Declaration of
Lynn Gould

POLLUTION CONTROL HEARINGS BOARD
FOR THE STATE OF WASHINGTON

AIRPORT COMMUNITIES COALITION, Appellant, v. STATE OF WASHINGTON DEPARTMENT OF ECOLOGY, and THE PORT OF SEATTLE, Respondents.	PCHB No. 01-133 DECLARATION OF C. LINN GOULD IN SUPPORT OF THE PORT OF SEATTLE'S RESPONSE OPPOSING ACC'S MOTION FOR STAY **AR 012549**

C. Linn Gould declares under penalty of perjury as follows:

1. I am over the age of 18, am competent to testify, and have personal knowledge of the facts stated herein.

2. I am a Risk Assessor and soil scientist by training, having received my BA in geology and an MS in soil science. I have additional post-graduate training in risk assessment, toxicology, and wetland evaluation. For the past 10 years I have been focusing my expertise on the application of the Model Toxics Control Act ("MTCA"), RCW 70.105D, to contaminated sites. I recently participated in the MTCA Policy Advisory Committee process, which prioritized risk assessment in the development of the new MTCA regulations. More specifically, I was technical project manager and facilitator for the Department of Ecology and other Washington State stakeholders in the development of a new risk-based strategy for Total Petroleum Hydrocarbons ("TPH") remediation in Washington

ORIGINAL

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State, which is now a part of the newly issued MTCA regulation (August, 2001). Insuring protection of water quality has been a routine aspect of all risk assessment projects that I have been involved in. A copy of my *curriculum vitae* is attached as Exhibit A.

3. Since 1993 I have worked for the Port of Seattle as a risk assessment specialist and project manager, primarily focusing on the remediation of contaminated sites. Since January, 2001, my work for the Port has concentrated on Third Runway issues, principally a risk analysis of the potential for imported fill to impact aquatic and other receptors and the subsequent strategy and generation of appropriate fill criteria for the embankment.

4. The amended Third Runway 401 Certification issued on September 21, 2001 (the "401 Certification"), sets out standards for fill to be used in construction of the Third Runway embankment. As described below, these criteria are based on a number of highly protective standards and conservative assumptions that are designed to ensure that aquatic life in associated surface waters—the most sensitive receptors as designated by exposure pathway analysis—are not adversely impacted. It is my professional opinion that fill meeting the 401 Certification's criteria will not adversely affect aquatic life or result in violations of water quality standards in the wetlands or streams near the Third Runway embankment.

5. The 401 Certification governs fill in a number of ways. First, it prohibits the use of fill that "consists in whole or in part of soils or materials that are determined to be contaminated following a Phase I or Phase II site assessment." *See* 401 Certification at §E(1)(d). Second, it prohibits the use in fill of soils that have been "treated in some manner so to be considered re-mediated soils or fill material." *Id.* Third, fill sources are limited to (a) State-certified borrow pits, (b) contractor-certified construction sites, and (c) Port of Seattle-owned properties. *See* 401 Certification at §E(1)(c). Fourth, for fill that meets these first three conditions, numeric criteria for fourteen (14) metals and total petroleum hydrocarbons (expressed as gasoline, diesel, and heavy oils) must also be satisfied. *Id.*

6. The soil criteria for the entire embankment have been derived by a risk assessment analysis that designates aquatic receptors as the most sensitive receptors to protect. In addition to

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the protective soil fill criteria that were developed for the majority of the embankment, the U.S. Fish & Wildlife Service ("FWS") required the Port to construct a 40-foot wedge of fill along the western edge of the embankment that tapers along the natural contours of the underlying soil as it continues to the east, called the "drainage layer cover." *See* Exh. B. ("USFWS Biological Opinion", May 22, 2001) at 41. This protective cover was designed to provide an "ultra-clean" layer of fill which will attenuate any potential contamination that might be leaching through the rest of the embankment above it, thereby giving FWS additional assurance that fill used in the Third Runway embankment would not adversely affect species listed under the Federal Endangered Species Act that may be present in nearby water bodies. FWS required that metals in fill used in the drainage layer cover comply with numeric fill criteria equal to natural background concentrations (when available in the literature) found in the Puget Sound region. *See* Exh. C (Ecology, 1994, Pub 94-115 Natural Background Soil Metals Concentrations in Washington State). Natural background is defined as "the concentration of hazardous substance consistently present in the environment which has not been influenced by localized human activities." WAC 173-340-200. Therefore, the soil metals used in the drainage layer cover should consist of soil that is no more "contaminated" than naturally occurring area soil.

7. The 401 Certification also adopted the drainage layer cover approach. *See* Table 1 to Attachment E to the Amended 401 Certification. In fact, all of the criteria in the 401 Certification that are applicable to the drainage layer cover are either equal to or more stringent than the criteria previously deemed by FWS to be protective.

8. For fill above the drainage layer cover, the 401 certification establishes soil fill criteria that are also protective of aquatic receptors. *See* Table 1 to Attachment E to the 401 Certification. As discussed below, while the soil fill criteria above the drainage layer cover are less stringent than those applicable to the drainage layer cover, they are more stringent than necessary to protect aquatic receptors. *Id.*

9. Work that I have done demonstrates that the soil criteria for the entire Third Runway embankment are protective of aquatic receptors. Ecology's Toxic Cleanup Regulation, WAC 173-340-747)(4), provides a conservative calculation method known as a "fixed parameter three-phase

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partitioning model," whose purpose is to establish soil concentrations that will be protective of applicable ground water concentrations. *See* Exh. D (WAC 173-340-747)(4)). The three-phase partitioning model performs what is often referred to as a "back-calculation" because it starts with the numeric water quality criteria for the receiving water effects and works backwards to derive a soil concentration that would be protective of the designated water quality effect. In other words, it determines how much of a particular constituent can exist in the soil without causing an exceedance of the appropriate standard in the receiving water. This "back-calculation" model was adapted for the Third Runway embankment by substituting applicable surface water concentrations in place of groundwater concentrations for the following nine (9) constituents: arsenic, cadmium, copper, lead, mercury, nickel, selenium, silver , and zinc. In the cases where surface water quality criteria were not available (antimony, barium, beryllium, chromium, thallium, and the total petroleum hydrocarbons), drinking water concentrations were used in the back-calculation model, in accordance with WAC 173-340-747, to derive a protective soil concentration for the fill. *See* Exh. E (Criteria Derivation Chart).

10. The back-calculated fill criteria are very conservative because they have been derived assuming that the receptor point is immediately underneath the embankment. However, associated creeks are over one hundred feet away from the embankment at its closest location. As constituents in the embankment seepage move through soils and groundwater, they are subjected to naturally-occurring physical, chemical, and biological processes that tend to reduce the original concentration of the constituent as it is transported between the embankment and the receptor point. These processes include adsorption onto soil and aquifer media, chemical transformation, biological degradation, and dilution due to mixing of the seepage with surface waters and underlying ground water. The reduction in constituent concentrations between the toe of the embankment and the associated creeks can be estimated by developing a site-specific dilution/attenuation factor that would further show that the fill criteria are protective of aquatic receptors. Because the attenuation/dilution factor between the embankment and the associated creeks was not accounted for in deriving the fill criteria, the criteria are more protective than necessary under a site-specific analysis which would consider these important biological, chemical and dilution processes.

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11. The chart attached as Exhibit E shows the derivation of all of the criteria used in the 401 Certification. *See* Exh. E (Criteria Derivation Chart). The majority of the soil criteria in the Third Runway embankment are set at Puget Sound natural background concentrations for metals. Background levels are the fill criteria for a majority of the drainage layer cover constituents (antimony, arsenic, beryllium, cadmium, chromium—chromium is less than background—copper, lead, mercury, nickel, zinc) and for several of the main embankment constituents (antimony, beryllium, copper, zinc). *Id.* The application of Puget Sound background levels is appropriate because these concentrations represent the natural diversity of regional soil formation over millions of years of geologic events. Furthermore, because potential contamination in fill materials below Puget Sound background concentrations cannot be distinguished from true background, it is difficult to contend that fill at or below background could cause a detrimental effect on water quality.

12. The fill criteria for two constituents (selenium, silver) in both the drainage layer and the main embankment are set at the Practical Quantitation Limit ("PQL") because it is greater than the ambient water back-calculation. *See* Exh. E (Criteria Derivation Chart). The PQL is the concentration below which a particular constituent cannot be reliably measured. As a practical matter, therefore, it would not make sense to set criteria below the PQL because it would be impossible to measure reliably whether the criteria were being met. For that reason, MTCA regulations state that when a calculated constituent level is less than natural background levels, the concentration "shall be established at a concentration equal to the practical quantitation limit (PQL) or natural background concentration whichever is higher." WAC 173-340-700(d). For selenium and silver, no Puget Sound background data are available, resulting in the use of a PQL as the soil criteria for those constituents in the entire embankment. *See* Exh. E (Criteria Derivation Chart).

13. For the drainage layer cover, the fill criteria have been calculated to be protective of surface water receptors according to the following decision tree logic:

(a) Use of Ecology's back-calculation model, described in WAC 173-340-747)(3)(a), to establish soil concentrations protective of applicable surface water concentrations for the following nine (9) constituents: arsenic, cadmium, copper, lead, mercury, nickel, selenium,

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silver, and zinc. In the case where surface water quality criteria were not available for antimony, barium, beryllium, chromium, thallium, and the total petroleum hydrocarbons, drinking water concentrations were used in the model according to WAC 173-340-747 to calculate a protective soil concentration for the fill. *See* Exh. E (Criteria Derivation Chart).

(b) All back-calculated concentrations were automatically adjusted either upward or downward to available Puget Sound background levels. Back-calculated concentrations higher than available Puget Sound background were adjusted downwards to that background. Back-calculated concentrations below the PQL were adjusted upward to available Puget Sound background concentrations or the PQL according to WAC 173-340-700(d). Where Puget Sound background concentrations were not available, the concentrations are designated according to the three-phase model described above in paragraph (a) above. *See* Exh. E (Criteria Derivation Chart). For two constituents, chromium and diesel, Ecology elected to use criteria more restrictive than the model indicated because those criteria were deemed to be protective of terrestrial ecological criteria according to WAC 173-340-749. *See* Exh. E.

14. Soil criteria established in the remainder of the embankment above the drainage layer cover are also protective of applicable water quality criteria. Although the concentrations are not as stringent as in the drainage layer cover, most are either set at Puget Sound background concentrations or back-calculated concentrations from applicable water quality criteria. *See* Exh. E (Criteria Derivation Chart).

15. MTCA Method A cleanup levels are only used for four constituents in the remainder of the embankment. All of those four are fully protective of water quality. For cadmium, the water quality back-calculation was below the PQL and was therefore moved to the PQL (173-340-900, Table 740-1). For mercury, the soil criterion is set at the MTCA Method A back-calculation for drinking water because the fresh water back-calculation was below the PQL. MTCA Method A concentrations are used for arsenic and lead as ceiling levels although the backcalculation approach allowed for higher soil criteria.

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I declare under penalty of perjury under the laws of the State of Washington that the foregoing is true and correct.

DATED this 29th day of September, 2001 at Seattle, Washington.

C. Linn Gould

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C. LINN GOULD

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PROFESSIONAL EXPERIENCE:

Risk Assessment/Management and Wetlands Consultant 7/91 to present
Erda Environmental Services, Inc, Seattle, WA, President
Owner and operator of environmental consulting firm since its inception in 1991.

- Assist the Port of Seattle with Third Runway project issues including risk based development of soil criteria for embankment.
- Acted as technical project manager and facilitator for Washington State stakeholders in developing a risk-based environmental policy for petroleum contamination and in re-writing petroleum regulations for the state from 1996-2000.
- Assist public and private clients in implementing cost effective remediation of contaminated sites and returning them to productive use in Washington, Oregon, and Alaska. Received Project Team of the Year Award (1996) in remediation of Southwest Harbor Project for the Port of Seattle.
- Delineate and evaluate wetlands with focus on mitigation of degraded wetlands and use of wetlands for wastewater disposal and improving water quality.

Risk Assessment Task Manager and Soil Scientist 01/90 to 7/91
CH2M Hill, Bellevue, WA

- Conducted risk assessments and developed successful strategies in remediating hazardous waste sites in the Pacific Northwest using risk-based methods.
- Delineated wetland boundaries and prepared wetland reports with focus on regulatory issues, permitting, and mitigation measures.

Research Specialist 09/85-09/88
Water Resources Center, University of Wisconsin, Madison, WI

- Studied the effects of septic systems on water quality in both the field and laboratory.
- Assisted in the preparation of water quality reports to be distributed for educational purposes in Wisconsin.

Engineering Geologist 10/81-07/82
Rittenhouse-Zeman & Associates, Bellevue, WA

- Worked in field, laboratory, and office in preparing foundation reports for airports and buildings in the Pacific Northwest.

Laboratory Technician 10/79-08/80
Geology Department, Smith College, Northampton, MA

- Assisted professor in soils laboratory on the effects of acid rain on lakes in the Adirondacks, N.Y.

PUBLICATIONS:

- Pascoe, GA; Riley, MJ; Floyd, T.A; Gould, C.L; Use of a Risk-Based Hydrogeologic Model to Set Remedial Goals for PCBs, PAHs, and TPH in Soils during Redevelopment of an Industrial Site, Environ. Sci. Technol. 1998, 32, 813-820.
- Erda Environmental Services, Inc. Risk Assessment for Unocal Former Bulk Fuel Facility,

Soldotna, Alaska, February 1998.

- Erda Environmental Services, Inc; Remediation Technologies, Inc, Southwest Harbor Project: Shoreland Public Access Exposure Analysis, Pacific Sound Resources Superfund Site, December 1995
- University of Wisconsin Water Resources Center and the Wisconsin Department of Natural Resources (joint publication, Potential Sources of Pollution for Lulu Lake (Status of Beach Contamination in Wisconsin, 1986.

EDUCATION:

- University of Washington, Seattle, WA

MPH candidate Public Health, 2000-

- University of Wisconsin, Madison, WI

MS Soil Science, 1988. Thesis on the potential for detergent formulation to affect nutrient movement through septic drainfields.

- University of Washington, Seattle, WA

Post-graduate research, 10/1982-5/1984. Graduate courses in risk assessment, soil science, and toxicology.

- Smith College, Northampton, MA

B. A. Geology, 1981. Research and senior thesis on the movement of acid precipitation through Adirondack, NY soils.

CONTINUING EDUCATION:

- French immersion program for 8 hours per day for two months - "Avance 1" in December 1999 and "Avance 2" in March 2000, Institut de Francais, Villefranche, France.
- "Wetland Vegetation of Western Washington", University of Washington, Seattle, WA, 1995
- "Hazardous Waste Site Operations", Seattle, WA, 1995
- "Creating and Using Wetlands for Wastewater Disposal and Water Quality Improvement", University of Wisconsin, Madison, WI, 1993
- "Creating Wetlands for Habitat Enhancement and Mitigation", University of Wisconsin, WI, 1993
- "On-Site Wastewater Treatment", University of Washington, Seattle, WA, 1992

PERSONAL:

- Memberships: Society for Risk Analysis, National Society of Consulting Soil Scientists, Society for Wetland Scientists, Soil Science Society of America
- Skills: Working knowledge of French; volunteered for two years as counselor in reproductive issues and sexually transmitted diseases at Planned Parenthood; computer literate; coaching experience
- Interests: Traveling, camping, hiking, biking, wine, reading, basketball

REFERENCES:

Available on request.

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FWS Reference #: 1-3-00-F-1420, Master Plan Update Improvements, Seattle-Tacoma International Airport

X Reference #: 1-3-96-I-29, 1-3-99-SP-0744

Dear Mr. Johnson:

This document transmits the U. S. Fish and Wildlife Service's (FWS) biological opinion (BO) regarding the effects of the proposed Master Plan Update Improvements (MPUI) for the Seattle-Tacoma International Airport (Sea-Tac) in King County, Washington on the threatened bull trout (*Salvelinus confluentus*), bald eagle (*Haliaeetus leucocephalus*), and marbled murrelet (*Brachyramphus marmoratus*) in accordance with Section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). This project is proposed by the Port of Seattle, Sea-Tac (Port). Your June 15, 2000, request for formal consultation was received by our office on approximately June 16, 2000. We received a letter by fax from you on August 21, 2000, requesting that we concur with a "may affect, not likely to adversely affect" call for the marbled murrelet rather than a "no effect."

This biological opinion is based on the following information: biological assessment (BA) dated June 2000; Supplement for Property Acquisition and Demolition for 34X Runway Protection Zone, dated September 2000; supplement to the BA, dated December 18, 2000; Memorandum, dated December 21, 2000; Sea-Tac Runway Fill Hydrology Studies Report (PGG 2000), Comprehensive Stormwater Management Plan (Parametrix 2000a); Seattle-Tacoma Airport Master Plan Update, Low Streamflow Analysis (Earth Tech, Inc. 2000) letter dated October 30, 2000 transmitting new Joint Aquatic Resources Permit Application; Final Natural Resource Mitigation Plan (Parametrix 2000b) information provided by fax from you on October 16, 2000 and January 10, 2001; e-mail and telephone communications from the Port on April 20, 21, and 23, 2001; e-mails, letters and attachments dated March 26 and 30, and April 20 and 24, 2001 from James Lynch, Stoel Rives, LLP, the law firm representing the Port; information provided by telephone, fax and e-mail by your consultant, Parametrix Inc., on August 18, 21, 22, and 23, 2000, December 28 and 29, 2000, and January 17, 18, and 19, 2001; documents from the Airport

Communities Coalition; and other supplemental information provided in numerous telephone calls, and email or written correspondence up through May 22, 2001. A complete administrative record of this consultation is on file at this office.

CONSULTATION HISTORY

The FAA originally consulted with the Service on this action in 1995. The BA for that consultation addressed effects to bald eagles and peregrine falcons, and concluded that the proposed MPUI "may affect, but will not adversely affect" these species (Tims 1995, FAA 1995). The FWS concurred with these determinations (USFWS 1995).

Due to the recent listing of bull trout, new information regarding the presence of marbled murrelets in the action area, and modifications to the project proposal not previously analyzed, the FAA has requested reinitiation of this consultation. Since that time, the peregrine falcon has been delisted (August 25, 1999, 64 FR 46542), and therefore, is not addressed in this reinitiation of consultation.

The FAA determined that the current proposed action is "not likely to adversely affect" the bull trout, the bald eagle and the marbled murrelet. Although ESA Section 7 compliance for the proposed project could be completed through informal procedures, the FAA requested that the FWS use the formal consultation process. Therefore, this BO will address the effects to bull trout, bald eagle, and marbled murrelet.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

Project Location

The proposed MPUI is located at Sea-Tac within the cities of SeaTac and Des Moines, King County, Washington (Sections 4 and 5, Township 22 North, Range 4 East, and Sections 20, 21, 28, 29, 32, and 33, Township 23 North, Range 4 East, Willamette Meridian). Associated with these improvements is the off-site wetland mitigation located in the City of Auburn, King County, Washington (Section 31, Township 22 North, Range 5 East, Willamette Meridian).

Project Description

The MPUI would develop portions of property located on and near the existing Sea-Tac airport, and provide wetland mitigation near the Green River in the City of Auburn. The proposed actions will impact creek, riparian and wetland habitats within the action area. The FAA's proposed actions are: 1) to approve future collection and use authorization for passenger facility charges related to implementation of Sea-Tac Master Plan update MPUI; 2) issue future grants and grants issued after May 24, 1999, related to the implementation of MPUI; and 3) direct construction of the airport traffic control tower and navigational aids. The U. S. Army Corps of Engineers (Corps) proposed action is the issuance of a Clean Water Act 404 permit for the proposed fill within waters of the United States, including wetlands, and associated mitigation. The proposed project will result in the permanent filling on-site of approximately 18.37 acres of wetlands and temporarily filling of 2.05 acres of wetlands. Also, approximately 21.64 acres of historically farmed and emergent wetlands will be temporarily filled and 0.12 acres of wetlands will be permanently filled as part of the off-site mitigation in Auburn. Mitigation for proposed aquatic impacts includes but is not limited to the following: restoration or enhancement of 25.21 acres of wetlands in basin and 49.48 acres of wetlands out-of-basin at the Auburn mitigation site. The following (Table 1) is a listing of all proposed actions included in the MPUI.

Table 1. Proposed Master Plan Update improvement projects at Sea-Tac Airport.

