of its Master Plan Update. The proposed new parallel runway site, which is shown in Exhibit 1, is located in the City of SeaTac in King County, Washington and encompasses the Airport.

Section 7 of the federal Endangered Species Act of 1973 (as amended) requires an analysis of the effects of any major construction project involving a federal nexus on any federally listed or proposed threatened or endangered species that may use the project area. An analysis of effects of a proposed project on candidate species is not required under the Endangered Species Act: however, in this case, it is advised because of the possibility that federal listing may occur for candidate species in the future, pending status reviews.

If a federally listed or proposed threatened or endangered species is known to use a proposed project area, a Biological Assessment (BA) must be prepared. The BA must evaluate the potential effect of the proposed action on threatened and endangered species. The conclusions of the BA are used to determine if formal consultation with the United States Fish and Wildlife Service (USFWS) is required, at which point conservation recommendations can be developed for the protection of the affected species.

Consultation with USFWS revealed use of the project area by the bald eagle (*Haliaeetus leucocephalus*) , a federally listed threatened species in Washington, and the peregrine falcon (*Falco peregrinus*), a federally listed endangered species (USFWS, 1994). Candidate species listed by USFWS that could potentially occur in the project area include bull trout (*Salvelinus confluentus*), mountain quail (*Oreortyx pictus*), northern red-legged frog (*Rana aurora*), northwestern pond turtle (*Clemmys marmorata*), and spotted frog (*Rana pretiosa*) (USFWS, 1994).

Breeding and wintering populations of bald eagles and migrant peregrine falcons may utilize portions of the project area for foraging and perch sites. No breeding sites for either species occurs in the project area. An active bald eagle nest located near Seahurst Park, approximately 2 miles northwest of the Airport, is the closest known activity center to the project site (WDFW, 1994). This nest does not fall within the boundaries of the project footprint: however, utilization of the project area by the nest occupants, as well as use by transient individuals, is largely unknown. Studies conducted for this report provide information on bald eagle and peregrine falcon use of the project area and surrounding vicinity (study area). This information, correlated with data on existing and predicted future noise levels in the project area, provides the basis for an analysis of the effects of the proposed project on breeding and wintering bald eagles and peregrine falcons.

This report describes eagle and falcon use in the project vicinity and evaluates potential impacts of the proposed project alternatives on these species. The study area encompasses the area along the Puget Sound shoreline, from approximately 4 miles north to approximately 7 miles south of the active bald eagle nest. The parameters of the study area were chosen to adequately evaluate eagle and falcon use of the project vicinity and nearby habitat features.

Effects on candidate species potentially occurring in the project area and the surrounding vicinity were also evaluated for this report.

(2) OBJECTIVES

The objectives of this report are to:

1) Review existing information on bald eagle and peregrine falcon use of the proposed project site and surrounding vicinity;

2) Describe the methods and materials that were used to collect and analyze data on bald eagles and peregrine falcons in the study area during December 1994 and January 1995.

3) Describe the methods used in conducting the habitat assessment for candidate species potentially occurring in the project area;

4) Present results of the field study in narrative form with tables, maps, and figures and provide a discussion of wintering bald eagle and peregrine falcon use of the study area and potential use of the area by candidate species;

5) Provide a discussion on the possible effects of the proposed project to bald eagles, peregrine falcons, and any candidate species based on the data collected during the field study and a review of the literature;

6) Provide recommendations to minimize any effect of the proposed project on bald eagles, peregrine falcons, and any candidate species;

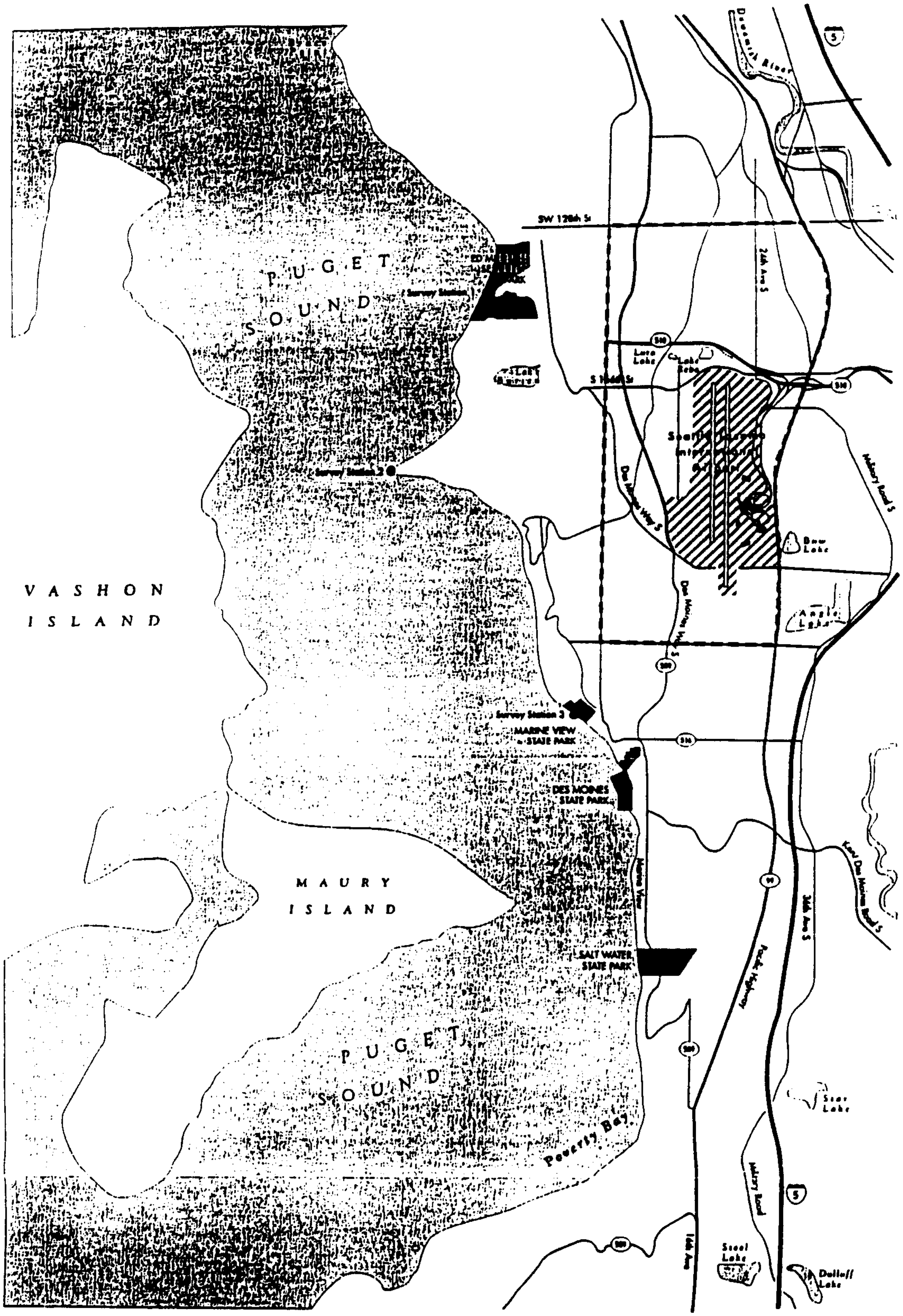
7) Provide a conclusion of the effects of the proposed project to all listed and candidate species.

(3) EXISTING DATA

B eagles and peregrine falcons are attracted to Puget Sound during winter because of its abundant fisheries resources and high density of wintering waterfowl. Eagles and falcons are opportunistic feeders in winter and fish and waterfowl provide a valuable food source (Steenhof, 1978). The mild winter climate also allows them to spend less energy maintaining body temperature and performing routine activities. These factors, and the availability of perch and roost sites, make Puget Sound a potential wintering area.

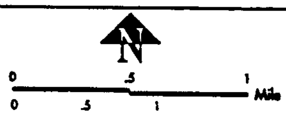
(A) Bald Eagles

Resident and wintering bald eagles are known to use sites throughout Puget Sound and Poverty Bay. During the winter, fish and large numbers of waterfowl provide ample foraging opportunities for eagles in the study area. USFWS (1994) and Washington Department of Fish and Wildlife (WDFW) (formerly Washington Department of Wildlife (WDW)) data (1994) indicate that bald eagles potentially use the project area for foraging. In addition, two bald eagle nest sites are located within 6 miles of the proposed project area (Exhibit 2) (WDFW, 1994). The closest nest, number 611, is located approximately 0.25 mile south of Seahurst Park. This nest is approximately 2 miles west of the project boundary and approximately 2.5 miles from the principal activity areas of the Airport. It has been active since 1993. Because of its proximity to the proposed project site, this nest, and surrounding areas along the Puget Sound shoreline, are the focus of this study. The next closest bald eagle nest to the project site (nest number 316) is located in Poverty Bay approximately 6 miles southwest of the Airport. This nest has not been active since 1992; however, a pair of eagles still occupies this territory. It is possible that another unidentified nest is located in this area (Taylor, 1995). Project-related activities would not affect this nest because of its distance from the project site. Table 1 shows the productivity of the eagle nests that are within six miles of the proposed project boundary.



AR 044919

EXHIBIT 1

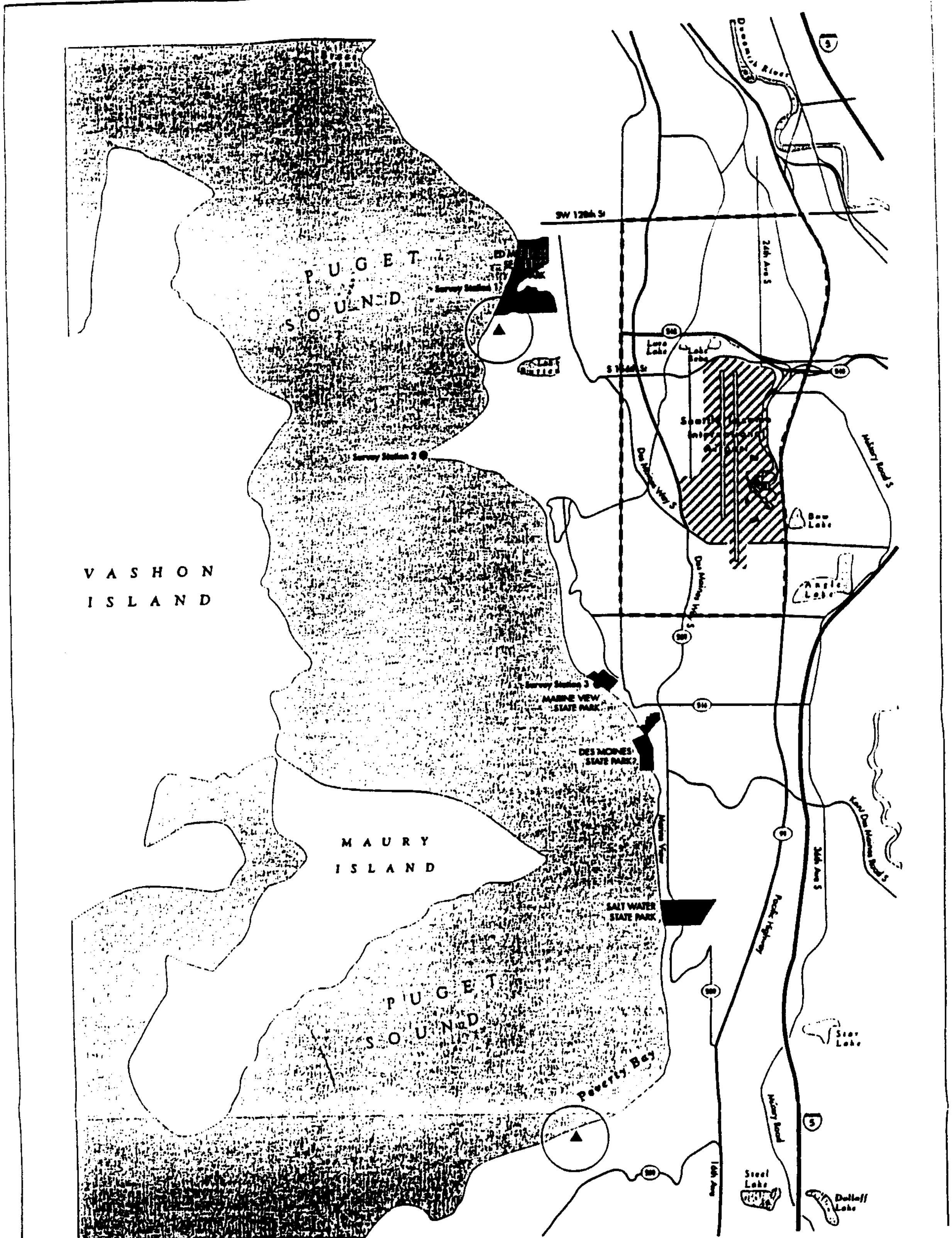


Legend
- Site Location
- Project Area Boundary
- Active Nest

SHAPIRO & ASSOCIATES, INC.

STUDY AREA MAP

SEA-TAC AIRPORT
MPU BIOLOGICAL ASSESSMENT



AR 044920

0 .5 1 Mile
0 .5 1 Kilometer

Legend
▲ Bald Eagle Nest Site
— — — Project Area Boundary

EXHIBIT 2

LOCATION OF BALD EAGLE NESTS WITHIN SIX MILES OF PROJECT AREA

SEA-TAC AIRPORT
MPU BIOLOGICAL ASSESSMENT

SHAPIRO & ASSOCIATES, INC.

WDW and Audubon Christmas Bird Count data indicate that small numbers of bald eagles inhabit King County during the winter. Table 2 shows the number of eagles that have been counted since 1986 in King County during the annual mid-winter bald eagle census. The number of eagles within the county varies from year to year and has steadily increased since 1986. 1989 was the last year of the WDW mid-winter bald eagle census, and the annual Audubon Christmas Bird Count data are the main source of information on wintering eagles in King County from 1990-present. Table 3 shows the number of eagles that have been counted since 1988 in King County during the annual Audubon Christmas Bird Count. Data from the 1994 Christmas Bird Count is not yet available.

Data trends in both censuses appear to indicate a slightly increasing winter population of bald eagles in King County, though allowances should be made for differences in survey techniques, varying weather conditions, and differences in observation accuracy. If wintering bald eagle populations are increasing in King County some habitats that support wintering eagles may be reaching a carrying capacity limit. The developed nature of shoreline areas in King County and the limited available habitat drastically reduces the potential carrying capacity of the area. Because of the increasing eagle numbers, and due to continuing development pressures, suitable bald eagle wintering habitat in King County is very limited.

TABLE 1

PRODUCTIVITY OF BAD EAGLE NESTS WITHIN FIVE MILES OF THE PROPOSED PROJECT SITE.*

Nest No.	1992	1993	1994
611	ND	ND	1**
316	1	U	U

* Numbers indicate fledged young.
** Egg shell found below nest. WDFW assumes 1 young produced, however no verified productivity information is available.
ND - No data available
U - Unoccupied nest

Source: Bernatowitz, 1994.

TABLE 2

TOTAL NUMBER OF BALD EAGLES OBSERVED IN KING COUNTY DURING THE ANNUAL MID-WINTER BALD EAGLE SURVEY

Year	Count
1986	33
1987	24
1988	32
1989	30

Source: Taylor, 1986-1989.

TABLE 3

TOTAL NUMBER OF BALD EAGLES OBSERVED IN KING COUNTY DURING THE ANNUAL AUDUBON CHRISTMAS BIRD COUNT

Year	Count
1988	28
1989	26
1990	30
1991	31
1992	33
1993	32

Source: American Birds, 1988-1994.

Incidental observations verify the use of the project area by adult and juvenile bald eagles. Local residents frequently observe adult eagles foraging and perching in the study area. Juvenile eagles are occasionally observed flying through the study area; however, no observations of foraging activity or perching by immatures have been made (Branson, 1995; Novak, 1995). Though these observations do provide additional information that verifies both immature and mature bald eagle use of the project area, they do not provide detailed data on age ratios or the seasonal use of the project area by eagles.

Large numbers of waterfowl and fish use Puget Sound for wintering and as a migratory corridor and provide a year-round food source for bald eagles. Gulls are common in the study area and potentially nest on nearby private beaches. Public beaches such as the ones at Seahurst Park and Marine View State Park are exposed to considerable amounts of disturbance from humans and domestic pets. This disturbance limits use of these areas for breeding by gulls. However, some of the more isolated beaches on privately owned property in the vicinity may provide some breeding habitat for gulls. These gull colonies may provide an additional food source for bald eagles.

The limited data suggest that the study area is important to wintering and resident bald eagles because it provides foraging habitat. In addition to the availability of prey, an important element of foraging habitat is the presence of large open areas where prey can be killed and eaten (WDW, 1991a). Bald eagles prefer sites that provide a wide visual field. Eagles also need sites that accommodate their large wingspans and need for takeoff and approach corridors. In the study area, prey can be eaten while eagles are on perches, shorelines, and beaches. Perch sites are numerous along the shoreline and suitable forested roosting sites are available. The data presented in this report are limited to observations of eagles foraging during winter; no data are available on the extent of foraging use of the study area by breeding eagles.

In summary, the mild maritime climate in the Puget Sound area and the availability of prey and nearby perch, roost, and open foraging sites in the study area provide wintering and breeding habitat for bald eagles. The project area, approximately 2 miles east of the study area, offers little habitat for wintering or breeding bald eagles. No breeding sites for eagles occur in the project area; however, eagles may forage for birds, small mammals, and fish in grasslands, wetlands, and open water areas of the project site. Wintering and resident bald eagles may occasionally forage or perch in the project area when food resources in the

Puget Sound are limited due to low salmon escapement or decreased numbers of wintering waterfowl.

(B) Peregrine Falcons

Washington contains important wintering areas for peregrine falcons that may be critical to maintaining of current population levels in Washington and adjacent British Columbia (USFWS, 1982). Intertidal mudflats and estuaries provide the most valuable wintering habitat for peregrines (Anderson and DeBruyn, 1979; WDW, 1991b). In Washington, important wintering areas are the Skagit Flats, Grays Harbor, and Willapa Bay. Wintering peregrine falcons favor forested shoreline habitats where they perch in trees along the shoreline waiting to prey on a wide range of wintering waterfowl and shorebirds. When hunting waterfowl, peregrines show a strong preference for the smaller species: teal (*Anas crecca*), wigeon (*Anas americana*), and coot (*Fulica americana*) are hunted more persistently than larger species such as mallard (*Anas platyrhynchos*) or pintail (*Anas acuta*) (Beebe, 1960). Like other raptors when in areas where waterfowl are being shot, they may be observed feeding on crippled birds. In Washington during winter, six species of waterfowl and shorebirds and five species of passerines were identified as prey items (Anderson and DeBruyn, 1979).

According to Beebe (1960), wintering peregrine falcons along the Pacific coast may be limited by parasitism by other predatory birds sharing their wintering range. Eagles and red-tailed hawks have been frequently observed stealing peregrines' prey, and eagle predation on young and adult peregrines may be moderately limiting peregrine falcon abundance (Beebe, 1960).

Evidence from band returns and sightings of peregrines has confirmed that spring and fall migration occurs along the west coast, although the extent of this movement remains largely unknown (Anderson, et al., 1986). Fall migration through Washington occurs from mid-August through mid-October (Beebe, 1960). Based on a small sample of band returns, there appear to be two general fall migration routes for peregrines in western Washington, one along the outer coast and one through the Puget Sound Basin. The two routes are separated geographically by the Olympic Mountains. In the Puget Sound basin, the largest concentrations of migrant peregrine falcons have been observed at the San Juan Islands and the Skagit Flats. Spring migration occurs from mid-March through early May along the outer coast of Washington (Anderson, et al., 1986).

In summary, wintering and migrant populations of peregrine falcons may occasionally forage or perch in habitats along Puget Sound. Peregrines are not expected to regularly use the project site due to lack of suitable habitat. Historical data suggest that the Skagit Flats, Grays Harbor, and Willapa Bay provide critical wintering areas for peregrines, and observations of this species in the study area are likely to be transient individuals using Puget Sound as a travel corridor between preferred habitats.

(C) Candidate Species

Several candidate species are listed by USFWS as potentially occurring in the project area (USFWS, 1994). These species are bull trout, mountain quail, northern red-legged frog, northwestern pond turtle, and spotted frog. Of these species, the red-legged frog is the only species likely to occur in the project area.

AR 044923

Red-legged frogs are common throughout western Washington at elevations from sea level to approximately 2,800 feet. From January through June, red-legged frogs are found in marshes, swamps, ponds, lakes, and slow-moving streams where breeding takes place. During the non-breeding season, these frogs are much more terrestrial and can be found considerable distances from water (Leonard et al., 1993). Red-legged frogs are commonly found in urbanized wetland areas similar to that of the project site. Aquatic habitats in the project area likely support breeding and overwintering populations of this species.

The historic range of the spotted frog includes portions of western Washington; although, over the past 50 years, this species has experienced a dramatic reduction in its historic range (Leonard et al., 1993). A spotted frog captured in Thurston County, Washington in 1990 is the only confirmed sighting in western Washington in over 23 years (McAllister and Leonard, 1991). Spotted frogs are highly aquatic, inhabiting wetland edges of ponds, streams, and lakes (Nussbaum et al., 1983). They are active in lowland habitats from February through October, and hibernate in muddy bottoms near their breeding sites in winter. Breeding takes place in shallow margins of ponds or in temporary pools. Reasons for the decline of the spotted frog in Washington are unclear (WDW, 1991c). Contributing factors to the decline of this species likely include habitat alteration, competition and/or predation by introduced frog species such as the bullfrog, and susceptability to toxic chemicals. Wetlands associated with aquatic resources in the project area could potentially provide habitat for spotted frogs; however, these resources have been subject to a variety of disturbances over the past several years including habitat alteration and toxic fuel spills, which likely limits use of these areas by this species.

Western pond turtles occur at elevations ranging from sea level to 5,400 feet where they inhabit marshes, sloughs, moderately deep ponds, and small lakes (WDW, 1991d). This species was once widely distributed throughout western Washington, but is now severely restricted in its range. Currently, populations in Washington are confirmed only in Klickitat and Skamania Counties (WDW, 1991d). No observations of any western pond turtles have been made in King County since 1987. Western pond turtles are highly aquatic and much about their life history remains unknown (Nussbaum et al., 1983). Generally, they inhabit waters with abundant aquatic vegetation and protected shallow areas where juveniles may rest and feed under cover. Females leave the water in late May to find nesting sites in sandy banks or shores. Basking sites, such as partially submerged logs, vegetation mats, rocks, or mud banks are a critical habitat requirement for this species (Nussbaum, et al., 1983). Aquatic habitats in the project area do not provide ample amounts of aquatic vegetation or basking sites. Due to lack of appropriate habitat, western pond turtles are not likely to occur in the project area.

Bull trout are found throughout the coastal and inland streams and lakes of Washington. Spawning occurs in the upper reaches of clear streams with uniform gravel or small cobble substrate. Juveniles and fry can be found on the bottom and slow-moving portions of streams, respectively. Adults are often found pools sheltered by large, organic debris or clean cobble substrate (WDW, 1991e). Limiting factors for bull trout include lack of spawning and rearing habitat, high sedimentation on spawning grounds, and high stream temperatures that exceed the normal spawning and incubation range (WDW, 1991e). Lack suitable habitat and degraded water quality in streams in the project area limit use by this species.

The mountain quail is found in mountainous regions at elevations up to 10,000 feet. This species typically occurs in brushy ravines and mixed woodlands at high altitudes, however many individuals descend to lower altitudes in winter to escape harsh weather conditions

(Robbins, et al., 1983). Mountain quail are not likely to inhabit the project area due to lack of suitable habitat.

(4) STUDY AREA

Bald eagles and peregrine falcons use habitats along the Puget Sound shoreline for wintering and breeding. These birds may occur as transients in the project area and occasionally forage and perch on the project site. To adequately evaluate habitat use in the vicinity of the project area, the study area for the bald eagle and peregrine falcon field surveys focused on the Puget Sound shoreline, approximately 2 miles west of the project area. The survey area encompasses over 16 miles of shoreline, extending from approximately 1 mile south of Brace Point to approximately 1 mile north of Salt Water State Park (Exhibit 1). An active bald eagle nest is located 0.25 mile south of Seahurst Park in the north central portion of the study area.

Three survey points were placed at intervals along the shoreline to facilitate maximum visual coverage of the study area. Westward visibility from all survey points ranged from 0.25 mile to 5 miles, depending on weather conditions. Vashon Island and Maury Island are located west of the study area opposite the survey stations (across Puget Sound) (Exhibit 1). On days with good visibility, shoreline areas along these islands were surveyed from Stations 2 and 3. On the landward side of the study area, vegetation, residential and commercial development, and topography limit view distances. Because of the use of the shoreline by eagles and falcons, and the existing development on the landward side of the study area, the focus of the study was on the shoreline and surrounding areas.

Land use surrounding this portion of Puget Sound is varied. Upland mixed coniferous/deciduous forest, fragmented by residential, commercial and marina-related development are the primary land use and cover types. A forested ridge lies on a north-south axis along the southwestern portion of Seahurst Park and extends approximately 1 mile southward. An active bald eagle nest is located on this ridge approximately 0.25 mile south of the park on private property.

(5) METHODS AND MATERIALS

Surveys for bald eagles and peregrine falcons were conducted twice a week from December 19, 1994, through January 27, 1995, with the exception of January 16, 1995, when no surveys were made. Previous studies in the Puget Sound area indicate that eagle and falcon use peaks in mid-winter, and the timing of this study coincides with this period.

Each survey was conducted by one biologist using a pair of 7 x 35 binoculars and a tripod-mounted 40 - 60 mm zoom spotting scope. Each survey was conducted for two hours; for a combined total of 38 survey hours during December and January. Survey start times ranged from 8 a.m. to 2 p.m. to allow surveys to be conducted during a variety of tidal conditions.

An observation blind was not used because a 360-degree view and overhead views were required for accurate data collection. Also, eagles and falcons using this area are likely habituated to the presence of humans and it was assumed that survey activities would not significantly alter the behavior of these species.

Consultation with WDFW personnel provided information on bald eagle nesting activity in the project area (Stein, 1994). Additional information on the active nest was provided by nearby residents and the owners of the property where the nest is located (Branson, 1995; Novak, 1995).

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(A) Bald Eagle Data

Bald eagle data were recorded and summarized after each observation. The study area was scanned with binoculars and the spotting scope was used to watch the activities of perching birds and allow for more detailed observation of birds far away from the survey station. Eagles were categorized as immature or mature based on plumage characteristics (Stalmaster, 1987).

Bald eagle behavior was divided into five general categories (Table 4). The number of immature and adult eagle observations for each behavior category was recorded for each survey. If an eagle exhibited more than one behavior during the survey, these were recorded as separate behavior observations.

The number of observations for each behavior category was totaled for each survey by age group. In addition, the highest number of immature eagles and the highest number of mature eagles observed at one time was recorded for each survey. This number reflects the minimum number of immature and mature eagles in the study area during the survey because it is assumed some birds may be out of view or simply missed during the observations. Because relatively few individuals were observed during each survey and no more than three individuals were ever observed at one time, the behavior and movements of each eagle were easily tracked. This method provided an accurate summary of bird behavior.

TABLE 4

BEHAVIOR CATEGORIES

Behavior Category	Associated Behavior
Perching	Perching Preening
Hunting	Eating prey Carrying prey Successful hunt Unsuccessful hunt Hunt - Outcome unknown Defending prey from other eagles Stealing prey
Other flying	Perch to perch flight Undetermined flight Soaring flight
Defense	Chasing or being chased off perch, no prey involved Chasing or being chased in air, no prey involved
Disturbance	Any discernible reaction to human activity

Source: Shapiro and Associates., Inc., 1995.

Tide elevation information was available from published tide tables that provided elevations in Puget Sound (Evergreen Pacific. 1994). An average tide elevation was assigned to each survey by dividing the difference between the tide levels at the beginning and end of each survey by the ensuing time interval. This provided an average tide elevation for each survey, which later could be compared to bald eagle activity.

Other related data that were collected included date, weather conditions, miscellaneous observations on other raptor and waterfowl species, and general notes on air and boat traffic and human activity levels.

(B) Peregrine Falcons

Data collection was similar between eagles and falcons. Peregrine falcons were identified according to subspecies and categorized as mature or immature based on plumage characteristics. When possible, sex was determined by size (Beebe, 1960; Anderson and DeBruyn, 1979).

(C) Candidate Species

A review of aerial photographs along with information provided in previous technical studies, agency reports, and natural resource inventories allowed an assessment of potential habitat for candidate species listed by USFWS. Field surveys of the project area and surrounding vicinity were conducted in November and December 1994 to verify information collected on potential use of the site by candidate species.

1. Mapping

Maps of the study area were used to describe eagle and falcon habitat use patterns. Observations were drafted on maps in the field and later summarized. Each observed bald eagle or peregrine falcon activity was recorded on field maps. Codes were used for each behavior category and a narrative description was filled out on the reverse side. The base maps used in the field are the same as those used for the final graphics.

For the purpose of clarity, bald eagle and peregrine data have been summarized separately. Specific activities have been separated and summarized for December and January.

Hunting

The location and direction of hunting flights and associated perches or eating sites were recorded. Maps that summarize hunts contain associated flights and perching or eating locations. Some hunt-related flight patterns are circular in shape and are represented on report maps by dotted circles. The number of birds participating in the hunt is represented by a small number next to the X, which is the symbol for an observed hunting location.

Perches

Perches are represented by dots or shaded areas on the report maps. A single location is represented by a dot and a cluster of perches is represented by shading.

The number of total perches is noted next to the dot or shaded area. Shaded areas are used when perch sites are in close proximity or too numerous to represent individually.

Flights

Bald eagle flight data have been summarized onto maps according to two categories of flight. Flights are either related to perching activity within the study area or are flights where an eagle did not land in the study area. Flight patterns have been summarized into vectors that represent a generalized flight direction. Arrows represent flight direction, and numbers indicate the quantity of flights represented by the vector.

A large percentage of observed short flights related to perching activity were circular or curved in shape. Other observed shorter flights also were circular or curved in shape, and were possibly related to perches not visible to field staff.

In addition to data on bald eagles and peregrine falcons, data were collected on waterfowl and shorebird use of the study area. Approximate counts of waterfowl and shorebirds in the study area were done after the completion of each survey. Weather, tide elevation, date, and species and numbers of waterfowl and shorebirds were recorded. General notes on location and behavior of waterfowl and shorebirds were made.

(6) RESULTS

While conducting surveys for bald eagles and peregrine falcons, a variety of dabbling and diving ducks were commonly observed in the study area. Pintail (*Anas acuta*), green-winged teal (*Anas crecca*), and wigeon (Anas americana) were the most commonly observed dabbling ducks in the study area. These birds favored shallow-water conditions along shoreline areas. Scaup (*Aythya* spp.), common loon (*Gavia immer*), and goldeneye (*Bucephala* spp.) were common diving ducks observed in the study area.

(A) Bald Eagles

Nineteen field surveys were completed between December 19, 1994 and January 27, 1995. Eagles were observed during eleven of the surveys. The number of bald eagles, as indicated by the maximum number of individuals observed each survey, was variable. Mature bald eagles were much more numerous than immature eagles during both December and January. A total of 18 mature bald eagle observations were recorded during the study, while only one immature eagle was observed (Exhibit 3). Bald eagle numbers reached a maximum for the study in early January. Three adult and one immature eagle represent the largest number of birds that used the study area during one survey. This occured in the vicinity of Station 1 on January 9, 1995.

Mature eagles observed in the study area spent the majority of their time perched. Non-hunting or perch-related flights were the second most frequently observed behavior for mature eagles and the only observed behavior for immatures. Hunting was the third most frequent behavior observed in adults (Exhibit 4).

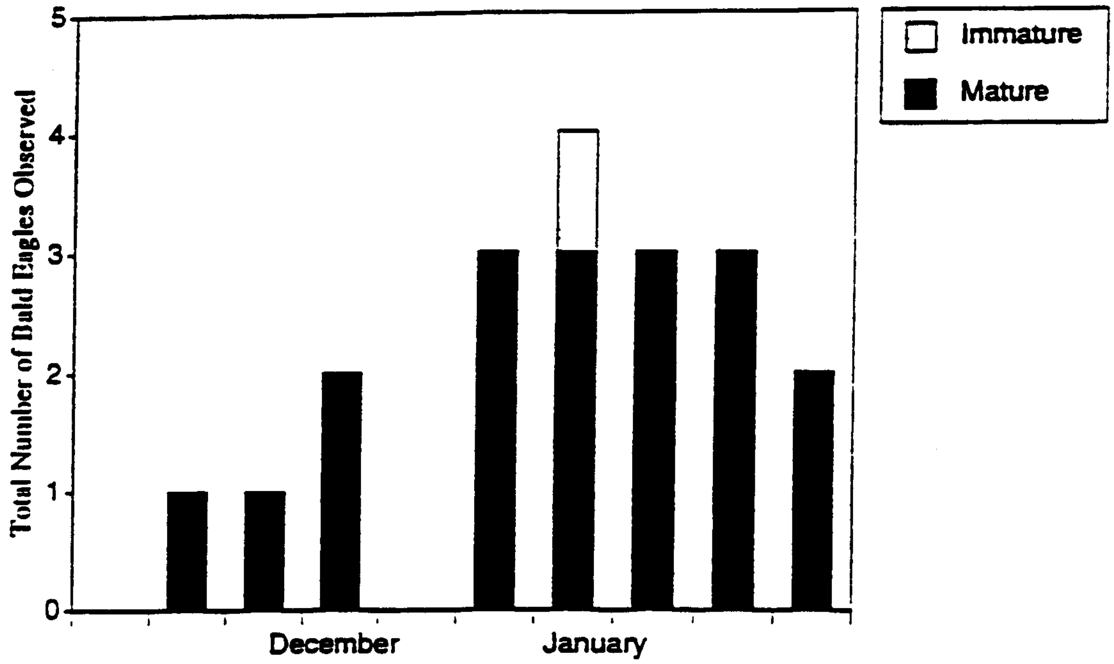


EXHIBIT 3

BALD EAGLE OBSERVATIONS
IN THE STUDY AREA
DURING DECEMBER AND JANUARY

SHAPIRO & ASSOCIATES, INC

SEA-TAC AIRPORT MPU
BIOLOGICAL ASSESSMENT

2/95

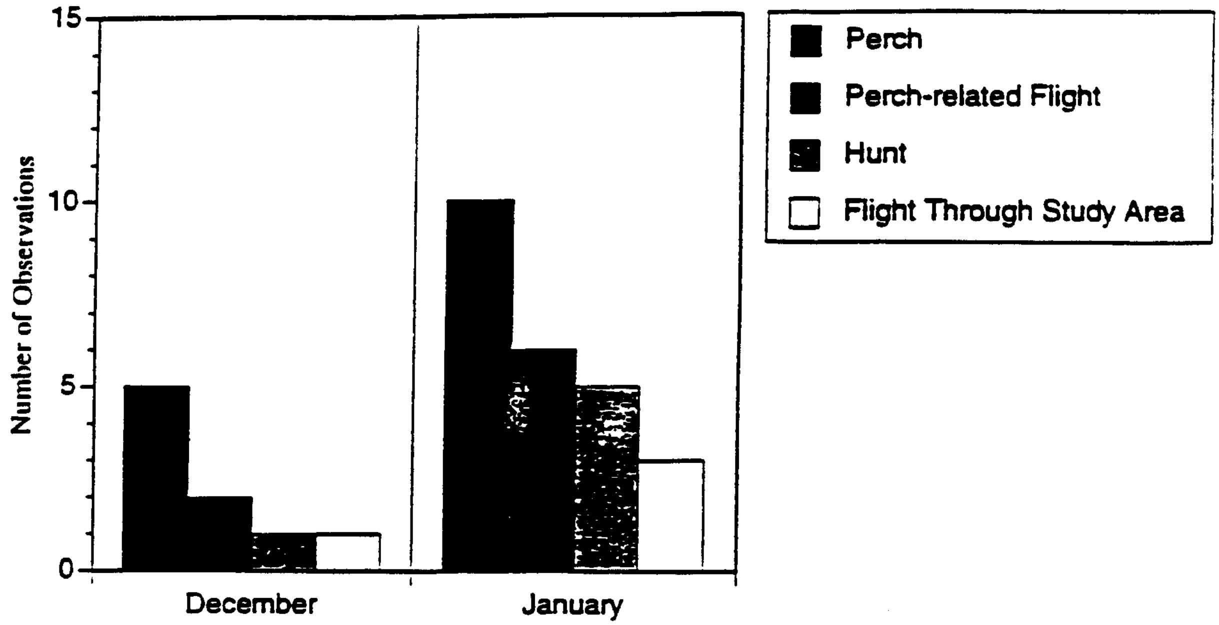


EXHIBIT 4

OBSERVED BALD EAGLE BEHAVIOR
IN THE STUDY AREA

SHAPIRO & ASSOCIATES, INC.

SEA-TAC AIRPORT MPU
BIOLOGICAL ASSESSMENT

2/95

The study area was used by perching bald eagles during both months of the study (Exhibit 5). Perching sites on the forested ridge near the active nest, forested areas adjacent to the shoreline from Seahurst Park north to Brace Point, shoreline areas on Vashon and Maury Islands, and the west-facing forested slope in Marine View State Park were used during the study. Live trees, snags, driftwood, and rocks were used as perches. Shoreline tree and snag perches also were most commonly used, especially along the forested ridge in Seahurst Park. Eagles would use one perch for up to 45 minutes or would frequently change perches.

Bald eagles were observed hunting in the study area during both December and January. Successful and unsuccessful hunts were observed where eagles either captured prey or scavenged. Waterfowl and fish were the prey that eagles captured in the study area. On two separate occasions, an adult eagle was observed scavenging a dead fish and an unidentified waterfowl on the shoreline near Seahurst Park. All of the observed hunts occurred within 1,500 feet of the shoreline. Table 5 summarizes the observed bald eagle hunting activity. Exhibit 6 illustrates the observed bald eagle hunting locations during December and January.

Eagles often flew from one perch to another within the study area or flew through the study area without perching or hunting. The flights to and from perches and through the study area are summarized into major flight patterns in Exhibits 7 and 8, respectively.

Observed flight lines of eagles did not indicate use of the project area. No eagles were observed flying to or from the vicinity of the Airport during the field study. Agency personnel and local residents occasionally observe eagles flying over Airport property, especially in the vicinity of Lake Reba; however, no observations of eagles perching or foraging on the project site were made. During a wetland survey conducted in November 1994, SHAPIRO personnel observed a mature bald eagle flying over the southern portion of the project site in a westerly direction (toward Puget Sound).

Records were made of any instances of eagles being disturbed by air traffic, boat traffic, or other human intrusions in the study area. On five occasions, aircraft approaching or departing from the Airport flew over the study area. On one instance, an adult bald eagle was perched in the northern portion of the study area area when a plane departing from the Airport flew overhead. Noise level from the plane was relatively low and the plane was barely visible because of its high altitude. The eagle had no apparent reaction to the aircraft activity. Bald eagle reactions to boat traffic varied. Large boats that travel relatively slowly are common in Puget Sound and appeared to have little or no disturbance effects to bald eagles. On one occasion, a smaller boat traveling relatively fast and close to the shoreline caused an adult eagle to flush from its perch on Vashon Island. During almost every survey humans were present in the area, doing activities such as walking or running along the beach or walking dogs. The eagles exhibited no signs of stress from human presence as long as a distance of approximately 200 meters was maintained between the person and the eagle. Once this distance was approached, the eagle would flush and often fly out of sight. On one occasion, a large dog running on the beach caused an eagle to flush from its perch. The eagle flew to another perch approximately 500 feet south.

TABLE 5

SUMMARY OF BALD EAGLE HUNTS

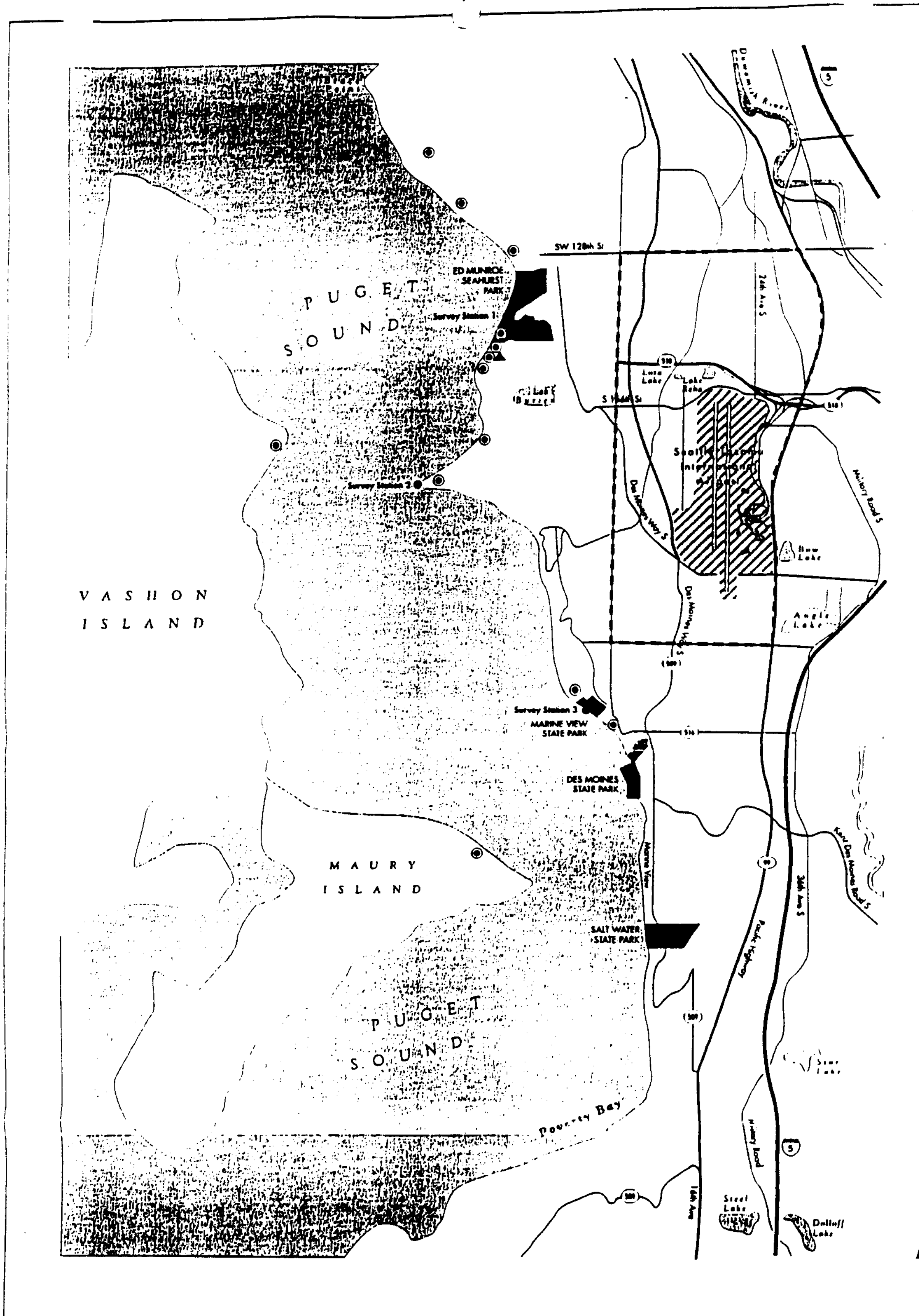
Date	Unsuccessful Type of Prey	Successful Type of Prey	Hunts of Unknown Success and Hunt-Related Activity
12/30		Scavenged unidentified waterfowl	Adult scavenged waterfowl from beach on Maury Island-possibly a scoter. Flew north out of sight with kill.
1/6	Fish		Adult attempt for fish approximately 1000 feet from shore - unsuccessful. Bird returned to perch on shoreline.
		Unidentified waterfowl	Adult attempt for duck along shoreline south of Seahurst Park - successful. Flew north out of sight with kill.
1/9		Fish	Adult successful catch - 10 inch fish. Bird flew to perch near nest tree with kill.
1/25	Unidentified waterfowl		Adult attempt for duck approximately 300 feet from shore - unsuccessful. Flew south towards Three Tree Point and out of sight.
1/2[illegible]		Scavenged unidentified fish	Adult scavenged fish from shore near Seahurst Park. Ate on shore then flew to perch on north end of park.

(B) Peregrine Falcon

A single brief peregrine falcon observation was the only sighting during the field study. On January 25, 1995 one mature peregrine falcon (*f.p. anatum*) was observed from Survey Station 1 (Exhibit 9). Sex of the individual was not determined. The falcon was observed perched in a live conifer on Vashon Island directly across from Survey Station 2. The bird was flushed from the perch by a passing eagle and flew northwest out of sight. The bird was not observed again during the remainder of the survey.

C. Candidate Species

No observations of any candidate species listed by USFWS were recorded during field studies.



AR 044933

0 .5 1 Mile

0 .5 1 Kilometer

Legend

◉ Perch Sites

— — Project Area Boundary

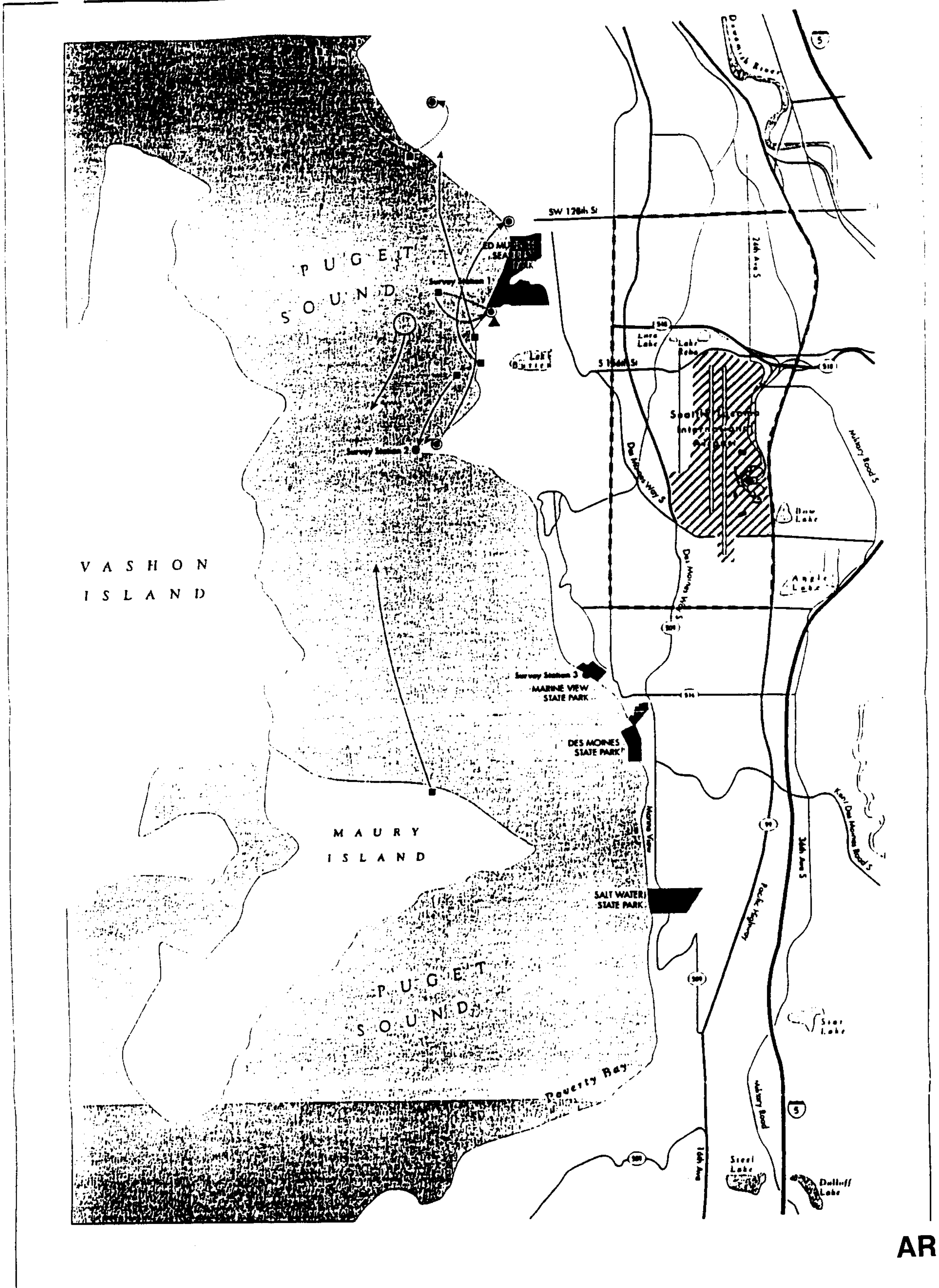
▲ Active Nest

SHAPIRO & ASSOCIATES, INC.

EXHIBIT 5

BALD EAGLE PERCH SITES IN STUDY AREA

SEA-TAC AIRPORT
MPU BIOLOGICAL ASSESSMENT



AR 044934

N

0 .5 1 Mile

0 .5 1 Kilometer

SHAPIRO & ASSOCIATES, INC.