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

Project (cont.)	Description (cont.)
Runway Safety Areas (RSAs)	
Runway 34R Safety Fill	Extend runway safety fill to meet FAA standards.
RSAs 16R/16L	Extend safety fills by 1,000 ft to meet FAA standards.
Relocation of Displaced Threshold on Runway 16L	Airfield taxiway improvements. The runway threshold (i.e., the emergency landing pad at end of runway pavement) to be relocated onto new RSA.
Miller Creek Sewer Relocation	Relocate sewer for third runway embankment and runway safety fills. New sewer to run along alignment of new 154th/156th Street.
Borrow Sites	
Borrow Sites	Sources of fill for third runway embankment, located on Sea-Tac property south of the airport. Approximately 6.7 million cy[1] of material to be excavated from three sites and transported across airport property to the embankment.
FAA Navigation Aids (NAVAIDS)	
New Airport Traffic Control Tower	New air traffic control tower to be located in existing developed area near terminal.
Relocate Airport Surveillance Radar, Airport Surface Detection Equipment, NAVAIDS	Existing radar and navigation equipment will be relocated to allow construction of third runway.
Airfield Building Improvements	
New Snow Equipment Storage	New building to house snow removal equipment.
Weyerhaeuser Hangar Relocation	Relocate existing hangar on west side of airfield to allow construction of third runway. New hangar will be located near south end of third runway.
Terminal/Air Cargo Area Improvements	
Relocation of Airborne Cargo	Relocate existing cargo building from air traffic control tower site to north cargo area. Located in existing developed area near terminal.
Central Terminal Expansion	Passenger terminal remodel. Located in existing developed area at terminal.
South Terminal Expansion Project (STEP)	Passenger terminal remodel. Located in existing developed area to the south of the main passenger terminal.
Northwest Hangar Relocation	Relocate Northwest hangar to site now occupied by Delta hangar. Located in existing developed area.

Project (cont.)	Description (cont.)
Satellite Transit Shuttle System Rehabilitation	Remodel and upgrade underground transit system linking terminal to satellites.
Redevelopment of North Air Cargo	New or expanded air cargo facilities along Air Cargo Road at north end of airport.
Expansion of North Unit Terminal (North Pier)	Addition to new passenger terminal located north of existing terminal. Located in existing developed area (Doug Fox parking lot and airport access freeway).
New Airport Rescue and Fire Fighting Facility	Replaces facility displaced by new North Terminal. The new facility will be located to the north of the North Terminal.
Cargo Warehouse at 24th Avenue South	New air cargo facility located north of SR 518 on 24th Avenue South.
Westin Hotel	New hotel located immediately north of main passenger terminal. Located in existing developed area at terminal.
New Water Tower	Construct new water tower and piping in engineering yard south of South 160th Street in subbasins (Gilliam Creek watershed) served by stormwater outfalls 012 and 013.
Roads[2]	
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	Relocate public roadway to allow construction of third runway embankment and runway safety fills. Existing road to be demolished.
154th/156th Street Bridge Replacement	Relocate existing South 156th Street bridge over Miller Creek to accommodate the third runway footprint and South 154th/156th Street relocation. In-water work associated with this project is limited to the removal of the existing bridge and bank restoration.
Improvements to Main Terminal Roads	Transportation circulation, seismic and other improvements to roadway systems serving terminal.
Improved Access and Circulation Roadway Improvements	Improvements to existing roadway system serving passenger terminal, garage, and air cargo facilities.
North Unit Terminal Roadways	Improvements to existing roadway system to serve the new North Terminal and garage.
Improvements to South Access Connector Roadway (South Link)	Improvements to existing roadway system serving passenger terminal, garage, and air cargo facilities. Will connect terminal and garage area to South Access roadway and SR 509 extension south of the airport.

Project (cont.)	Description (cont.)
Parking	
Main Parking Garage Expansion	Expand parking facility at main passenger terminal on north and south sides (existing developed areas), and add floors to portions of the existing garage.
The North Employees Parking Lot (NEPL), Phase 1	New parking facility for employees, located north of SR 518.
North Unit Parking Structure	Construction of new garage serving new North Terminal facility. Facility will be located at existing Doug Fox parking lot.
The South Aviation Support Area	
The SASA and Access Taxiways	New airport support facility for cargo and/or maintenance, located at the south end of the airport south of the Olympic Tank Farm and South 188th Street. Airplane access will be by new parallel taxiway constructed along Runway 34R.
Relocation of Existing Facilities to the SASA	Airport operation support facilities will be relocated to the SASA once SASA site development is completed. Many of these facilities must be relocated from their present locations due to main terminal expansion (i.e., STEP and North Terminal), including Northwest hangar, ground support equipment, ground and corporate aviation facilities, new airport maintenance building, and United maintenance complex.
Stormwater Facilities[3]	
Miller Creek Detention Facility Expansion	Expand the Miller Creek Detention Facility by 16.4 acre-ft to provide flow control retrofitting for existing Sea-Tac discharges to Miller Creek. All construction would take place in uplands, and would create free-draining detention volume.
SASA Detention Pond	Create regional stormwater detention pond for the SASA project and other sites. The pond is 33.4 acre-ft and discharges to Des Moines Creek.
NEPL Vault	A 13.9 acre-ft vault to retrofit the NEPL; discharges to Miller Creek via Lake Reba.
Third Runway Vaults and Ponds	Stormwater detention vaults and ponds at the north, west, and south sides of the airport, discharging to Miller, Walker, and Des Moines Creeks.
Sea-Tac Retrofit Facilities	Detention vaults or ponds to provide flow control retrofitting for existing Sea-Tac discharges to Des Moines Creek. Vaults to be constructed in combination with third runway facilities when possible.

Project (cont.)	Description (cont.)
Cargo Vault	Detention vault for North Cargo Facility (4.5 acre-ft discharging to Miller Creek via Lake Reba).
Natural Resources	
Miller Creek Relocation	Approximately 980 ft of Miller Creek immediately downstream of the Miller Creek Detention Facility will be relocated to accommodate third runway embankment and runway safety fill.
Miller Creek Buffer and Wetland Enhancement	Establish a 100-ft buffer (average) along approximately 6,500 linear ft of Miller Creek and riparian wetlands associated with Miller Creek within the acquisition area. Enhance approximately 7.4 acres of existing wetlands along the stream.
Miller Creek Floodplain and Wetland Restoration	Excavate approximately 9,600 cy from the Vacca Farm site adjacent to Miller Creek to compensate for approximately 8,500 cy of floodplain fill for third runway embankment and north safety fill. Restore and enhance approximately 17 acres of stream habitat, floodplain wetlands, aquatic habitat in Lora Lake, and buffers at Vacca Farm.
Miller Creek Instream Habitat Enhancement	Project 1: South of the Vacca Farm site, approximately 650 ft of channel. Remove rock riprap, footbridges, and trash. Place large woody debris (LWD) throughout this section of the stream. Plant riparian areas along the stream with native wetland and upland plant species. Project 2: Approximately 150 ft upstream of South 160th Street, approximately 235 ft[1] of channel. Install LWD in the stream channel, grade a small section of the west bank of the stream to create a gravel bench in the floodplain, remove two rock weirs to improve fish passage, and plant the upland area with native trees and shrubs. Project 3: Immediately downstream of South 160th Street, approximately 380 ft[1] of channel. Grade a section of the east bank, remove a rubber-tire bulkhead and install LWD in the stream and on its banks. Plant buffer areas with native trees and shrubs. Project 4: Miller Creek immediately upstream of 8th Avenue South, approximately 820 ft[4] of channel. Grade portions of both banks. Remove footbridges and portions of concrete block walls. Install LWD in the stream and on its banks. Plant buffer areas with native trees and shrubs.

Project (cont.)	Description (cont.)
Miller Creek Instream Habitat Enhancement (cont.)	In addition to these specific enhancements, debris such as tires, garbage, and fences will be removed throughout the entire stretch of Miller Creek from the Vacca Farm site south to Des Moines Memorial Drive. In areas where access is readily available, LWD will be selectively placed throughout the stream to improve instream habitat conditions.
Drainage Channels Relocation	Relocate a minimum of 1,290 linear ft of drainage channels to accommodate the third runway embankment. Plant buffers along the drainage channels with native grass and shrubs.
Restoration of Temporarily Impacted Wetlands	Approximately 2.05 acres of wetland located west of the third runway embankment, north of relocated South 154th Street, and west of the Miller Creek relocation project, will be temporarily filled or disturbed during embankment construction. When construction activities are completed, remove fill material, restore pre-disturbance topography, and plant wetlands with native shrub vegetation.
Tyee Valley Golf Course Wetlands Enhancement and Des Moines Creek Buffer Enhancement	Restore approximately 4.5 acres of emergent wetland area and approximately 1.6 acres of buffer located within Tyee Valley Golf Course to a native shrub vegetation community. The enhancement actions would be integrated into plans to construct a Regional Detention Facility on the golf course[2] (King County Capital Improvement Project Design Team 1999). The enhancement would convert the existing turf wetland to native shrub wetland community. Enhance approximately 3.4 acres (average 100 ft wide) of buffer and 1.0 acre of existing wetland along Des Moines Creek.
Wetland Habitat (including Avian Habitat) near the Green River in Auburn	Restore wetland functions to a 67-acre parcel near the Green River in the City of Auburn. Create and/or restore approximately 17.2 acres of forest, 6.0 acres of shrub, 6.2 acres of emergent, and 0.60 acre of open-water wetland. Enhance approximately 19.5 acres of existing wetlands. Enhance protective buffers totaling about 15.90 acres.

1 Size modified from that originally stated in BA.

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

3 Des Moines Creek Basin Plan Committee may construct a Regional Detention

Facility on Tyee Golf Course to provide regional flow control. This project would eliminate the need for Sea-Tac retrofit facilities described above. As this is project would be subject to a future federal action, it is not considered a Master Plan Update improvement and is not addressed in this BO.

4 Project length includes approximately 12 ft of instream work as part of driveway demolition, and 400 ft of riparian enhancement.

The proposed project would result in a relatively small increase in the total number of operations (airplane take-offs or landings) over existing conditions. Operations without the new facilities are approximately 460,000 annually. With the proposed project, by 2010, the operations would reach 474,000 (M. Vigelanti, Synergy Consultants, pers. com., 2001). This is an increase of approximately 14,000 take-offs or landings or approximately 3 percent.

STATUS OF THE SPECIES (rangewide and/or recovery unit)

Bull Trout

On November 1, 1999, the FWS (USDI 1999a) listed all distinct population segments (DPSs) of the bull trout, a member of the family Salmonidae, within the coterminous United States as threatened. Five DPSs with 187 subpopulations are currently identified. They include 1) Coastal/Puget Sound, 34 subpopulations; 2) Columbia River, 141 subpopulations; 3) Jarbidge River, 1 subpopulation; 4) St. Mary-Belly River, 4 subpopulations and; 5) Klamath River, 7 subpopulations. Critical habitat has not been designated at this time. The bull trout is mainly threatened by habitat degradation, passage restrictions at dams, and competition from non-native lake trout (*Salvelinus namaycush*) and brook trout (*Salvelinus fontinalis*).

The FWS has identified 35 subpopulations of native char (bull trout and/or Dolly Varden) within the Coastal/Puget Sound DPS. These subpopulations are grouped into five analysis areas based on their geographic location: Coastal, Strait of Juan de Fuca, Hood Canal, Puget Sound, and Transboundary. These groupings were made in order to identify trends that may be specific to certain geographic areas.

The FWS has rated the subpopulations as either strong, depressed, or unknown, modified after Rieman et al. (1997). A strong subpopulation is defined as having all life history forms that once occurred, abundance that is stable or increasing, and at least 5,000 total fish or 500 adult fish present. A depressed subpopulation is defined as having either a major life history form eliminated, abundance that is declining or half of the historic abundance, or less than 5,000 total fish or 500 adults present. A subpopulation status is unknown if there is insufficient information to determine whether the status is either strong or depressed. Within the Coastal/Puget Sound DPS, only one subpopulation is considered strong, 10 are depressed, and 25 are unknown.

The proposed project is located within the Puget Sound Analysis Area of the Coastal/Puget Sound DPS. Fifteen subpopulations occur in the Puget Sound Analysis Area, from the Nisqually River north to the Upper Middle Fork Nooksack River. The more northern subpopulations appear to be relatively more abundant compared to the southern populations (USDI 1999). The large amount of federal land in these northern drainages, and the lower levels of urbanization, provide better habitat conditions than in southern Puget Sound. All five of the subpopulations within the Seattle-Olympia urban corridor are considered depressed. These subpopulations are within the Nisqually River, Puyallup River, Green River, and Lake Washington basins. Although there is scant historical information on population abundance, adverse impacts associated with habitat degradation have been documented for other salmonid species in these systems (e.g., chinook salmon (*Oncorhynchus tshwytscha)*). Given the bull trout's more restrictive habitat requirements, it is reasonable to assume that native char have been similarly affected. These adverse impacts include fish passage barriers, water temperature, interactions with nonnative salmonids, geomorphic processes, timber harvest, agricultural practices, and urban development.

Taxonomists have considered the bull trout to be a separate char species from Dolly Varden (*Salvelinus malma*) since 1978 (Cavender 1978). The American Fisheries Society formally accepted the two separate species in 1980. Bull trout populations exhibit four distinct life history forms: resident, fluvial, adfluvial, and anadromous.

Resident bull trout inhabit the same streams or nearby tributaries in which they were hatched. Fluvial bull trout spawn in tributary streams where the young rear from one to four years before migrating to a river where they grow to maturity. Adfluvial bull trout spawn in tributary streams, and, after rearing, migrate to a lake (Fraley and Shepard 1989). Anadromous char are known only to occur in Coastal/Puget Sound DPS subpopulations where major growth and maturation occurs after migration to and from salt water. Potentially anadromous bull trout populations have been identified in the Puyallup, White, Carbon, and Green Rivers. These diverse life histories are important to the stability and viability of bull trout populations (Rieman and McIntyre 1993).

Bull trout have more specific habitat requirements than other salmonids. High quality bull trout habitat is typically characterized by cold temperatures; abundant cover in the form of large wood, undercut banks, boulders, etc.; clean substrate for spawning; interstitial spaces large enough to conceal juvenile bull trout; and stable channels. Because habitat has been degraded in many basins and bull trout populations in these basins may be depressed, the fish may utilize less optimal habitat.

Stream temperatures and substrate types are critical for their sustained long-term residence. Bull trout are found primarily in colder streams, although the fish are also found in larger, warmer river systems that may cool seasonally or provide migratory corridors and important forage bases. Bull trout are associated with the coldest, cleanest and most complex stream reaches within basins. Temperature is critical for spawning and early life history requirements. Very cold water is required for incubation, and juvenile rearing appears to be restricted to areas with cold water.

Spawning areas are often associated with the coldest streams in a river basin. In one study by Goetz (1994), juvenile bull trout were not found in water temperatures above 12 ° Celsius (C). Many studies show that temperatures must drop below 9 ° C or 10 ° C before spawning occurs (McPhail and Murray 1979; Craig 1997). Egg survival decreases as water temperature increases, with higher survival levels documented at 2 ° C to 4 ° C (McPhail and Murray 1979). The best bull trout habitat in several Oregon and Washington streams had temperatures which seldom exceeded 15 ° C (Buckman et al. 1992; Craig 1997; Ratliff and Howell 1992; Ziller 1992). Stream bottom and substrate composition are also highly important for bull trout (Pratt 1992), especially for juvenile rearing and spawning site selection (Rieman and McIntyre 1993; Graham et al. 1981; McPhail and Murray 1979). Fine sediments can influence incubation survival and emergence success (Weaver and White 1985) but might also limit access to substrate interstices that are important cover during rearing and over-wintering (Goetz 1994; Jakober 1995; USDI 1999a).

The anadromous life-form is more complex than the other life-forms discussed. Limited information on the marine and estuarine residency for bull trout is known. While it was thought that the Dolly Varden were primarily anadromous and the bull trout were fluvial and adfluvial in the north Puget Sound area, this is not the case. In the limited sampling done in Port Susan and Skagit Bay, the char have been identified as both bull trout and Dolly Varden (Kraemer in prep.).

In the north Puget Sound area many of the sub-adult char migrating out of headwater or mainstem areas adopt an anadromous life history. The smolts move downstream in the spring of the year (April, May, and early June) to the river mouths and nearby beaches. Sub-adults typically spend the spring and most of the summer in the marine environment where they experience rapid growth (25 millimeters (mm) to 40 mm per month).

Bull trout are opportunistic feeders. Like other apex predators, they require a large prey base and a large home range. Sub-adult and adult migratory bull trout move throughout and between basins in search of prey. Resident and juvenile bull trout prey on terrestrial and aquatic insects, macrozooplankton, amphipods, mysids, crayfish, and small fish (Wyman 1975; Rieman and Lukens 1979 in Rieman and McIntyre 1993; Goetz 1989; Donald and Alger 1993). Adult and sub-adult migratory bull trout are primarily piscivorous, feeding on various trout and salmon species, whitefish, yellow perch, and sculpin. A recent study in the Cedar River Watershed of western Washington found adult bull trout diets to also consist of salamanders (Connor et al. 1997).

Limited stomach content work and feeding observations indicate that while the char are in the marine environment of Skagit Bay and Port Susan they feed heavily on surf smelt (*Hypomesus pretious*). Other food items eaten in the marine waters include Pacific herring (*Clupea harengus pallasi*), Pacific sand lance (*Ammodytes hexapterus*), pink salmon smolts (*Oncorhynchus gorbuscha*), chum salmon smolts (*O. keta*), and a number of invertebrates. In Port Susan and Skagit Bay the smelt and herring spawning beaches match nearly exactly those used by the char while they are in the marine area (Kraemer in prep.). This matches information for foraging in freshwater, where bull trout were found to aggregate near seasonally concentrated forage fish in Flathead Lake, Montana (MBTSG 1998).

After several months in salt water, maturing adult bull trout begin their spawning migration. The fish leave the tidal areas in late May, June and early July. At this time, the first time spawners are 400 mm to 525 mm in length. In the Sauk basin the spawning migration can be as long as 195 km and the fish may climb to an elevation of 1000 meters (Kraemer in prep.). Bull trout become sexually mature between 4 and 9 years of age (Shepard et al. 1984), and may spawn in consecutive or alternate years (Shepard et al. 1984; Pratt 1992). Migratory bull trout frequently begin their spawning migrations as early as May, moving from the salt water back to the lower river and its tributaries to begin their spawning migration. The anadromous life-form does make considerable migrations. Migratory bull trout have been known to move upstream as far as 259 kilometers (155 miles) to spawning grounds (Fraley and Shepard 1989). Fish may be in salt water areas 40 km from the river mouth in the spring of the year and have been documented moving nearly 200 km upstream of the river mouth during spawning migrations. An adult tagged while staging in the spawning areas of the upper South Fork Sauk was recaptured by a fisherman the following spring in the marine area on the east side of Camano Island, fifteen air miles from the mouth of the Skagit River. A radio tagging study on the South Fork Skykomish (Kraemer pers. com. *in* WDFW 1997) showed that when the fish did migrate in the upper watershed, they commonly moved 2 km to 3 km a day with the maximum distance traveled of 15.2 km. In the lower river, the fish may travel at an even greater rate. During the low flows of summer and fall, most of the movement seemed to occur during the low-light periods just after dawn or before sunset. Once the fish reach staging areas near the spawning ground they may remain in the same general area, even the same pool, for several months.

In the Coastal/Puget Sound region, spawning occurs from August through December. Spawning typically occurs in cold, low-gradient 1st- to 5th-order tributary streams, over loosely compacted gravel and cobble having groundwater inflow (Shepard et al. 1984; Brown 1992; Rieman and McIntyre 1996; Swanberg 1997; MBTSG 1998). Spawning sites usually occur near cover (Brown 1992). They typically spawn in headwaters of tributary streams (Craig 1997). Hatching occurs in winter or early spring, and alevins may stay in the gravel for extended periods, sometimes exceeding 220 days. After spending the winter in the lower 35 kilometers (km) to 40 km of the river, the sub-adult char return to the marine environment. Some fish reenter the salt water as early as late February. Post-spawning mortality, longevity, and repeat-spawning frequency are not well known (Rieman and McIntyre 1996), but lifespans may exceed 10-13 years (McPhail and Murray 1979; Pratt 1992; Rieman and McIntyre 1993; USDI 1999a).