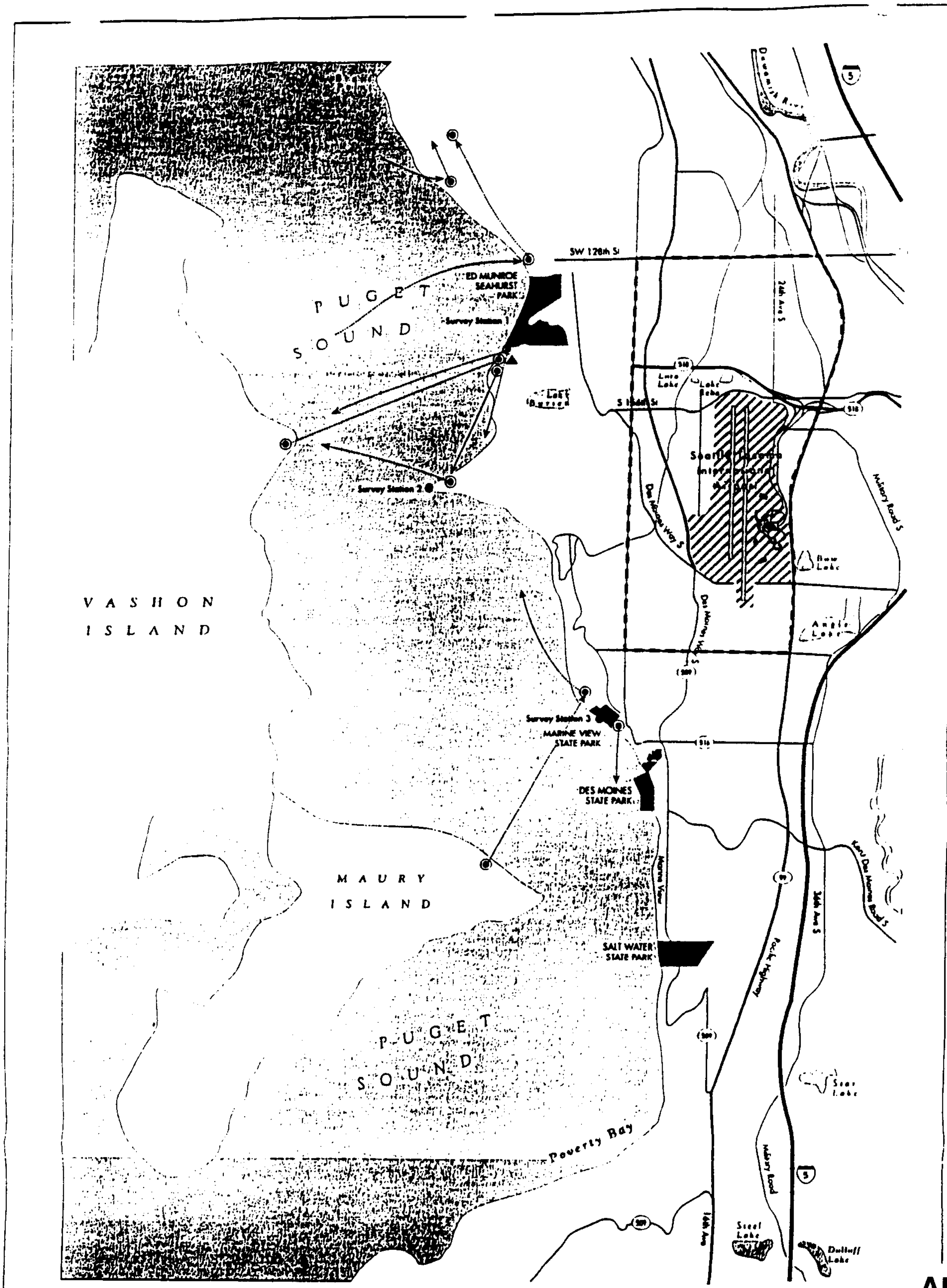
Legend

- ■ Hunt Location
- ◉ Perching or Eating Location
- ○ Circular Flight without Kill Attempt
- → Flight Direction
- – – – Project Area Boundary
- ▲ Active Nest

EXHIBIT 6

BALD EAGLE HUNTS IN THE STUDY AREA

SEA-TAC AIRPORT
MPU BIOLOGICAL ASSESSMENT



Legend
- Perch Site
- Flight Direction
- Project Area Boundary
- Active Nest

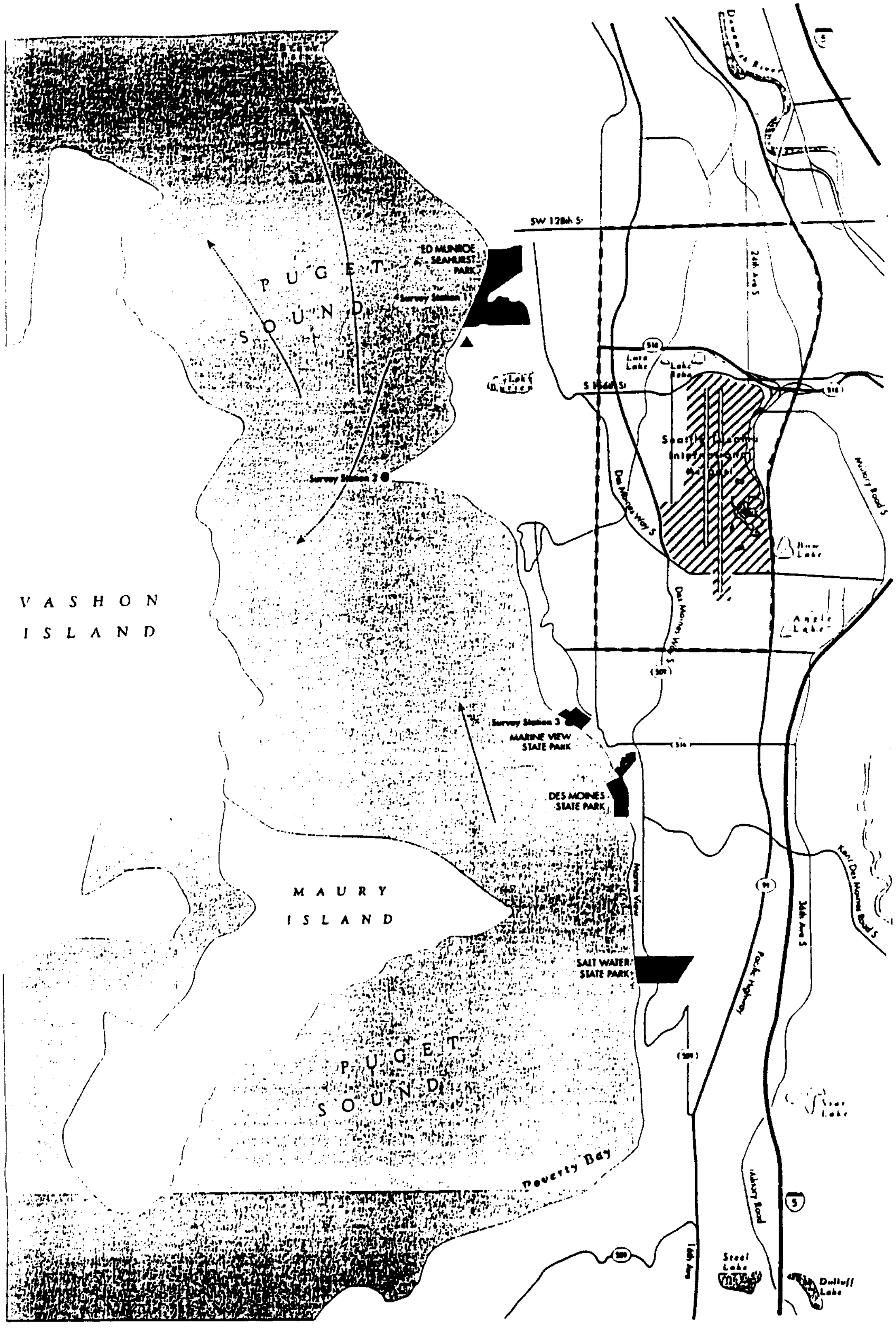
0 .5 1 Mile
0 .5 1 Kilometer

SHAPIRO & ASSOCIATES, INC.

EXHIBIT 7

BALD EAGLE PERCH-RELATED FLIGHT PATTERNS

SEA-TAC AIRPORT
MPU BIOLOGICAL ASSESSMENT



AR 044936

EXHIBIT 8

BALD EAGLE FLIGHT PATTERNS THROUGH THE STUDY AREA

0 .5 1 Mile

0 .5 1 Kilometer

Legend

Flight Direction

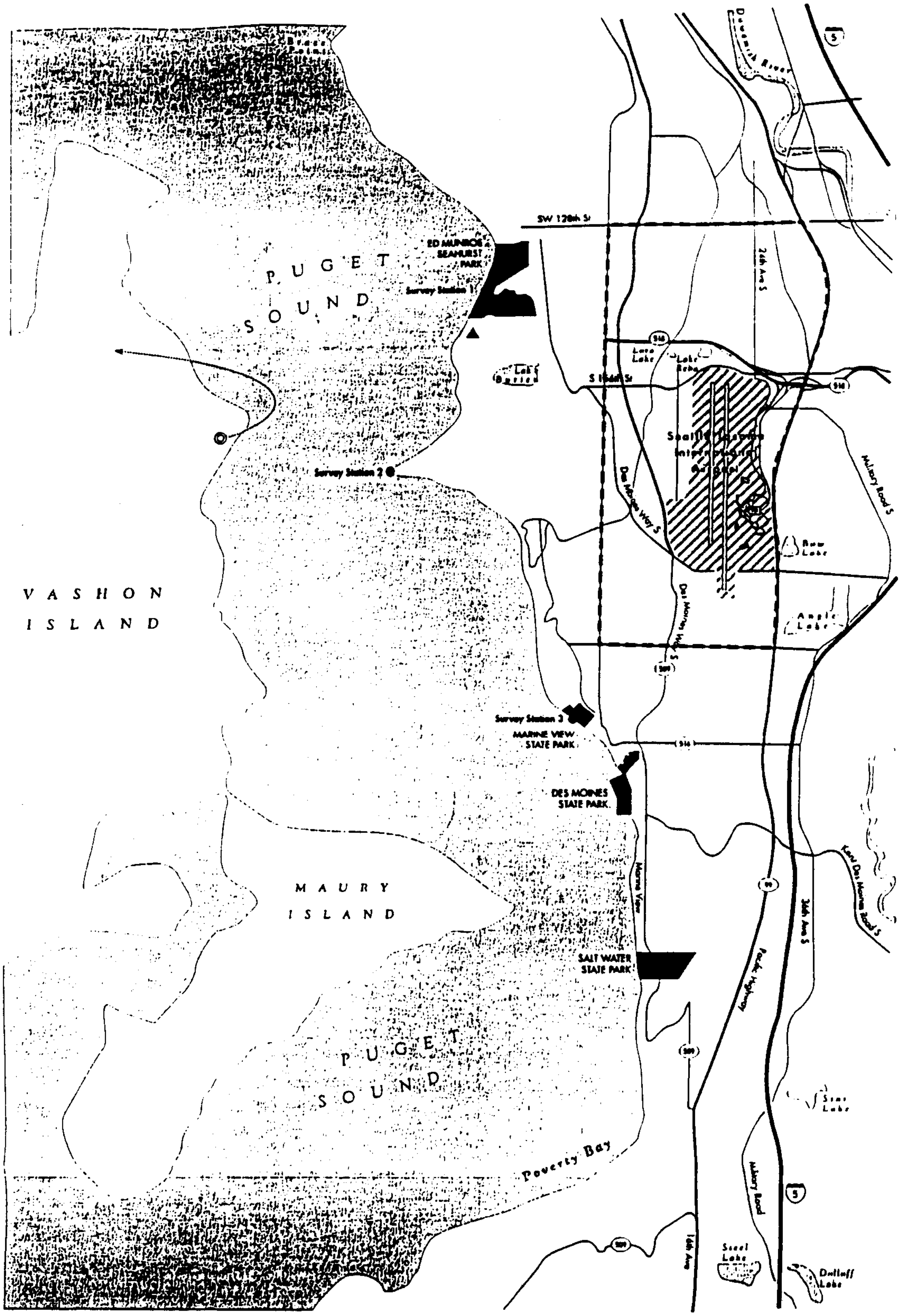
Project Area Boundary

Active Nest

SHAPIRO & ASSOCIATES, INC.

SEA-TAC AIRPORT
MPU BIOLOGICAL ASSESSMENT

2/95



AR 044937

Legend
- Perch Site
- Flight Path
- Project Area Boundary
- Active Nest

SHAPIRO & ASSOCIATES, INC.

EXHIBIT 9

PEREGRINE FALCON BEHAVIOR OBSERVED IN STUDY AREA

SEA-TAC AIRPORT
MPU BIOLOGICAL ASSESSMENT

(7) DISCUSSION

(A) Bald Eagles

1. Abundance

Information gathered from WDFW and survey results from the December and January surveys of 1994-95 (Tims, 1995) indicate that the study area is regularly used by the nearby nesting pair of bald eagles and occasionally used by winter residents that travel south from Canada and Alaska.

The limited data suggest that the seasonal abundance of eagles within the study area generally conforms to wintering eagle data for the northwest (Stalmaster, 1987): eagle numbers generally peak in late January and decrease through February and March as birds disperse. Comparison between existing eagle data and data obtained from this study is difficult because of the short duration of this study.

Three mature eagles were the highest number of confirmed individuals observed within the study area at one time. This peak in abundance occurred on January 12, 1995 at the southern end of Seahurst Park (Station 1). Two adults were first observed circling approximately 1,000 feet above the water when they were joined by another adult eagle. The three birds circled together for approximately 4 minutes until the newcomer flew south and out of sight. This group of birds possibly included at least one of the local breeding birds. The breeding pair was regularly observed in this area throughout the field study. Most eagles that breed in the Pacific Northwest probably winter in the general vicinity of their nests. Others move relatively short distances to more accessible winter food sources (USFWS, 1986; Fyfe and Olendorff, 1976).

Many eagles that winter in the northwest have migrated from breeding grounds in northwest interior Canada; others have traveled from coastal regions of British Columbia and southeast Alaska (USFWS, 1986).

A number of factors can influence the time and duration of an eagle's use of a site. Seasonal fluctuations in eagle abandance may be tied to prey abundance and movements, or the hatching of young and the need to forage more intensely. Daily fluctuations in the number of eagles that use the project area may be affected by the movements of prey species, tides, weather conditions, and daylight. The importance of the project area to bald eagles can be determined only generally from the existing data.

Productivity of the active nest near Seahurst Park during 1994 is unknown (Stein, 1994). WDFW conducts an occupancy survey of all known eagle nests in the State during April of each year. On April 24, 1994, WDFW personnel observed one eagle incubating and one eagle perching near the nest tree (Bernatowitz, 1994). WDFW personnel later found an eggshell underneath the nest tree. Hatching and fledging success of young is unknown. Local property owners in the vicinity of the eagle nest observed nesting and feeding activities throughout the breeding season; however, no observations of fledglings occurred (Novak, 1995). Observation of the nest itself is very difficult because of its location in the tree. This may account for the limited observations. One immature eagle was observed in the vicinity of Seahurst Park on January 9, 1995 (Tims, 1995). The movements of immature eagles once they leave their nest site is not well documented. Juvenile eagles often travel considerable distances from their nest area during winter to congregate at areas with concentrated food sources (Steenhof, 1976). This may account for the lack of juvenile eagle sightings during the field study.

(2) Behavior

Perching

Wintering eagles generally spend about 98% of a 24-hour day perching or roosting (Stalmaster, 1987). Eagles keep their activity to a minimum during winter to conserve resources. During this study, approximately 75% of the eagle observations were of perched birds. Unusually mild weather during late December and most of January may account for the low percentage of observed perching behavior in comparison to expected results.

The number and variety of perch sites in the study area and the availability of adjacent foraging sites, attracts wintering eagles. Snags, [illegible] trees, driftwood, and large rocks were used as perches. Vashon Island and the steep, forested slopes adjacent to the Seahurst Park shoreline were favored perch sites within the study area. The high, relatively unobstructed perch sites located on the forested slopes of Seahurst Park in the eastern portion of the study area provide optimal perch sites for hunting. Topography in the western portion of the study area on Vashon and Maury Islands' varied much less in comparison to the eastern side of the study area. Perches are low compared to the shoreline perches by Seahurst Park; however, they provide optimal unobstructed viewpoints for foraging.

The breeding pair of eagles that have a nest in the densely forested area immediately south of Seahurst Park were regularly observed perched near the nest tree during the day, and probably use the surrounding forested area as a night roost; however, there were no observations of this woodlot being used by any concentration of eagles for a night roost. Perch sites in this area afford a view of the shoreline and water from along the ridge.

Hunting

The frequency of eagle hunting observations was generally consistent with published accounts of the amount of time eagles spend hunting during the day. Based on a 24-hour period, eagles typically spend only 1-2% of their time foraging and feeding (Stalmaster, 1987). Observations of eagle foraging and feeding in the study area represented approximately 11% of total observations. Many of these observations were of short duration, such as during attempted hunts when an eagle missed the intended prey. The percentage of observations reflect the frequency that a behavior was observed not the length of time a behavior lasted. The actual percentage of time eagles spent foraging and feeding is less than what the percentage of frequency indicates.

The abundance of fish, particularly salmon, and waterfowl that use the Puget Sound attract eagles to the area. All of the observed eagle foraging and feeding occurred along the shoreline or in open water. Waterfowl regularly used nearshore habitats for feeding on invertebrates or marine vegetation. The eagles preyed upon

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ducks foraging in the shallow water and used shoreline habitat for scavenging dead fish and waterfowl. Eagles also foraged for fish in open water. This activity occurred in both shallow areas near the shoreline and also several hundred meters out into Puget Sound. Both dabbling and diving ducks commonly used the open water portions of the study site and were preyed upon by eagles. Eagles may hunt for small mammals in undeveloped upland areas on Vashon and Maury Islands; however the only observed activity on the islands was perching.

Eagles flew to a variety of perch sites when a prey item was captured. Vashon Island on the west side of Puget Sound and the forested area near the active nest site on the east side were used by feeding eagles. Eagles perched in live trees, snags, or on the ground for feeding. Eagles would occasionally take captured prey to perch trees in the forested slopes near Brace Point in the northern portion of the study area.

Flying

The majority of flights associated with perches took place in two general corridors; north/south between Three Tree Point and Seahurst Park, and east/west between the western shoreline and the islands (Exhibit 7). This partially reflects the travel between favored perch sites in the study area. Perch trees are mainly selected according to their proximity to a food source (USFWS, 1986). Eagles often use the tallest trees in a selected area, and preferred branches are consistently used (Stalmaster, 1976). Eagles were observed using several perches in the forested area surrounding the active nest.

Eagles that flew through the study area generally flew in a north/south corridor through Puget Sound. Aside from the two resident eagles, most individuals observed during field surveys flew through the study area without perching. This provides evidence that this area is used more frequently as a travel corridor for wintering eagles rather than for perching and hunting.

Disturbances

The project area and surrounding vicinity is very urbanized and subject to a variety of human-related disturbances. Eagles in the study area exhibited no signs of stress from human activity as long as a distance of at least 200 meters was maintained between the eagle and the person. Studies conducted by Stalmaster and Newman (1978) showed that wintering eagles tolerated human activities at a distance of 300 meters; however 50% of eagles flushed at 150 meters. Minor auditory disturbances without associated visual cues probably would not disrupt the activities of wintering eagles (USFWS, 1986).

From the limited observations at the study area, eagles appear to tolerate air traffic. Only one observation of a plane traveling through the study area was made while an eagle was perched in the vicinity. The eagle appeared to have no adverse reaction to the airplane activity. The resident eagle pair is currently occupying the same nesting territory as last year which may indicate that these birds are tolerant of current aircraft activity levels in the study area. Eagles have been found to habituate to some regular human activities such as car traffic (Grier, 1969, Steenoff, 1976), and wintering and resident eagles may be accustomed to the amount of human activity and existing airplane traffic through the area.

(B) Peregrine Falcon

1. Abundance

Only one peregrine falcon was observed in the study area during field surveys. The sex of the observed falcon could not be determined due to poor visibility and the short duration of the observation. The information in this study reflects the lack of peregrine falcons in the study area.

2. Behavior

Perches

One observation was made of a peregrine that was perched in a tree on Vashon Island directly across from Survey Station 2. The bird was well hidden until it was flushed from its perch by a passing eagle. No antagonistic behavior in either bird was observed. Because this was the only observation of a peregrine falcon during the study, it appears that this falcon is a transient in the area and probably using this portion of Puget Sound as a travel corridor.

Flying

No non-perch related flights of peregrine falcons were observed during the study.

Hunting

No falcon hunts were observed during the study.

Disturbances

The use of an observation blind for conducting peregrine falcon surveys was not possible beacuse a 360-degree and overhead view of the study area was needed for accurate data collection. As a result, a peregrine falcon entering the study area also can observe the surveyor and, because of this, the falcons may have altered their behavior.

The high level of human activity in the study area likely limits peregrine falcon use. Little is known about the tolerance of wintering peregrine falcons to human disturbance. The literature suggests that breeding peregrine falcons are highly sensitive to human disturbances (Hickey, 1942; Herbert and Herbert, 1965; Fyfe and Olendorff, 1976) and have been known to abandon a breeding site after one visit by a human.

(C) Candidate Species

The northern-red-legged frog is the only candidate species listed by USFWS that may occur in the project area. Red-legged frogs are common throughout western Washington and likely use wetlands in the project area for breeding and overwintering. The presence of any other candidate species in the project area is unlikely because appropriate habitat for these species does not exist in the project vicinity.

(8) EFFECTS OF THE PROPOSED PROJECT

Potential effects of construction and operation of the proposed new parallel runway and associated facilities at the Airport are evaluated here in terms of bald eagle and peregrine falcon food resources, habitat, and tolerance to project-related activities. Of the three issues, tolerance of these species to project-related activities is of most concern.

(A) Bald Eagles

The proposed project would not cause significant adverse effects to breeding or wintering bald eagles. Minor indirect impacts may occur, however. These impacts can be placed in four general categories. These are:

- A loss of potential feeding and perching habitat for wintering and breeding eagles on the project site;
- An indirect loss of available feeding and perching habitat from increases in disturbances from construction activity, air traffic, and human activity;
- A reduction in the wintering waterfowl habitat on the project site, causing a reduction in a primary prey source for eagles; and
- An increase in airplane activity in the area.

1. Construction

Construction of the proposed project is not expected to result in significant adverse impacts on wintering or breeding bald eagles. The project site provides limited eagle habitat. Bald eagles may occasionally use the site for foraging and perching; however the proximity of preferred habitat outside the project area reduces use of the site by this species. The loss of habitat associated with development of the proposd project would not significantly affect eagle foraging or perching behavior.

While eagles use urbanized areas in the Puget Sound region for perching and foraging, including Green Lake, Lake Washington, Tub Lake, Elliott Bay, and Shilshole Bay, extensive development and noise disturbance from traffic may make these areas unsuitable for nesting.

Seahurst Park is an island of undisturbed habitat within a highly urbanized landscape. An active bald eagle nest is located approximately 0.25 mile south of the park in a residential area. The types and levels of human activities in the vicinity of the nest are limited, and most likely more predictable than in surrounding urban areas. The immediate area around the nest tree is relatively inaccessible to humans because of its location on privately owned property and its position on an extremely steep, forested slope. This provides the eagles with some seclusion from disturbance. Since the area is already developed and construction of new homes in the immediate vicinity is not possible, disturbances are limited to routine yard maintenance, such as lawn mowing, tree cutting, or thinning, and noise from local automobile traffic. Most of these activities are predictable and the eagles seem to have become well adapted to this residential environment.

Although the limits of the eagles' tolerance to disturbance is unknown, there is most likely some threshold beyond which additional activity will adversely affect their behavior (i.e., avoidance of the disturbed area, disruption of nesting activities). Studies have shown many human activities to be sources of disturbance, but it is not clear what it is about each activity that causes the eagles to percieve it as a threat (Stalmaster, 1987). For example, eagles may be disturbed by auditory, visual, or spatial elements of an activity.

The *Bald Eagle Management Guidelines for Oregon and Washington* (USFWS, 1981) and the *Pacific Bald Eagle Recovery Plan* (USFWS, 1982) suggest primary and secondary buffer zones around bald eagle nests and critical wintering areas. Temporary restrictions on disruptive activities within these buffer zones are suggested within the critical nesting and wintering periods. Because of the distance of the nest from the proposed project site, seasonal construction restrictions are not anticipated.

The active bald eagle nest located west of the project area would not be directly affected by construction of the proposed project. Potentially disturbing activities are most critical during the early part of the nesting season because most nest failures occur at this time (Stalmaster, 1987). Courtship, egg-laying, and incubation at the active nest will likely occur from mid-February through mid-April. A study of the effects of ferry dock construction in the San Juan Islands concluded that construction activities has little to no effect on bald eagles accustomed to human activities if construction is no closer than 0.5 miles (Washington Department of Transportation, 1987). Because the Airport is over 2 miles from the eagle nest and separated by several physical and cultural features, the effects of construction on the breeding eagle pair should be minor and related mostly to the removal of potential foraging habitat and perch sites within construction areas.