The full range of depths bull trout may use in Puget Sound is not known. There is some limited information on preferred depths available from freshwater lakes. This may be an appropriate surrogate for marine waters. One bull trout has been captured at 60 meters in Lake Washington, Washington (D. Beauchamp, University of Washington, pers. com. 2000). Bull trout were captured infrequently in Flathead Lake, Montana at depths greater than 34 meters (MBTSG

1998). However, there appeared to be tendency for bull trout to be associated with depths less than 34 meters (Leathe and Graham 1982 *in* MBTSG 1998, Huston 1975 *in* MBTSG 1998).

Bull trout are threatened by land management activities, water management activities, over-harvest, and competition or hybridization with non-native fishes (USDI 1999a). Urban and agricultural development has resulted in the loss of riparian habitat and wetlands, with a subsequent increase in impervious surfaces. These changes, especially in the lowland streams, have resulted in increased stream temperatures, alteration of stream flows and water quality, and impacts to forage species. Logging, road building activities and associated cumulative effects impact bull trout through increased sediment production and delivery to streams, loss of large pools and woody debris, increased water temperatures, and degradation of water quality and quantity. Dam, reservoir and irrigation construction and operations have altered portions of bull trout habitat. Dams without fish passage create barriers to migratory bull trout metapopulations. Dams and reservoirs also alter the natural hydrograph, thereby affecting forage, water temperature, and water quality.

Bald Eagle

A detailed account of the taxonomy, ecology, and reproductive characteristics of the bald eagle is presented in the Pacific States Bald Eagle Recovery Plan (USFWS 1986) and the final rule to reclassify the bald eagle from endangered to threatened in all of the lower 48 States (60 FR 36010). Additional information on the listing of the species, and its status in Washington State was included in the biological opinion for the Point Roberts golf course (USFWS 1999a).

The bald eagle is found throughout North America. It breeds primarily in Alaska, Canada, the Pacific Northwest states, the Rocky Mountain states, the Great Lake states, and Chesapeake Bay (USFWS 1986, American Ornithologists' Union 1983). The bald eagle winters over most of the breeding range, but is most concentrated from southern Alaska and southern Canada southward.

The recent proposal to delist the bald eagle in the lower 48 states (USDI 1999b) indicates that numeric delisting goals have been met for the bald eagle in the Pacific Recovery Region since 1995. The proposed project is located within the Pacific Recovery Region.

In Washington, bald eagles are most common along saltwater, lakes, and rivers in the western portion of the state and along the Columbia River east of the Cascade Mountains (Larrison and Sonnenberg 1968). Resident, breeding eagles are found throughout the state near large bodies of water. Most nesting habitat in Washington is located in the San Juan Islands and on the Olympic Peninsula coastline (Grubb 1976).

The primary wintering range of bald eagles in Washington is Puget Sound and its major rivers. Most eagles wintering in Washington occur along the Skagit, Nooksack, and Sauk River Basin (USFWS 1986).

The bald eagle is found along the shores of saltwater, and freshwater lakes and rivers. In Washington, breeding territories are located in predominantly coniferous, uneven-aged stands with old-growth components (Anthony et al. 1982).

Bald eagles typically build large stick nests in mature or old-growth trees, and these nests are generally used over successive years. In Washington, courtship and nest building activities normally begin in March or early April, with eaglets hatching in mid-April or early May. Eaglets usually fledge in mid-July (Anderson et al. 1986).

The size of an eagle nest is dictated by the forest type and tree species found within a geographic area; eagles apparently select nest sites for structure rather than tree species (Anthony et al. 1982, Anthony and Isaacs 1989). The three main factors affecting distribution of nests and territories include: 1) nearness to water and availability of food, 2) suitable trees for nesting, perching, and roosting, and 3) the number of breeding-aged eagles (Stalmaster 1987).

Wintering bald eagles generally concentrate in areas where food is abundant and disturbance is minimal. The birds use perches near feeding areas during the day, which are typically isolated areas in old-growth and mature stands that have trees larger than the surrounding trees; the perches also provide views of foraging areas. Night roost trees are chosen according to their diameter and growth form. The canopy of night roost trees provides protection from inclement weather and disturbances (USFWS 1986).

Important food items during fall and winter include carrion such as "spawned out" salmon taken from gravel bars along wide, braided river stretches (Stalmaster et al. 1985, Stalmaster 1987). Anadromous and warm-water fishes, small mammals, carrion, waterfowl, and seabirds are among the most prevalent food items consumed during the breeding season (Anderson et al. 1986, USFWS 1986).

Marbled Murrelet

The marbled murrelet was federally listed as threatened on September 28, 1992 (57 FR 45328). Critical habitat was designated on May 24, 1996 (61 FR 26256). In North America, marbled murrelets range along the Pacific coast from Alaska south to central California. Wintering birds have occasionally been found in southern California. Puget Sound has one of the more concentrated marbled murrelet populations of California, Washington and Oregon (USFWS 1997). An account of the taxonomy, ecology, and reproductive characteristics of the marbled murrelet is found in: the 1988 Status Review (Marshall 1988); the final rule designating the species as threatened; the Service's biological opinion for Alternative 9 (USFWS 1994) of the FSEIS (USDA and USDI 1994); the *Ecology and Conservation of the Marbled Murrelet* (Ralph et al. 1995a); the final rule designating critical habitat for the species (61 FR 26256); the recovery plan for the species (USFWS 1997); and, the biological opinion on the Simpson Habitat Conservation Plan (USDI 2000). The following summarizes some of this information.

The population size of murrelets in Washington, Oregon, and California has been estimated at 18,550 to 32,000 (Ralph et al. 1995b). The large range in the population estimate is a result of two widely divergent population estimates in Oregon. Based on demographic analyses, Beissinger and Nur (1997) estimate the murrelet population to be declining at a rate of at least 4 percent per year and perhaps as much as 7 percent per year in Washington, Oregon, and California.

Ralph et al. (1995b) summarized some of the reasons for variability in population estimates among researchers, including differences in methodology, assumptions, spatial coverage, and survey and model errors. Nevertheless, both Ralph et al. (1995b) and the Marbled Murrelet Recovery Team (1994) have concluded that the listed population appears to be in a long-term downward trend. The Marbled Murrelet Recovery Team estimates that the population may be declining at rates of between 4 and 12 percent, which means that in 20 years the population could be less than one-half to one-twelfth its current size.

In Washington, Speich and Wahl (1995) concluded that murrelet populations are lower now than they were at the beginning of the century. Total estimates for Washington, which were derived from surveys conducted in the early 1980s, are about 5,500 murrelets (Speich and Wahl 1995). Based on surveys conducted in 1993, Varoujean and Williams (1995) estimated that 3,250 murrelets occur on the outer coast of Washington and the western portion of the Strait of Juan de Fuca.

Nesting habitat is crucial to murrelets. Unlike other alcids, marbled murrelets nest inland in mature and old growth coniferous forests as far as 52 miles from the ocean (Marshall 1989). In Washington, Oregon, and California, murrelet nests have been found in trees. South of the Alaskan tundra, murrelets nesting occurs within mature or old growth coniferous forests within 50 miles of the ocean (Carter and Erickson 1988, Hamer and Cummins 1990, Hamer and Cummins 1991, Nelson 1989, Nelson 1990, Paton and Ralph 1990, Sealy and Carter 1984).

Murrelet nests have been found on platforms or broad surfaces that are formed by large limbs, moss, branches deformed by diseases such as mistletoe, or damaged branches. Suitable nesting platforms are found most commonly on older trees. Most nests are directly under overhanging branches, which may provide protection from harsh weather and predators. The Pacific Seabird Group defines potential nesting habitat as 1) mature (with or without an old growth component) and old growth coniferous forests; and 2) younger coniferous forests that have deformation or structures suitable for nesting (Ralph et al. 1993). Preferred tree species are Douglas-fir, coast redwood, western hemlock, Sitka spruce, or western red cedar. Because murrelets are seabirds, their nesting habitat must be within flight distance of a marine environment (USDA Forest Service et al. 1993).

The loss of nesting habitat (older forests) has generally been identified as the primary cause of the marbled murrelet's population decline and disappearance across portions of its range (Ralph et al. 1995a). Prey resources and nesting habitat are identified as the two main factors which can affect seabird populations (Cairns 1992 *in* USFWS 1997). As the proposed project may affect the marine environment as opposed to nesting habitat, we will focus on the former aspect of the environment.

Marbled murrelets typically are found foraging within 0.6 miles to 1.2 miles from shore (USFWS 1997). Marbled murrelets feed mostly in near-shore marine waters and in inland saltwater bays and sounds, and occasionally inland freshwater lakes (Marshall 1989). They often gather at the mouths of rivers. Many prey species concentrate in specific nearshore areas where conditions concentrate lower trophic levels which are food for marbled murrelet prey species. In areas were marbled murrelet prey are concentrated, foraging marbled murrelets have also been concentrated (Carter 1984 *in* USFWS 1997, Carter and Sealy 1990 *in* USFWS 1997).

Marbled murrelets are considered opportunistic foragers. They are known to feed on invertebrates as well as fish. Mysids, gammarid amphipods and euphausiids invertebrates have been identified as important forage species during various times of the year and in certain localities. Invertebrate species appear to be more important during the winter and spring, as opposed to the summer breeding period. The prey is known to differ by species and/or its size between that eaten by adults versus chicks (Sealy 1975 *in* USFWS 1997, Carter 1984 *in* USFWS 1997, Carter and Sealy 1990 *in* USFWS 1997, Burkett 1995).

In the Pacific Northwest, the main fish prey for marbled murrelets has been identified as Pacific sand lance (*Ammodytes hexapterus*), Pacific herring (*Clupea harengus*), northern anchovy (*Engraulis mordax*), and smelt (Osmeridae) (USFWS 1997). Marbled murrelets have been seen occasionally foraging on salmonids in inland lakes in British Columbia and Washington (Carter and Sealy 1990 *in* USFWS 1997).

While declines in forage species may affect marbled murrelet populations, little information on any direct effect is available. Declines in species such as the Pacific herring have been documented in parts of Puget Sound (Burkett 1995, WDFW 1995 *in* USFWS 1997). However, the spawning biomass of Pacific herring has remained stable over the last 20 years (WDFW 1995 *in* USFWS 1997).

Marbled murrelets may shift their feeding areas in response to changes in prey in localized areas. Marbled murrelets are known to shift their nearshore foraging areas between years off of the Oregon coast (Strong 1995). Marbled murrelets may change their foraging area by up to 50 miles, based on daily foraging distances from nest sites and feeding areas (Carter and Sealy 1990 *in* USFWS 1997, Jodice and Collopy 1995 *in* USFWS 1997, Kuletz et al. 1995).

Some anthropogenic impacts to marbled murrelets in marine waters include mortality from gill nets, oil spills, and other marine pollution. The actual number of net mortalities in Washington is low. These impacts are addressed in the biological opinions for Puget Sound area non-treaty commercial salmon net fisheries (USFWS 1996) and the treaty commercial salmon net fisheries in the Strait of Juan de Fuca and Puget Sound (USFWS 1999b). Oil pollution is a significant threat or conservation problem in southern Alaska, southern British Columbia, Washington, and California (King and Sanger 1979 *in* USFWS 1997, Wahl et al. 1981, Sealy and Carter 1984, Carter and Erickson 1988, Carter and Erickson 1992 *in* USFWS 1997, Marshall 1988, Carter and Kuletz 1995 *in* USFWS 1997). Oil spills include large spills, such as the 1991 Tenyo Maru spill off the Olympic Peninsula, Washington, to small spills which may result from tank cleaning and bilge pumping. Other marine pollution which may affect marbled murrelets includes chemical contaminates which enter the water way via direct dumping and effluent from onshore sources. Marbled murrelets in Washington which were analyzed for contaminants appeared to be within the normal ranges for seabirds from clean environments (Grettenberger et al., in prep.).

Habitat Conservation Plans

The range-wide status of the bald eagle, marbled murrelet and bull trout has been affected by a number of recent Habitat Conservation Plans (HCPs) that were prepared in conjunction with incidental take permit applications to the Service pursuant to Section 10(a)(1)(B) of the Act.

Six HCPs have been completed within Washington. The following summarizes the anticipated and/or permitted take of bald eagles, marbled murrelets, and bull trout for the HCPs which include these species:

- West Fork Timber Co. HCP (formerly Murray Pacific HCP): bald eagle, marbled murrelet
- Port Blakely L.P.- Robert .B. Eddy Tree Farm HCP: bald eagle, marbled murrelet
- Washington Department of Natural Resources (WDNR) HCP: bald eagle, bull trout, marbled murrelet
- Seattle Public Utility's Cedar River Watershed HCP: bald eagle, bull trout, marbled murrelet
- Plum Creek Timber Company I-90 HCP: bull trout, marbled murrelet
- Simpson Timber HCP: bald eagle, bull trout, marbled murrelet,

West Fork Timber Co. HCP (formerly Murray Pacific HCP)

The West Fork Timber Co. HCP 100-year amended incidental take permit for the 53,527-acre Mineral Tree Farm, located in Lewis County in western Washington, was approved in June, 1995. Although no marbled murrelet occupancy has been identified by current surveys, the amended permit allows incidental take of murrelets associated with 800 acres out of 1,091 acres of potential murrelet habitat. If murrelets occupy potential habitat in the future, some incidental take may occur as a result of disturbance.

The HCP does not anticipate the incidental take of bald eagles, although bald eagles are a "covered" species under the terms of the permit.

Port Blakely L .P.- Robert B. Eddy Tree Farm HCP

The Port Blakely Tree Farms, L. P. 50-year incidental take permit for the 7,486-acre R. B. Eddy Tree Farm, located in Pacific and Grays Harbor counties in southwest Washington, was approved in July, 1996. No modification nor disturbance of known occupied murrelet sites is authorized under the HCP. However, due to the possibility that habitat surveyed in the first 5 years of the plan could eventually become occupied in the future, incidental take may result from harvest of 210 acres of deferred habitat and 250 acres of habitat that may develop in Riparian Management Zones. In addition, incidental take from disturbance due to harvest may occur during the nesting season. The HCP permits the incidental take of up to 25 wintering eagles due to harvest of wintering habitat.

City of Seattle for the Seattle Public Utility's Cedar River Watershed HCP

The City of Seattle for the Seattle Public Utility's Cedar River Watershed HCP permitted the take of an undetermined number of marbled murrelets associated with one known occupied stand and an unknown number of other occupied stands over a 50-year period as a result of the proposed action. The number of marbled murrelets taken annually could not be determined. Specifically, incidental take of marbled murrelets was authorized within the watershed as a result of 14,400 acres of forest restoration (ecological and restoration thinning, and conifer under-planting), 240 miles of road removal, and 380-520 miles of on-going road maintenance, and as much as 4 miles of streambank stabilization and re-vegetation work and 50 in-stream wood placement projects over the term of the HCP.

The incidental take permit for the HCP allowed an undetermined number of bald eagles to be taken over a 50-year period as a result of this proposed action. The number of bald eagles taken annually could not be determined. However, the number of bald eagles expected to be taken is very small, both because of the low number of bald eagles thought to occur within the watershed at this time (only transients and migrants and no known nesting activity), and due to the level of protection provided by the HCP.

Two harm and harassment estimates of take were determined for bull trout based on the assumption that this species occurs throughout lands managed by the City of Seattle.

The incidental take permit for the HCP allows the take of bull trout associated with 420 acres of restoration thinning (0 to 30-year old trees) conducted in the first fifteen years on the HCP and 150 acres of ecological thinning (30 to 60-year old trees) over the full term of the HCP. It also included take associated with maintenance of 520 miles of currently maintained roads, and with the ground disturbance associated with removing about 240 miles of existing roads during the first 20 years of the HCP. However, by year twenty of the HCP, the total maintained road mileage will drop to approximately 380. Some incidental take in the form of harm associated with improvement of about 4 miles to 10 miles of road per year is also anticipated.

Incidental take of bull trout in the Chester Morse Lake/Masonry Pool system occurs from entrainment through two intakes devices, the Cedar Falls Hydroelectric Project at Masonry Dam and the Overflow Dike into Masonry Pool. It is expected that no more than seven percent of the estimated bull trout population in that system will be killed per year through any combination of these intake devices. Take is also expected to occur due to inundation of redds and preventing spawners from accessing the tributaries of the reservoir by unusually low water levels in the reservoir. Studies have shown that less than ten percent of the bull trout redds in the Cedar River have been located below the normal high pool elevation of 1,563 feet. Thus, these lower elevation redds would be subject to take every year. Nearly all (~95 percent) Rex River bull trout redds were annually located below 1,563 feet. Therefore, these redds would be subject to some form of take, because they can be reasonably expected to be inundated for some duration before juvenile bull trout emerge. Reservoir management zones of "Infrequent" (2) and "Very Infrequent" (1) are expected to take more bull trout than the "Normal" (3) operating zone. Zone (2) and (1) are expected to occur once every ten and fifty years, respectively, with durations exceeding one week. Short durations of spawner impedance can be expected to occur in the reservoir management zone (Appendix 38) of "Normal" (3) every year, but periods longer than one week will only occur once every four years. Spawner blockage is not expected to occur in the "Normal" (3) zone. The "Infrequent" zone (4) is expected to occur with a frequency of one in ten years where both spawner impedance and blockage is expected to occur with durations of one to three weeks. The "Very Infrequent" zone (5) will impede and block spawners, but is expected to occur only once in fifty years.

Plum Creek Timber Company I-90 HCP

The Plum Creek Timber Company I-90 HCP addressed about 170,600 acres for 50 to 100 years in King and Kittitas Counties, Washington. The permit allows incidental take of murrelets associated with up to 400 acres of unsurveyed low-quality habitat west of the Cascade Crest and 1,400 acres of unsurveyed land east of the Crest. The amended HCP to address the I-90 land exchange in 1999 permitted the additional take of 721 acres of low-quality suitable habitat or marginal habitat west of the Cascade Crest. Also, some portion of 1,741 acres of nonhabitat (Mature Forest Structural Stage) west of the Cascade Crest, could eventually become habitat during the 100-year permit, and subsequently subject to harvest without surveys.

The Plum Creek Timber Company's HCP amended the HCP (USDI 1998a) to include the Columbia River DPS of bull trout. The amendment allowed for the take of bull trout associated with habitat degradation/loss due to 150 acres of selective and thinning/restoration-oriented silvicultural harvest per year, 2 miles of stream restoration per year, and 20.2 miles of road construction, maintenance, and removal per year.

WDNR's HCP

The WDNR incidental take permit for 1.6 million acres of State forest land in the State of Washington was approved on January 30, 1997. The 70-year permit covers all WDNR-managed lands within the range of the spotted owl and authorizes incidental take occurring from commercial forest activities as well as non-timber resource activities. The HCP permits the incidental take (in the form of harm) of all bald eagles associated with the harvest of 200,000 acres of forested habitat over the life of the HCP. In addition, incidental take (in the form of harassment) of bald eagles due to disturbance may occur on a total of 2,402,820 acres over the life of the HCP. This disturbance is due to both forest (i.e., harvest) and non-forest resource activities. Incidental take was issued for bald eagles under the WDNR HCP. However, inadvertent incidental take of bald eagles will be minimal because the DNR will actively conserve known nest sites.

Approximately 376,000 acres of State Forest land occurs within the Olympic Peninsula. Of this 376,000 acres, 23,836 acres of suitable murrelet habitat are scheduled for harvest under the HCP. In addition to habitat removal, disturbance related take for marbled murrelets due to timber harvest and non-timber resource activities may occur on 6,402 acres per year for the first decade of the HCP on the Olympic Peninsula.

The WDNR's HCP amendment (USDI 1998b) to include bull trout allowed for incidental take of bull trout associated with habitat degradation/loss due to 29 miles of road construction and maintenance per year, and 158 acres of selective and thinning harvest per year. This amendment added only the Coastal/Puget Sound DPS of bull trout to the WDNR's HCP.

Simpson Timber HCP

The Simpson Timber incidental take permit was issued on October 12, 2000. The HCP encompasses the Plan Area of 261,575 acres and approximately 640,000 acres of additional lands (known as the Assessment Area) surrounding the Plan Area. The Assessment Area lands are not currently owned by Simpson, but may be in the future. All lands occur in Mason, Grays Harbor, and Thurston counties. The incidental take permit authorizes take of bald eagles, bull trout, and marbled murrelets associated with commercial timber harvest and land management activities for a period of 50 years.