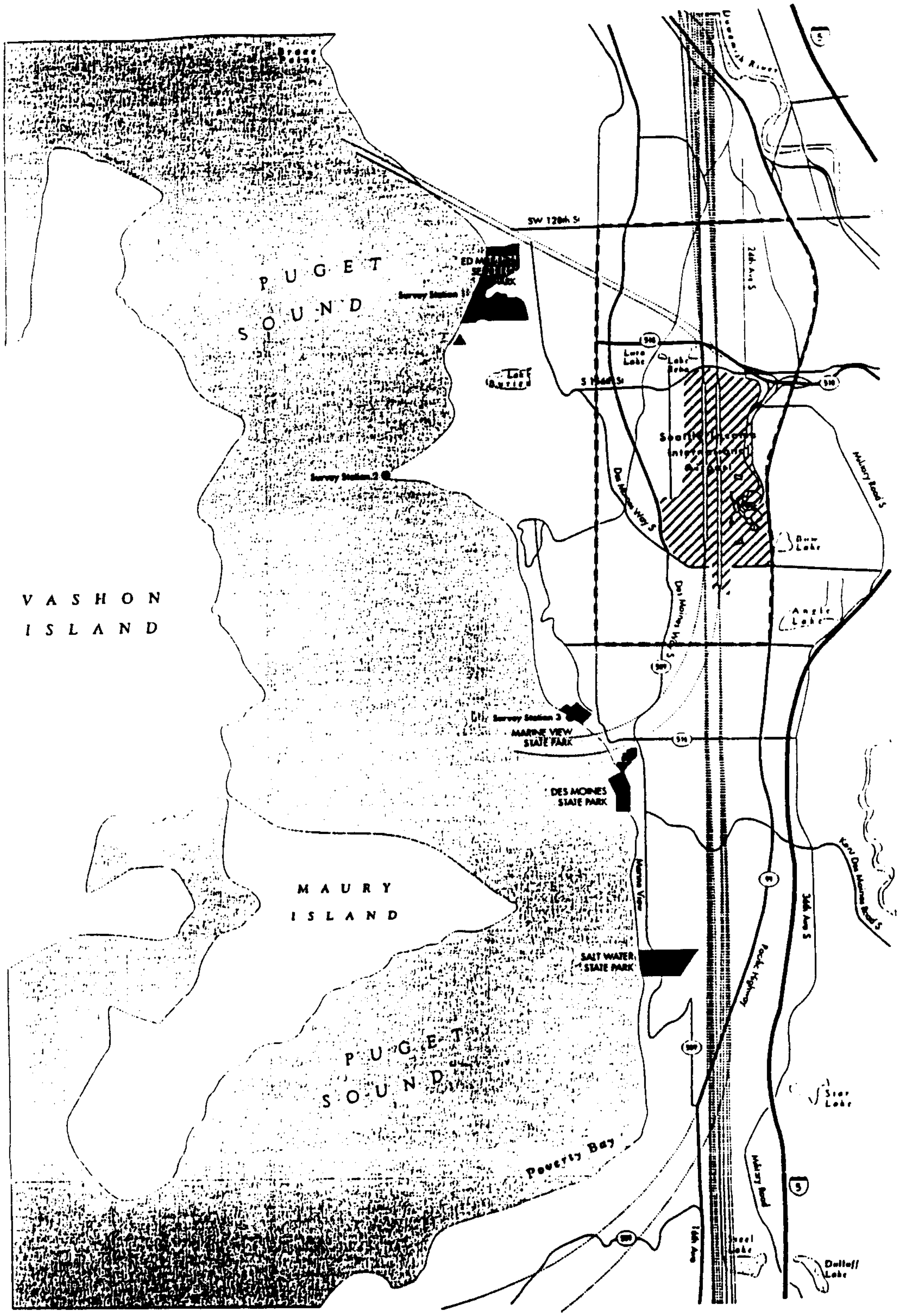
The local pair of breeding bald eagles may occasionally forage in the proposed project area throughout the year. This is uncommon due to the lack of quality eagle foraging habitat in this area. The proximity of high quality foraging habitat west of the project area along the Puget Sound shoreline reduces use of the project area by this species. The shoreline is used by breeding and wintering gulls and several species of waterfowl and offers potential prey for bald eagles.

In addition to removing potential eagle perching and foraging habitat, the noise and activity associated with excavation and construction would cause eagles to avoid an area around the construction zone. These areas are used infrequently by eagles and no significant adverse impact is expected.

2. **Operation**

Operation of the proposed project could affect bald eagles as a result of increased aircraft activity in the area. Effects on bald eagles typically associated with airport operation can include interference with established eagle flight paths, elevated noise levels and increased air traffic in eagle use areas, and risk of in-flight collisions between aircraft and eagles.

No significant changes in bald eagle flight patterns are expected as a result of operation of the proposed project. The area where bald eagles are commonly found in the study area is shown in Exhibits 10 and 11, in relation to current arrival and



0 .5 1 Mile
0 .5 1 Kilometer

Legend
Aircraft Arrival Path
Project Area Boundary
Active Nest

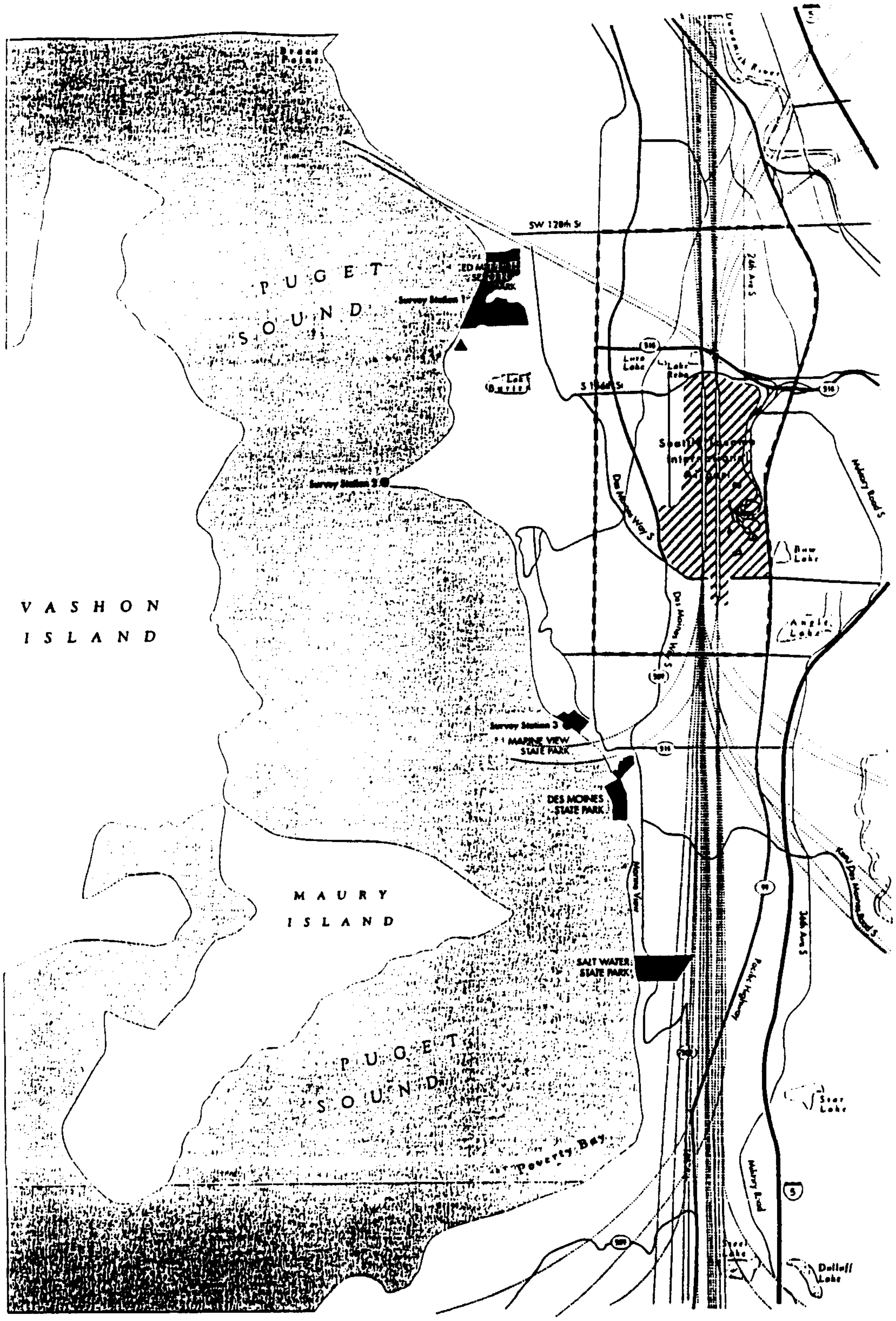
SHAPIRO & ASSOCIATES, INC.

EXHIBIT 10

FLIGHT LINES OF ARRIVING FLIGHTS 1995

SEA-TAC AIRPORT
MPU BIOLOGICAL ASSESSMENT

AR 044944



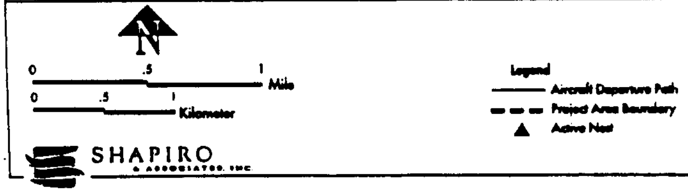


EXHIBIT 11

FLIGHT LINES OF DEPARTING FLIGHTS 1995

SEA-TAC AIRPORT
MPU BIOLOGICAL ASSESSMENT

departure flight paths for the Airport. Future flight paths assuming construction of the proposed new parallel runway are not expected to be significantly different from current approach and departure zones (Port of Seattle, 1994). The occupied nesting territory is located approximately 2.5 miles northwest of the Airport runways, and available wintering habitat is located 2.5-3 miles west of the Airport runways. Most of the observed bald eagle flights through the study area were in a north/south corridor along Puget Sound. These eagles were presumably using Puget Sound as a travel corridor between preferred wintering habitats. Other observed flights were short and concentrated around the active nest and preferred perches along the shoreline. Eagles were also observed circling above 2,000 feet in the thermal winds aloft above Puget Sound near Seahurst Park. Bald eagle flight paths through the project area were most common in the northern portion of the site, near Lake Reba.

Eagle-airplane collision is very unlikely. Eagles fly relatively slow and have high visual acuity which allows them to avoid collisions (Olendorff, et al., 1981). Approximately 75% of all bird-airplane collisions reported in the United States occur below an altitude of 1,500 feet (USFWS, 1982). Planes flying through bald eagle use areas along the Puget Sound shoreline would generally be above 1,500 feet, according to current and proposed future approach and departure procedures.

Few studies have been conducted on the effects of noise and aircraft activity on bald eagles. A study was completed around the Bellingham Airport to evaluate any effects of aircraft activity on eagle behavior, especially for jet flights (Fleischner and Weisberg, 1986). The effects of four types of aircraft (jets, propeller airplanes, helicopters, and smaller private jets) were compared in this study. A concentration of wintering eagles occurs approximately 0.75 mile south of the Bellingham airport, and a bald eagle nest is located 2.7 miles northwest of the airport. During the study period, there were 173 observations of bald eagles while aircraft flew through the study area. Bald eagles reacted to aircraft 12% of the time, most reactions were to small jet aircraft and helicopters, rather than to commercial jets. Propeller airplanes received the least reactions. The most common observed reaction was turning of the head to watch the aircraft. The second most common reaction was flushing from a perch site. One eagle-eagle interaction was interrupted for ten seconds. It was concluded from this study that the level of aircraft activity in the area was not significantly affecting the bald eagle population.

Numerous other studies have examined the effects of human disturbance on eagles caused by recreational activities, shooting, habitat removal and alteration, and boat and automobile traffic. In general, most studies show that bald eagles are significantly disturbed by human intrusions in wilderness settings, but seem relatively tolerant in more urbanized settings, when the activity is not directed at them (Beebe, 1960).

Noise contours representing existing conditions and predicted future (year 2020) noise levels in the vicinity of the Airport are illustrated in Exhibits IV.1-1, IV.1-4, and IV.1-7. Future noise level assumptions reflect a growth in total aircraft operations with or without future airfield development. Noise contours were determined through assessment of existing and predicted future aircraft operations, fleet mix and their distribution throughout the day, anticipated utilization of the runways, and the location of the arrival and departure flight paths to and from the runways (Port of Seattle, 1994). The changes between existing and future noise conditions primarily reflect the mandated transition to a 100% Stage 3 aircraft fleet (quieter aircraft). By the year 2020, the fleet mix at the Airport is expected to consist solely of aircraft meeting Stage 3 noise levels. The use of Stage 3 aircraft willl result in an overall decrease in noise levels, even with the expected future increase in aircraft operations at the Airport (Port of Seattle, 1994).

Without construction of a new parallel runway, significant delays are expected at the Airport (Port of Seattle, 1994). Delays would require planes to circle in the vicinity of the airport at various altitudes. This may cause an increase in low-altitude airplane activity in eagle use areas, which could increase disturbance.

Because last years' productivity of the active nest is not known, it is difficult to assess the amount of disturbance caused by current Airport operations on the breeding pair. Field observations confirm use of the study area by the pair for breeding and wintering. The continued use of the area may indicate that the eagles have become habituated to airport activities.

Based on the studies described above and the limited observations of wintering eagle reactions to airplane activity in the study area, and because airplane noise in the Airport vicinity is expected to decrease in the future, effects from noise and air traffic are not expected to be significant.

(B) <u>Peregrine Falcon</u>

Wintering peregrine falcons may occasionally use the study area for perching and hunting. Development of the proposed project is not expected to have significant adverse impacts on this species. Minor indirect impacts, similar to those described for bald eagles, may occur. These impacts include:

- A loss of feeding and perching sites on the project site;
- An indirect loss of available feeding and perching habitat due to increases in disturbance from construction activity, human activity, and air traffic; and
- A loss of waterfowl habitat on the project site, affecting birds that are preyed upon by wintering peregrine falcons.

Little is known about the tolerance of wintering peregrine falcons to human disturbance. The literature suggests that breeding peregrine falcons are highly sensitive to human disturbances (Hickey, 1942; Herbert and Herbert, 1965; Fyfe and Olendorff, 1976) and have been known to abandon a breeding site after one visit by a human. The Pacific Peregrine Falcon Recovery Plan does not provide any specific recommendations for buffers from human disturbances, but generally recommends protecting wintering habitat from human disturbances. The authors of the Recovery Plan suggest that wintering habitat may be a limiting factor for the Pacific peregrine falcon population. The WDW *Draft Management Recommendations for Priority Species* does not offer specific recommendations for the width of buffers from human activity for peregrine falcons but does recommend the preservation of intertidal mudflats, estuaries, and coastal marshes as key winter feeding habitat (Washington Department of Wildlife, 1991b).

(C) Candidate Species

The northern red-legged frog is the only candidate species listed by USFWS likely to occur in the project area or surrounding vicinity. Impacts on red-legged frogs resulting from construction of the proposed project would include displacement of individuals or local populations and loss of breeding and overwintering habitat. No impacts on this species are anticipated as a result of operation of the proposed project.

(9) MITIGATION

Flight paths should avoid the bald eagle nesting territory and associated wintering areas along Puget Sound to the extent possible. When flights are directed to or from the Airport from the west through bald eagles use areas, planes should be directed to fly at as high an altitude as possible to minimize disturbance to wintering or nesting bald eagles.

(10) CONCLUSIONS

Construction and operation of the proposed project is not expected to result in significant adverse impacts on bald eagles, peregrine falcons, or candidate species.

Bald eagles observed in the study area primarily consisted of the resident pair, with occasional sightings of other eagles flying through the study area. Only one observation of a peregrine falcon was made during the study. This falcon was likely a transient in the area, as it was never observed again during the field study.

The only candidate species likely to occur in the vicinity of the project area is the northern red-legged frog. This species is common throughout western Washington, and significant impacts are not expected as a result of the proposed project.

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Attachment A

Agency Correspondence

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
ENVIRONMENTAL & TECHNICAL SERVICES DIVISION
911 NE 11th Avenue - Room 620
PORTLAND, OREGON 97232
503/230-5400 FAX 503/230-5435

F/NWO3

JUN 30 1994

Ms. Julia Tims, Wildlife Ecologist
Shapiro and Associates Inc.
1201 Third Avenue - Suite 1700
Seattle, Washington 98101

Re: Species List Request for Sea-Tac International Airport Master Plan

Dear Ms. Tims:

The National Marine Fisheries Service (NMFS) has reviewed your May 16, 1994, letter to Brian Brown requesting a list of threatened or endangered species to aid in your preparation of an environmental impact statement for the Sea-Tac International Airport Master Plan. It is our understanding that this project will entail the construction of a new runway at the airport.

We have enclosed a list the anadromous fish species that are listed as endangered or threatened under the Endangered Species Act (ESA) and those that are candidates for listing. This list includes only anadromous species (salmon and steelhead) under NMFS jurisdiction that occur in the Pacific Northwest. The U.S. Fish and Wildlife Service should be contacted regarding the presence of species falling under its jurisdiction.

Available information indicates that no listed Snake River salmon are in the project area or immediately downstream from it. The final critical habitat designated for the listed salmon (December 28, 1993, 58 FR 68453) does not include the proposed project area.

However, some of the anadromous fish species that are presently *candidates* for listing under the ESA may be present in, or downstream from, the proposed action area. The candidates for listing that may be present are coho salmon (*Oncorhynchus kisutch*), steelhead (*Oncorhynchus mykiss*), and chum salmon (*Oncorhynchus keta*). Candidates for listing have no status under the ESA. Once a candidate species is proposed for listing, or is listed, a conference or consultation may be required.

Please refer to the ESA section 7 implementing regulations, 50 CFR Part 402, for information on the conference and consultation process.

If you have further questions, please contact Steve Stone, of my staff, at (503) 231-2317.

Sincerely,

Brian J. Brown

Brian J. Brown
Acting Division Chief

Enclosure

ENDANGERED AND/OR THREATENED SPECIES UNDER NATIONAL MARINE FISHERIES SERVICE JURISDICTION THAT OCCUR IN THE PACIFIC NORTHWEST

Listed Species

Sacramento River Winter-Run Chinook Salmon	*Oncorhynchus tshawytscha*
Snake River Sockeye Salmon	*Oncorhynchus nerka*
Snake River Fall Chinook Salmon	*Oncorhynchus tshawytscha*
Snake River Spring/Summer Chinook Salmon	*Oncorhynchus tshawytscha*

CANDIDATES FOR LISTING

Mid-Columbia River Summer Chinook Salmon	*Oncorhynchus tshawytscha*
Coho Salmon	*Oncorhynchus kisutch*
Steelhead	*Oncorhynchus mykiss*
North Umpqua River Cutthroat Trout	*Oncorhynchus clarki clarki*

SPECIES FOR WHICH NMFS HAS RECEIVED LISTING PETITIONS

Baker River sockeye salmon	*Oncorhynchus nerka*
Hood Canal/Discovery Bay/Mud bay/ Eld Inlet chum salmon	*Oncorhynchus keta*
Elwha/Lower Dungeness River pink salmon	*Oncorhynchus gorbuscha*
White/Dungeness/North and South Fork Nooksack River spring chinook salmon	*Oncorhynchus tshawytscha*

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
3704 Griffin Lane SE. Suite 102
Olympia, Washington 98501-2192
(206) 753-9440 FAX: (206) 753-9008

June 17, 1994

Julia Lisa Tims
Wildlife Ecologist
Shapiro & Associates
1201 Third Ave., Suite 1700
Seattle, Washington 98101

FWS Reference: 1-3-94-SP-530

Dear Ms. Tims:

This is in response to your letter dated May 5, 1994, and received in this office on May 6. Enclosed is a list of listed threatened and endangered species, and candidate species (Attachment A), that may be present within the area of the proposed Sea-Tac International Airport Master Plan update and new runway. The list fulfills the requirements of the Fish and Wildlife Service (Service) under Section 7(c) of the Endangered Species Act of 1973, as amended (Act). We have also enclosed a copy of the requirements for the Federal Aviation Administration (FAA) compliance under the Act (Attachment B).

Should the biological assessment determine that a listed species is likely to be affected (adversely or beneficially) by the project, the FAA should request Section 7 consultation through this office. If the biological assessment determines that the proposed action is "not likely to adversely affect" a listed species, the FAA should request Service concurrence with that determination through the informal consultation process. Even if the biological assessment shows a "no effect" situation, we would appreciate receiving a copy for our information.

Candidate species are included simply as advance notice to federal agencies of species which may be proposed and listed in the future. However, protection provided to candidate species now may preclude possible listing in the future. If early evaluation of your project indicates that it is likely to adversely impact a candidate species, the FAA may wish to request technical assistance from this office.

In addition, please be advised that federal and state regulations may require permits in areas where wetlands are identified. You should contact the Seattle District of the U.S. Army Corps of Engineers for federal permit requirements and the Washington State Department of Ecology for state permit requirements.

Your interest in endangered species is appreciated. If you have additional questions regarding your responsibilities under the Act, please contact Jim Michaels or Jodi Bush of this office at the letterhead phone/address.

Sincerely,

F David C. Frederick
State Supervisor

jb/ac
SE/FAA/1-3-94-SP-530/King
Enclosures

c: WDFW, Region 4
WNHP, Olympia

ATTACHMENT A

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES AND CANDIDATE SPECIES WHICH MAY OCCUR WITHIN THE VICINITY OF THE PROPOSED SEA-TAC INTERNATIONAL AIRPORT MASTER PLAN UPDATE AND NEW RUNWAY PROJECT IN KING COUNTY, WASHINGTON (T22N R04E S4-5; T23N R04E S16-17/20-21/28-29/32-33)

FWS REFERENCE: 1-3-94-SP-530

LISTED

Bald eagle *(Haliaeetus leucocephalus)* - wintering bald eagles may occur in the vicinity of the project from about October 31 through March 31.

Peregrine falcon *(Falco peregrinus)* - spring and fall migrant falcons may occur in the vicinity of the project.

Major concerns that should be addressed in your biological assessment of project impacts to bald eagles and peregrine falcons are:

1. Level of use of the project area by bald eagles and peregrine falcons.
2. Effect of the project on eagles' and falcons' primary food stocks and foraging areas in all areas influenced by the project.
3. Impacts from project construction and implementation (e.g., increased noise levels, increased human activity and/or access, loss or degradation of habitat) which may result in disturbance to eagles and falcons and/or their avoidance of the project area.

PROPOSED

None

CANDIDATE

The following candidate species may occur in the vicinity of the project:

Black tern *(Chlidonias niger)*
Bull trout *(Salvelinus confluentus)*
Mountain quail *(Oreortyx pictus)*
Northern red-legged frog *(Rana aurora)*
Northwestern pond turtle *(Clemmys marmorata)*
Spotted frog *(Rana pretiosa)*

ATTACHMENT B

FEDERAL AGENCIES' RESPONSIBILITIES UNDER SECTIONS 7(a) AND 7(c) OF THE ENDANGERED SPECIES ACT OF 1973, AS AMENDED

SECTION 7(a) - Consultation/Conference

Requires:
1. Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species;
2. Consultation with FWS when a federal action may affect a listed endangered or threatened species to ensure that any action authorized, funded, or carried out by a federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The process is initiated by the federal agency after it has determined if its action may affect (adversely or beneficially) a listed species; and
3. Conference with FWS when a federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or an adverse modification of proposed critical habitat.

SECTION 7(c) - Biological Assessment for Construction Projects *

Requires federal agencies or their designees to prepare a Biological Assessment (BA) for construction projects only. The purpose of the BA is to identify any proposed and/or listed species which is/are likely to be affected by a construction project. The process is initiated by a federal agency in requesting a list of proposed and listed threatened and endangered species (list attached). The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the species list, please verify the accuracy of the list with our Service. No irreversible commitment of resources is to be made during the BA process which would result in violation of the requirements under Section 7(a) of the Act. Planning, design, and administrative actions may be taken; however, no construction may begin.

To complete the BA, your agency or its designee should: (1) conduct an on-site inspection of the area to be affected by the proposal, which may include a detailed survey of the area to determine if the species is present and whether suitable habitat exists for either expanding the existing population or potential reintroduction of the species; (2) review literature and scientific data to determine species distribution, habitat needs, and other biological requirements; (3) interview experts including those within the FWS, National Marine Fisheries Service, state conservation department, universities, and others who may have data not yet published in scientific literature; (4) review and analyze the effects of the proposal on the species in terms of individuals and populations, including consideration of cumulative effects of the proposal on the species and its habitat; (5) analyze alternative actions that may provide conservation measures; and (6) prepare a report documenting the results, including a discussion of study methods used, any problems encountered, and other relevant information. Upon completion, the report should be forwarded to our Endangered Species Division, 3704 Griffin Lane SE, Suite 102, Olympia, WA 98501-2192.

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* "Construction project" means any major federal action which significantly affects the quality of the human environment (requiring an EIS), designed primarily to result in the building or erection of human-made structures such as dams, buildings, roads, pipelines, channels, and the like. This includes federal action such as permits, grants, licenses, or other forms of federal authorization or approval which may result in construction.

Appendix K
Sea-Tac Airport Master Plan Update Final EIS

Addendum to
BIOLOGICAL ASSESSMENT
SEA-TAC AIRPORT
MASTER PLAN UPDATE FINAL EIS

Prepared for:

Port of Seattle
and
Federal Aviation Administration

Prepared by:

SHAPIRO AND ASSOCIATES, INC.
1201 Third Avenue, Suite 1700
Seattle, Washington 98101

December 1995

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(1) INTRODUCTION

This report is an addendum to the Biological Assessment for Bald Eagles and Peregrine Falcons prepared for the Sea-Tac Airport Master Plan Update Draft EIS. After completion of the draft Biological Assessment in April 1994, information was provided to the Port identifying a new bald eagle nest in the vicinity of the Airport. This report provides background information on the new nest and an analysis of potential effects of the proposed project on the nesting eagles.

(2) BACKGROUND INFORMATION

An active bald eagle nest is located along the northeast border of Angle Lake, approximately 0.75 mile southeast of the Airport (Exhibit 1). The nest is located in a Douglas fir tree on private property that abuts the northeastern corner of Angle Lake. The nest was built in early 1995, and the subsequent nesting attempt was unsuccessful. According to Washington Department of Fish and Wildlife (WDFW) personnel and the owners of the property on which the nest is located, the eagle pair abandoned the nest before laying eggs, apparently as a result of crow harassment (Thompson, 1995). Recent observations by local residents confirm continued use of the Angle Lake territory by the eagle pair.

(3) EFFECTS OF THE PROPOSED PROJECT

The proposed project would not cause significant adverse effects to the resident eagle pair at Angle Lake. Minor indirect impacts could occur as a result of the following: (1) the loss of potential feeding and perching habitat on the project site; and (2) the indirect loss of available feeding and perching habitat immediately outside the construction zone as a result of increased disturbance from construction and other human activity.

(A) Construction

Construction of the proposed project is not expected to result in significant adverse impacts on the resident bald eagle pair at Angle Lake. No direct construction impacts would occur on Angle Lake as a result of any of the Master Plan Update alternatives. Because the Airport is more than 0.75 mile from the Angle Lake eagle nest and separated by several physical and cultural features, the effects of construction on the breeding eagle pair should be minor and related mostly to the removal of potential foraging habitat and perch sites within construction areas.