The FWS authorized incidental take of marbled murrelets in the form of harm, as a result of harvest of up to a total of 315 acres of suitable marbled murrelet (but currently unoccupied) habitat outside of Riparian Conservation Reserves (RCR). Take, in the form of harassment, due to disturbance of undiscovered nesting marbled murrelets, is anticipated to occur. Specifically, the FWS authorized take of marbled murrelets due to disturbance associated with timber harvest activities within the Plan Area, on potentially covered lands allowed to be added per Provision 10 of the Implementing Agreement (IA), and those immediately adjacent (within one mile) of the Plan Area. The FWS authorized take of marbled murrelets, due to harassment, as a result of activities near suitable habitat within the RCRs that are currently occupied, or which could become occupied over the proposed incidental take permit term (162 acres expected to develop within the RCR by the year 25, and 1231 acres are expected to develop within the RCR by the year 50 of the incidental take permit term). Marbled murrelets could be taken due to harassment as a result of harvest of trees outside of, but adjacent to RCRs. The FWS authorized take for marbled murrelets associated with habitat outside of RCRs that becomes occupied prior to being harvested, and for marbled murrelets associated with occupied habitat outside of the RCRs as a result of harvest of trees within 300 feet of such habitat. The FWS authorized take, due to harassment, of marbled murrelets associated with habitat that is within 0.25 mile of up to 250 miles of new road construction over the term of the HCP, a small portion of which may be as close as 300 feet to occupied marbled murrelet habitat, and for activities associated with potential remediation of a maximum of 2,001 miles of system roads (during the first 15 years of the proposed permit term,100 percent of all roads needing remediation would have such work completed; thus all potential take associated with road remediation would occur within the first 15 years of the permit term). The FWS authorized take due to harassment of all marbled murrelets associated with activities in habitat adjacent to a maximum of 6,160 acres of experimental thinning sites over the proposed ITP term, where timber harvest may occur. A small portion of the 6,160 acres could be adjacent to occupied marbled murrelet habitat (but would not occur within suitable or occupied habitat). The FWS anticipated take due to harassment for all marbled murrelets within one mile of any blasting activities occurring between September 1 and September 15 of any given year. Take due to harassment of marbled murrelets is not authorized during the time period April 1 through August 30 for blasting, as Simpson has stated that they would not blast during this time period near marbled murrelets. Take may occur on an unknown number of acres due to blasting in an unknown number of sites and locations over the life of the HCP, potentially causing nesting upset, loss of eggs, or nest abandonment if this blasting occurs proximal to nests. The FWS anticipated take in the form of harassment in limited areas of the Plan Area involved in proposed Covered Activities that were subject to protocol surveys and determined to be unoccupied, but become occupied during the ITP term.

The FWS authorized bull trout take as a result of timber harvest and experimental thinning associated with stream habitats on 2,987 acres (187 acres in the first 10 years of the permit term, and up to 5,973 (total of 6,160 acres minus 187 acres) for the remaining 40 years of the permit term. In addition, the FWS authorized take for bull trout associated with habitat adjacent to 250 acres of new road construction, and with habitat adjacent to potential remediation of 2,001 miles of system roads (during the first 15 years of the proposed permit term, 100 percent of all roads needing remediation would have such work completed). By year 15 of the HCP, effects to bull trout habitat resulting from road remediation should be eliminated.

The FWS authorized take, in the form of harassment, due to disturbance of all bald eagles associated with timber harvest adjacent to bald eagle roosting habitat, a maximum of 250 miles of new road construction, a maximum of 2,001 miles of system road remediation within the first fifteen years of the proposed ITP term, and a maximum of 6,160 acres of experimental thinning. Only winter roosting and migrant bald eagles are currently known from the Plan Area; no nesting activity is currently known. The communal roost site supports approximately 30 bald eagles. A small amount of nesting is likely to occur during the proposed ITP term within the Plan Area. Nesting during the proposed permit term is more likely within lands allowed to be added for coverage per Provision 10 of the IA, particularly near Puget Sound (nesting activity in this area is currently undetermined). The number of bald eagles anticipated to be taken is small, but the potential for take to occur is moderate. A small number of bald eagles are expected to occur

within the Plan Area and environs during the proposed permit term as most of the potential habitat is in a relatively young successional stage, and a relatively small amount of high function perching and nesting habitat is expected to develop during the proposed ITP term.
ENVIRONMENTAL BASELINE (in the action area)

Bull Trout and Aquatic Resource Conditions

The proposed project is located within and adjacent to the Green River Sub-Population of bull trout. Very limited information is available on the status of bull trout in this sub-population of the Coastal/Puget Sound DPS.

Green River

Very limited information is available on the status of bull trout in the Green River basin. Extensive surveys specifically for bull trout have not been conducted in the Green River. Bull trout are presumed to occur in very low numbers in this system. It is unknown how bull trout specifically use the Green River and its tributaries, although it is likely used for foraging, and migration for the purpose of this BO. However, there is unlikely to be any suitable spawning habitat in the action area. No spawning locations are known (WDFW 1998). The life history forms of bull trout in this drainage are not known; however, they are likely to be anadromous and/or fluvial. Historical accounts suggests that bull trout were once common (Suckley and Cooper 1860). However, creel counts on the Green River, dating from 1940, indicate bull trout are now extremely rare, with only four char taken by over 35,500 anglers checked between 1940 and 1973 (Cropp *in* WDW 1993). Though few in number, Cropp (*in* WDW 1993) indicated that char are still occasionally caught in the Green River. A native char was caught in May 1994 in the Duwamish River that was positively identified as a bull trout both by Haas measurements and by genetic work (E. Warner, Muckleshoot Indian Tribe, pers. com. 1997). Eight native char were caught in the turning basin of the Duwamish River Estuary near river mile (RM) 1.5 in August and September, 2000 (Taylor Associates 2001). Positive identification as bull trout has been established by genetic analysis for two of the six fish; the remaining fish have not been analyzed to date (W. Mavros, King County, pers. com. 2001a). Watson and Toth (1994 *in* WDFW 1998) state that native char have been harvested in the Green River as far upstream as RM 64. More recently, a bull trout, as determined by genetic work, was caught at the mouth of Newaukum Creek off the mainstem of the Green River, approximately 40 miles upstream from the mouth of the Green/Duwamish River (E. Warner, Muckleshoot Indian Tribe, 2000). Plum Creek Timber Company has conducted presence/absence surveys for bull trout in the upper Green River watershed above Howard Hanson dam, with no presence documented.

Mongillo (1993) listed bull trout in the Green River as a remnant population, with status unknown, and with an immediate need for data. WDFW (1998) lists the Green River population as unknown status. The FWS believes the status of this subpopulation is depressed, based on available information that indicates native char occur in very low numbers in comparison to historic levels. Total abundance for the subpopulation is believed to be less than 5,000 individuals or 500 adults.

The Green River and its tributaries presently provide only poor to fair habitat for bull trout because of industrial, residential and agricultural developments along the lower and middle reaches of the Green River and its tributaries, the presence of two dams at RM 61 and 64.5, and extensive timber harvest in the upper basin. These activities have resulted in the increase in fine sediments, a severe reduction in the riparian corridor, constriction of the river channel and isolation from its floodplain, a reduction in channel complexity and habitat diversity, instream flow reductions, alteration of the natural flow regime, elevated water temperatures, the interruption of the transport of large woody debris and spawning gravels, and the blockage of access to upstream habitats.

Bull trout spawning habitat is limited by the availability of suitable substrate and water temperatures. The Green River channel below Howard Hanson Dam and extending downstream to near Flaming Geysers Park is largely armored due to the interception of coarse sediments by Howard Hanson Dam (Perkins 1999). A large landslide near Flaming Geysers State Park and several tributaries, including Soos, Newaukum and Burns Creeks, contribute large amounts of fine sediment. Most of the tributary streams are also impacted by sedimentation. The temperature of the water released from Howard Hanson Dam may be too high for successful bull trout spawning and incubation in the Green River downstream from Howard Hanson Dam, but springs entering the channel bed may provide suitable conditions. Some of the spring fed tributaries, both upstream and downstream of Howard Hanson Dam, may also provide suitable spawning and incubation habitat.

Bull trout rearing habitat is likely limited by high water temperatures and the relative lack of channel complexity and habitat diversity. The Green River has been listed as water quality impaired by Washington Department of Ecology (WDOE) (WDOE 2000). It is on the 303(d) list for the following parameters: elevated temperatures, metals, ammonia, fecal coliform bacteria, pH, low dissolved oxygen, and high biochemical oxygen demand. However, State temperature standards themselves may not be adequate for bull trout given that the temperature standard for the highest class of waters is 16 ° C, whereas temperatures in excess of about 15 ° C are thought to limit bull trout distribution (Rieman and McIntyre 1993). The removal of riparian vegetation and large woody debris from the system, the confinement of the channel by levees and riprap, the elimination of the channel forming flood flows, water withdrawals, and reduced groundwater recharge have all contributed to degradation of bull trout rearing habitat. As a consequence, the Green River mainstem probably provides suitable rearing habitat for only a portion of the year, with spring fed tributaries providing summertime refuge.

The Green River and many of its tributaries provide suitable foraging habitat for bull trout, given the significant number of chinook, coho *(Oncorhynchus kisutch)* and chum salmon, and steelhead trout that are produced within the basin. Other potential prey resources include sculpins, suckers, whitefish, and crayfish, as well as a number of estuarine and marine species within the tidally influenced portion of the lower river.

Gilliam Creek

Gilliam Creek basin is highly developed by urban land uses. This has resulted in increased peak flows and runoff due to impervious surfaces. The creek is scoured and eroded in its upper reaches, with sediment deposition in the lower reaches. Gilliam Creek drains into the Green River with its confluence at RM 12.7. Its basin is composed of 2.9 square miles. The creek has been fragmented by streets, freeway crossings, residential and commercial development, and wetland fill.

Gilliam Creek does not have a specific water quality designation by the WDOE. The water quality designation is determined by its receiving water, the Green River (City of Tukwila 2000), which is currently listed as impaired.

Chinook, coho, chum, steelhead, and sea-run cutthroat (*Oncorhynchus clarki clarki*) have been reported from Gilliam Creek (Partee1999 pers. com. *in* City of Tukwila 2000, Jones and Stokes 1990 *in* City of Tukwila 2000). Partee (2000) reports that the correct list for Gilliam Creek is chinook and coho salmon, and cutthroat trout. Partee (2000) has identified juvenile chinook salmon in the lower reaches of the creek. Pacific lamprey (*Lampera tridentata*), river lamprey (*L. ayresi*), rainbow trout (*Oncorbynchus mykiss*), western brook lamprey (*L. richardsoni*), cutthroat trout (*O. clarki*), sculpin (*Cottus* sp.), longnose dace (*Rhinichthys cataractae*), largescale sucker (*Catostomus macrocheilus*), three-spine stickleback (*Gasterosteus aculeatus*), and speckled dace (*R. osculus*) may also occur within this creek system (Wydoski and Whitney 1979). There is a flap gate where Gilliam Creek drains into the Green River. Anadromous fish access to Gilliam Creek is therefore limited, although access by juveniles does occur. There is potential salmon spawning and rearing habitat in the lower reach of the creek (City of Tukwila 2000).

Miller Creek, Walker Creek and Miller Creek Estuary

The Miller Creek Watershed is approximately 8 square miles in size. The creek is approximately 4 miles long. At RM 1.8, the creek flows through a ravine. Miller Creek has been altered as a result of the loss of riparian habitat, and impervious surfaces which has lead to stream degradation. The estimates of the amount of impervious surfaces range from 23 percent to 49.4 percent.

Benthic macroinvertebrate sampling was performed in Miller Creek. A benthic index of biotic integrity (B-IBI) of 10 was scored. B-IBI scores tend to decrease with increasing impervious areas. B-IBI may be as high as 40 plus in Puget Sound lowlands for areas of low impervious surface (Kleindl 1995 *in* Karr and Chu 1999). Low B-IBI scores in Puget Sound creeks have indicated habitat degradation. Miller Creek has not been listed by WDOE as an impaired stream (WDOE 2000).

The streambank and riparian condition are variable. The upper sections of the creek are within urbanized areas, with housing in close proximity to the stream. Native and non-native vegetation occurs along the streambanks, providing some canopy cover and detrital matter. Some sections of the creek have been stabilized with hardened structures. The lower section winds through a private park, which includes its estuary. The park is primarily a grassy area with deciduous trees. The estuary banks are confined by riprap. The shoreline adjacent to Miller Creek is predominantly gravel and sand, with some driftwood. The intertidal zone at the mouth of the creek is composed predominantly of mixed gravel and sand. The creek channel in the upper intertidal zone contains more cobble than adjacent areas. The estuary channel is vegetated with green algae.

A water fall at RM 3.1 may be a migration barrier for anadromous fish. No anadromous fish have been reported upstream of this location, to date. Bull trout are known to ascend waterfalls that other anadromous fish are unable to pass. No bull trout have been noted within the creek. Bull trout may use the Miller Creek estuary for foraging. It is unlikely that they forage upstream of tidal influence due to the low forage base produced in the stream, high water temperatures, lack of cover, and their inability to osmoregulate rapidly.

Threespine stickleback, pumpkinseed sunfish, black crappie, and cutthroat trout have been found upstream of the water fall. Cutthroat and coho have been detected rearing below the falls. Chum salmon spawn in lower Miller Creek. Five chum redds were located in the lower 1.75 miles of the creek during the 1998-1999 spawning period.

Walker Creek is a tributary to Miller Creek. It enters Miller Creek at approximately 300 ft upstream from the mouth of Miller Creek. Its watershed is primarily urbanized. Its channel is approximately 3-ft wide and is incised approximately 1.5 ft. The creek is tidally influenced to approximately 100 ft of a control weir. Walker Creek is an anadromous fish bearing stream. Coho and chum salmon redds, and potentially a cutthroat trout redd have been located in the lower sections of the creek.

Des Moines Creek and Estuary

The Des Moines Creek Watershed is approximately 5.8 square miles. The watershed is urbanized, with approximately 35 percent impervious surface. Most of the stream in the upper watershed has been placed in culverts, road side ditches and drainage pipe. The creek is 3.5 miles long, beginning on a plateau, and then descending through a ravine before it reaches Puget Sound. The Des Moines Creek estuary is located within the Des Moines Creek Beach public park. Prior to flowing into the estuary, the creek flows through the park, and under buildings which span the creek.

Des Moines Creek is listed as a 303(d) stream by the WDOE (WDOE 2000). It is listed as an impaired water due to high fecal coliform levels.

Fish production in Des Moines Creek is limited due to fish barriers, high stream flows, limited rearing and overwintering habitat, low summer flows, low dissolved oxygen, and high water temperatures (Des Moines Creek Basin Committee 1997). Due to high flows, some areas of the creek have eroded, and the stream bed has been scoured of gravel.

Bull trout have not been noted within Des Moines Creek. Bull trout may use the creek estuary for foraging. It is unlikely that they forage upstream of tidal influence due to the low forage base produced in the stream, high water temperatures, lack of cover, and their inability to osmoregulate rapidly.

In the lower reaches of the creek, coho and chum salmon, steelhead, and cutthroat trout have been seen. Some spawning in the lower reaches also occurs. A culvert at Marine View Drive (RM 0.4) limits the migration of fish to spawn upstream. In 1998-1999, 22 coho redds were found in the first 1.24 miles of Des Moines Creek, with 21 of these redds in the first half mile. Sixteen chum redds were found during this same time period in the first half mile of the creek.

Puget Sound

Limited information regarding bull trout use of marine waters is available. No specific sub-population unit is specified for Puget Sound. Bull trout are known to use these waters for migration and foraging.

Puget Sound has been significantly altered from its original condition. It has been estimated that one-third of the shoreline in Puget Sound has been altered (PSWQAT 1998). In the eastern side of Puget Sound's main basin, which includes the action area, approximately 80 percent of the shoreline from Mukilteo to Tacoma has been altered (PSWQAT 1998). It is not known how the distribution of eelgrass has been affected over time. Eelgrass is important spawning and rearing habitat for bull trout forage fish.

Declines in populations, productivity and survival of a number of organisms that live in Puget Sound have been noted in recent years. This includes declines in the spawning runs of Pacific herring, rockfish stocks, and coho salmon, as well as declines in over-wintering grebes and scoters (PSWQAT 1998).

The distribution of the char in marine waters is believed to be closely tied to the distribution of the bait fish, especially their spawning beaches. A sandlance spawning area is known from less than one mile north of the Miller Creek estuary. Surf smelt spawning areas are identified approximately one mile north and south of the Des Moines Creek estuary (WDFW 2000). Marine observations of native char, including bull trout, nearest to the proposed project site have occurred in the turning basin of the Duwamish River and at Shilshole (W. Mavros, King County, pers. com. 2001b).

Toxic contaminants have also been released into Puget Sound from various sources, degrading the aquatic habitat. Some contaminants are in declining levels, which may be a result of improved pollution control. However, there is some evidence that polyaromatic hydrocarbons may be increasing in some areas. There has been a higher incidence of liver lesions in English sole in Elliot Bay, which may be the result of increased polyaromatic hydrocarbons (PSWQAT 1998). The WDFW is conducting tests on Pacific herring, a forage species for bull trout and marbled murrelet, to monitor the pollutants in Puget Sound (PSWQAT 1998). Results from the1995 pilot study in Fidalgo Bay showed that Pacific herring accumulated the same type of contaminants that have been observed for other species in Puget Sound. Some of the contaminants detected included polychlorinated biphenyls (PCB's), dichloro diphenyl dichloroethane (DDD) and dichloro diphenyl dicholorethylene (DDE) (metabolites of dichloro diphenyl tricholoroethane)(DDT)), and metals (i.e., mercury). These levels were within the range of that observed for other Puget Sound fish species (PSWQAT 1998). The Washington State Puget Sound Ambient Monitoring Program in the future plans to monitor the effects of PCB accumulation in the Puget Sound food webs (PSWQAT 1998).

Sea-Tac currently uses deicers, flocculents, petroleum products, pesticides, and herbicides which may enter the ground and surface water. Existing treatment facilities reduce but may not eliminate these contaminants in the aquatic system. Existing levels of potential contaminants, such as copper (Cu) and zinc (Zn), may be at levels which could have acute and/or chronic toxicity effects on aquatic species.

Des Moines Creek and Miller Creek, and discharges from the industrial wastewater system (IWS) may currently exceed lethal and sub-lethal toxicity levels for bull trout and their forage species for Cu and Zn (Eisler 1998) (Table 2). Except for lethal levels for Zn, all potential impacts are based on values available for other fish species. There is currently no specific information available for bull trout regarding Cu toxicity or sublethal effects of Zn.

Table 2. Cu and Zn concentrations within action area and sublethal and acute toxicity values for fish species, including bull trout.

Chemical	Location		
	Mouth of Miller Creek	Mouth of Des Moines Creek	IWS Outfall
Cu, existing levels, micrograms/liter[1](µg/L)	7 - 45	10 - 24	2 - 30

Cu sublethal effects (μg/L)[2]	4 - 10		
Cu LC_{50} toxicity value (μg/L)[3]	42 - 110		
Zn, existing levels (μg/L)[1]	35-234	24-60	7-103
Zn, sublethal and lethal effects (μg/L)[4]	50-235 4.9-9.8 for the brown trout (*Salmo trutta*)		
Zn LC_{50} toxicity value for bull trout, (μg/L)[5]	31.9-86.9		

1 Adapted from BA, Tables 7-10 and 7-11.

2 Eisler 1998.

3 Adapted from BA, Table 7-12.

4 Eisler (1993).

5 96 hour and 120 hour exposures at variable temperatures (8° C and 12° C), pH (6.5 and 7.5) and hardness (30 mg/L and 90 mg/L), and based on Spearman-Karber and Probit statistical analyses, Stratus Consulting, Inc. (1999).

Tempo, Banner, Triester, Cidekick, Diuron, Roundup, Crossbow, and Deluxe Turf with Trimec are included on the list of pesticides and herbicides that may be used on Sea-Tac. Tempo and Diuron have not been used. The Landscape Management Plan for Sea-Tac currently imposes a 50 ft buffer around waterbodies. A buffer of 50 ft may not adequately prevent some of these chemicals from entering the aquatic system via surface water and/or groundwater. This plan does not apply to the proposed mitigation areas and their buffers (J. Kelley, Parametrix, Inc. pers. com. 2000).