The Airport area provides limited eagle habitat. The Angle Lake eagle pair might occasionally forage and perch in the Airport area throughout the year, although this is uncommon because of the lack of quality eagle foraging habitat in this area. The proximity of high quality foraging habitat west of the project area along the Puget Sound shoreline reduces use of the proposed project area by these eagles. The loss of habitat associated with construction of the proposed project would not significantly affect eagle foraging or perching behavior.

The noise and activity associated with excavation and construction would cause eagles to avoid an area around the construction zone. These areas are used infrequently by eagles, and no significant adverse impact is expected.

(B) Operation

Operation of the proposed project is not expected to cause significant adverse effects to the resident bald eagle pair at Angle Lake. Effects on bald eagles typically associated with airport operation can include interference with established eagle flight paths, elevated noise levels, and increased air traffic in eagle use areas.

N[illegible]nificant changes in bald eagle flight patterns are expected as a result of operation of the p[illegible]sed project. Exhibits 10 and 11 of the Biological Assessment illustrate current and projected fu[illegible] arrival and departure flight paths for the Airport. Because Puget Sound is the predominant foraging area for eagles in the project vicinity, east-west flight patterns between Angle Lake and Puget Sound are likely a common flight path for the Angle Lake eagles. These east-west flight patterns cross the current approach and departure zones of the Airport. Because the pair is currently occupying the same nesting territory as last year, it can be assumed the eagles have established flight patterns that are not in conflict with current approach and departure zones of the Airport. Future flight paths with the proposed new parallel runway are not expected to be significantly different from current approach and departure zones. Therefore, no significant changes in bald eagle flight patterns are expected as a result of operation of the proposed project.

In addition, no airplane flight paths occur over or in the immediate vicinity of Angle Lake. The closest air[illegible]ane flight path to Angle Lake is approximately 0.5 mile. In this area, planes will fly at an altitude of approximately 1,500 feet, well above regular eagle use areas.

Noise data representing existing conditions and predicted future (year 2020) noise levels in the vicinity of the Airport are illustrated in Exhibit 2. Future noise level assumptions reflect the same growth in total aircraft operations with or without future airfield development (i.e., Do-Nothing alternative vs. "With Project" alternative). Changes between existing and future noise conditions primarily reflect the mandated transition to a 100% Stage 3 aircraft fleet (quieter aircraft). By the year 2020, the fleet mix at the Airport is expected to consist solely of aircraft meeting Stage 3 noise levels, as reflected in the Draft EIS, and the use of Stage 3 aircraft will result in an overall decrease [illegible] noise levels, even with the expected future increase in aircraft operations at the Airport. The new parallel runway would be located approximately 2,500 feet to the west of the existing westernmost runway (16R/34L) and thus farther from Angle Lake than under existing runway conditions.

[illegible]sting noise levels at Angle Lake are 66.2 day night sound level (DNL). Predicted future noise [illegible]els for the year 2020 show a decrease in noise levels at Angle Lake for all alternatives (including Do-Nothing alternative). In addition, all "With Project" alternatives result in lower noise levels ([illegible]1.0-61.1 DNL) than the Do-Nothing alternative (62.3 DNL).

The number of flights arriving and departing to and from the airport are expected to be the same with or without the addition of the new parallel runway. Without construction of the new parallel runway, significant delays are expected at the Airport. Delays would require planes to circle in the vicinity of the airport at various altitudes. This could increase low-altitude airplane activity in eagle use areas, which could increase disturbance.

F[illegible]se the nest has only been active one year, it is difficult to assess the amount of disturbance c[illegible]ed by current Airport operations on the breeding pair. Field observations by WDFW personnel and local residents confirm use of the study area by the pair for breeding and wintering. Continued use of the area might indicate that the pair has become habituated to Airport activities.

(4) CONCLUSIONS

In conclusion, construction and operation of the proposed project is not expected to result in [illegible]nificant adverse impacts on the resident bald eagle pair at A[illegible]le Lake.

[illegible]o direct construction impacts are anticipated on Angle Lake as a result of any of the Master Plan Update alternatives. Because of the distance of the Angle Lake eagle nest from the Airport, indirect impacts associated with construction of the proposed project are not expected to result in significant adverse impacts on the eagle pair.

The eagle pair is currently occupying the same nesting territory as last year, which indicates that these birds are tolerant of current aircraft activity levels in the area. Other studies have shown eagles habituate to some regular human activities.

Significant impacts associated with noise are not anticipated, as noise levels are projected to decrease with or without the proposed project. Predicted future noise levels show a decrease in noise levels at Angle Lake for all alternatives (including the Do-Nothing alternative). In addition, all alternatives resulting in construction of the new parallel runway result in lower noise levels than the Do-Nothing alternative. The new parallel runway would be located 2,500 feet farther from Angle Lake than the existing westernmost runway (16R/34R).

(5) REFERENCES

Thompson, Patricia, October 31, 1995. Washington Department of Fish and Wildlife. Personal Communication with Julia Tims.

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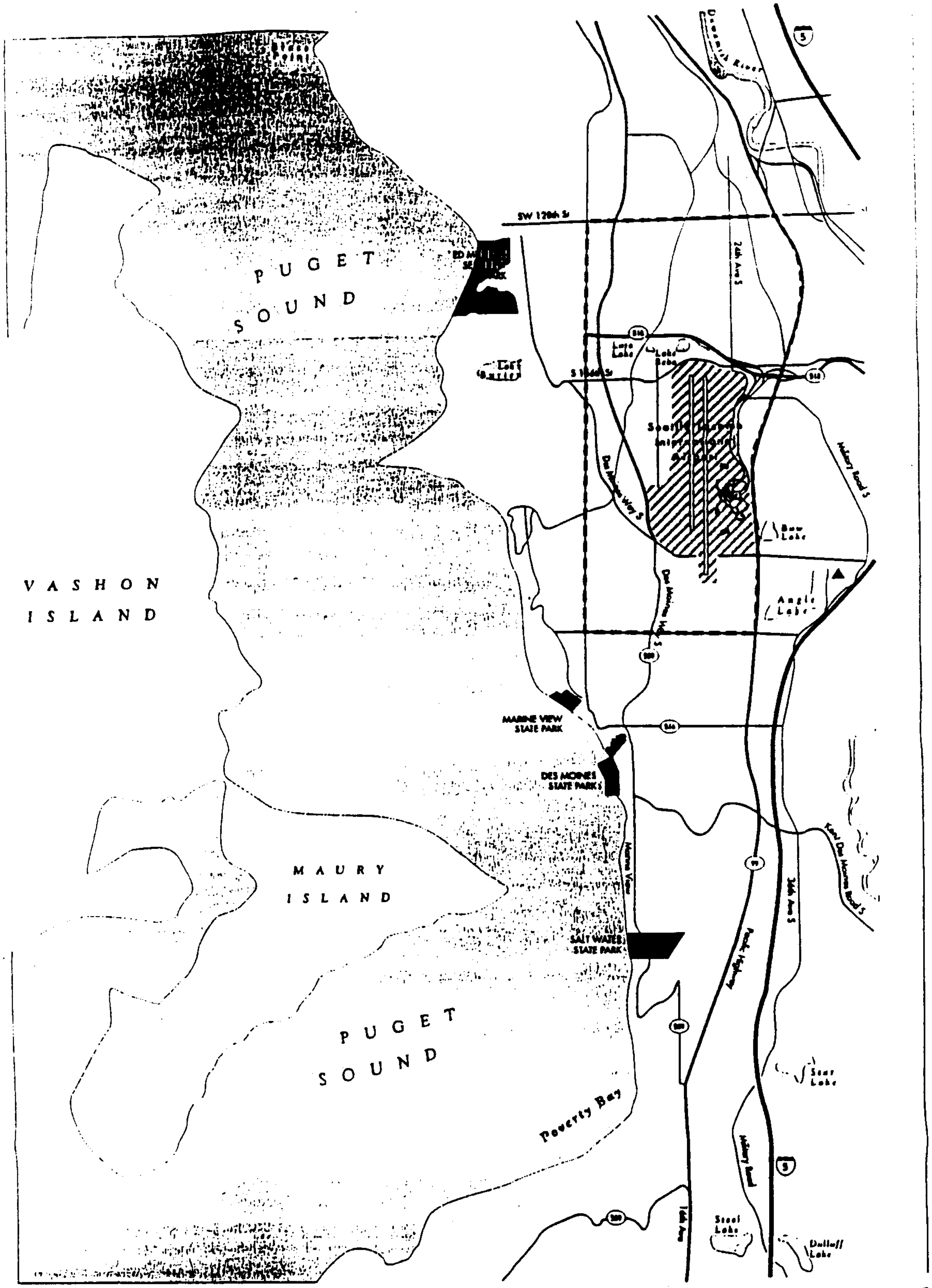

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EXHIBIT 1

LOCATION OF ANGLE LAKE BALD EAGLE NEST

0 .5 1 Mile

0 .5 1 Kilometer

Legend
Site Location
Active Nest
Project Area Boundary

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SEA-TAC AIRPORT
MPU BIOLOGICAL ASSESSMENT ADDENDUM

Park #	Park	Jurisdiction	1994 Exist.	Year 2000 Alt. 1	Year 2000 Alt. 2	Year 2000 Alt. 3	Year 2000 Alt. 4	Year 2010 Alt. 1	Year 2010 Alt. 2	Year 2010 Alt. 3	Year 2010 Alt. 4	Year 2020 Alt. 1	Year 2020 Alt. 2	Year 2020 Alt. 3	Year 2020 Alt. 4
P30	Hazel Valley Park	King Cnty	56.3	51.8	52.2	52.1	52.2	52.0	52.3	52.3	52.4	52.3	51.6	52.6	52.7
P31	Ed Munro Seahurst Park (N)	King Cnty	50.4	48.7	51.9	51.9	51.4	50.0	52.9	52.9	52.4	51.7	53.0	53.0	53.3
P31	Ed Munro Seahurst Park (S)	King Cnty	51.3	47.7	48.7	48.7	48.5	48.5	49.4	49.4	49.2	49.8	50.4	50.4	50.2
P32	Chelsea Park	Burien	54.6	51.8	53.9	53.9	53.6	52.6	54.5	54.5	54.2	54.0	55.1	55.1	54.9
P33	Burien Park	Burien	56.4	53.7	54.7	54.7	54.7	53.7	55.4	55.4	55.4	55.2	56.3	56.3	56.1
P34	Lakeview Park	Seattle	58.2	55.2	56.1	56.1	56.1	55.9	56.7	56.7	56.7	57.4	57.8	57.9	57.4
P35	Kiwanis Park	Kent	57.0	53.9	55.0	55.0	55.0	54.5	55.5	55.5	55.5	55.7	56.4	56.4	56.1
P36	City Hall Park	Norm. Park	55.3	51.5	51.7	51.7	51.7	51.9	52.2	52.2	52.2	52.7	53.1	53.1	53.3
P37	Private Park	Norm. Park	53.1	50.1	49.7	49.7	49.7	50.5	50.3	50.3	50.3	51.3	51.2	51.2	51.3
P38	Valley Ridge Park	SeaTac	57.1	51.8	51.7	51.7	51.7	52.1	52.1	52.1	52.1	53.1	52.9	52.9	52.9
P39	Midway Meander Park	Kent	49.2	44.7	44.6	44.6	44.6	45.0	44.8	44.8	44.8	45.9	45.7	45.7	45.7
P40	Van Dorens Landing Park	Kent	51.4	50.2	50.0	50.0	50.0	49.6	49.0	49.0	49.0	49.9	49.4	49.4	49.4
P41	Grandview Park	SeaTac	57.8	54.3	53.5	53.5	53.5	54.4	53.6	53.6	53.6	55.2	54.3	54.3	54.3
P42	West Canyon Park	Kent	54.5	51.6	50.9	50.9	50.9	51.7	51.1	51.1	51.1	53.6	53.0	53.0	53.0
P43	Angle Lake Park	SeaTac	66.2	61.3	60.2	60.2	60.2	61.7	60.5	60.5	60.5	62.3	61.1	61.0	61.0
P44	Des Moines Creek Park	SeaTac	75.6	71.6	70.9	70.9	70.9	71.6	70.8	70.8	70.8	71.8	71.0	71.0	71.0
P45	Des Moines Beach Park	Des Moines	61.9	57.7	58.5	58.5	58.5	57.6	58.6	58.6	58.6	57.9	58.8	58.8	58.8
P46	Des Moines Park	Des Moines	61.9	59.5	60.6	60.6	60.6	59.6	60.8	60.8	59.8	60.9	60.9	60.9	60.9
P47	Nature Trails Park	Norm. Park	54.0	52.4	53.8	53.8	53.8	53.3	54.4	54.3	54.4	54.7	55.5	55.5	55.5
P48	Normandy Park	Norm. Park	55.4	53.7	54.5	54.5	54.5	53.2	54.5	54.4	54.5	54.0	55.0	55.0	55.0
P49	Marine View Park	Norm. Park	53.9	52.0	51.3	51.3	51.3	50.8	51.1	51.1	51.1	52.1	51.6	51.6	51.6
P50	Fishing Hole Park	Kent	51.8	49.3	48.4	48.4	48.4	49.5	48.7	48.7	48.7	50.6	49.7	49.7	49.7
P51	Lake Fenwick Park	Kent	52.6	48.8	48.0	48.0	48.0	49.0	48.3	48.3	48.3	49.7	48.9	48.9	48.9
P52	Linda Heights Park	Kent	60.0	55.6	54.9	54.9	54.9	55.7	55.0	55.0	55.0	56.1	55.3	55.3	55.3
P53	Parkside Park	Des Moines	66.1	62.0	61.1	61.1	61.1	62.0	61.1	61.1	61.1	62.2	61.2	61.2	61.2
P54	Parkside Wetlands	Des Moines	66.3	62.2	61.4	61.4	61.4	62.2	61.4	61.4	61.4	62.4	61.3	61.3	61.3
P55	Glenn Nelson Park	Kent	61.2	56.5	55.8	55.8	55.8	56.6	55.9	55.9	55.9	56.8	56.1	56.1	56.1
P56	Saltwater State Park	Des Moines	60.9	57.4	58.1	58.1	58.1	57.6	58.3	58.3	58.3	57.8	58.4	58.4	58.4
P57	Woodmont Park	King Cnty	63.0	59.3	59.8	59.8	59.8	59.8	60.1	60.1	60.1	60.0	60.2	60.2	60.2
P58	Woodmont Beach	King Cnty	58.3	54.6	55.3	55.3	55.3	54.0	55.6	55.6	55.6	55.0	55.6	55.6	55.6

SHAPIRO & ASSOCIATES, INC.

EXHIBIT 2

DNL NOISE LEVELS IN PARKS AND RECREATIONAL RESOURCES

Appendix C

APPENDIX C

ESA STORMWATER EFFECTS

GUIDANCE FOR PROJECTS

SECTION 5.6 OF THE
ENDANGERED SPECIES AND TRANSPORTATIO HANDBOOK
WASHINGTON STATE DEPARTMENT OF TRANSPORTATION
REVISED OCTOBER 1999

5.6 ESA Stormwater Effects Guidance for Projects

Purpose:

The purpose of this document is to provide interim guidance on making effect determinations for biological assessments prepared for NMFS. **This guidance is for projects which**: (A) Increase Impervious Surface Area . or (B) Clear. Grade or Fill (Erosion Control). or (C) Have Spill Potential

The effect determinations included in this document have been agreed upon between WSDOT and NMFS. Some but not all of these determinations have been agreed to by USFWS.

This document only covers specific project activities. This document does not cover all of the possible project elements which must be analyzed by the project biologist before a final effect determination based upon all of the projects activities is made. Effect determinations must be project specific and this guidance may not fit in every case. There may be instances where the project conditions and site specific circumstances are such that the project does not meet the conditions outlined under one of the effect determinations (e.g. no effect) in this document. but the final analysis reaches that conclusion. In this case. the project specific conditions and rationales can be thoroughly documented in the Biological Assessment.

This guidance is temporary and may change in the future when changes are made to the Highway Runoff Manual. Until changes are made. use the Highway Runoff Manual or other local ordinances (if they are more stringent) to design the stormwater treatment system. Changes due to ESA will be added in the form of an instructional letter within the next 30 days. In addition. we are required to change the Highway Runoff Manual within 2 years of any Ecology mandated change.

Procedure: Evaluate each project for its location. evaluate for the effects due to stormwater. clearing. grading and filling. and the effects of all project elements on the baseline indicators before making a final project. specific effect determination.

*** Projects located within a Water Resource Inventory Area with no habitat or potential habitat for listed fish species will have no effect on listed fish species and require no further evaluation.

NO EFFECT

<u>Stormwater from new impervious surface area has no effect when:</u>

1. *New impervious surface area:* Infiltrate w/ pretreatment for all new impervious surface area.

OR

2. Stormwater treatment for project is designed to = 140 % x the Area of New Impervious surface area. (This is based on the assumption that post-project net pollutant loading should not exceed the pre-project loading.) In other words the new impervious surface area should not result in any additional pollution to the receiving waters. Since our stormwater BMPs are not 100% efficient (see attachment), some amount of preexisting impervious surface area will have to be treated to attain a no-net increase in pollutant

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loading. The treatment level has been established at 140% of new impervious surface area to make up for the fact that the BMP's are not 100% efficient.

Example: A project adds 10 acres of new impervious surface area . which will be 100% treated. How much impervious surface area will the project have to treat to attain a "no effects" determination?
Answer: 140% x (10 acres) = 14.0 acres which is the 10 new acres plus 4 acres of the existing untreated surface area..

Clearing. Grading and Filling has no effect when:

The project is within ESU/DPS[2]. clears. grades. and grubs over 300' from any waterbody. provided:

- Temporary Erosion Sedimentation Control (TESC)/ Stormwater Site Plan (SSP) is fully implemented (including spill control)
- "Environmental baseline" is not degraded. including spawning areas (determined by the BE3). LWD. riparian habitat. etc.

MAY AFFECT NOT LIKELY TO ADVERSELY AFFECT

Stormwater from new impervious surface area may affect but is not likely to adversely affect listed fish species and their habitat when:

Impervious Surface Area: Treatment w/ detention for all new impervious and treats less than 0.40 times the new impervious surface area.[1] (The Western WA office of the USFWS is not in agreement with this effect call.)

Clearing. Grading and Filling may affect but is not likely to adversely effect listed fish when:

The project within ESU/DPS. clears. grades. and grubs within 300' of any waterbody (which supports or drains into a listed fish supporting waterbody) but completes no in water work. provided:

- TESC/ SSP is fully implemented (including spill control)
- "Environmental baseline" is not degraded. including spawning areas (determined by BA). LWD. riparian habitat. etc.
- All other factors evaluated for the project by the project biologist result in a no effect or may effect. not likely to adversely effect determination. This must include a analysis of direct and indirect effects of the action.[4]

  ** Not all projects will be able to meet the above. Some may fall into the may effect. likely to adversely effect call.

Projects which work within water. may effect but are not likely to adversely effect listed fish if all three of the following conditions are met:

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- Work must be conducted within fish window (Gold & Fish list or as per HPA)
- Work must occur in a non-spawning or rearing area (as determined by project biologist in conjunction with WDFW Habitat Biologist or Tribal Biologist or other Fisheries Biologist)
- The project doesn't degrade the environmental baseline

(Rearing areas include pools, eddies, structures etc. but do not include glides)

MAY AFFECT LIKELY TO ADVERSERLY AFFECT

Stormwater from new impervious surface area may affect and is likely to adversely affect when:
Less than full treatment for all new impervious surface area when project is within a subbasin that provides habitat or potential habitat for a listed fish species.

Projects which work within water, but do not meet the "not likely to adversely affect category for in-stream work "will result in an adverse affect to listed fish.

Clearing, Grading and Filling may effect and is likely to adversely effect listed fish when:
Project is within ESU/DPS and does not fully implement TESC/SSP (including spill control) and is within a sub-basin that provides potential habitat for listed fish species.

BENEFICIAL EFFECT

Projects will have a beneficial effect when the stormwater treatment is :

Treatment + detention for a existing impervious area that is a greater than 0.40 * (new impervious area) within the project limits.

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1 NMFS is concerned that the detention ponds and other BMP's may not be sized large enough due to the fact that the Highway Runoff Manual is based on outdated rainfall data. Section 2-5 of the Highway Runoff Manual includes a chart which addresses the current safety margin included in the pond's size. This section will be revised to increase the safety margin at a later date. In addition, a study is underway to update the rainfall data.

2 DPS = Distinct Population Segment. USFW designation for bull trout listings.

3 BE = Biological Evaluation an evaluation done by a project biologist to determine the effects of the project on listed species. The BE may lead to a biological assessment if necessary.

4 A direct and indirect effect analysis must be included which covers the action area. The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action. Thus if it is a bridge replacement, address the upstream and down stream impacts, bank impacts, construction easement impacts, the road approach impacts, temporary bridge impacts, impacts caused by the detour route etc.

WSDOT Highway Runoff Manual BMP effectiveness rates

BMP	Information Source	MEDIAN REMOVAL RATE (%)				
		TSS	N	P	Lead	Zinc
Biofiltration Swale	FHWA	**70**	25	30	70	70
	WPT	**81**	38	29	67	71
	NTIS	**60**	10	20	70	60
	King Co. SWM	**77**	25	33	66	—
Wet Pond	FHWA	**90**	48	65	—	—
	WPT	**67**	24	48	73	51
	NTIS	**60**	35	45	75	60
Vegetated Filter Strip	FHWA	**70**	30	40	70	70
	WPT	**81**	38	29	67	71
	NTIS	**85**	—	90	—	85
	WSDOT	**83**	—	—	—	—
Extended (nutrient control) wet pond	FHWA	**79**	34	46	66	66
	WPT	**60**	42	58	73	51
Wet vaults/tanks	FHWA	**30**	<10	<10	<10	<10
	NTIS	15	5	5	15	5

Averaging all the pollutant removal effectiveness data for wet ponds and bioswales, which constitute ~90% of HRM BMPs constructed by WSDOT, yields a mean 72% (5/7) effectiveness ratio. Assuming that pollutant loading from new and preexisting impervious are identical, the area of preexisting impervious that needs to be provided treatment to yield no net increase in pollutant loading becomes (1-5/7)/5/7 = 2/5 = 0.4.

References:

FHWA - *Evaluation and Management of Highway Runoff Water Quality*, FHWA Publication No. FHWA-PD-96-032. June 1996.

NTIS - *Evaluation of Highway Runoff Pollution Control Devices*. U.S. Dept. of Commerce/National Technical Information Service, Publication Number PB97-138481, December 1996.

King Co. SWM - *Evaluation of Water Quality Ponds and Swales in the Issaquah/East Lake Sammamish Basins*. Final Report for Task 5 of Centennial Grant Agreement No. TAX90096, October 1995.

WPT - *Comparative Pollutant Removal Capability of Urban BMPs: A Reanalysis*, Watershed Protection Techniques, Vol. 2, No. 4, June 1997.

WSDOT - *Performance Evaluation of Vegetative Filter Strips and Safety Slopes as Water Quality BMPs*, unpublished ongoing research conducted by Dr. David Yonge, WSU - College of Civil and Environmental Engineering.

Appendix D

APPENDIX D

**TECHNICAL MEMORANDUM:
EROSION AND SEDIMENTATION CONTROL DURING
THIRD RUNWAY EMBANKMENT CONSTRUCTION**

Technical Memorandum

EROSION AND SEDIMENTATION CONTROL DURING THIRD RUNWAY EMBANKMENT CONSTRUCTION

Seattle-Tacoma International Airport
Third Runway Project

November 12, 1999

Prepared For:
The Port of Seattle

Prepared By:
HNTB Corporation

I. Introduction

Placement of earth and gravel fill material necessary for the proposed Third Runway embankment and other construction projects associated the Seattle-Tacoma International Airport Master Plan Update will be completed over several years. During the multi-year embankment project, material placement will be completed over much of the annual periods, including the wetter months, in order meet the project schedule. Embankment construction during the wetter times of the year could generate stormwater runoff containing silt, sand, or other suspended solids in excess of permit requirements. This technical memorandum describes the approach for collection, storage, treatment, and discharge stormwater runoff during embankment construction in order to meet required water-quality standards. These or similar methods were successfully implemented during the 1998-1999 construction period. Despite wet weather construction during record periods of heavy rain, all storm water discharges were achieved.

II. Construction Stormwater Standards

The Washington State Water Quality Standards (WAC 173-201A) requires that runoff from construction projects not increase receiving stream turbidity by more than 5 NTU (Nephelometric Turbidity Units). To meet those requirements, standard BMPs will be constructed and maintained as necessary in and around the embankment construction areas. Standard BMPs can be utilized to remove most of the suspended solids in the stormwater while also providing conveyance and retention. However, due to the large scale of the proposed third runway project, combined with the proximity of the construction sites to Miller Creek, Walker Creek, and Des Moines Creek, standard BMPs alone will likely not satisfy water quality requirements for turbidity. The standard BMPs have not historically provided adequate removal of very small (colloidal) suspended particles from the embankment runoff. Even with liberal application of standard BMPs throughout the project site, experience on previous projects indicates that additional treatment of construction stormwater runoff may be necessary to meet water quality standards for turbidity.

Standard BMPs alone will not provide the level of safety desired by the Port to assure that water quality requirements will be achieved during Third Runway Embankment construction. Therefore, additional or supplemental stormwater treatment is proposed as part of the Third Runway Embankment Construction Erosion and Sedimentation Control Plan (CESCP) to provide assurance that water quality requirements will be met and wet weather construction will be allowed. Specific supplemental stormwater treatment systems are described in the 1999 Draft Ecology Stormwater Management Manual. It is anticipated that the type of supplemental stormwater treatment system described in the draft Ecology Manual will be utilized during embankment construction to control erosion and sediment. The following section summarizes the anticipated overall Third Runway

Embankment CESCP, including the use of standard and experimental BMPs during construction. Development of the Third Runway Embankment CESCP is based on experience gained on wet-weather embankment projects completed in 1998 and 1999, as well as other projects in the region.

III. 1998 and 1999 Embankment Projects

During the spring, summer, and fall of 1998 and 1999, approximately 1.8 million cubic yards of embankment was placed in the northwest corner of the existing airfield. Standard construction erosion and sedimentation controls for the 1998 and 1999 projects included the following standard BMPs:

- silt fence
- grass and rock-lined swales,
- check dams,
- sediment traps,
- a large sedimentation pond,
- a truck wheel wash,
- soil coverings (bonded fiber matrix)
- hydroseeding

In addition to the above BMPs, the top of the embankment was sloped away from the embankment face at all times during fill placement. This reduced erosion by preventing runoff from the top of the fill from flowing down the embankment face. Collection of runoff from the top at the back of the embankment also allowed flexibility in routing the runoff to gain the most benefit from the standard BMPs. In addition, only fill material containing a lower percentage of very fine particles was placed during periods of wet weather to reduce the amount of sedimentation generated in the construction stormwater runoff.

Even with the above-described controls, it was determined early in the 1998 project that standard BMPs alone would not provide the treatment necessary to consistently meet DOE stormwater quality requirements for turbidity. Potential supplemental treatment systems were evaluated to ensure that water quality discharge standards would be achieved throughout construction.

A polymer stormwater batch treatment system was selected to provide supplemental stormwater treatment prior to discharge. The treatment system developed for these embankment projects was approved as an experimental BMP by the Department of Ecology. A brief summary of the supplemental treatment system constructed for the 1998/1999 embankment projects follows.

IV. 1998/1999 Supplemental Treatment Summary

Construction runoff containing suspended solids (silt and/or sand) was intercepted in collection swales and collected in a large sedimentation pond. Under standard Department of Ecology design criteria, stormwater would normally be discharged from the sediment pond after a pre-determined "residence time" which, in theory, would result in satisfactory water quality conditions. The pond and standard BMPs helped remove the larger particles, but the polymer treatment system further cleaned the runoff water by removing the smaller suspended fine particles (colloidal particles) that the standard BMPs could not adequately remove. The polymer treatment system developed for this project involved pumping of stormwater runoff from the sedimentation pond into one of several lined treatment cells constructed adjacent to the sedimentation pond. Each treatment cell acted as an individual mixing tank/settling pond in which liquid flocculents were added at closely monitored rates. The flocculents, when properly mixed with silt-laden water, cause the suspended particles to "bind" to each other creating a heavier particle. Eventually gravity causes the flocculents and silt particles to settle to the bottom of the cell (precipitation). After testing of the water in the cell to verify quality parameters, it is pumped to a roadside storm drainage system that ultimately discharges to Miller Creek. The cell is then refilled with silt-laden water and the process started again. The sludge that accumulates at the bottom of the cells is removed with vacuum trucks as needed and disposed of at approved disposal areas off Port property.

The process was extremely successful, with stormwater discharges from the 1998 embankment site exceeding water quality standards throughout the winter of 1998/1999, a record setting season for precipitation. Much of the treated water discharge was at or below creek turbidity, and at no time was the discharge greater than 5 NTU above the creek background turbidity. The treatment system resulted in construction storm water discharges far exceeding water quality standards, which call for no *increase* of background creek turbidity greater than 5 NTU.

In accordance with the approved BMP request, water quality monitoring and testing were regularly preformed on the treated water prior to discharge. The monitoring included tests for pH, turbidity, and settleable solids, as well as bioassays to assess treated water toxicity. The bioassays were performed by a Department of Ecology accredited laboratory and test results indicated 100% conformance to Department of Ecology construction stormwater quality criteria, including toxicity, pH, and turbidity. Approximately 15 million gallons of construction stormwater were treated without incident during the winter of 1998/1999.

A similar treatment system has been used for a private development project in Redmond, WA. Through November 1997, approximately 40 million gallons of storm water had been treated and discharged without incident.

Although effective, the batch treatment process used is labor intensive. Ongoing research is being conducted to evaluate other potential supplemental treatment systems that will improve on the batch treatment system used in 1998 and 1999.

Chemical treatment of construction stormwater runoff is a relatively new application of technology that is used extensively by municipalities for drinking water and wastewater treatment. The application of this technology is fostered by increasing standards for environmental protection and the need for extended construction seasons for large projects. The Puget Sound region, in particular the Cities of Redmond and Issaquah, Washington, are national leaders in the development of chemical treatment for construction stormwater management. Chemical treatment of construction stormwater runoff is being used for a number of both public and private development projects in those cities. It is anticipated that chemical treatment of construction stormwater runoff will become more widely used due to increased scrutiny of the effectiveness of current BMPs and greater enforcement of water quality standards to protect fish and fish habitat protected under the Endangered Species Act.

V. Future Embankment Projects

This section describes a general sequence of embankment construction and the associated erosion and sedimentation control facilities anticipated for use during future construction. Contract specifications for future embankment projects will include detailed construction phasing and sequencing plans with associated stormwater runoff controls necessary for each phase of construction. The contract documents may allow the construction sequencing plan contained in the contract documents to be tailored to best suit the operations of a general contractor. However, the stormwater runoff standards and treatment approach cannot be modified by any contractor-proposed revision to the sequence of construction contained in the plans.

Conceptual Construction Sequencing & Associated Storm Water Treatment

Generally, Third Runway embankment placement is anticipated to begin in the lowest portions of the area to be filled. The lowest portion of the topography also corresponds to one of the more environmentally sensitive areas within the project boundaries (due to adjacent wetlands and proximity to Miller Creek).

Stormwater runoff naturally flows to this low point of the site. In order to reduce the impacts to wetlands in this low area, no large sedimentation pond will be constructed in this area as would typically be necessary for stormwater control. One or more collection "sumps" or small ponds will be constructed. These "sumps" are intended to collect construction runoff that flows to this low area, but are not intended to hold the runoff water for settling or supplemental treatment. Instead, runoff collected by these sumps will be pumped to larger sedimentation ponds and supplemental treatment facilities located upstream of the low point and outside of wetlands. The larger, upslope sedimentation pond and treatment facilities will be located in non-wetland areas to reduce wetland impacts and reduce the risk of potential encroachment into wetlands.

The sumps needed for runoff collection will be sized to reduce wetland impacts, yet provide an adequate margin of safety to prevent unauthorized stormwater discharge during emergency conditions (i.e. extreme storm events or power failures). The capacity of the combined sumps and pump systems will be sized to accommodate at least twice the required stormwater runoff volume.

Runoff water will be diverted directly to the upstream sedimentation pond and treatment facilities once embankment construction reaches a height that will allow runoff to gravity flow directly to the sedimentation pond(s). After settling in the sedimentation ponds and supplemental treatment as necessary, runoff water will be released to Miller Creek.

Standard BMPs will be constructed and maintained throughout the work area, including the low-point construction area. The BMPs may include, but will not be limited to, silt fence, cutoff swales, rock check dams, truck wheel washes, and fabric erosion control matting. Embankment side slopes will be covered with bonded fiber matrix, hydroseeding, and/or erosion matting as necessary as soon as possible following finish grading. Runoff water flowing into the sumps in the low portions of the site will continue to be pumped to sedimentation ponds and treatment facilities as needed ensure water quality standards are met. When the side slopes in the area have been established with vegetative growth (hydoseeding) and the runoff meets water quality standards without additional settling or treatment, pumping will cease. Water flowing into the sumps will then be allowed to flow into drainage channels and eventually to Miller Creek or the adjacent wetlands via point discharges, perforated pipe, porous rock berms, or infiltration swales as appropriate.

Runoff from construction areas outside the lowest topographical areas will be routed directly to sedimentation ponds and supplemental treatment facilities (as needed) located west of the construction zone and outside of wetlands. In general, a temporary cutoff swale will be constructed just outside (west) of the toe of the embankment prior to any site preparation or material placement. The cutoff swale will intercept construction runoff from the work area and divert it to previously constructed sedimentation ponds/treatment facilities.

To protect the outer fill slopes from erosion throughout the embankment program, fill will be placed to always slope back from the toe of the slope (to the east) as was successfully accomplished during the 1998 Embankment. A collection channel at the back of the embankment will collect stormwater runoff from the top of the fill and flow to the sedimentation ponds/treatment facilities, similar to the collection method used for the 1998 Embankment. The exposed face of the fill slope will be stabilized with hydroseeding and/or erosion matting as soon as possible following finish grading.

A conceptual storm drainage plan is shown in Figure 1, and sequential cross sections of the embankment during construction are depicted in Figures 2 and 3. Embankment will be placed in phases over several years. The exposed surface area at any given time during construction will be limited to an area equal to or less than the area of exposed surface that would generate turbid runoff in excess of the capacity of the stormwater treatment systems, less an appropriate factor of safety. Capacity of the various treatment systems (including ponds and supplemental treatment) is dependent on several varying factors and that will also influence the area of allowable exposed surface. The factors include existing soils type, fill material type, season of construction activity, and type of supplemental treatment system. On-going planning and research is being conducted to determine the construction phasing schedule and combination of treatment systems that will best meet project needs, including water quality requirements.

Special Considerations

- Pond Sizing and Overflow:
  The sedimentation ponds, sump ponds, swales, pumps, and supplemental treatment facilities necessary for a particular work area will be constructed and operational prior to fill placement. The facilities will be designed to accommodate the runoff flow that can be expected, in accordance King County and Ecology Requirements. In the unlikely event stormwater runoff volume in the ponds exceeds the design storm, pond overflow structures will be provided to allow controlled overflow discharges to minimize potential damage from the overflow. Backup power supply sources will be available for the pumping and treatment systems that require power to operate, and at least one-foot of freeboard will be provided in sedimentation ponds.

- Supplemental Treatment:
  As with the previous projects, supplemental stormwater treatment in addition to standard BMPs may be provided to ensure water quality standards are met throughout the embankment construction program. Potential supplemental treatment systems include:

  - Chemical batch treatment cells (i.e.: 1998/1999 system)
  - High-volume mechanical filtering devices, with or without chemical treatment
  - Flow-through clairifiers, with or without chemical treatment
  - Flow-through ponds, with chemical treatment

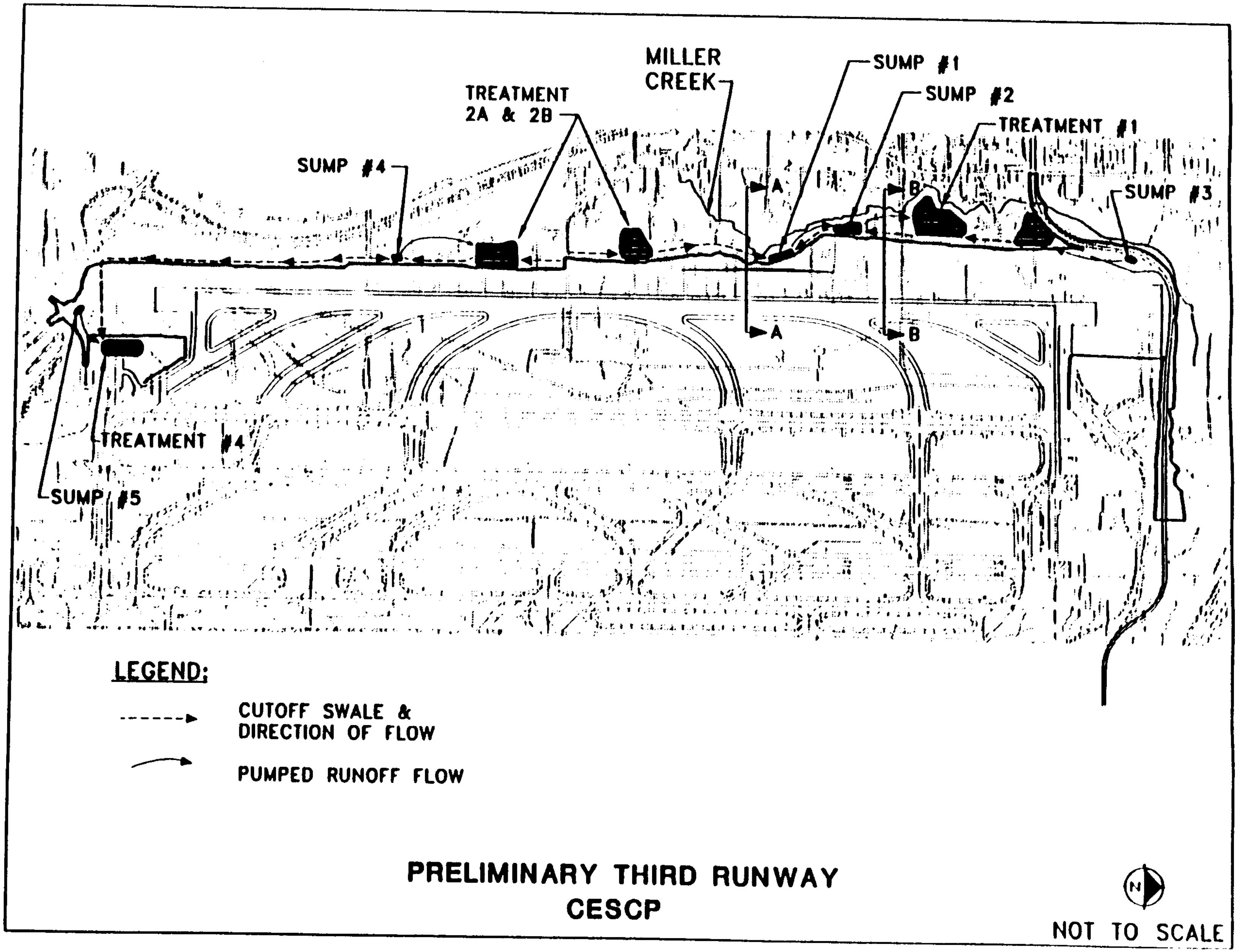
  On-going research is being conducted to develop the experimental BMPs that will achieve water quality standards and best fit the needs of the Third Runway Embankment projects. It is expected that the approved experimental BMPs will utilize one or more of the above supplemental treatment systems.

  Supplemental treatment will be provided as necessary to meet runoff water quality requirements throughout future embankment programs. The supplemental treatment system(s) will be approved for use by the Department of Ecology prior to operation. The BMP request will also include detailed description of the water testing and quality assurance program, similar to the testing program developed for the 1998/1999 batch treatment system. The specific treatment systems to be utilized for the future embankment programs will be chosen based on past experience, the ability to fulfill project requirements for performance and reliability, and DOE approval.

- Pumping:
  Pumping of stormwater runoff will allow flexibility in locating sedimentation ponds and thereby reduce wetland impacts. Pumping of stormwater was a key component of the successful 1998/1999 Embankment project. Pumping in 1998/1999 was achieved utilizing trailer-mounted portable pumps. Similar pumps are anticipated to be used during future embankment programs.

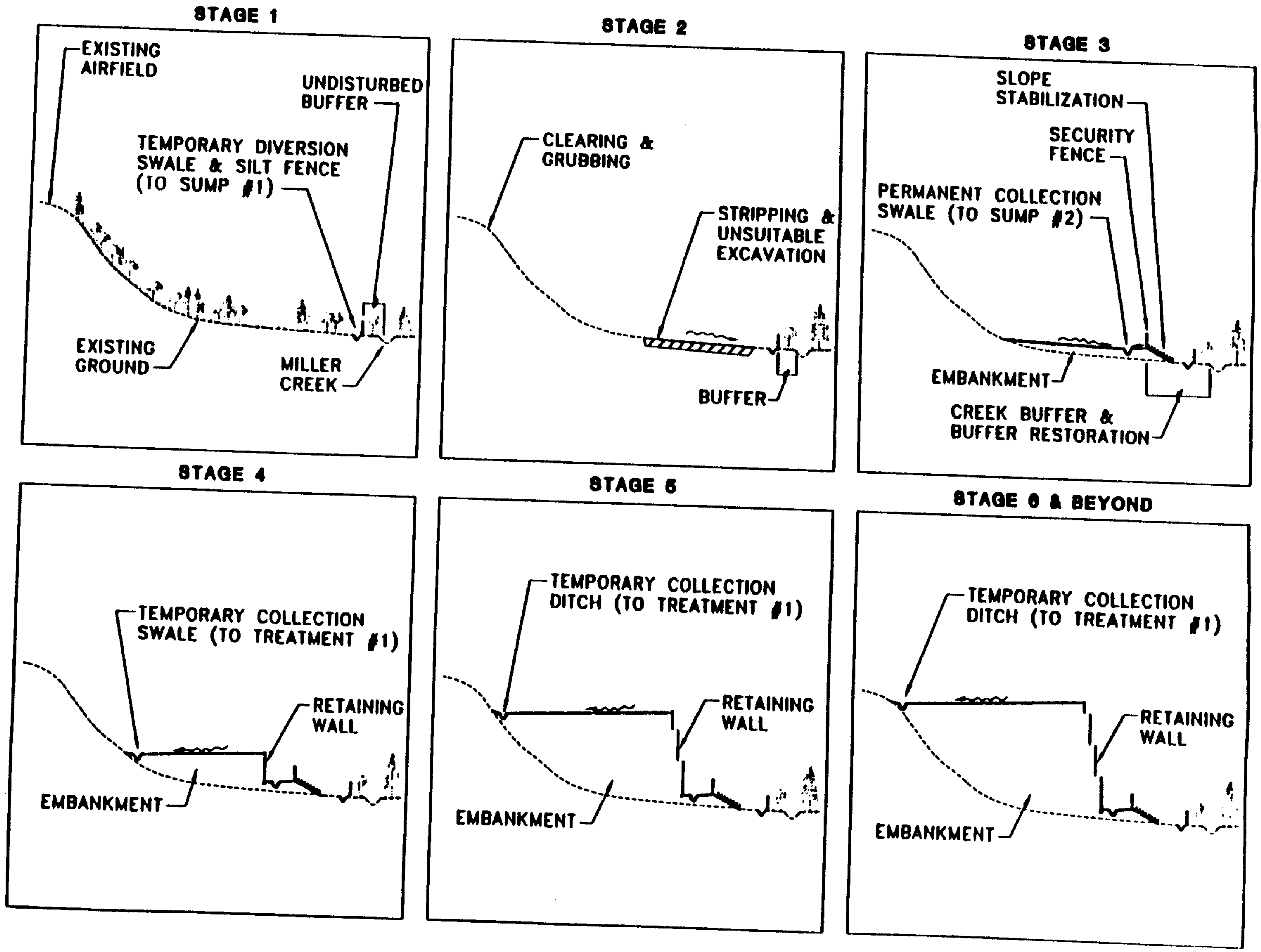
- Clean Runoff Diversion:
  During construction, runoff from undisturbed areas will be routed, as much as possible, around disturbed areas. This will reduce runoff quantities from exposed surfaces to further assure water quality standards can be met. Diversion will be accomplished using diversion swales and/or temporary piping around construction areas. Pipe outlets, level spreaders, swales, or other devices may be used to reduce erosion at the discharges of these diverted clean water flows.

- Maintenance:
  The stormwater management facilities will be regularly maintained throughout the multi-year construction period. Maintenance may include soil and turf repair as necessary, removal of sediment accumulation from the swales and ponds, and restoration of silt fencing, pipe inlets and outfalls.



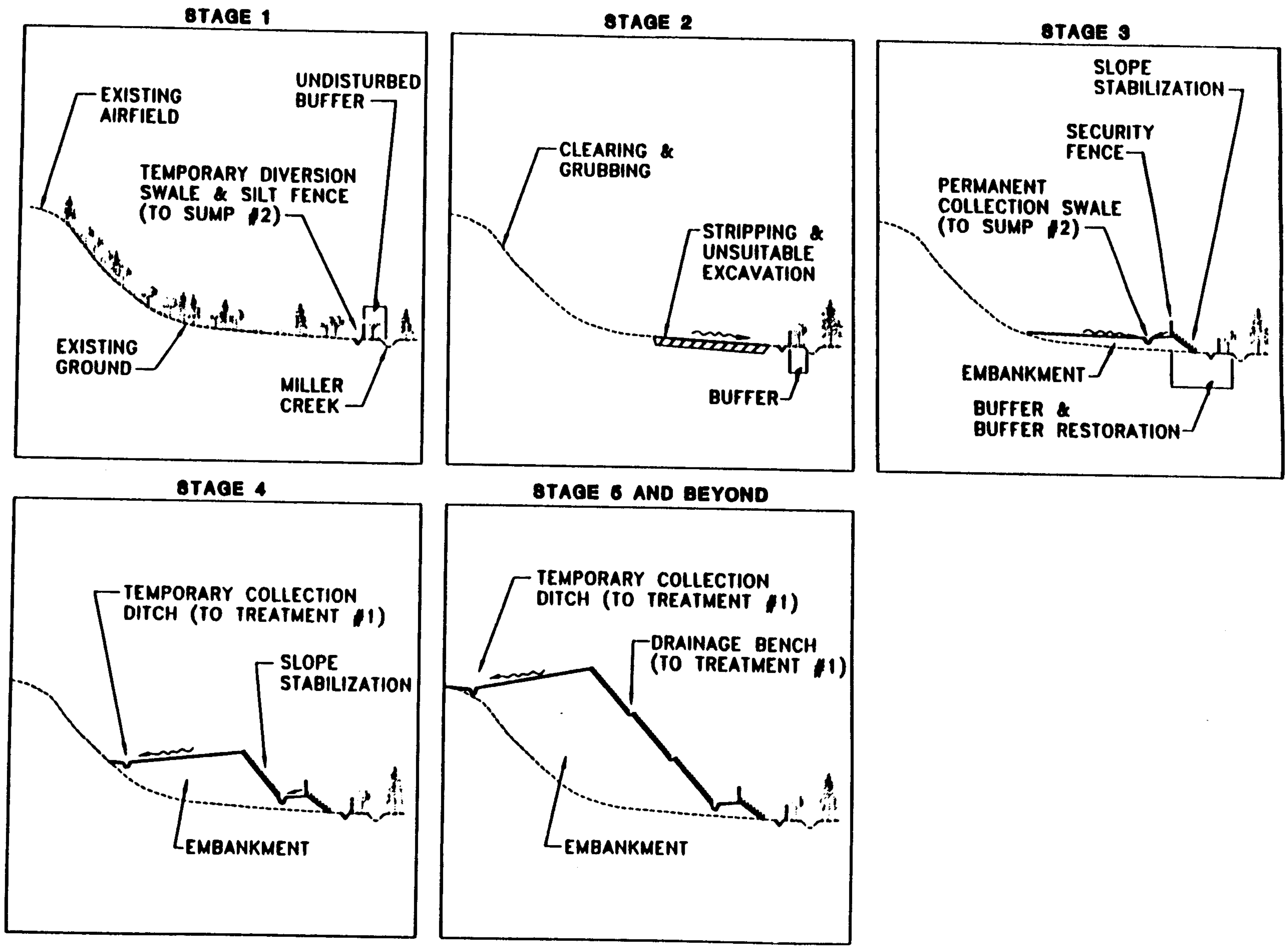
PRELIMINARY THIRD RUNWAY
CESCP

FIGURE 1



SECTION A-A

FIGURE 2
NOT TO SCALE



SECTION B-B

FIGURE 3
NOT TO SCALE

Appendix E

APPENDIX E

TECHNICAL MEMORANDUM: USE OF INTERSPECIES EXTRAPOLATION TO DEVELOP TOXICITY THRESHOLDS FOR CHINOOK SALMON AND BULL TROUT

INTRODUCTION

Assessing the allowable toxicant concentration in environmental systems is often hindered by the lack of toxicity data for all organisms inhabiting a particular ecosystem and the specific chemicals or metals under evaluation. In many cases, toxicity data are only available for a standard test species that may not represent the sensitivity of the organism of interest. Because of the time and costs associated with testing all species of interest, extrapolation among different species is frequently used to assess toxicity values in the absence of the full suite of toxicity parameters (King County 1999). Suter et al. (1983) examined the implications of the extrapolation of LC50 data among piscine taxonomic categories. These authors found that the correlation of LC50 values followed taxonomic rank, with the greatest correlation occurring among congeners and decreasing to comparisons between orders. The following discussion explores the utility and implications of extrapolating LC50 values among Pacific salmon and between salmon and standard toxicity test organisms to evaluate potential water quality impacts associated with the Port of Seattle MPU projects.

This approach replicates the work of Suter and his colleagues by constructing linear relationships among the LC50 values of different species of the family salmonidae, the fathead minnow and *Daphnia*. The toxicity data for the organic compounds used in this analysis was taken from Johnson and Finley (1980). The value of using this study was that all tests were conducted in a single laboratory under similar conditions, thus eliminating the issue of inter-laboratory variation in test results. The data are 96-hour LC50 values (µg/L) for various salmon species and fathead minnows (*Pimephales promelas*) for a variety of insecticides and other organic compounds (Tables E-1 and E-2). The data were culled to assure that LC50 comparisons were made between identical formulations of compounds and that similar sized test specimens were used in the respective studies. The toxicity data for metals were compiled from ambient water quality criteria documents developed by the U.S. EPA and from the scientific literature. The metal toxicity data compiled from the scientific literature met U.S. EPA guidelines for test acceptability (Stephan et al. 1985). These guidelines ensure that toxicity data are compiled from tests based on standard methods and are of reliable quality. LC50 data for both organic compounds and metals was most available for rainbow trout, fathead minnow, and *Daphnia magna* (metals only), therefore each of these species served as the independent variable against which the other species were regressed. An additional comparison between the genus *Oncorhynchus* and fathead minnows and between *Oncorhynchus* and *Daphnia* was conducted by regressing the average LC50 of species in the *Oncorhynchus* genus against the LC50 of fathead minnows or *Daphnia*. The natural log of the LC50 values was used in all regression models to reduce heterogeneity of variance and improve the linear fit of the regression models.