Cationic polyacrylamides (PAM) are currently used at Sea-Tac, and are proposed for continued use to reduce suspended solids from its treatment systems. Sojka and Lentz (no date) state that neutral and especial cationic PAMs have been shown to have LC_{50}s low enough for concern to certain aquatic organisms, whereas, anionic PAMs do not. Cationics are attracted to the hemoglobin in fish gills, which may result in suffocation. It is noted, however, that when PAMs are used in waters containing sediments, humic acids, or other impurities, the effects of PAMs on biota are buffered greatly (Buchholz 1992 *in* Sojka and Lentz (no date), Goodrich et al. 1991 *in* Sojka and Lentz (no date).

Bald Eagle

The action area is located in the Puget Sound Management Zone, which has the highest density of nesting bald eagles in Washington. In 1998, 298 occupied territories were documented (WDFW data), which far exceeds the recovery objective of 115 territories.

No bald eagle nest sites are located within the action area. The nearest nest is approximately one mile east of the action area, near Angle Lake. Bald eagles forage within Puget Sound and the Green River. It is assumed that the bald eagles occupying the Angle Lake nest site forage primarily in Angle Lake, though use of Puget Sound is also possible. Angle Lake has been stocked with rainbow trout and kokanee for a number of years (at least since 1982), therefore providing a very localized forage base for these eagles.

There is currently a risk of airplane strikes with bald eagles at the airport. However, no airplane strikes of bald eagles have been reported to date at Sea-Tac. Bald eagles have been seen on, and flying over and near the airport (Tables 3 and 4).

Table 3. Total bald eagle sightings reported by month at Sea-Tac, 1995 - April 2001.[1]

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2001	3	1 (2)[2]	5	3								
2000			3	1 (2)	1	1			1	3 (5)		
1999					1							
1998	1 (2)	1 (2)		1							1	
1997	1				1							
1996					2 (3)							
1995		2 (3)	1 (2)							1 (2)	1 (2)	1
Total	5 (6)	4 (7)	9 (10)	5 (6)	5 (6)	1	0	0	1	4 (7)	2 (3)	1

[1] Osmek (2001a)

[2] Numbers in parentheses represent actual number of birds sighted.

Table 4. Bald eagle behavior reported at Sea-Tac, 1995 - April 2001.[1]

Behavior	Total	Frequency (percent)
Fly (Passing over)	21 (25)[2]	
Fly (Passing over)/Harassed (by birds)	1	
Total Fly	22 (26)	59
Towering/Soaring	9 (15)	
Towering/Soaring/Harassed (by birds)	1	
Total Towering/Soaring	10 (16)	27
Loafing/Standing	4 (5)	
Perching	1	
Total Loafing/Standing/Perching	5 (6)	14
Grand Total	37 (48)	100

[1] Osmek (2001a)

[2] Numbers in parentheses represent actual number of birds sighted.

Based on the information provided by Osmek (2001a), most bald eagle sightings have been during the nesting and late wintering seasons. The number of bald eagles sighted has increased over the six and a half year period that was reported. This may be due to two factors: an increase in observer effort and an overall increase in bald eagle numbers in Washington.

Observations on the airport include the use of the embankment for loafing and use of the VHF tower for perching (S. Osmek, Port of Seattle, pers. com. 2001b). The embankment is currently about 50 ft higher than the rest of the airport (excluding facilities). Bald eagles have also been seen on the infield of the airport (between the runway and the taxiway) (M. Cleland, USDA, pers. com. 2001). There are likely to be close encounters between bald eagles and airplanes which do not result in airplane strikes. For example, a bald eagle was recently seen hunting over the Tyee Golf Course, in proximity to the end of runway 34R (M. Cleland, USDA, pers. com.2001) when a plane was landing. The majority of landings and take-offs on the runways are from the north heading south (71 percent). Bald eagle sightings at the airport are primarily in the south (65 percent). The largest risk to bald eagles may therefore occur in the southern portion of the airport due to the higher number of bald eagles and take-offs. Airplanes on take-off tend to lift-off at about the central part of the airport, and reach an altitude of approximately 1000 ft at the end of the airport. Bald eagles are more likely flying at a lower elevation at this point in their use near the airport, especially if they are moving between Angle Lake and Puget Sound.

Bald eagles may also forage near the mouths of Miller and Des Moines Creeks, but specific information on the use of these areas is not known. Due to the developed nature of and associated activity at Des Moines Creek estuary, use by bald eagles is likely to be minimal.

Marbled Murrelet

The action area for the proposed project is located in the Puget Sound Conservation Zone (USFWS 1997) in the marbled murrelet recovery plan. A population estimate for this zone has not been made. However, Speich and Wahl (1992) have estimated that there are approximately 2,600 marbled murrelets for the Strait of Juan de Fuca and Puget Sound. In this management zone, the largest number of murrelets is found in the northern Cascades and east Olympic Mountains and associated marine waters. Murrelets are found most commonly in the near shore waters of the San Juan Islands, Rosario Strait, the Strait of Juan de Fuca, Admiralty Inlet, and Hood Canal. They are more sparsely distributed elsewhere in this region, with smaller numbers observed at various seasons as far south as the Nisqually Reach and Budd Inlet, as well as in Possession Sound, Skagit Bay, Bellingham Bay, and along the eastern shores of Georgia Strait. Aggregations of murrelets are consistently observed in certain locations and at certain seasons. Marbled murrelets use these areas because of food availability, shelter or other ecological factors, and are also affected by the proximity and availability of nesting habitat.

In Puget Sound, few marine surveys have been conducted in the action area, primarily because murrelet occurrence is so infrequent. WDFW conducted surveys of Puget Sound from 1993 through 1995 during the marbled murrelet post-breeding season (Stein, J. and D. Nysewander 1999). Although the survey did not include the area specifically within the action area of this project, it did include areas north and south. These included surveys from Picnic Point to Edwards Point in the north, and Garden Point to Tatsolo Point, transect from Tatsolo Point to Sandy Point, transect from Yoman Point to McNeil Island stack, and shoreline from McNeil Island stack to Hyde Point. As the first survey in 1993 did not locate any marbled murrelets (first survey for Garden Point to Tatsolo Point occurred in 1994), future surveys of these areas were discontinued. The majority of marbled murrelet occurrences were documented in the Hood Canal area (Nysewander pers. com. 2000). Additional information regarding marbled murrelet occurrences in Puget Sound, including summer occurrences, is provided in Table 5. The majority of these occurrences are south of the action area.

Table 5. Marbled murrelet observations in Puget Sound.[1]

Date of Observation	Location	Number of Birds	Observer
NI[2]	Saltwater State Park	NI	T. Bock
NI	Redondo Beach	2 (1 pair)	T. Bock
NI	Narrow's Bridge, Tacoma	2 (1 pair)	T. Bock
NI	Brown's Point	NI	T. Bock
NI	Dash Point to Des Moines	6 (3 pair)	T. Bock
NI	Des Moines	4 (2 pair)	T. Bock
Summer 1990	Des Moines	6	T. Bock
NI	Des Moines	2 (1 pair)	T. Bock
NI	Brown's Point	12	T. Bock
NI	Brown's Point	8 (4 pair)	T. Bock
May 26 - June 3, 1993	Brown's Point	35-40	T. Bock
NI	Brown's Point	15	T. Bock
May 6, 1996	Brown's Point	8	T. Bock
NI	Brown's Point	7 (3 pair)	T. Bock
Summer 1999	Eastern Shore of Vashon-Maury Island	NI	M. Raphael, USFS

1 Adapted from information provided by Norman, D. 2001 *in* Airport Communities Coalition. 2001.

2 NI - No information provided.

Anecdotal observations indicate that marbled murrelets may occasionally forage in or near the Miller and Des Moines Creek estuaries on fish produced in these watersheds (including Walker Creek) and which migrate to the estuary and Puget Sound. The use of these estuaries and their vicinity by marbled murrelet, particularly during the breeding season, is likely to be limited due to low numbers of birds nesting in the nearest habitat, and possibly the lack of preferred prey species present in this area.

The number of murrelets nesting in the Cascades east of the action area, and using marine waters associated with the action area is relatively small. No suitable nesting habitat for marbled murrelets occurs within the action area. Detections of marbled murrelet exhibiting occupied behavior associated with nesting habitat, occur between 17 and 45 miles from the action area. There have been nine marbled murrelet detections (four occupied sites and five detections only) east of Sea-Tac whose flight path might cross the airport. It is likely that numbers of marbled murrelets are low in the Cascades east of the proposed project area and in the marine area west of the project area because of the limited availability of suitable nesting habitat and the degraded condition of the marine shoreline as a result of urban development.

Outside of marine areas, observations of marbled murrelets in the vicinity of the action area have been rare. In addition to the detections of marbled murrelets described in the BA, two additional detections of marbled murrelets are provided in the WDFW data base. These occurred approximately 8 miles north and south of the action area. These detections were for a marbled murrelet in flight (1992) and a grounded chick in a person's yard (1974). It is unknown how the marbled murrelet reached the yard, as it still had down, which could indicate a nearby nest. A sandlance spawning area is known to be less than one mile north of the Miller Creek estuary. Surf smelt spawning areas are identified approximately one mile north and south of the Des Moines Creek estuary (WDFW 2000). However, most spawning areas are disjunct from known marbled murrelet feeding areas (USFWS 1997). Certain herring stocks in local areas have probably gone extinct in Puget Sound due to the loss of eelgrass beds, which provide spawning habitat for this species (Pantella, pers. com. 1996 *in* USFWS 1997).

Information does not exist to indicate that, other than Pacific sardine and the northern anchovy in offshore and shelf waters, marbled murrelet prey resources have either increased or decreased in inner Washington waters from historical ranges (MacCall pers. com. *in* USFWS 1997, Pantella pers. com. 1996 *in* USFWS 1997). Although prey species abundance, such as Pacific herring in Puget Sound, may have been reduced in certain areas this is not known to affect the overall prey abundance and their availability for marbled murrelets (USFWS 1997). As a result, insufficient information exists to state that the overall prey abundance and availability have changed to a degree that it affects the maintenance and recovery of marbled murrelet populations.

EFFECTS OF THE ACTION

The proposed action may result in a variety of environmental effects, including short-term negative impacts from construction, and potentially long-term negative impacts from reduced baseflows and increased peak flows in Miller and Des Moines Creeks and chronic and acute toxicity due to chemical contaminants. Longer-term positive effects may result from improved forage fish habitat, and a reduction of sediments and chemical contaminants. There is also a risk of long-term adverse effects due to potential bird strikes from in-coming or out-going airplanes. How these impacts affect listed species will be evaluated below.

Bull Trout

The subpopulation of bull trout in Puget Sound, Miller and Des Moines Creek estuaries, and the Green River is likely composed of individuals from other spawning streams in the Coastal/Puget Sound DPS. Bull trout spawning and rearing habitat are not known to be present in Puget Sound, Miller, Des Moines, Walker, and Gilliam Creek, or the mainstem Green River at this time. Therefore, bull trout spawning and rearing habitats are unlikely to be affected by the proposed project. Bull trout habitats that could be affected, therefore, are primarily foraging and migratory habitat.

The proposed project would result in the construction of mechanically stabilized earth (MSE) walls in proximity to Miller Creek. Failure of these walls could result in significant impacts to Miller Creek and the aquatic resources within the creek and the estuary due to filling the creek and wetlands, and increasing sediment loads. There have been concerns raised regarding the potential failure of the embankment. FAA has stated that the embankment has been properly engineered to avoid failures (FAA, pers. com. May 2001). The Corps will be evaluating the stability of the MSE wall. We also understand that an independent review is being conducted by the University of Washington on the stability of this wall (M. Walker, Corps, pers. com., 2001). Should their evaluation determine that there is a high and/or likely risk of failure, we will reevaluate our determination of the effects of the proposed MSE walls. We currently do not believe that failure of the MSE walls is reasonably foreseeable, and therefore the effects of its failure will not be further addressed in this BO.

There are potential long term and short term direct and indirect effects to bull trout from the proposed project. These impacts include a potential reduction of forage species, exposure of bull trout to contaminants through surface water and consumption of contaminated forage species, and physical effects due to sediment. However, due to proposed water quality measures during construction, potential water quality improvements over baseline conditions, minimal exposure to potential contaminants, and the very low likelihood for bull trout to be present during construction or in proximity to the affected areas, we believe that the proposed impacts are not likely to be significant, as discussed below.

To reduce water quality impacts related to construction of the proposed action, the BA states that the Washington Department of Ecology standard best management practices are to be implemented (Table 6).

Table 6. 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

In addition to the above measures, the BA also commits to the following:

- MPU projects will meet the turbidity standard for Class AA waters. This standard states that turbidity may not increase more than 5 Nephelometric Turbidity Units (NTU) over background when background is 50 NTU or less, or register more than 10 percent increase in turbidity when background exceeds 50 NTU.

- Implementation of advanced BMPs, as needed, including polymer stormwater batch treatment system or high-volume mechanical filtering devices.

Stormwater quality and hydrology mitigation implemented as part of the Sea-Tac MPU projects is proposed to improve water quality and hydrologic conditions in Miller and Des Moines creeks. Improved conditions may occur 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 to improve instream habitat for fish and invertebrates.

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. 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.

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.

Degradation of the natural bank and stream will occur due to relocating and dewatering approximately 980 ft of the existing Miller Creek channel, and habitat enhancement activities. Some increased turbidity is likely to occur due to construction activities in-stream and along the banks. 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.

De-watering of Miller Creek within the project area will impact invertebrates inhabiting the substrate. These organisms could represent a potential food source for bull trout, but are primarily a food source for their forage fish. As the channel will only be dewatered for approximately 2 weeks and nearby sources of invertebrates are likely to recolonize the affected area following re-establishment of stream flows, the impact to bull trout is likely to be minimal.

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). 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. A 100-ft buffer is also proposed on the West Branch of Des Moines Creek. The buffer enhancement should improve creek habitat over existing conditions. However, a 100-ft. buffer may not fully protect the aquatic resources. A 100-ft buffer may not adequately provide for sources of large woody debris. Large wood delivery into streams lessens at distances greater than one site potential tree height (FEMAT 1993). On the west side of the Cascades, one site potential tree height equates to approximately 150 ft.

Foraging bull trout are likely to be found in close association with their forage species. A sandlance spawning area is known from less than one mile north of the Miller Creek estuary. Surf smelt spawning areas are identified approximately one mile north and south of the Des Moines Creek estuary (WDFW 2000). Miller and Des Moines Creek estuaries may be used primarily as migration corridors for bull trout, with occasional foraging occurring on salmonids produced in these creeks. Since we believe that their primary forage base is not found within the Miller and Des Moines Creek estuaries, bull trout are unlikely to use these areas for extended periods of time. Therefore, their exposure to any potential increased sediment or contaminants which may enter the Miller or Des Moines Creek estuaries, or consumption of forage species which may have accumulated any contaminants from discharges associated with the proposed project, are reduced and likely insignificant.

Construction activities at the Auburn mitigation site could result in increased sediment inputs to the Green River. Prior to construction, the Auburn mitigation site will be dewatered. The pumped water will be discharge to the Green River about 1 mile north of the site via an existing drainage channel and outfall at South 277th Street. Dewatering will occur from approximately May 2001 through September 2001 for one or two seasons. 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. The existing farm drainage ditch between the site and South 277th Street will later be enlarged to create the outlet channel for the wetland. Discharged water will meet state water quality standards, and include pre-discharge treatment for sediment removal if necessary. Following dewatering, the mitigation site will be excavated and planted.

Pumped ground water may contain some sediments, but levels are not expected to be high. During excavation and until vegetation has formed adequate cover, turbid water may leave the site via the drain system, which eventually enters the Green River. Due to the proposed water quality controls and low levels of sediment which may be discharged, the distance from the project site to where the flows enter the Green River (thus allowing for some settling of sediments), and low likelihood for bull trout to be present near the existing outfall of the Green River, impacts to bull trout are expected to be insignificant.

During flood events, the Green River will back water into drainage channels and the wetland mitigation site (events greater than the approximate 10-year flood). The existing flap-gated culvert on the Green River, in its existing condition, may allow bull trout to access the drainage channel, where stranding may be possible. However, there is a low probability that bull trout access the drainage ditch through the drainage pipe. If bull trout do access the ditch, it is not anticipated that they would swim upstream to the mitigation site due to the lack of favorable conditions in the ditch and the minimal numbers of forage species present.

As bull trout are unlikely to be found within Miller, Walker, Des Moines, and Gilliam Creeks, as previously discussed, direct effects to this species in these waterways are unlikely. Indirect impacts may result due to impacts to bull trout forage species within these water bodies due to changes in flow, sediment discharges and chemical toxicity. However, based on the minimization measures proposed, these effects are likely to be minimal.

Indirect impacts caused by increases in impervious surfaces within a basin can increase the peak flows (duration and frequency) in receiving streams because the conversion to impervious surface speeds runoff and decreases infiltration and evapotranspiration (May *et al.* 1997). When a watershed's natural runoff cycle is modified by stormwater runoff, abnormal high flows increase erosion and destabilize channels during the wet season, and low summer flows are diminished due to lack of groundwater recharge. This limits fish populations by a number of interrelated mechanisms (Scott *et al.* 1986; Weaver *et al.* 1994; Whiles *et al.* 1995).

The proposed project will result in an increase of impervious surfaces as follows: approximately

106 acres (net) in Miller Creek watershed; approximately 6 acres in Walker Creek watershed; and approximately 128 acres in Des Moines Creek watershed. No increase in impervious surfaces is proposed for the Gilliam Creek watershed.

To minimize impacts from increases in impervious surfaces within these watersheds, stormwater management actions are proposed to reduce and minimize peak flows. Detention facilities will be sized to meet King County Level 2 flow control standards. These standards require that the flow duration of post-developed runoff match the pre-developed flow duration for all flow magnitudes between 50 percent of the 2-year flow event and the 50-year flow event.

The proposed project may result in reduced baseflows within Miller and Des Moines Creeks. Existing baseflows in Miller and Des Moines Creeks are approximately 1.8 cfs and 2.4 cfs, respectively. A reduction of approximately 4 percent (0.07 cfs) in Miller Creek baseflows and 7 percent (0.17 cfs) in Des Moines Creek baseflows was projected by Pacific Groundwater Group (2000). For Miller Creek, this equates to a reduction of approximately 1/8 inch to 1/4 inch in depth. In Miller Creek, there may be lower winter flows, but higher summer flows as a result of the potential for more groundwater infiltration with the project than currently exists. No information is available in the change in depth for Des Moines Creek. Additional streamflow analyses were conducted by Earth Tech, Inc. (2000) which also predicted reduced streamflows for both Des Moines and Miller Creeks during the low flow periods of August and September. Stream flows for Walker Creek were predicted to increase during August and September, 0.008 cfs and 0.010 cfs, respectively, as a result of pervious fill recharge and secondary impervious recharge. No net change in 7-day/2-year low flow is anticipated for Walker Creek. For the 7-day duration/2-year frequency stream discharge, a deficit of 0.10 cfs for Miller Creek at the SR 509 crossing and 0.08 cfs for Des Moines Creek were predicted. The reduction in baseflow may affect forage fish species. To minimize these impacts, reserved stormwater releases are proposed to be provided to Miller and Des Moines Creeks to off-set these reduced flows. The stormwater needs are calculated as 8.9 acre-feet for Miller Creek and 7.1 acre-feet for Des Moines Creek. The stormwater would be released at a prescribed rate, aerated, and discharged to the stream. Augmentation of baseflow in Des Moines Creek is also proposed using an existing Port owned well on the Tyee Golf Course. However, there are unresolved water rights issues with use of this well; therefore, other augmentation measures are being investigated. The well currently draws water from two zones. The Des Moines Creek Basin Plan includes inserting a casing and "packing off" the upper zone to eliminate potential wetland impacts resulting from well pumping. The Des Moines Creek Basin Committee would be responsible for implementing the use of the well for baseflow augmentation. Please see Table 7 for a summary of potential low flow changes.

Table 7. Summary of Des Moines, Miller and Walker Creek Streamflow Effects[1].