RESULTS

Organic Compounds

All regressions resulted in a significant linear relationship between the organic pesticide LC50 values for the different species and most of the regressions resulted in a one to one relationship between LC50 values (Figures 1-2).

Table E-1. Common name of organic compounds and metals used in LC50 determination.

Organic Compounds			
Aldrin	Carbaryl	DDT	RU-11679
Folpet	Naled	Phthalic Acid Esters	d-Trans Allethrin
Aminocarb	Carbofuran	Dichlofenthion	SD-141114
Leptophos	Parathion Ethyl	Picloram	Endothall
Antimycin A	Chlordane	Dieldrin	SD-17250
Lindane	Parathion Methyl	Purifloc C-31	EPN
Azinphos Methyl	Chlorpyrifos	Dinitramine	Temephos
Malathion	Pentachlorophenol	Resmethrin	Fenitrothion
Benzene Hexachloride	Coumaphos	Dioxathion	Toxaphene
Methomyl	Pentachlorophenol Sodium Salt	Ronnel	Fenthion
Captan	Crotoxyphos	Diuron	Trichlorfon
Methyl Trithion	Phosmet		
Metals			
Cadmium	Mercury	Silver	Zinc
Copper	Nickel		

Table E-2. Common and scientific name of fish and invertebrate used for LC50 comparisons

Family (fish) or Order (invertebrate)	**Genus**	**Species**	**Common Name**
Salmonidae	Oncorhynchus	mykiss	Rainbow Trout/Steelhead
	Oncorhynchus	kisutch	Coho Salmon
	Oncorhynchus	tshawytscha	Chinook Salmon
	Salmo	trutta	Brown Trout
	Salvelinus	namaycush	Lake Trout
Cyprinidae	Pimephales	promelas	Fathead Minnow
Cladocera	Daphnia	magna	Water flea

For *Oncorhynchus* species examined, regression coefficients of determination (r^2) ranged from 0.97 to 0.90 between species. Correlation between rainbow trout and coho salmon was greatest while the correlation between rainbow trout and chinook salmon was the lowest. The slopes of the regressions strongly suggest a one to one relationship between *Oncorhynchus* sp. LC50 values, with all slopes statistically indistinguishable from 1.0 (Table E-3).

Table E-3. Results of LC50 regression analysis, all regressions and slopes tested at α=0.05.

Independent Variable	Dependent Variable	Regression Equation	r^2	n	Slope=1
		Organic Compounds			
Rainbow trout	Coho salmon	$Ln(LC50)_{Coho}$=0.12+ 1.03*ln$(LC50)_{Rainbow}$	0.97	15	Yes
	Chinook salmon	$Ln(LC50)_{Chinook}$=1.4+ 0.74*ln$(LC50)_{Rainbow}$	0.90	7	Yes
	Brown trout	$Ln(LC50)_{Brown}$=-1.39+ 1.23*ln$(LC50)_{Rainbow}$	0.92	13	Yes
	Lake trout	$Ln(LC50)_{Lake}$=1.58+ 0.72*ln$(LC50)_{Rainbow}$	0.83	16	No
Fathead minnow	O. spp.	$Ln(LC50)_{O. spp}$ =-0.46+ 0.91*ln$(LC50)_{Fathead}$	0.86	22	Yes
	Rainbow trout	$Ln(LC50)_{Rainbow}$=-0.32+ 0.89*ln$(LC50)_{Fathead}$	0.84	18	Yes
	Coho salmon	$Ln(LC50)_{Coho}$=-0.84+ 0.93*ln$(LC50)_{Fathead}$	0.85	12	Yes
	Brown trout	$Ln(LC50)_{Brown}$=-2.61+ 1.11*ln$(LC50)_{Fathead}$	0.73	8	Yes
	Lake trout	$Ln(LC50)_{Lake}$=-0.70+ 0.85*ln$(LC50)_{Fathead}$	0.80	10	Yes
		Metals			
Rainbow trout	Coho salmon	$Ln(LC50)_{Coho}$=0.76+ 0.98*ln$(LC50)_{Rainbow}$	0.93	5	Yes
Fathead Minnow	O. spp.	$Ln(LC50)_{O. spp}$ =-1.62+ 1.31*ln$(LC50)_{Fathead}$	0.89	6	Yes
	Rainbow trout	$Ln(LC50)_{Rainbow}$=-2.15+ 1.35*ln$(LC50)_{Fathead}$	0.85	5	Yes
	Coho salmon	$Ln(LC50)_{Coho}$=-2.23+ 1.53*ln$(LC50)_{Fathead}$	0.80	5	Yes
Daphnia	All Salmonids	Not Significant	-	-	-
	Fathead	$Ln(LC50)_{Fathead}$=2.72+ 0.72*ln$(LC50)_{Daphnia}$	0.74	6	Yes

Comparisons between genus within the family salmonidae were limited to regressing brown trout and lake trout against rainbow trout. As with congener comparisons, the regression coefficients of determination were high, 0.92 and 0.83 for brown trout and lake trout respectively with only the slope of lake trout (0.72) significantly different from the one to one relationships.

Comparison of the family salmonidae with fathead minnow, a standard test organism, resulted in significant linear relationships with slopes indistinguishable from 1 (see Table E-3). LC50 values for fathead minnows were strongly correlated with those of the genus *Oncorhynchus* (r^2=0.86, Figure 3). Regression coefficients of determination for individual species ranged from 0.73 (fathead minnow vs. brown trout) to 0.85 (fathead minnow vs. coho salmon), with low values occurring in comparisons with low sample size.

Metals

The regressions of LC50 values for metals resulted in strong linear relationships only between congeners. Correlation above taxonomic rank of genus was hindered by the reported LC50 values of cadmium, for which salmonids show greater sensitivity than fathead minnow and Daphnia.

Within the genus *Oncorhyncus*, the linear relationships between metal LC50 values are strong, but limitations of sample size only allow for regression analysis between rainbow trout and coho salmon. The rainbow trout-coho salmon regression resulted in a coefficient of determination of 0.93 with a slope indistinguishable from 1.0 (Figure 3).

The increased sensitivity of salmonids to cadmium is evident in the comparison between fathead minnows and salmonids. However, even with the discrepancy between cadmium sensitivity, the LC50 values of coho and chinook salmon as well as the genus *Oncorhynchus* were linearly related to those of fathead minnows. The coefficient of determination were 0.80, 0.85, and 0.89 for coho, chinook, and *Oncorhynchus* spp., respectively (Figure 4).

Among the linear comparisons with Daphnia, the only significant regression resulted between fathead minnows and Daphnia (r^2=0.73). All comparisons to individual salmon species and the *Oncorhynchus* spp. group were not significant, primarily due to the high sensitivity of salmonids to cadmium (Figure 5).

Discussion

The results of this analysis coincide with that of Suter et al. (1983). Taxonomically close organisms exhibit high correlation between LC50 values and the strength of the correlation is dependent upon the taxonomic diversity of the organisms under consideration. This general linear relationship among LC50 values was evident in both the metal and organic compounds. However, the taxonomic differences were highlighted more obviously in the metal toxicity analysis.

Because of the strong linear relationships between the LC50 for the organic compounds of the fish species examined, it is reasonable to employ the toxicity data of test species such as fathead minnow and rainbow trout as estimates of LC50 for taxonomically related species where no such data exists. Estimates of the LC50 for organic compounds could be garnered directly from the regression equations generated (Table 3) or more conservatively, but calculating the lower 95th percentile of the estimated LC50. For example, the LC50 for chinook salmon could be estimated from a fathead minnow LC50 using the lower 95th percentile of the *Oncorhynchus* spp. regression (Figure 6) using the following equation:

$$Ln(LC50_{Chinook}) = Y_{Est} - t_{0.05,n-2} \times \sqrt{MS_{Res}^2\left(1+\frac{1}{n}+\frac{(x-\bar{x})}{\sum x^2}\right)}$$

Where Y_{Est} is the predicted LC50 value from the *Oncorhynchus* spp. equation in Table 3, $t_{0.05,n-2}$ is the t critical value with n-2 degrees of freedom, MS_{res} is the mean squared residuals from the regression analysis, n is the number of observations, x is the LC50 for fathead minnows, and x bar is the mean fathead minnow LC50 used to generate the regression.

The identical equation can also be used to estimate the LC50 for metals of chinook salmon. However, rainbow trout should be used as the basis for estimation because of the differences in sensitivity to cadmium between fathead minnows and salmonids.

Figure 1. Scatter plot of salmonid LC50 values for organic compounds. Solid line represents 1 to 1 relationship.

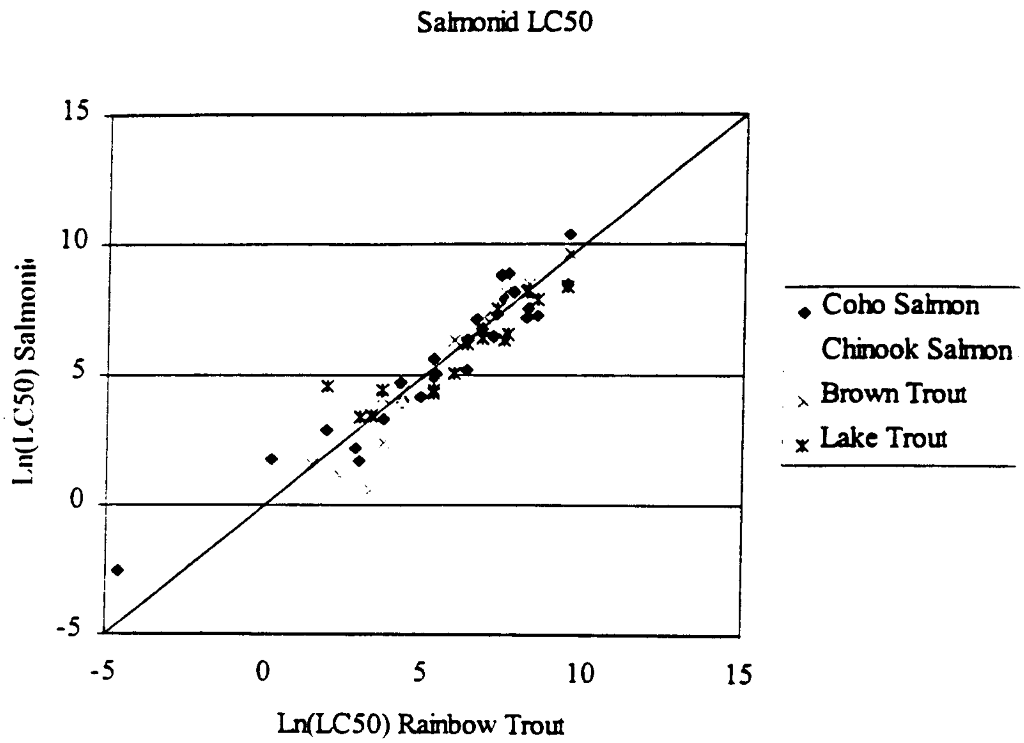


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Figure 2. Scatter plot of salmonid LC50 values against LC50 for Fathead minnow for organic compounds. Solid line represents a 1 to 1 relationship.

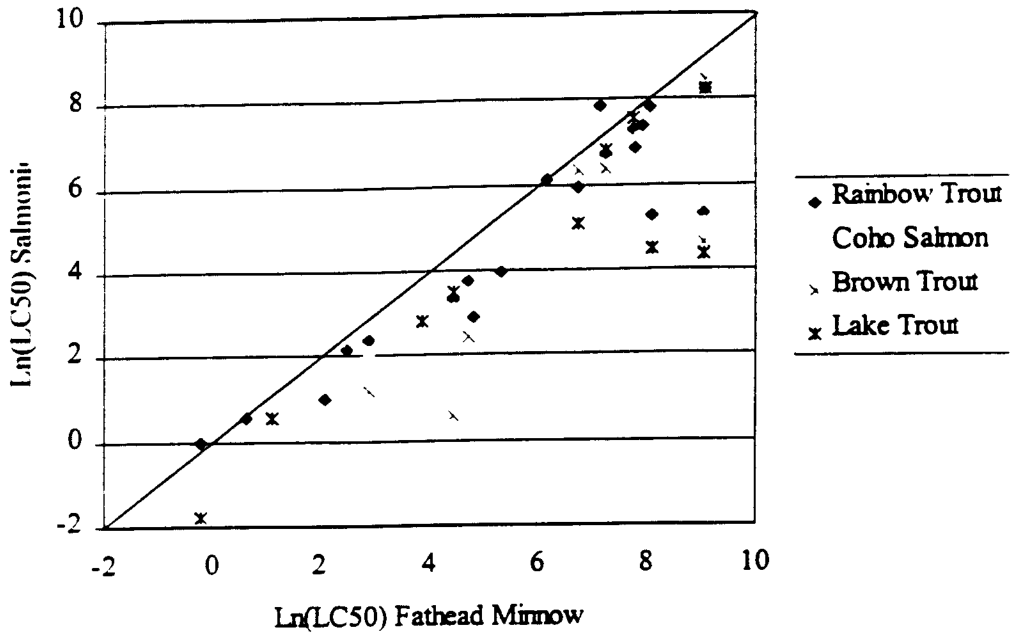


Figure 3. Scatter plot of salmonid LC50 values for metals.

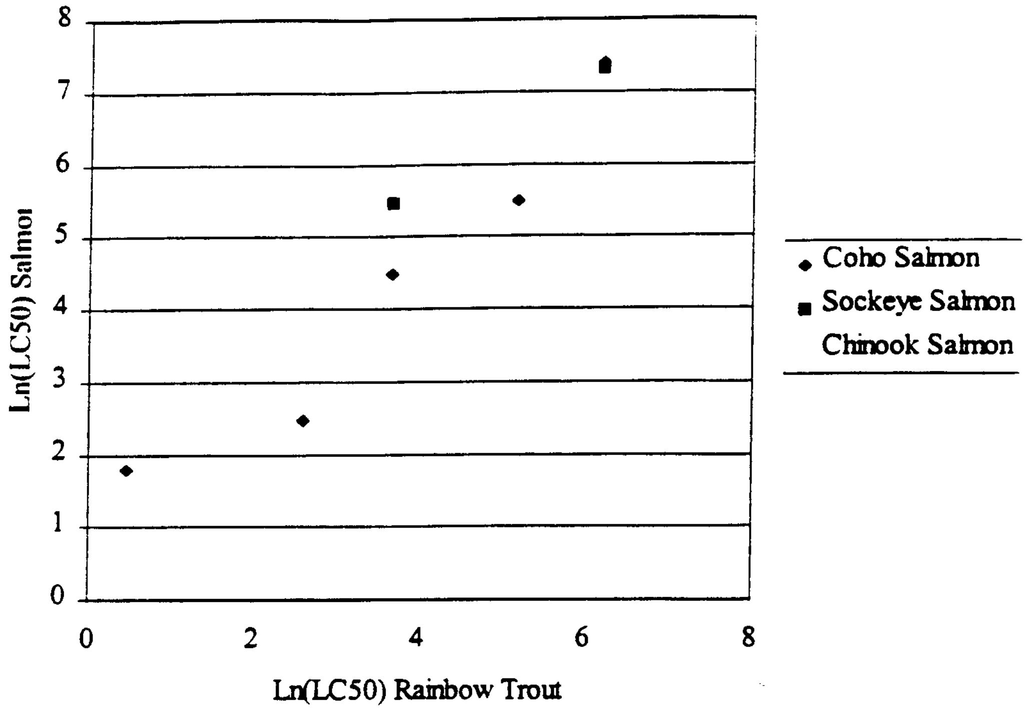


Figure 4. Scatter plot of salmonid LC50 values against LC50 for fathead minnow for metals.

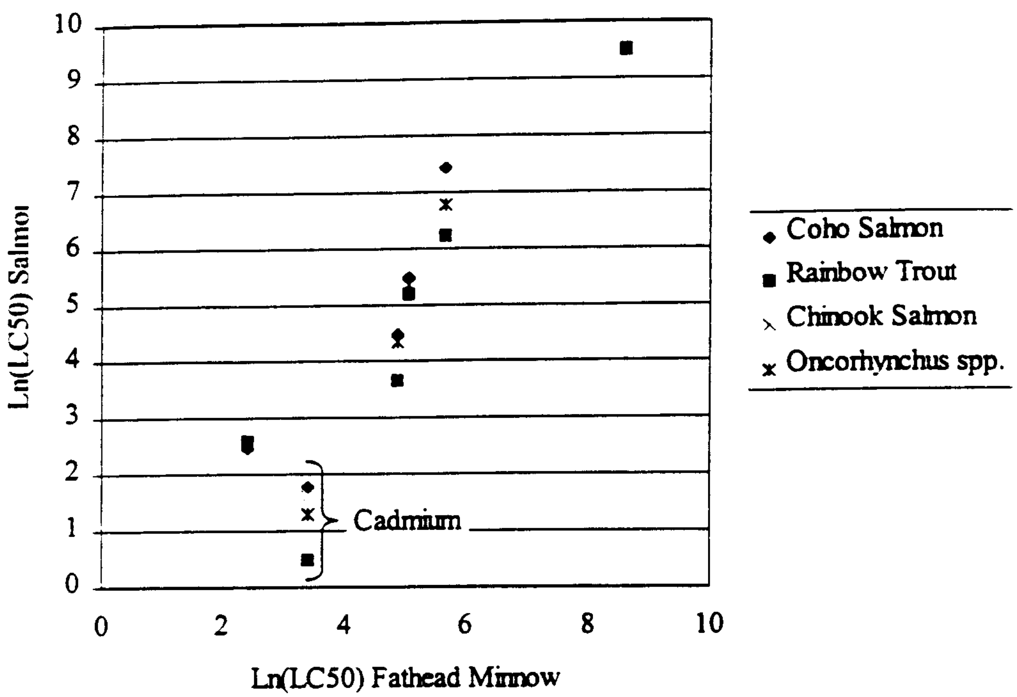


Figure 5. Scatter plot of salmonid and fathead minnow LC50 values against LC50 Daphnia magna for metals.

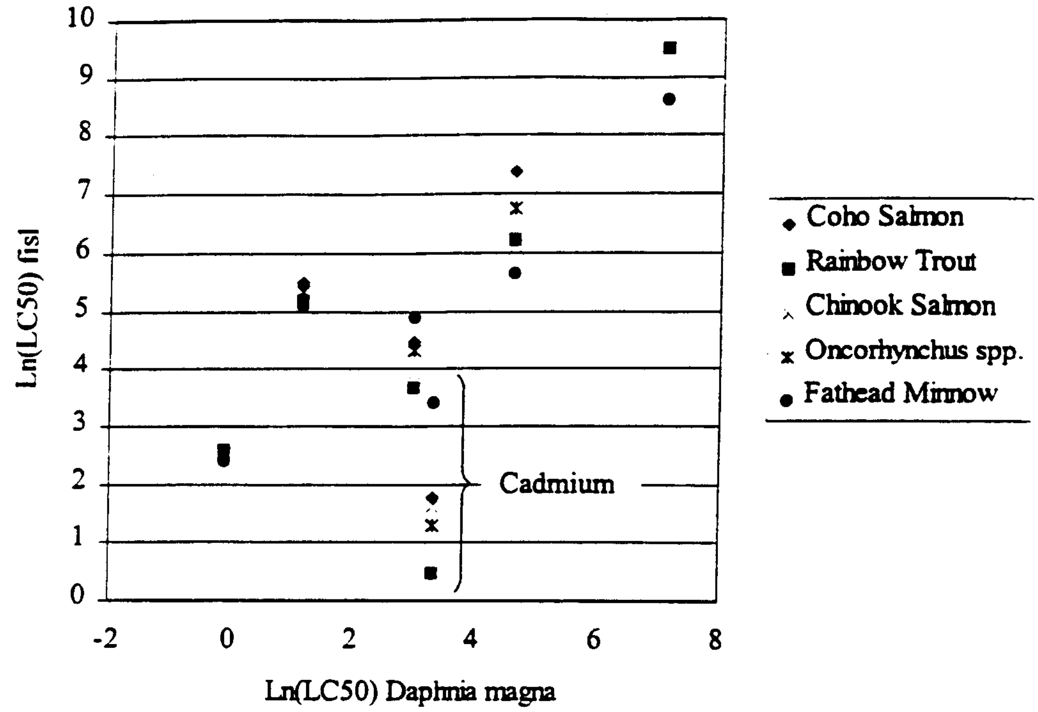
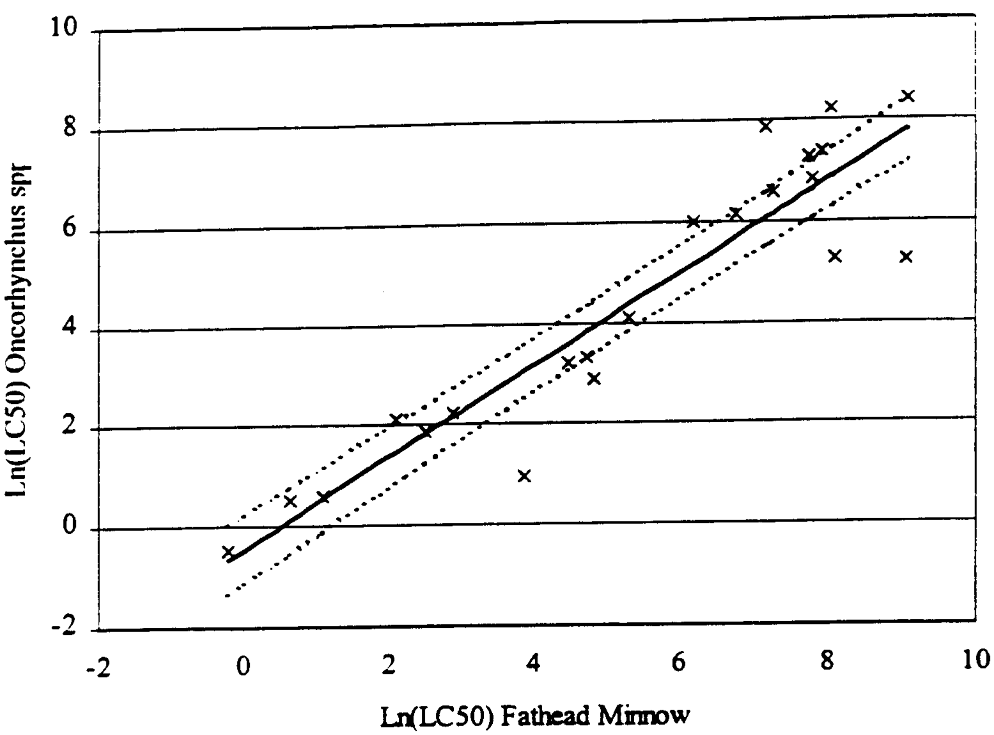


Figure 6. Regression of average salmonid LC50 values for organic compounds against those for fathead minnows. Solid line indicates the predicted linear relationship (the equation in Table 3), dashed lines represent the 95 % confidence interval.



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Appendix F

APPENDIX F

WATER QUALITY MODELING

1. INTRODUCTION

Evaluating the affects of chemicals discharged to the aquatic environment requires knowing the concentrations where listed species may be present, as well as the effects of these concentrations[1]. This appendix presents the methods used to determine the potential exposure concentrations to the species evaluated in the Biological Assessment (BA). A modeling approach was used to predict these concentrations because no direct measurements have been made at the possible exposure locations. Chemical concentrations of copper, zinc, and glycols in areas where listed species could be exposed to Seattle Tacoma International Airport (STIA) stormwater were predicted using two mathematical models[2]. These models used measured concentrations from existing discharges to mathematically predict exposure concentrations where chinook salmon and bull trout may be present in the Action Area. Measured concentrations for several years (1994 to 2000) are available as a result of a regular compliance monitoring of stormwater chemical concentrations as required by the STIA NPDES permit. Chemical concentrations in stormwater discharged to Miller, Walker, and Des Moines creeks as well as from the Industrial Wastewater Treatment Plant (IWTP) were available for incorporation into this study.

This evaluation applies the best available scientific analyses to the best available hydraulic and chemical data to predict exposure concentrations which can be evaluated in the BA for effects on listed species. The following sections identify the data sources, mathematical models, and the methods specific to the Industrial Wastewater System (IWS) and the Stormwater Drainage System (SDS) systems, and the results of the analysis.

2. METHODS

2.1 DATA SOURCES AND MODELS

Concentrations discharged from the IWS system to the Midway Sewer District Discharge were calculated using measured concentrations reported in the Port of Seattle discharge monitoring reports submitted to the Department of Ecology per NPDES permit requirements (WA-002465-1). Data were available from December 1994 through January 2000 (available from the Washington Department of Ecology or in the Burien Public Library). Four additional copper and zinc concentrations for the North Employee Parking Lot (NEPL) were used from a November, 1999 letter from Earl Munday, Port of Seattle Aviation Project Management Group to Dave Hilmoe, Seattle Public Utilities Water Quality and Supply (Table F-1).

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[1] Methods used to establish effect concentrations are presented in Appendix E.

[2] Copper, zinc, and glycols were selected for evaluation after reviewing the Port of Seattle discharge monitoring reports. Glycols were selected based on the extensive use of these chemicals in airport operations. Copper and zinc were selected based on the observed concentrations in stormwater.