Creek		HSPF Model Stream Flow (cfs) 1994	HSPF Model Stream Flow (cfs) 1996	Predicted 2006 Conditions (cfs)[2]	Net Change from 1994 Conditions (cfs)
Des Moines	August	1.08	1.07	1.15	+0.07
	Sept	1.64	1.73	1.81	+0.17
	Aug./Sept	1.36	1.40	1.48	+0.12
	7-day/2-year low flow	0.35	0.27	0.35	0
Miller	August	1.27	1.10	1.31	+0.04
	Sept	1.50	1.40	1.55	+0.05
	Aug/Sept	1.39	1.25	1.43	+0.04
	7-day/2-year low flow	0.79	0.64	0.79	0
Walker	August	0.033	0.031	0.041	+0.008
	Sept	0.035	0.039	0.045	+0.010
	Aug/Sept	0.034	0.035	0.043	+0.009
	7-day/2-year low flow	0.021	0.015	0.021	0

1 Based on Earth Tech, Inc. (2000).

2 Flows based on the sum of 2006 HSPF streamflow, fill pervious recharge, non-hydrologic changes, secondary impervious recharge, and reserved stormwater release, as appropriate.

With the successful implementation of the proposed mitigation within the Miller and Des Moines Creek watersheds, the proposed action may benefit fish species due to improved riparian and instream conditions. The removal of structures near the stream channel, elimination of water withdrawals within the action area of Miller Creek, reduced turbidity, increased riparian vegetation, and augmented summer flows in Des Moines Creek should result in improved instream conditions in the long term for bull trout prey species. It is expected that baseline production for salmonids should be maintained or improved with successful implementation of the proposed mitigation as described in the BA and supporting documents. Even if the projected streamflows are not achieved, and potential forage species for bull trout are impacted (i.e., reduced spawning grounds, reduced survival due to increased temperatures, increased stranding, reduced flows, dewatering, and/or a reduction in invertebrate forage), we do not anticipate these levels to be reduced to such an extent as to significantly impact this listed species. Potential forage fish currently produced in Miller, Des Moines, and Walker creeks are believed to represent an insignificant portion of the available forage base for bull trout in Puget Sound.

There is a potential for contaminated leachate to enter Miller Creek from the embankment fill, as well as for terrestrial organisms to expose and possibly bioaccumulate toxic materials that are contained in the fill material. Exposure of bull trout, bald eagles and marbled murrelets could potential result in impacts to these species. Some fill materials which have been accepted for use as part of the proposed action are known to contain DDT, PCBs, PAHs, and mercury (Table 8).

Table 8. Detected contaminants in fill material for the Sea-Tac MPUI.

Contaminant	Maximum Level Detected (USCOE[1])	Maximum Level Detected (Boeing[2])
Total DDT	14 parts per billion (ppb)	no detection
Total PCB	160 ppb	no detection
PAHs (Carcinogenic)	no detection	459 ppb
Mercury	0.074 parts per million (ppm)	0.51 ppm

1 Corps detections, Hamm Creek Restoration Site, sampled June 16 and 17, 1997.

2 Boeing detections, Hamm Creek Restoration Site, sampled April 17 and 18, 1990.

The Port is accepting fill material which generally meets the Model Toxics Control Act (MTCA) Method A contaminant levels. The Port may determine that specific material that does not satisfy MTCA Method A contaminant levels is appropriate for placement in a specific project location and will consult with the Washington Department of Ecology (WDOE) for approval prior to placement. Material that is obtained from state-certified commercial borrow pits is generally accepted for airport airfield projects without source-specific environmental certification. State certified materials are those that the Washington Department of Transportation has found to have geotechnically suitable material. The Washington Department of Transportation testing does not include testing for contaminants. Over 50 percent of the soil that the Port has placed to date has been from large pits. Most of these pits are state-certified and do not have historical sources of contamination. To date, all fill material accepted by the Port has met the requirements of the Port/WDOE 1999 airfield project soil fill acceptance criteria, which includes the Method A standards for MTCA.

Limited information is available regarding effects of contaminants on bull trout. The lake trout, *S. namaycush,* a closely related species to bull trout, is the most sensitive species known for early life stage mortality associated with exposure of embryos to tetrachlorodibenzo-dioxin and related compounds. However, Cook et al. (1999) looked at the effects of 2, 3, 7, 8-Tetrachlorodibenzo-p-dioxin (TCDD) and polychlorinated biphenyl (PCB) 126 on early life stages of bull trout. Preliminary data indicated that bull trout are approximately three times more sensitive to TCDD than lake trout.

To ensure that leachate from the embankment fill does not result in contamination of aquatic resources in and adjacent to Miller Creek, and to reduce the risk to terrestrial organisms, the Port has agreed to the following measures, which are summarized below (see Enclosures 1 and 2 for the complete text):

8. No soil will be accepted that exceeds MTCA Method A standards for Resource Conservation and Recovery Act (RCRA) metals (Table 9) or organochlorines. If the Port considers placement of fill material that does not meet MTCA Method A Standards, the Port will discuss the results with the Service and reinitiate consultation, as appropriate. 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. The drainage layer cover (that layer immediately above the drainage layer of the embankment) will be composed of "ultra-clean" fill (as described below). It will measure at least 40 ft thick at the face of the embankment and will reduce in height to the east at a rate of 2 percent.

9. No soil will be accepted for the drainage layer cover that exceeds the back-calculated values in the second column of Table 9, unless the Synthetic Precipitation Leaching Procedure (SPLP) confirms the suitability of the soil, as described in Appendix 1, Attachment A, 1(b)(iv). The Port will consult with the FWS if site-specific data is collected which may merit a recalculation of the three phase model soil concentrations in Table 5, and reinitiate consultation, as appropriate.

10. If soil in the drainage cover layer exceeds background concentrations of metals, as stated in column 6 of Table 9, SPLP testing will be conducted to demonstrate that MTCA Method A criteria are protective of the baseline conditions for surface water receptors.

11. The Port will require testing for organochlorines where such compounds may be present.

12. Soils found to contain organochlorines at concentrations below Three Phase Partitioning Model concentrations (adjusted for PQLs) will be deemed acceptable. No soil will be

accepted for the drainage layer cover that exceeds Three Phase Partitioning Model concentrations unless SPLP testing confirms the suitability of the soil.

13. The surficial three feet of fill will be screened to not exceed the Proposed Ecological Standard or MTCA Method A, which ever is less.

14. The Port shall develop a plan to monitor the quality of seepage from the drainage layer beneath the embankment fill. Should monitoring detect adverse impacts to aquatic life in the project area, the Port shall reinitiate consultation as appropriate and implement measures to address such impacts.

Table 9. Soil Screening Criteria for the SeaTac Embankment Fill (milligram/kilogram (mg/kg)) (adapted from J. Lynch, Stoel Rives, pers. com. 2001).

RCRA [1] Metals	Three Phase Partioning Model Concentrations[2]	MTCA [3] Unrestricted Land Use			Puget Sound Background (upper 90 percent) [5]	Screening Criteria	
		Current Method A Standard	Proposed Method A Standard [4]	Proposed Ecological Standard [4]		Drainage Layer Cover	Top 3-feet of Embankment
Arsenic	88	20	20	95 (As V)	7	7 - 20 [6]	20 [7]
Barium	12,000	NA [8]	NA	1,250	NA	12,000 [9]	1,250 [10]
Cadmium	0.15	2	2	25	1	1 - 2 [11]	2 [7]
Chromium (total)	NA	100	NA	42	48	48 - 100 [11, 12]	48 [13]
Lead	500	250	250	220	24	24 - 250 [14]	220 [10]
Mercury (inorganic)	0.013	1	2	9	0.07	0.07 - 2 [11]	2 [7]
Selenium	0.52	NA	NA	0.8	NA	5 (PQL [15]) [16, 17]	5 (PQL) [16]
Silver	0.11	NA	NA	NA	NA	5 (PQL [15]) [16, 17]	5 (PQL) [16]

1 RCRA: Resource, Conservation and Recovery Act

2 MTCA WAC 173-340 747 (3), (4), and (5) Three Phase Partitioning Model soil concentrations calculated using aquatic freshwater quality criteria (WAC 173-201A). For purposes of this table, the lowest criteria from "Freshwater CCC Chronic" Screening Quick Reference Table (NOAA SQuiRT Table) were used.

3 MTCA: Model Toxics Control Act, Washington Administrative Code (WAC) 173-340.

[4] Proposed MTCA Method A and Ecological standards were finalized on February 15, 2001, and will become effective on August 15, 2001.

[5] Natural Background Soil Metals in Washington State (Ecology Publication 94-115).

[6] The MTCA Method A standard of 20 mg/kg is less than the Three Phase Partitioning Model concentration of 88 mg/kg indicating that the MCTA Method A standard is protective of surface water receptors. When soil concentrations are greater than background but below the MCTA Method A standard, sufficient SPLP testing will be conducted to confirm that the MCTA Method A standard is protective (see associated text in Attachment A for discussion of SPLP testing).

[7] Screening criteria based on MTCA Method A standards.

[8] NA: not available. Insufficient information available to develop the criteria.

[9] Three Phase Partitioning Model concentrations calculated using MTCA Method B ground water quality criteria because there was no available criteria for barium in surface water. If concentrations exceed calculated values, SPLP testing will be required to evaluate the suitability of the soil.

[10] Screening criteria based on ecological standards.

[11] Three Phase Partitioning Model concentrations, adjusted upward to background, and MTCA Method A standards. To verify the protectiveness of MCTA Method A standards, SPLP testing will be conducted when soil concentrations exceed background but are below MCTA Method A standards. (Note: exceedances in background concentrations anticipated due to natural variability of soil types being used as fill.)

[12] Chromium speciation may be conducted in the event SPLP is applied.

[13] Screening criteria based on ecological standards, adjusted for background.

[14] The MTCA Method A standard of 250 mg/kg is less than the Three Phase Partitioning Model concentration of 500 mg/kg indicating that the MTCA Method A standard is protective of surface water receptors. When soil concentrations are greater than background but below the MTCA Method A standard, sufficient SPLP testing will be conducted to confirm that the MCTA Method A standard is protective.

[15] PQL: Practical Quantification Limit

[16] PQLS from Department of Ecology "Implementation Memo No. 3: PQLs as Cleanup Standards," November 24, 1993.

[17] Three Phase Partitioning Model concentrations, adjusted upward to PQL. If soil concentrations exceed the PQL, SPLP testing will be

required to evaluate the suitability of the soil.

In addition to these measures, the exposure to terrestrial organisms is further reduced as portions of the embankment are paved, and therefore, species cannot come into contact with fill material. Also, the Port actively manages the airport to dissuade the use of terrestrial organisms due to potential aircraft safety issues. Although some wildlife, such as small birds and rodents, may use and feed in areas of embankment fill, the numbers are expected to be low. It is anticipated that organisms which may utilize the embankment would provide a minor food source for bald eagles and there would be a low risk of bioaccumulation occurring should this listed species feed on these organisms.

Des Moines Creek and Miller Creek, and discharges from the IWS may currently exceed sub-lethal toxicity levels for bull trout and their forage species for Cu based on values available for other fish species (Eisler 1998) (Table 2). No specific information on Cu toxicity is available for bull trout.

IWS discharge rates will increase as a result of the proposed action. The plume from the IWS outfall diffuser is located at a depth of 156 ft to178 ft, 1,800 feet off shore in Puget Sound, and could raise baseline levels above ambient within 65 meters (213.2 ft) of the outfall. Bull trout could occur within this zone. Bull trout may also occur at the mouths of Des Moines and Miller Creeks. However, bull trout are unlikely to be exposed for long periods of time to chronic toxicity levels. Bull trout are opportunistic feeders, and their presence within an area of the marine environment is based largely on the forage base present. Cu is known to interact with many compounds in water. The amount of Cu compounds and complexes in solutions depends on many factors, including water pH, temperature, and alkalinity, as well as the concentrations of bicarbonate, sulfide, and organic ligands (USEPA 1980 *in* USGS 1998). The toxicity of Cu will depend on the interactions it has with other compounds. For example, mixtures of Cu and Zn salts are more-than-additive in toxicity in the marine and freshwater environment (Eisler and Garner 1973 *in* USGS 1998, Birge and Black 1979 *in* USGS 1998, Hodson et al. 1979 *in* USGS 1998). However, sequestering agents, increasing salinity, sediments and other variables reduce the toxicity of Cu in invertebrates and aquatic plants that have been tested (USGS 1998). Mortality from Cu to bony-fish is reduced in waters with high concentrations of organic sequestering agents (Hodson et al. 1979 *in* Eisler 1998). In rainbow trout, high salinities resulted in lower Cu toxicity (Wilson and Taylor 1993 *in* Eisler 1998).

The proposed project may result in a minor increase or possibly a reduction of Cu over existing levels due to the proposed conversion of land use from residential to open space and runway and taxiways, based on information provided in the BA and additional information provided by the consultants (Table 10).

Table 10. Estimation of Cu concentration change for Sea-Tac.[1]

	Runway/Taxiway	Residential	Commercial	Open-Space	Total Cu µg/L
Cu µg/L (median)	26	20	32	10	
Existing Conditions (acres)	149.2	373.7	0	0	
Existing Conditions (acres * Cu µg/L)	3,879	7,474	0	0	11,353
With Project (acres)	343.5	0	7.3	172.1	
With Project (acres * Cu µg/L)	8,931	0	234	1,721	10,886

[1] Based on information provided by Parametrix, from J. Lynch dated April 20, 2001.

The BA states that the median level of Cu from the runway and taxiway areas is 37 µg/L. This value has been updated based on two years of additional water quality data, and is currently calculated as 26 µg/L of Cu. Data for residential areas was assumed by the consultants to be similar to the data available for King County Metro of 20 µg/L. It was also assumed that any open space areas converted from residential would have a lower Cu value. Ten µg/L was estimated as the value for open-space based on the consultant's best professional judgement.

The Cu values cited for residential areas may not represent the Cu values currently discharged from the residential areas in the project area as the data used is a composite from King County rather than site specific information. Additionally, some of the residential area is misclassified. For example, Vacca Farms should be classified as agricultural lands, which may have a different Cu value from that presented. Therefore, the above values do not accurately predict existing or future conditions for Cu. However, we believe it is likely that lands that will be taken out of residential use and converted to open-space should result in a reduction of Cu being generated for this land use type. Taking into account the revised Cu discharges levels from Sea-Tac and the conversion of residential areas to open-space lands which should result in less Cu being generated over existing levels, we believe that the predicted Cu discharges are not likely to increase significantly over baseline values and may, in fact, be reduced.

Therefore, due to the relatively low production of forage fish in Miller and Des Moines Creeks, and the low forage base level near the outfall, limited exposure of bull trout to potential chronic toxicity levels, and potentially minor increase or decrease of Cu over existing conditions, affects from Cu are likely to be minimal compared to baseline conditions.

Zn levels within Des Moines and Miller Creek estuaries, and discharges from the IWS (Table 2) currently exceed acute toxicity levels for bull trout based on studies conducted by Stratus Consulting, Inc. (1999). Acute toxicity analyses were performed for bull trout with regard to Zn and cadmium (Cd) (Stratus Consulting, Inc. 1999). Bull trout had a lethal concentration for fifty percent of the test animals (LC_{50}s) ranging from 31.9 µg to 86.9 µg Zn/L, with an average value of 54 µg Zn/L. Higher hardness and lower pH water produced lower toxicity of Zn and Cd in bull trout, but higher water temperature increased their sensitivity to Zn. Several trends have been noted regarding the affects of Zn on fish: 1) freshwater fish are more sensitive to Zn than marine species; 2) embryos and larvae are the most sensitive developmental stages; 3) effects are lethal or sublethal for most species in the range 50-235 µg Zn/L and at 4.9-9.8 µg Zn/L for the brown trout specifically; and 4) behavioral modifications, such as avoidance, occur at concentrations as low as 5.6 µg Zn/L (Eilser 1993). Impacts to reproduction may be one of the more sensitive indicators of Zn stress in freshwater teleosts, with effects evident in the 50-340 µg Zn/L range (Spear 1981 *in* Eisler 1993).

The toxicity of Zn to aquatic organisms depends on the physical and chemical forms, the toxicity of each form, and the degree of interconversion among the various forms (Eisler 1993). Suspended Zn has minimal effect on aquatic plants and fish, but many aquatic invertebrates and some fish may be adversely affected from ingesting enough Zn-containing particulates (EPA 1987 *in* Eisler 1993). Freshwater fish are affected by Zn toxicosis by destruction of gill epithelium and consequent tissue hypoxia. Osmoregulatory failure, acidosis and low oxygen tensions in arterial blood, and disrupted gas exchange at the gill surface and at internal tissue sites are all indicators of acute Zn toxicosis in freshwater fish (Spear 1981 *in* Eisler 1993). Zn may also affect fish immune systems (Ghanmi et al. 1989 *in* Eisler 1993). Additionally, combinations of Zn and Cu are generally more-than-additive in toxicity to a wide variety of aquatic organisms, including freshwater fish (Skidmore 1964 *in* Eisler 1993; Hilmy et al. 1987a *in* Eisler 1993) and marine fish (Eisler and Gardner 1973 *in* Eisler 1993; Eisler 1984 *in* Eisler 1993).

There are a number of factors which are known to modify the biocidal properties of Zn in aquatic environment. Zn tends to be more toxic to embryos and juveniles than to adult, to starved animals, at elevated temperatures, in the presence of Cd and mercury, in the absence of a chelating agent, at reduced salinities, under conditions of marked oscillations in ambient Zn concentrations, at decreased water hardness and alkalinity, and at low dissolved oxygen concentrations (Skidmore 1964 *in* Eisler 1993; Weatherley et al. 1980 *in* Eisler 1993; Spear 1981 *in* Eisler 1993; EPA 1987 *in* Eisler 1993; Paulauskis and Winner 1988 *in* Eisler 1993).

Although the existing levels of Zn typically exceed those levels detected to have an acute effect on bull trout, the toxicity values are based on 96 and 120 hours of exposure. It is unlikely that bull trout will remain in proximity to the mouths of Des Moines and Miller Creeks, or in the vicinity of the IWS outfall for this length of time. Chronic toxicity levels of Zn were not tested and are not known for bull trout. Chronic toxicity levels would be expected to be lower than acute levels.

Again, bull trout exposure at these sites to acute or chronic levels is expected to be minor due to the low likelihood of their feeding or occupying these areas for a significant length of time. Additionally, Zn levels may be reduced from existing levels due to the conversion of residential land use to airport runway and taxiway areas based on information provided in the BA as well as from the Washington Department of Ecology NPDES permit for Sea-Tac (WDOE 1998). The predicted levels of Zn may affect other fish or invertebrate species which occupy these water bodies. For example, the LC_{50} values listed in the BA for chinook salmon (446 µg/L) and brook trout (2,100 µg/L) are higher than those found by Stratus Consulting, Inc. (1999) for rainbow trout (27.3 µg/L to 447 µg/L). Therefore, although the data indicates that acute toxicity standards may not be exceeded for some species, prey species for bull trout and their forage fish may be affected by the levels of Zn occurring in these waters. However, we believe that the effects of Zn to bull trout as a result of the proposed project are likely to be minimal compared to existing baseline conditions.

Additionally, the proposed action includes improved stormwater treatment over existing conditions. Currently, approximately 166.2 acres of the 479.1 acres of pollutant generating impervious surface (PGIS) (the area requiring water quality treatment best management practices) are untreated. With the proposed project, approximately 80 acres will remain untreated due to proposed retrofitting of existing facilities or conversion from a PGIS to a non-PGIS status (approximately 7.3 acres). This increased treatment of stormwater includes source controls and additional best management practices, including wet vaults and bioswales. Based on the increased stormwater treatment over existing conditions, even with the new development which will also be fully treated, there is a potential improvement over existing water quality conditions.

The Port has committed to removing Tempo and Diuron from the list of allowable chemicals currently included for use on the airport (K. Smith, Port of Seattle, pers. com., 2001). The other pesticides and herbicides do to not pose as great a risk to aquatic species as do Tempo and Diuron (Meister 1995). In addition to the chemicals already included for use on Sea-Tac, the BA proposes to use 2,4-D amine and Garlon in the Green River mitigation area. No use of herbicides is proposed within other mitigation areas. Due to limited exposure bull trout would have to these chemicals, the effects are likely to be minimal.

Advanced stormwater treatment systems that use flocculation agents could potentially add chemicals to stormwater runoff. 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. 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. The use of cationic PAMs may result in impacts to forage fish and bull trout. However, due to the potential for buffering of treated water from sediments and the limited exposure bull trout may have to this chemical, the effects are likely to be minimal.

Bald Eagle

The proposed action is unlikely to result in significant impacts to bald eagles. Impacts are

expected to be minor since no bald eagle nesting territories occur within the action area and no potential nest trees will be removed. If permits to construct the third runway are obtained, the fill currently elevating the embankment 50 ft above the airport ground would be leveled and no longer serve as a perching area for bald eagles. Although trees within the MPUI are proposed to be removed, there is a low likelihood that they are used for perching due to the small forage base in Des Moines and Miller Creeks. Also, due to the high amount of noise generated by the airport, bald eagles are less likely to frequent this area in high numbers. Bald eagles may use the Tyee Golf Course area to forage for waterfowl. There is likely to be a reduction in waterfowl use of this area due to its conversion to scrub-shrub wetlands and airport facilities. This could result in a reduction in bald eagle foraging in this area over baseline conditions, should it currently occur. However, due to the existing human use and disturbance of this area, loss of this area as a possible foraging base is not expected to be significant to bald eagles. Additionally, since no additional habitat is provided by the proposed airport facilities, flight paths of bald eagles over the airport are not anticipated to increase due to the proposed project.
Runway 34R, which is the runway closest to Angle Lake, will be extended by 600 ft. It is estimated that larger planes will use the additional runway extension several times a year over existing conditions (E. Levitt, Port of Seattle, pers. com., 2001). Bald eagles flying from the nest site are likely to be at a lower flight elevation than planes that may be landing. Although there is a risk of collisions of bald eagles with airplanes due to the extension of this runway, the risk is anticipated to be minimal due to the few additional flights which will use this part of the runway over existing conditions. Additionally, most bald eagles are likely to be below 1000 ft. when planes are taking off from the airport, thus avoiding being struck by a plane.

No air strikes of bald eagles have been documented at Sea-Tac. There are a number of "unidentified" species that were struck by aircraft at Sea-Tac between 1991 and 1997. Of this total of 53 birds, 19 were small, 1 was large, and 33 were unknown (FAA 1999). Bald eagles have been identified in bird strikes by civil aircraft in the United States (FAA 1999). In a national report on bird strikes, out of a total of 22,320 bird strikes reported between 1990 and 1998, 20 were bald eagles and 32 were unidentified hawks, kites, and eagles. At least an additional 7 bald eagle strikes have occurred since 1998 (S. Wright, unpublished data). None of the eagle strikes reported were in Washington. The majority of the eagle strikes occurred in Alaska. Bird strike information is not required to be reported to FAA, and it is estimated that only about 20 percent of the bird strikes are reported, therefore the number of strikes is likely to be an underestimate (FAA 1999). Most bird strikes (53 percent) result during takeoff and climbing. Over 55 percent occurred within 99 ft above ground level and approximately 87 percent occurred within 2,000 ft above ground level (FAA 1999). Although bald eagles may be at risk of airplane strikes, the risk can be very low. Only one unconfirmed bald eagle strike in 1989 has been documented for Whidbey Island Naval Air Station, a site which is on Puget Sound north of the proposed project site and has daily use by bald eagles (M. Klop, Whidbey Island Naval Air Station, pers. com. 2001). Due to the large size of the bald eagle, should an air strike have occurred at Sea-Tac, it would be assumed that the bird would have been identified prior to contact or some body parts, including feathers, would still be identifiable. Even though reports of bird strikes are not required by FAA, Sea-Tac twice daily performs runways searches which would likely find signs of wildlife strikes should they occur. No bald eagles have been reported as a result of these searches.

Therefore, although there is a risk of an air strike of a bald eagle at Sea-Tac, we do not believe that this risk is significantly increased as a result of the proposed action

Concerns have been raised that air strikes of bald eagles might occur as this species may use thermals produced by the proposed retaining wall. It is unlikely that bald eagles would utilize the area near the retaining wall due to the lack of forage. Additionally, bald eagles primarily hunt from perches as opposed to soaring. Therefore, the risk of airplane strikes of bald eagles from their use of thermals is expected to be minimal.

The proposed on-site and off-site mitigation for the project could have some minor long term benefit for the bald eagle should it be successful. The proposed improvements to Miller and Des Moines Creeks may improve the forage base for bald eagles. However, bald eagles are not likely to forage in the upper watersheds. The creeks are relatively narrow with some canopy, limiting the ability of bald eagles to forage effectively. The proposed off-site mitigation may also have a beneficial effect on bald eagles, should it be successful, due to the potential to enhance waterfowl habitat, as waterfowl are prey for the bald eagle. However, depending on the amount of future disturbance due to increased development in the vicinity of the Auburn mitigation site, use of the site by foraging bald eagles may be minimal.

Marbled Murrelet

The proposed project is likely to result in insignificant impacts to marbled murrelets. Suitable marbled murrelet nesting habitat does not occur within the action area, including the off-site mitigation area. The nearest potential habitat to the east of the action area is approximately 32 miles away. The nearest known occupied site is approximately 36 miles away. Potential foraging habitat is present at the mouths of Miller Creek and Des Moines Creek, and within Puget Sound. Although the proposed project may result in some short term impacts to potential prey species (i.e., salmonids) that occur within Miller and Des Moines Creeks, salmonids are not known to form the primary diet of marbled murrelets. Thus, the effect to marbled murrelets from any impacts to the salmonid prey base would be minimal. There is a potential for a long term benefit to marbled murrelets should the proposed mitigation successfully enhance fish habitat and result in increased fish production within these creeks. However, as stated above, this benefit is likely to be minor as salmonids do not form the primary diet of the marbled murrelet.

Impacts from air strikes are unlikely. No air strikes have been documented for marbled murrelets at Sea-Tac. Although there are a number of "unidentified" species which have been struck by airplanes, the likelihood of aircraft striking marbled murrelets is considered insignificant. This conclusion is based on: 1) no alcids have been identified in any reported wildlife strikes to civil aircraft in the United States between 1990 and 1998 (FAA 1999); 2) marbled murrelets typically fly at altitudes greater than 2,770 ft (1,000 meters) in altitude when leaving the ocean to nesting habitat (Burger 1997) and most air strikes are within 900 ft above ground level (FAA 1999); and 3) marbled murrelets are fast fliers and can move quickly to avoid collisions, while the majority of bird strikes involve slower flying birds. Additionally, due to the rarity of marbled murrelets, few are likely to fly over Sea-Tac, therefore the risk of air strikes is reduced. Despite the numerous surveys which have occurred within this area, there have only been nine marbled murrelet detections (four occupied sites and five detections only) east of Sea-Tac whose flight path might cross the airport. The majority of marbled murrelet sightings and detections for nesting and foraging are north and south of the project area. Their travel paths are unlikely to cross the airport between nesting and foraging locations. Although this does not represent all marbled murrelets which might travel near Sea-Tac between Puget Sound and the Cascades, it does demonstrate the small population that has been found to date.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future state, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this Section because they require separate consultation pursuant to Section 7 of the Act.

Three broad categories of cumulative effects which may occur in the action area include: 1) growth and development; 2) forest management; and, 3) other management actions. Growth and development refer to permanent loss of suitable habitats. Growth and development actions include conversion of forest habitat to urban, other residential, commercial, or agricultural uses, and for structures or networks providing infrastructure support such as hydro power and irrigation diversions, roads, and power-lines. Forest management refers to temporal and spatial changes from other state or private actions in suitable habitats across the landscape in the action area. Examples include age or structural changes resulting from harvest and other forest-management actions such as planting, pruning, fertilizing, forest growth, and wildland fires. Other management actions refer to actions within suitable habitats which impact habitat structures or composition such as recreation, grazing, fishing, and mining. Each of these categories of impacts may result in the loss of secure habitat for species using suitable habitats within the action area. Examples of this include physical displacement, exposure to contaminants, and declining air and water quality. The proposed MPUI site may be developed further. Redevelopment of the borrow or acquisition areas may occur in the future. However, the Port states that they have no immediate plans to develop the sites. Proposed actions near the off-site wetland mitigation project in Auburn include a proposed trail along the Green River and development of private property to commercial and residential uses. Some of these proposals may have a federal nexus (i.e., ACOE Section 404 permits) associated with them. It is not known to what extent these proposals will be addressed by future consultations. These proposed actions could result in increased impervious surfaces with potential stormwater and water quality impacts, increased access and use (including fishing) within the Green River, and the reduction of restoration potential of the riparian buffer and input of large woody debris into the Green River.

CONCLUSION

After reviewing the current status of the bull trout, bald eagle, and marbled murrelet, the environmental baseline for the action area, the effects of the proposed MPUI, and the cumulative effects, it is the FWS's biological opinion that the MPUI, as proposed, is not likely to jeopardize the continued existence of the bull trout, bald eagle or marbled murrelet. We reached this conclusion on the basis that the proposed action is not likely to adversely affect these species, as discussed in the Effects section of this opinion.

No critical habitat has been designated for the bull trout or bald eagle. Therefore, none will be affected for these species. Critical habitat has been designated for the marbled murrelet. However, the project does not occur within designated critical habitat, therefore none will be affected for this species.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and federal regulation pursuant to Section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the FWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the FWS as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Section 7(b)(4) and Section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The FWS does not anticipate the proposed action will incidentally take bull trout, bald eagle or marbled murrelet. Therefore, no take exemption for the bull trout, bald eagle or marbled murrelet is provided.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

These are as follows:

1. The riparian buffers along Miller Creek and Des Moines Creek should be at least 150 ft on each side to better protect the aquatic environment, including cutthroat trout and coho salmon, which is a federal candidate for listing under the Act. This increased buffer width is critical in providing large woody debris and nutrients to the streams, as well as additional storm water benefits, should development occur immediately outside of the riparian buffers. Wider buffers also benefit wildlife species which use the riparian habitat for reproduction, foraging and resting by reducing the disturbance from human activities.

2. Monitor fish use, including spawning activities, in Miller and Des Moines Creeks to determine success of habitat enhancement and restoration activities.

3. Evaluate effects to invertebrates in the restored section of Miller Creek. Include changes in species composition from existing conditions, and recovery of the system following diversion of flows into the new channel.

4. Viable native plants shall be salvage and reused at mitigation sites.

5. Large diameter trees with attached rootwads or large rootwads that are to be removed as a result of the project should be retained/saved for future use on Port or other restoration/ mitigation sites in King County.

6. Large woody debris placed in Miller Creek should be keyed into the bank at a minimum 1 to 1 ratio (for every foot of wood instream, one foot should to be keyed into the bank). Root wads without boles should not be used. This will better insure the success that large woody debris placed for stream restoration will function as designed.

7. Pesticides and herbicides should not be used due to the potential to enter the groundwater and surface water where it may potentially affect the invertebrate forage base and fish species. Should their use be unavoidable, we recommend that a minimum 200 ft. buffer from waterbodies be required If a 200 ft buffer cannot be implemented, we recommend that a monitoring program be implemented to determine the adequacy of the 50 ft. buffer in protecting aquatic resources, including wetlands, from pesticide and herbicide contamination. Rodeo may be used if other non-chemical methods to control reed canary grass prove to be unsuccessful. If Garlon is used in the Green River mitigation area, it should be restricted to the use of Garlon 3a. Garlon 4 should not be used. Organophosphates, carbamates and triazine herbicides should not be used under any circumstance.

8. Reduce or eliminate airport sources of Cu and Zn. Implement additional best management practices to treat stormwater to levels of Cu and Zn below acute and chronic toxicity levels for aquatic organisms. Sufficient monitoring must be performed to determine that reduced levels are being achieved.

9. New structures should not contain pollution generating impervious surfaces.

10. Use anionic PAM products which have reduced toxicity on aquatic organisms compared to cationic PAM.

11. Evaluate the effectiveness of temporary erosion and sediment control measures.

12. Provide copies of monitoring reports to the Western Washington Office.

13. Conduct research to better define population status and use by bull trout of watersheds and marine areas where Port of Seattle and FAA activities occur.

For the FWS to be kept informed of actions minimizing or avoiding adverse affects or benefitting listed species or their habitats, we request notification of the implementation of any conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the actions outlined in the request. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: 1) the amount or extent of incidental take is exceeded; 2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; 3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or 4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

The WDOE and the Corps have not completed their review of the project at this time; therefore, issuance of the NPDES permit, water quality certification (401), and Clean Water Act Section 404 permit have not occurred. The BA includes a number of best management practices which are proposed to meet state water quality standards. The BA acknowledges that additional measures may be necessary. The FWS, in our review of the effects of the proposed action, assumes that the criteria in the Washington State surface water quality standards will be met by the project at all times. Any future actions that may be taken to meet state surface water quality standards or Section 404 permit requirements need to be evaluated to determine if reinitiation of this consultation is necessary.

If you have any questions regarding this Biological Opinion, please contact Nancy Brennan-Dubbs, of my staff, at (360) 753-5835 or Jim Michaels, of my staff, at (360) 753-7767.

Sincerely,

Ken S. Berg, Manager
Western Washington Office

c: Corps, Seattle (M. Walker)
NMFS, Seattle (T. Sibley)
WDOE. Bellevue (A. Kenny)
Port of Seattle, Sea-Tac (E. Levitt)

Enclosures

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Enclosures

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Enclosure A

ATTACHMENT A

Response to U.S. Fish and Wildlife Service Comments and Recommendations
Concerning Embankment Fill at Seattle-Tacoma International Airport
(FWS Comments and Recommendations in Bold)

1. All fill material within the first 20 feet above the rock underdrain of the embankment fill shall be contaminant free (e.g., below probable affect levels stated in the appropriate NOAA SQuiRT tables or below background levels found within the area).

Through its Clean Water Act section 401 permitting process, Washington Department of Ecology (Ecology) has required the Port to develop a process for insuring that contaminated fill material *is not* incorporated into the Third Runway embankment. The screening process developed by the Port includes the use of MTCA Method A standards as a tool to evaluate what is or is not environmentally suitable for placement in the embankment. In our January 22, 2001, meeting, and in its February 27, 2001, comments, FWS requested additional information concerning the Port's screening process, including information indicating this process is adequately protective of listed species.

First, it is important to recognize that the Port is not accepting large amounts of soil with constituent concentrations just at or below levels defined as "clean" by MTCA Method A standards. Over 50 percent of the soil placed in the Third Runway embankment to date has been from large pits, most state-certified, without historical sources of contamination. Though it is the responsibility of the individual contractor to identify sources of fill material, the Port anticipates that large pits will continue to be a primary source of fill for the embankment. Second, the remaining amount of embankment fill will not include contaminated soil that has been remediated to MTCA Method A standards. Rather, such soil will be taken from sites or portions of sites that have not historically been affected by contamination. Thus, Method A standards in this case are used simply as a screening tool to verify that clean fill sources are in fact clean.

To evaluate the environmental suitability of a proposed fill source, the Port currently requires that, for those fill sources for which testing is mandated, the supplier at a minimum test for concentrations of total petroleum hydrocarbons (TPH) and the eight Resource Conservation and Recovery Act (RCRA) metals. Analysis for chemicals other than TPH and metals is presently required based upon site-specific conditions. The approach used for evaluating appropriate testing, including location of samples, number of samples, and type of analysis, is similar to that used for Phase I and Phase II Environmental Site Assessments as discussed below.

When the Washington Department of Ecology and the Port developed the process for evaluating fill material proposed for placement in the Third Runway embankment, they used standards for conducting Phase I and Phase II Environmental Site Assessments as a model. Typically, Phase I and Phase II Environmental Site Assessments are conducted to identify environmental conditions at a site prior to some change of use or ownership. The nationally-accepted standard for these assessments is the American Society for Testing and Materials Standard (ASTM) Practice for Environmental Site Assessment: Phase I and Phase II Site Assessment Process (ASTM E 1527 and ASTM E 1903). Though not all ASTM procedures are relevant (e.g., lead paint testing, radon surveys, etc), the basic ASTM procedures for a site reconnaissance, review of historic operations, and appropriate testing to be conducted by a qualified environmental professional were adapted to the fill acceptance process. The use of Phase I and Phase II Environmental Site Assessments as a model is appropriate because it is a nationally-accepted process for evaluating the potential for contamination at a site.

Phase I and Phase II Environmental Site Assessments differ in objectives from Puget Sound Dredge Disposal Analysis (PSDDA) and remedial investigation studies. Phase I and Phase II Environmental Site Assessments look specifically for contamination. In contrast, PSDDA is a program which addresses the management and disposal of sediments that may be contaminated. As a result, sampling and analysis protocols are different. For Phase I and Phase II Environmental Site Assessments, the level of sampling and type of analyses can vary considerably from site to site based on the potential presence of contamination. This approach differs from PSDDA, in that PSDDA specifies a standard sampling protocol, including the number of samples and type of analyses, for evaluating the bulk characteristics of material proposed for open water disposal. This Phase I and II Environmental Site Assessment approach also differs from the more rigorous requirements for remedial investigation studies, which are designed to evaluate impacts from known contaminated sites.

When evaluating the suitability of proposed fill material, the Port uses MTCA Method A standards as a screening tool. However, the final suitability determination relies on best professional judgement. In general, the approach used in evaluating the fill suitability is similar to that of a prospective purchaser evaluating environmental information obtained in Phase I and Phase II Environmental Site Assessments. Careful consideration is given to other factors in addition to chemical test results. These include current and historic site uses, adequacy of the environmental documentation, type of proposed fill material (e.g., native vs. non-native) and the nature of the proposed excavation activities (e.g., Does the contractor have sound operational controls in place?). In some cases, the Port will condition acceptance to a specific area of a site, require ongoing testing and monitoring during excavation, or require regular site inspections to insure the quality of the incoming fill material. For example, the Port may determine that upper non-native soil at a source site may not be suitable because of its potential to contain asphalt or other debris, but that the underlying native soils at the same site are suitable. At the same site the Port may require an environmental professional monitor the site to ensure that the native and non-native materials are indeed separated.

In our January 22, 2001, meeting, and in subsequent comments, FWS inquired as to the protectiveness of Method A standards for the RCRA metals and for organochlorines. The Port will address these issues as follows:

(a) Drainage layer cover: The Port will establish a zone of "ultra-clean" fill above the drainage layer, in an area termed "drainage layer cover." The drainage layer cover will measure at least 40 feet thick at the face of the embankment and will reduce in height to the east at a rate of 2 percent (see Figures 1 and 2). The 2 percent slope is required for consistency with the embankment construction design, which has been developed to allow for appropriate drainage and runoff control. The overall thickness of the drainage layer cover will decrease away from the face of the embankment and will vary based on underlying topography. This configuration allows for the greatest protection for aquatic resources in the areas closest to the wetlands and Miller Creek, and will protect surface water quality in nearby Miller Creek.

(b) RCRA metals: The Port will employ the following standards and protocols concerning the placement of fill in the drainage layer cover with the goal of ensuring that baseline conditions are not altered for surface water receptors:

(i) For the drainage layer cover, as with the remainder of the embankment fill, no soil will be accepted that exceeds MTCA Method A standards for the RCRA metals per agreement with the Washington State Department of Ecology. These values are shown in columns 3 and 4 of Table 1.

(ii) The second column of Table 1 shows values for the RCRA metals that have been calculated using the Washington State Department of Ecology's (Ecology) "Three Phase Partitioning Model." Ecology uses this conservative model to establish soil concentrations that are protective of ground water as a drinking water source (see WAC 173-340-747(3), (4), and (5)) (Attachment B). The values in the second column of Table 1 are derived by using this model to "back-calculate" soil concentrations using freshwater ambient water quality criteria (WAC 173-201A) instead of ground water quality criteria. In other words, the model used by Ecology to establish soil concentrations that are protective of groundwater as a drinking water source has been employed to calculate soil concentrations that are protective of surface water receptors exposed to discharge or seepage from the drainage layer. No soil will be accepted for the drainage layer cover that exceeds the back-calculated values shown in the second column of Table 1 (with adjustments for PQLs and background concentrations as noted in Table 1 footnotes) unless the Synthetic Precipitation Leaching Procedure (SPLP) confirms the suitability of the soil as discussed below in (b)(iv). The Port will consult with the FWS if site-specific data is collected which may merit a recalculation of the three phase model soil concentrations in Table 1, and reinitate consultation as appropriate.

(iii) Column 6 shows Puget Sound Background concentrations for the eight RCRA metals. Exceedences of background metal concentrations can be expected due to the natural variability in soil types which will be offered from numerous sources in the region. Thus, in column 7, a range of screening criteria between background levels, when available, and Method A standards is shown. In the event the Port desires to establish site-specific background criteria, it will discuss proposed criteria with FWS and reinitiate consultation as appropriate. If the suppliers wish to place soil in the drainage cover layer that exceed background concentrations, the Port will confirm the acceptability of the material by requiring suppliers using that source to conduct sufficient SPLP testing to show that Method A criteria are protective of baseline conditions for surface water receptors.