Table F-1. NEPL stormwater analytical results used to predict stormwater concentrations. All units are mg/L. (See above referenced letter for the raw data set).

Parameter	Observed Value – Jan. 14, 1999	Observed Value - Feb. 22, 1999	Observed Value - May 15, 1999	Observed Value – Oct. 8, 1999
Total Cadmium	<0.00020	<0.00020	<0.00020	<0.00020
Total Copper	<0.0020	<0.0020	0.0118	0.0070
Total Lead	<0.0020	<0.0020	<0.0020	<0.0020
Total Zinc	0.049	0.038	0.124	0.102

The diluted concentrations of contaminants after mixing with the Midway Sewer District effluents were predicted at the outfall into Puget Sound using the PLUMES model (U.S. EPA 1993a). Dilution factors were calculated using information about the diffuser geometry and the characteristics of the receiving water, e.g. salinity and temperature (Cosmopolitan Engineering Group, Inc. and Kennedy-Jenks Consultants, 1997).

The HSPF model (U.S. EPA 1993b) was used to simulate daily flow volumes from each outfall (or combination of outfalls) contributing to Miller, Walker, and Des Moines creeks for a period of 49 years, 1948-1996. This period was selected to use all available rainfall monitoring data available for the airport. Only data through 1996 were available when the model was developed and the data have not been updated[3].

2.2 INDUSTRIAL WASTEWATER SYSTEM

Discharges contributing to the Midway Sewer District Outfall are the STIA IWS and the Midway Wastewater Treatment Plant. IWS effluent combines with Midway effluent in the Midway conveyance pipe which is then diluted by marine water when it is discharged to Puget Sound. To estimate chemical loadings to this outfall, 95th percentile concentrations[4] were calculated for the IWS effluent and the Midway Sewer District effluent for ethylene and propylene glycols, copper, and zinc. (The Midway effluent was assumed to have no glycol concentrations.) IWS effluent glycol 95th percentile concentrations were calculated from a fitted lognormal distribution. Detection limits were included at half their values and the zero reporting sample results were excluded. Copper and zinc 95th percentile concentrations were estimated using EPA recommended methods (U.S. EPA 1991).

Calculating the 95th percentile for copper and zinc concentrations in the IWS effluent and the Midway effluent required a special approach due to the limited amount of data available (only 7

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[3] Data from the *September 1999 Annual Stormwater Monitoring Report* (Port of Seattle 1999) were used to calculated the 95th percentile concentrations used in these dilution calculations

[4] The 95th percentile represents 95% of the chemical concentrations that could be contributed by STIA operations. It is intrinsically a conservative estimate of these loadings, as most of the time, these concentrations will be below this amount.

sample results reported). Rather than calculating a coefficient of variation (CV) from the actual data, per EPA recommendations, a CV of 0.6 was assumed. The 95th percentile was then calculated as a multiplier times the maximum concentrations, 35 mg/L for copper and 130 mg/L for zinc. The multiplier for a sample size of 7 and CV of 0.6 is 2.0 (U.S. EPA 1991). The same method was used for the Midway effluent using the single concentration measured, 13 mg/L for copper and 44 mg/L for zinc. The multiplier for a single sample is 6.2 (U.S> EPA 1991). Copper and zinc concentrations were converted from a total to a dissolved basis by multiplication by a "metals translator," i.e. a conversion factor, (Washington Department of Ecology Water Quality Standards (WAC 173-201A)).

The total contaminant concentrations discharged were then calculated as a flow-weighted sum of the concentrations discharged from IWS and Midway. The 95th percentile concentration from each outfall was multiplied by the percent contribution that each outfall contributed to the total flow then summed to obtain the total contaminant contributed.

Once the loadings concentrations were calculated as 95th percentiles, the PLUMES model was used to calculate dilution factors for different flow rates from the Midway outfall. The concentration at various distances from the diffuser port was calculated as the maximum flow-weighted concentration divided by the average dilution factor predicted at that distance. The dilution results presented are for the single five-inch port at the end of the diffuser. The discharge is estimated to be greater from this port than any of the three-inch ports, and therefore the concentrations in the receiving water are expected to be greatest near the five-inch port.

2.3 STORMATER DRAINAGE SYSTEM

The 95th percentile concentrations for ethylene and propylene glycols, copper, and zinc at individual outfalls were calculated using concentration data reported in the *Annual Stormwater Monitoring Report, September 1999* (Port of Seattle 1999). Individual creeks received discharges from the following outfalls:

- Miller Creek - SDN-1, SDN-3, SDN-4, NEPL, Cargo, and SDW-1
- Walker Creek - SDW-2
- Des Moines Creek - SDE-4, SDS-1, SDS-2, SDS-3, SDS-3A, SDS-4, SDS-5, SDS-6, and SDS-7

Some outfalls were combined to facilitate direct use of the contaminant concentrations with the stormwater runoff model (output) which does not simulate each outfall but various combinations of them. The methods used to estimate non-sampled outfalls are described in the following paragraphs.

Estimates were made for SDN-1, NEPL, Cargo, SDW-1, and SDW-2 for Miller creek. The 95th percentile concentrations for SDN-1 were calculated from a lognormal distribution fit to all of the SDN-1 concentrations. NEPL was assumed to have zero glycol concentration because no planes are deiced in this area. The copper and zinc 95th percentile concentrations were calculated per EPA recommended methods (U.S. EPA 1991) using the four concentrations reported at each outfall. The calculated 95th percentile concentrations for SDN-1 were also used to represent the concentrations from Cargo because of the similarity of land uses and airport operations between the two drainage areas. SDW-1 and SDW-2 concentrations were represented by the aggregate airfield 95th percentile concentrations reported due to the similarity of land uses and airport operations between the drainage areas. The airfield is a combination of outfalls SDS-3, SDS-4, SDN-3 and SDN-4.

Estimated concentrations for outfalls into Des Moines creek included combined SDS-3, SDS-3A, and SDS-7 and SDS-2, SDS-5, and SDS-6 combined. The 95th percentile concentrations for SDS-3 were used to represent the combined SDS-3, SDS-3A and SDS-7 outfalls. The combined SDS-2, SDS-5, and SDS-6 outfalls 95th percentile glycol concentration was assumed to be zero because planes are not deiced in these areas. The copper and zinc concentrations used were the higher of the 95th percentile concentrations for outfalls B and D, outfall B for copper and outfall D[5] for zinc.

The total concentration contributed by all outfall discharges was calculated as a flow-weighted sum of the 95th percentile concentrations from each individual outfall. The percent contributed by each outfall was calculated as the ratio of outfall flow to total outfall flow. This flow ratio was multiplied by the 95th percentile concentration for each outfall and summed to obtain the total concentration flowing into the creek. This method assumes that the 95th percentile concentration would occur concurrently at each outfall, i.e. all outfalls covary perfectly[6].

The HSPF model was used to calculate hourly runoff from each SDS outfall and total flow near the mouth of each creek[7]. The effect of choosing these locations is that the total freshwater discharge to the estuarine zone is slightly underestimated for the purpose of calculating dilution factors. Therefore dilution factors at the mouth of each creek will be slightly greater, and contaminant concentrations slightly lower.

The hourly output of the HSPF model was aggregated into total daily discharge volumes. Diluted concentrations near the mouth of Miller, Walker, and Des Moines creeks were calculated daily using the simulated flow based on the 49 years of rainfall record at STIA.

For each creek, daily dilution factors were calculated on the basis of daily runoff volumes as the total flow at the mouth divided by the total flow from all of the contributing outfalls. Estimated daily dilution factors for Miller Creek ranged between approximately 1 and 75 with a median of about 16. At Walker Creek dilution factors ranged from approximately 5 to 5500 with a median of about 50. For Des Moines Creek the range of the estimated daily dilution factors was approximately 1 to 930 with a median of about 80.

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[5] The drainage system now known as SDS-2, SDS-5, and SDS-6 was previously called outfalls B and D.

[6] Meaning there is a five percent chance of observing the 95th percentile concentration in all of the outfalls simultaneously.

[7] The downstream locations where flow was calculated are at locations where streamflow gauging stations exist and where stations are not subject to tidal influence which complicate streamflow measurement.

Finally, frequency curves of contaminant concentrations were estimated for the 49 years of daily concentrations near the mouth of each of the creeks and at a point approximately 4,000 feet upstream of the mouth[8]. The frequency curve predicts the probability that a contaminant concentration will be exceeded in 49 years. This probability is calculated by taking the distribution of 95th percentile concentrations that would occur at the mouth of the creeks and multiplying each probability by 5% since the 95th percentile concentration would be expected to occur only five percent of the time. The probability of concentrations at the mouth depends on the particular flow volume predicted by the model. This probability is generated from the 49 years of predicted daily flow. The 0.05 concentration probability assumes that all outfalls covary perfectly such that if one outfall contains its 95th percentile concentration then all of the other outfalls do also. Therefore there is a five percent chance of measuring the 95th percentile concentration or greater in all of the outfalls simultaneously (which is actually a very infrequent occurrence). The probability that both a contaminant concentration greater to the 95th percentile concentration value and the flow volume being greater than the indicated volume that dilutes the contaminant is estimated by multiplying together each probability of occurrence. These are independent events and thus their joint probability is simply the product of the individual probabilities.

3. RESULTS

The actual results of this modeling exercise are presented in the main body of the BA (Section 7.1.3.2, page 7-14). The maximum ethylene and proplyene glycol concentrations predicted for the IWS discharge and at the mouths of Miller and Des Moines creeks are presented in Table 7-9, page 7-19.

The percent of time in 49 years the creek mouth concentrations of copper and zinc exceeded specific levels are presented in Table 7-10, page 7-21. The adopted approach is very conservative as the exceedance percentages were calculated assuming: (1) the 95th percentile concentration is observed every day of the 49 years worth of simulated flow; and (2) all outfalls were assumed to covary perfectly (meaning they will all discharge the highest concentration at the same time). These assumptions are very conservative, and will likely overestimate the contribution of STIA stormwater to copper and zinc concentrations observed in the creek mouths. In contrast, the contribution of other currently unidentified sources of copper and zinc in the Miller and Des Moines basins has not been determined, which could contribute to the uncertainty of the modeling predictions presented in the BA.

Finally, Table 7-11, page 7-21 reports the copper and zinc predicted concentrations near the IWS outfall along with distance from the diffuser port.

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[8] This point corresponds roughly to upstream barriers to fish passage in each creek.

4. REFERENCES

Cosmopolitan Engineering Group, Inc. and Kennedy-Jenks Consultants. 1997. Effluent mixing zone study for Port of Seattle Industrial Wastewater Treatment System. Prepared by Cosmopolitan Engineering Group, Inc., 805 Pacific Avenue, Tacoma, Washington 98402 and Kennedy/Jenks Consultants, 530 South 336th Street, Federal Way, 98003. January 1997.

Port of Seattle. 1999. Annual Stormwater monitoring report for Seattle-Tacoma International Airport for the period July 1, 1998 through June 30, 1999. Seattle, Washington.

U.S.EPA. 1991. Technical Support Document for Water Quality-based Toxics Control, EPA/505/2-90-001. United States Environment Protection Agency, Office of Water, Washington, D.C.

U.S. EPA. 1993a. Dilution models for Effluent Discharges. United States Environmental Protection Agency, Office of Research and Development, Washington, D.C. 20460. EPA/600/R-93/139. July 1993.

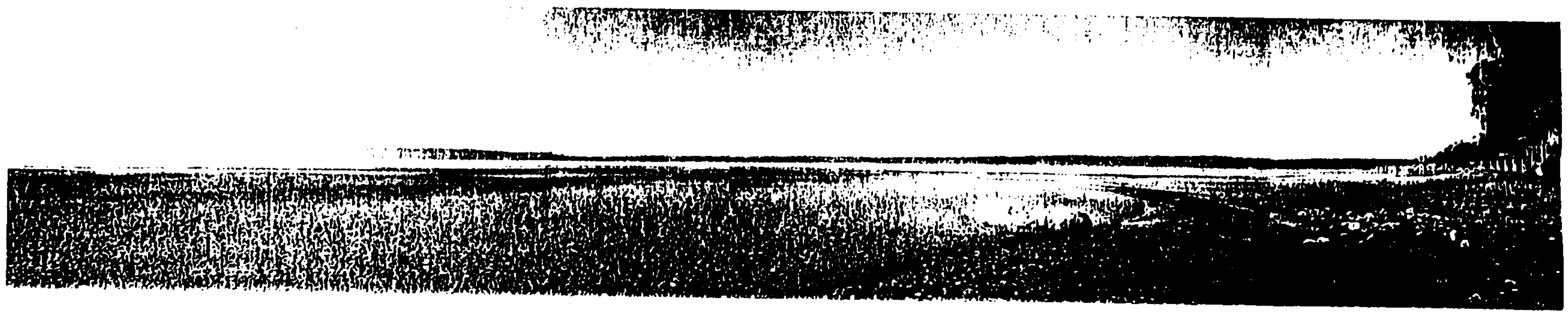
U.S. EPA. 1993b. Hydrological Simulation Program – Fortran. User's Manual for Release 10. United States Environmental Protection Agency, Office of Research and Development, Washington D.C. EPA/600/R-93/174. September 1993.

Appendix G

APPENDIX G

ESTUARIES OF MILLER AND DES MOINES CREEKS

The following figures (G-1a.b and G-2a.b) provide a graphical description of the current conditions of the estuaries of Miller and Des Moines creeks.

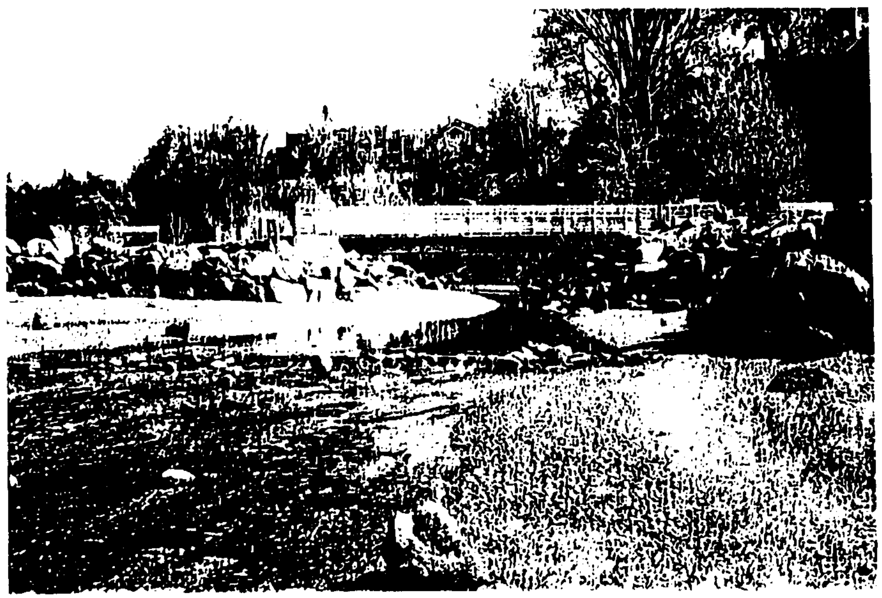


A. View of Miller Creek Looking West from the Shoreline

B. View of Miller Creek Looking East from the Shoreline

Figure G-1
East and West Views of
Miller Creek from the Shoreline

A. View of Des Moines Creek Looking West from the Shoreline



B. View of Des Moines Creek Looking East from the Shoreline

Figure G-2
East and West Views of
Des Moines Creek from the Shoreline

Appendix H

APPENDIX H

BENEFITS OF ACQUIRING WATER RIGHTS ON MILLER CREEK
SEA-TAC AIRPORT MASTER PLAN UPDATE

As part of the acquisition of private properties along Miller Creek, the Port of Seattle will be acquiring the water right permits, certificates, and claims associated with those properties. Existing water rights along Miller Creek give the property owners the right to withdraw water from Miller Creek for domestic personal use, lawn and yard watering, and commercial irrigation. After acquiring these rights through the process of property acquisition, the Port of Seattle proposes to cease the exercise of these water rights as part of the mitigation for the Master Plan projects. Because the water rights allow property owners to divert water directly from Miller Creek during the summer when stream flows are at a minimum, there will be a direct and immediate benefit to the stream when the stream diversions are eliminated.

H1. DEFINITIONS

The terms water right permit, certificate, and claim (from Ecology) are defined as follows:

> **Water Right Permit:** A water right permit is permission given by the state to applicants to develop a water right. Water right permits remain in effect until the water right certificate is issued, if all terms of the permit are met, or the permit has been canceled.
>
> **Water Right Certificate:** A water right certificate is issued by the Department of Ecology to certify that water users have the authority to use a specific amount of water for beneficial use as specified in the permit.
>
> **Water Right Claim:** A water right claim is a statement of claim to a water use that began before the State Water Codes were adopted and is not covered by a permit or certificate (i.e., vested right).

For this analysis, it was assumed that all holders of permits, certificates and claims have equal likelihood of withdrawing water from Miller Creek. Although a water right claim is not a specific legal authorization to use water from the stream, the validity of whether the claim is legal cannot be determined until those vested rights are confirmed through a process known as a general water right adjudication, which is conducted through the Superior Court. Only a relatively few watersheds in Washington have undergone this process. In the meantime, persons with water right claims are assumed to continue to withdraw water. This is a valid assumption because, for a property owner to file a claim, they must have a current documented water use. Although most claims were filed in the 1970s during claims registration period, it is likely that this water use is still occurring. In addition, it is very likely that more individuals are withdrawing water from Miller Creek, but did not file a water right claim with the State at the time when they had a opportunity to do so.

H2. WATER RIGHTS RECORDED BY STATE

Ecology maintains a database of recorded water right permits, certificates, and claims. A search of those files at the Northwest Regional Office identified five water right certificates and 13 water right claims in the acquisition area. These are listed in Table 2-1 along with the current parcel number and property owner. Not all certificate and claims reference a street address or tax parcel number. Also, the name on the certificate or claim often was not the same as the current property owner due to transfer of ownership since the water right documents were filed (the water right typically stays with the property). Therefore, a few of the certificates and claims could not be located precisely. However, it is highly likely that all certificates and claims in Table 1 are located within the acquisition area.

Table H-1 lists surface water rights only. The water rights database was also reviewed for groundwater, but it was determined that most or all uses were for domestic use only. It also cannot be determined whether these groundwater withdrawals are affecting streamflows. Therefore, the potential benefits of ceasing the exercise of groundwater rights was not evaluated.

H3. ESTIMATE OF WATER USE BY CURRENT WATER RIGHTS HOLDERS

The amount of water currently being withdrawn by the water rights holders along Miller Creek was estimated from the information recorded on the certificates and claims. In general, the documents should identify the maximum instantaneous withdrawal rate, the annual quantity, and the number of acres of irrigation. Because information on the water right claim forms was often incomplete (e.g., the quantity of water used was not specified), the quantity of water being used had to be assumed in many cases. Also, if the rate of withdrawal was specified, it represents only the maximum instantaneous rate that the property owner can divert from the stream. The actual average rate of withdrawal is probably less than the maximum rate allowed.

Of the 18 identified water rights certificates and claims on Miller Creek, all but one are for domestic use or irrigation of about 1 acre or less of land. The allowed instantaneous withdrawal rates for these mostly vary between 5 gpm (0.01 cfs) and 20 gpm. Typically, a water right for a single domestic use is set to 0.01 cfs when a certificate is issued.

Of the five large properties that commercially irrigated (i.e., Genzales, Raffo, Scarsella, Vacca, and Mason), only Raffo has a recorded water right claim. Although the remaining properties do not appear to have a recorded water right or claim in Ecology's files, it is assumed that the farmer either has a permit that is not filed with Ecology, or feels that they have a valid vested right for the water.

Table H-1. Water rights, claims, and uses in Port of Seattle acquisition area.

Water Right Certificate	Water Right Claim	Rate (Qi)	Quantity (Qa)	Acres	Parcel	Tax ID	Site Address	First Name	Owner's Last Name
RESIDENTIAL PROPERTIES									
	121808 (Lora Lake)	—	—	—	050R	202304-9347	15015 Des Moines Memorial Dr	William F	Eisminger
	96247 (Miller Creek)	20 gpm	6.1 acft	1	143R	202304-9090	15618 Des Moines Memorial Dr	David P. & Frances	Brate
	14424 (Miller Creek)	20 gpm	3 acft	1	214R	725120-0015	15914 Des Moines Memorial Dr	Kana A	Kamp Martin D Martinez & Theresa
	106884 (Miller Creek)	—	—	—	088R	369680-0015	15419 9th Place S	Helen V	Goodmansen
	115026 (Miller Creek)	—	—	—	185R	725120-0045	15823 9th Ave. S	Cari M. & Nanny E	Berry
	160107 (Miller Creek)	120 gpm	1 acft	0.6	097R	202304-9071	15454 Des Moines Memorial Dr.	Roy C	Smith
	117834 (Miller Creek)	15 gpm	1.5 acft	0.75	142R	947530-0010-0100	15600 Des Moines Memorial Dr		Wind of the Willows Condos
s1-20949c (Miller Creek)		0.01 cfs	1.0 acft		322R	384660-0080	16628 8th Ave. S.	David C	Longridge
s1-05991c (Miller Creek)		0.01 cfs	—	1.7	311R	384660-0145	16422 8th Ave. S.	Clifford C	Rhoton
	42012 (Miller Creek)	20 gpm	1.0 acft	0.75	321R	384660-0115	16616 8th Ave. S.	Commander F.X.	Beaudin II
	41157 (Miller Creek)	—	—	—	298R	292304-9196	849 S. 164th St.	Lee & Bonnie J	Warner
	112315 (Miller Creek)	10 gpm	2.0 acft	0.5	253R	384660-0060	632 S. 168th St.	Pegi	Kobela
	137915 (Miller Creek)	20 gpm	1.0 acft	0.75	246R	384660-0035	16463 8th Ave. S.	John & Joseph	Galando
	14425 (Miller Creek)	5 gpm	1.0 acft	1	182R	202304-9426	actual 15836, closest 15820 Des Moines Memorial Dr.	Paul R.	Iles
s1-04903c (Miller Creek)		0.01 cfs	—	0.25	316R	384660-0125	raw land	Richard H./Bette M	Roullard/Markley
s1-04904c (Miller Creek)		0.01 cfs	—	0.50 ac	244R	384660-0030	16609 8th Ave. S.	Earl D	Randall & Vean Sandback
s1-06355c (Miller Creek)		0.01 cfs	—	—	302R	292304-9270	16429 12th Ave. S.	Alfredo & Roberta	Lopez

Total water use: Assume 17 certificates/claims at minimum rate of 0.01 cfs each, assuming only 50% are continuously active.
Q = 17 * 0.01 cfs * 50% = 0.09 cfs

Water Right Certificate	Water Right Claim	Rate (Qi)	Quantity (Qa)	Acres	Parcel	Tax ID	Site Address	First Name	Owner's Last Name
FARM PROPERTIES									
	55350 (Miller Creek)	25 gpm (not used)	7 acft (not used)	3.5	093R	202304-9229	15416 Des Moines Memorial Dr	attn: Ray Rosatto	RST Enterprises (Nick Raffo)
	none (city water)				055R	202304-9068	15127 12th Ave. S		Port of Seattle (Mason)
	none (city water)				060R	202304-9100	15208 Des Moines Memorial Dr		Port of Seattle (Vacca)
	none (city water)				061R	202304-9099	raw land		Port of Seattle (Vacca)
	No permit, but pumps from Miller Creek				062R	202304-9144	raw land	Tony	Scarsella
	No permit, but pumps from Miller Creek				068R	202304-9122	15225 12th Ave. S	Anthony	Genzale, Trustee

Total water use: Assume 5.2 acres total farm (based on 1988 aerial photo) pumped from stream for Genzale and Scarsella properties.
(Source: Phil Vacca, 5/19/98). Other properties are supplied by municipal water.
Water consumption: assume 0.008 cfs/acre (equal to 2 acre-feet per acre over 4 month irrigation season)
Q = 5.2 acres * 0.008 cfs/acre = 0.04 cfs

TOTAL WATER USE TO BE RELINQUISHED INSIDE ACQUISITION AREA = 0.13 CFS

Phil Vacca, whose family has farmed their property (known locally as the "pumpkin patch") along with Mason's and Raffo's property for many years, said that they irrigate their property with municipal water. Although the Raffo property has a water right claim, Mr. Vacca said it has been at least 30 years since they pumped from the stream. These low-lying properties are naturally wet and require only infrequent watering. Mr. Vacca said that the Genzales and Scarsella properties (farmed by Genzales) are irrigated on a regular basis by water that is pumped from Miller Creek. At least one, and probably two (according to Mr. Vacca) pump stations with 5 horsepower pumps are located on the stream. Because they are on private property that cannot be accessed by the Port, the pumps could not be inspected to verify their capacities. The Genzales and Scarsella properties are on higher ground and require more irrigation.

To estimate the average rate of withdrawal from Miller Creek by the property owners, the following was assumed:

- For the 17 domestic users, it is assumed that 50 percent of them are withdrawing at a 0.01 cfs rate at any given time during the critical low-flow period in August.
- For the commercial irrigation users, it is assumed that 5.2 acres (the amount of farm area on the Genzales and Scarsella parcels) are irrigated at a rate of 0.008 cfs per acre. This rate is the amount needed to apply 24 inches of total water use over a 4-month irrigation season. No water use was assumed under the Raffo claim.

Based on these assumptions, the estimated total quantity of water used by the identified water rights holders and the commercial irrigation users is 0.13 cfs. Of this amount, 0.09 cfs is from the domestic users and 0.04 cfs is from the commercial irrigation users. The calculation is summarized in Table H-1.