(iv) To confirm the protectiveness of the Method A standards and the Three Phase Partitioning Model, SPLP testing will be used as a laboratory method to ensure that leaching of metals through potential embankment soil will not occur at unacceptable levels. SPLP testing according to the procedures contained in WAC 173-340-747(7) and SPLP methodology are shown in Attachments B and D respectively. SPLP results will be compared, as an initial screening tool, to freshwater ambient water quality criteria according to guidelines outlined at WAC 173-201A-040 (Attachment C). If the SPLP results indicate that metals in the proposed fill material *do not leach* at levels above the freshwater ambient water quality criteria, adjusted for PQLs as appropriate, the material will be considered suitable for placement. If the SPLP indicates that metals in the proposed fill material *leach* at levels above ambient water quality criteria, the Port will either reject the material or discuss the results of the SPLP with FWS before acceptance of the material. The Port shall submit to FWS for its review and approval a plan describing the Port's SPLP protocol. The FWS shall approve this plan prior the Port's implementation of the SPLP protocol.

(c) Organochlorines: The Port will employ the following standards and protocols concerning the placement of fill in the drainage layer cover:

(i) The Port will require testing for organochlorines on those sites where such compounds may be present, including sites with potential commercial pesticide applications, and sites with historic wood preserving operations. The supplier, with Port review, will identify sites potentially containing such compounds through the process discussed above under Response 1 (i.e., Phase I and II Environmental Site Assessments). The Port will update guidelines provided to suppliers to clearly state that testing for additional constituents must be conducted as appropriate based on current and historical site land uses.

(ii) As with the remainder of the embankment fill, sources of fill proposed for placement in the drainage layer cover which have detectable levels of organochlorines will not exceed MTCA Method A criteria.

(iii) Sources of fill proposed for placement in the drainage layer cover which have detectable levels of organochlorines will be evaluated using the "Three Phase Partitioning Model" discussed in (b) above. When organochlorines are detected in potential fill, the Port will use the Three Phase Partitioning Model to back-calculate soil concentrations using freshwater ambient water quality criteria. Soil found to contain organochlorines at concentrations below Three Phase Partitioning Model concentrations (adjusted for PQLs) will be deemed acceptable. No soil will be accepted for the drainage layer cover that exceeds Three Phase Partitioning Model concentrations (adjusted for PQLs) unless SPLP testing confirms the suitability of the soil as discussed below in (c)(iv).

(iv) The Port will require SPLP testing when proposed soil exceeds calculated Three Phase Partitioning Model concentrations. SPLP test results will be compared, as an initial screening tool, to freshwater ambient water quality criteria according to guidelines outlined at WAC 173-201A-040 (Attachment C). If the SPLP results indicate that organocholorines in the proposed fill material *do not leach* at levels above the freshwater ambient water quality criteria, adjusted for PQLs as appropriate, the material will be considered suitable for placement. If the SPLP indicates that organochlorines in the proposed fill leach at levels above ambient water quality criteria, the Port will either reject the material or discuss the results of the SPLP with FWS before acceptance of the material, and reinitiate consultation as appropriate.

2. To isolate organisms in the biologically active zone from contaminants that may be contained in the fill material, the surficial 3 feet of fill should be contaminant free (e.g., below probable affect levels stated in the appropriate NOAA SQuiRTs or below background levels found within the area if available).

As discussed in our January 22, 2001, meeting, and dates thereafter, from a practical standpoint it is difficult to apply different acceptance criteria to the upper three feet of embankment fill material versus the underlying fill material. Final grading of the embankment will involve working and reworking of the upper material to achieve appropriate compaction and site elevations. Portions of the embankment will be paved for the runway and associated taxiways. Remaining embankment areas will be grass covered and will have very strict wildlife controls (i.e., hazing and elimination) in accordance with FAA regulations to insure aircraft safety.

During our January 22, 2001 meeting, the Port agreed to evaluate the eight RCRA metals with respect to the recently-adopted MTCA regulation WAC 173-340-7490 Terrestrial Ecological Evaluation Procedures (Attachment E). The goal of the terrestrial ecological evaluation process is the protection of terrestrial ecological receptors from exposure to contaminated soil with the potential to cause significant adverse effects. Table 749-2 - Priority Contaminants of Ecological Concern for Sites that Qualify for the Simplified Terrestrial Ecological Evaluation Procedure lists soil concentrations for seven of the eight RCRA metals (Attachment E). These concentrations are developed to protect wildlife through direct ingestion of soil using a robin/shrew food chain model, two surrogate receptors meant to represent highly exposed species. Soil concentrations were also developed for plants and soil invertebrates using toxicity values from the published literature. The most restrictive value was then placed into Table 749-2.

Generally, the Method A concentrations are less than or similar to Table 749-2 (see Table 1). However, the MTCA Method A standards list does not include values for barium, total chromium or selenium. For these constituents, the Table 749-2 ecological standards listed in Table 1 (adjusted for background and PQLs) will be used as screening criteria for the top three feet of embankment fill.

3. The Port of Seattle will monitor the seepage water from the rock underdrain for contaminants. Monitoring shall be for a period of 10 years, on a monthly basis. Based on the monitoring results, the monitoring schedule may be modified by FWS.

The Port of Seattle shall prepare a water quality monitoring plan to track the quality of seepage from the drainage layer beneath the Third Runway embankment fill. Such a plan shall be prepared to address the amount of monitoring in a tiered or phased approach. For example, if it is determined that water flowing through the new embankment is exceeding designated surface water quality criteria, new monitoring points may be established between the embankment and Miller Creek to evaluate the fate and transport of the impacted fill water. Monitoring Miller Creek would represent the final phase of a monitoring program if it were determined that constituents in embankment fill water were reaching the creek. The Port shall develop a monitoring plan in consultation with FWS. The Port shall submit a draft monitoring plan to FWS for its review and approval within 120 days after FWS' issuance of a biological opinion or concurrence letter. The monitoring plan shall provide for a minimum of three years of monthly monitoring, with the monitoring period commencing upon detection of seepage from the drainage layer of the completed embankment. At the end of the three-year monitoring period, the Port and FWS shall reevaluate the need to modify or continue the monitoring program. In the event seepage is not detected within six years after completion of embankment construction, the Port and FWS shall likewise reevaluate the need to modify or continue the monitoring program.

4, 5. If material is used which is known to have contaminants, this material shall be distributed over a large area to avoid creating a "hot spot" in the embankment. The Port of Seattle will request FWS approval for those fill materials proposed that do not meet MTCA Method A standards, at a minimum. Information on why these materials are to be used and proof that their chemical constituents/levels will not result in environmental impacts to aquatic organisms needs to be provided.

The use of MTCA Method A as a screening standard for incoming fill material will avoid the creation of "hot spots" in the embankment. In the event that the Port considers placement of fill materials that do not meet MTCA Method A standards, the Port will discuss results with FWS and consultation will be reinitiated as appropriate.

Acceptance of material above MTCA Method A standards requires Ecology approval. Discussion with the agencies will provide information regarding the environmental suitability of this material and proposed placement methods and locations.

TABLE 1
SOIL SCREENING CRITERIA FOR THIRD RUNWAY EMBANKMENT FILL (MG/KG)

		MTCA(a) – Unrestricted Land Use				Screening Criteria	
RCRA Metals	Three Phase Partioning Model Concentrations(b)	Current Method A Standard	Proposed Method A Standard (c)	Proposed Ecological Standard (c)	Puget Sound Background (Upper 90%) (d)	Drainage Layer Cover	Top 3-feet Embankment
Arsenic	88	20	20	95 (As V)	7	7 to 20 (e)	20 (l)
Barium	12000	NA	NA	1250	NA	12,000 (f)	1250 (m)
Cadmium	0.15	2	2	25	1	1 to 2 (g)	2 (l)
Chromium (Total)	NA	100	NA	42	48	48 to 100 (g), (h)	48 (n)
Lead	500	250	250	220	24	24 to 250 (i)	220 (m)
Mercury (Inorganic)	0.013	1	2	9	0.07	0.07 to 2 (g)	2 (l)
Selenium	0.52	NA	NA	0.8	NA	5 (PQL), (j), (k)	5 (PQL), (j)
Silver	0.11	NA	NA	NA	NA	5 (PQL), (j), (k)	5 (PQL), (j)

Note: See associated text in Attachment A for related discussion.

Footnotes:

NA: Not available. Insufficient information available to develop criteria.

PQL: Practical Quantitation Limit

(a) Model Toxics Control Act WAC 173-340.

(b) MTCA WAC 173-340 747 (3), (4), and (5) Three Phase Partitioning Model soil concentrations calculated using aquatic freshwater quality criteria (WAC 173-201A). For purposes of this table, the lowest criteria from "Freshwater CCC Chronic" Screening Quick Reference Table (NOAA SQuiRT Table) were used.

(c) Proposed Method A and Ecological standards were finalized on February 15, 2001, and will become effective on August 15, 2001.

(d) Natural Background Soil Metals in Washington State (Ecology Publication 94-115).

(e) The MTCA Method A standard of 20 mg/kg is less than the Three Phase Partitioning Model concentration of 88 mg/kg indicating that the Method A standard is protective of surface water receptors. When soil concentrations are greater than background but below the Method A standard, sufficient SPLP testing will be conducted to confirm that the Method A standard is protective (see associated text in Attachment A for discussion of SPLP testing).

(f) Three Phase Partitioning Model concentrations calculated using MTCA Method B ground water quality criteria because there was no available criteria for barium in surface water. If concentrations exceed calculated values, SPLP testing will be required to evaluate the suitability of the soil.

(g) Three Phase Partitioning Model concentrations, adjusted upward to background, and Method A standards. To verify the protectiveness of Method A standards, SPLP testing will be conducted when soil concentrations exceed background but are below Method A standards. (Note: exceedances in background concentrations anticipated due to natural variability of soil types being used as fill.)

(h) Chromium speciation may be conducted in the event SPLP is applied.

(i) The MTCA Method A standard of 250 mg/kg is less than the Three Phase Partitioning Model concentration of 500 mg/kg indicating that the Method A standard is protective of surface water receptors. When soil concentrations are greater than background but the Method A standard, sufficient SPLP testing will be conducted to confirm that the Method A standard is protective.

(j) PQLS from Department of Ecology "Implementation Memo No. 3: PQLs as Cleanup Standards", November 24, 1993.

(k) Three Phase Partitioning Model concentrations, adjusted upward to PQL. If soil concentrations exceed the PQL, SPLP testing will be required to evaluate the suitability of the soil.

(l) Screening criteria based on MTCA Method A standards.

(m) Screening criteria based on ecological standards.

(n) Screening criteria based on ecological standards, adjusted for background.

ATTACHMENT B

WAC 173-340-747(3-5, 7) (February 12, 2001)

WAC 173-340-747 (3) Overview of methods. This subsection provides an overview of the methods specified in subsections (4) through (10) of this section for deriving soil concentrations that meet the criteria specified in subsection (2) of this section. Certain methods are tailored for particular types of hazardous substances or sites. Certain methods are more complex than others and certain methods require the use of site-specific data. The specific requirements for deriving a soil concentration under a particular method may also depend on the hazardous substance.

(a) Fixed parameter three-phase partitioning model. The three-phase partitioning model with fixed input parameters may be used to establish a soil concentration for any hazardous substance. Site-specific data are not required for use of this model. See subsection (4) of this section.

(b) Variable parameter three-phase partitioning model. The three-phase partitioning model with variable input parameters may be used to establish a soil concentration for any hazardous substance. Site-specific data are required for use of this model. See subsection (5) of this section.

(c) Four-phase partitioning model. The four-phase partitioning model may be used to derive soil concentrations for any site where hazardous substances are present in the soil as a nonaqueous phase liquid (NAPL). The department expects that this model will be used at sites contaminated with petroleum hydrocarbons. Site-specific data are required for use of this model. See subsection (6) of this section.

(d) Leaching tests. Leaching tests may be used to establish soil concentrations for certain metals. Leaching tests may also be used to establish soil concentrations for other hazardous substances, including petroleum hydrocarbons, provided sufficient information is available to demonstrate that the leaching test can accurately predict ground water impacts. Testing of soil samples from the site is required for use of this method. See subsection (7) of this section.

(e) Alternative fate and transport models. Fate and transport models other than those specified in subsections (4) through (6) of this section may be used to establish a soil concentration for any hazardous substance. Site-specific data are required for use of such models. See subsection (8) of this section.

(f) Empirical demonstration. An empirical demonstration may be used to show that measured soil concentrations will not cause an exceedance of the applicable ground water cleanup levels established under WAC 173-340-720. This empirical demonstration may be used for any hazardous substance. Site-specific data (e.g., ground water samples and soil samples) are required under this method. If the required demonstrations cannot be made, then a protective soil concentration shall be established under one of the methods specified in subsections (4) through (8) of this section. See subsection (9) of this section.

(g) Residual saturation. To ensure that the soil concentration established under one of the methods specified in subsections (4) through (9) of this section will not cause an exceedance of the ground water cleanup level established under WAC 173-340-720, the soil concentration must not result in the accumulation of nonaqueous phase liquid (NAPL) on or in ground water. The methodologies and procedures specified in subsection (10) of this section shall be used to determine if this criterion is met.

WAC 173-340-747 (4) Fixed parameter three-phase partitioning model.

(a) Overview. This subsection specifies the procedures and requirements for establishing soil concentrations through the use of the fixed parameter three-phase partitioning model. The model may be used to establish soil concentrations for any hazardous substance. The model may be used to calculate both unsaturated and saturated zone soil concentrations.

This method provides default or fixed input parameters for the three-phase partitioning model that are intended to be protective under most circumstances and conditions; site-specific measurements are not required. In some cases it may be appropriate to use site-specific measurements for the input parameters. Subsection (5) of this section specifies the procedures and requirements to establish site-specific input parameters for use in the three-phase partitioning model.

(b) Description of the model. The three-phase partitioning model is described by the following equation:

[Equation 747-1]

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Place illustration here.

Where:
Cs = Soil concentration (mg/kg)
Cw = Ground water cleanup level established under WAC 173-340-720 (ug/l)
UCF = Unit conversion factor (1mg/1,000 ug)
DF = Dilution factor (dimensionless: 20 for unsaturated zone soil; see (e) of this subsection for saturated zone soil)
Kd = Distribution coefficient (L/kg; see (c) of this subsection)
&thgr;w = Water-filled soil porosity (ml water/ml soil: 0.3 for unsaturated zone soil; see (e) of this subsection for saturated zone soil)
&thgr;a = Air-filled soil porosity (ml air/ml soil: 0.13 for unsaturated zone soil; see (e) of this subsection for saturated zone soil)
Hcc = Henry's law constant (dimensionless; see (d) of this subsection)
&rgr;b = Dry soil bulk density (1.5 kg/L)

(c) Distribution coefficient (Kd). The default Kd values for organics and metals used in Equation 747-1 are as follows:

(i) Organics. For organic hazardous substances, the Kd value shall be derived using Equation 747-2. The Koc (soil organic carbon-water partition coefficient) parameter specified in Equation 747-2 shall be derived as follows:

(A) Nonionic organics. For individual nonionic hydrophobic organic hazardous substances (e.g., benzene and naphthalene), the Koc values in Table 747-1 shall be used. For hazardous substances not listed in Table 747-1, Kd values may be developed as provided in subsection (5) of this section (variable three-phase partitioning model).

(B) Ionizing organics. For ionizing organic hazardous substances (e.g., pentachlorophenol and benzoic acid), the Koc values in Table 747-2 shall be used. Table 747-2 provides Koc values for three different pHs. To select the appropriate Koc value, the soil pH must be measured. The Koc value for the corresponding soil pH shall be used. If the soil pH falls between the pH values provided, an appropriate Koc value shall be selected by interpolation between the listed Koc values.

[Equation 747-2]
Kd = Koc x foc
Where:
Kd = Distribution coefficient (L/kg)
Koc = Soil organic carbon-water partitioning coefficient (ml/g). See (c)(i) of this subsection.
foc = Soil fraction of organic carbon (0.1% or 0.001 g/g)

(ii) Metals. For metals, the Kd values in Table 747-3 shall be used. For metals not listed in Table 747-3, Kd values may be developed as provided in subsection (5) of this section (variable three-phase partitioning model).

(d) Henry's law constant. For petroleum fractions, the values for Henry's law constant in Table 747-4 shall be used in Equation 747-1. For individual organic hazardous substances, the value shall be based on values in the scientific literature. For all metals present as inorganic compounds except mercury, zero shall be used. For mercury, either 0.47 or a value derived from the scientific literature shall be used. Derivation of Henry's law constant from the scientific literature shall comply with WAC 173-340-702 (14), (15) and (16).

(e) Saturated zone soil concentrations. Equation 747-1 may also be used to derive concentrations for soil that is located at or below the ground water table (the saturated zone). The following input parameters shall be changed if Equation 747-1 is used to derive saturated zone soil concentrations:

(i) The dilution factor shall be changed from 20 to 1;

(ii) The water-filled soil porosity value shall be changed from 0.3 ml water/ml soil to 0.43 ml water/ml soil; and

(iii) The air-filled soil porosity value shall be changed from 0.13 ml air/ml soil to zero.

WAC 173-340-747 (5) Variable parameter three-phase partitioning model.

(a) Overview. This section specifies the procedures and requirements to derive site-specific input parameters for use in the three-phase partitioning model. This method may be used to establish soil concentrations for any hazardous substance. This method may be used to calculate both unsaturated and saturated zone soil concentrations.

This method allows for the substitution of site-specific values for the default values in Equation 747-1 for one or more of the following five input parameters: Distribution coefficient, soil bulk density, soil volumetric water content, soil air content, and dilution factor. The methods that may be used and the requirements that shall be met to derive site-specific values for each of the five input parameters are specified in (b) through (f) of this subsection.

(b) Methods for deriving a distribution coefficient (Kd). To derive a site-specific distribution coefficient, one of the following methods shall be used:

(i) Deriving Kd from soil fraction of organic carbon (foc) measurements. Site-specific measurements of soil organic carbon may be used to derive distribution coefficients for nonionic hydrophobic organics using Equation 747-2. Soil organic carbon measurements shall be based on uncontaminated soil below the root zone (i.e., soil greater than one meter in depth) that is representative of site conditions or in areas through which contaminants are likely to migrate.

The laboratory protocols for measuring soil organic carbon in the Puget Sound Estuary Program (March, 1986) may be used. Other methods may also be used if approved by the department. All laboratory measurements of soil organic carbon shall be based on methods that do not include inorganic carbon in the measurements.

(ii) Deriving Kd from site data. Site-specific measurements of the hazardous substance concentrations in the soil and the soil pore water or ground water may be used, subject to department approval, to derive a distribution coefficient. Distribution coefficients that have been derived from site data shall be based on measurements of soil and ground water hazardous substance concentrations from the same depth and location. Soil and ground water samples that have hazardous substances present as a nonaqueous phase liquid (NAPL) shall not be used to derive a distribution coefficient and measures shall be taken to minimize biodegradation and volatilization during sampling, transport and analysis of these samples.

(iii) Deriving Kd from batch tests. A site-specific distribution coefficient may be derived by using batch equilibrium tests, subject to department approval, to measure hazardous substance adsorption and desorption. The results from the batch test may be used to derive Kd from the sorption/desorption relationship between hazardous substance concentrations in the soil and water. Samples that have hazardous substances present as a nonaqueous phase liquid (NAPL) shall not be used to derive a distribution coefficient and measures shall be taken to minimize biodegradation and volatilization during testing.

(iv) Deriving Kd from the scientific literature. The scientific literature may be used to derive a site-specific distribution coefficient (Kd) for any hazardous substance, provided the requirements in WAC 173-340-702 (14), (15) and (16) are met.

(c) Deriving soil bulk density. ASTM Method 2049 or other methods approved by the department may be used to derive soil bulk density values.

(d) Deriving soil volumetric water content using laboratory methods. ASTM Method 2216 or other methods approved by the department may be used to derive soil volumetric water content values.

(e) Estimating soil air content. An estimate of soil air content may be determined by calculating soil porosity and subtracting the volumetric water content.

(f) Deriving a dilution factor from site-specific estimates of infiltration and ground water flow volume. Site-specific estimates of infiltration and ground water flow volume may be used in the following equation to derive a site-specific dilution factor:

[Equation 747-3]
DF = (Qp + Qa)/Qp
Where:
DF = Dilution factor (dimensionless)
Qp = Volume of water infiltrating (m3/yr)
Qa = Ground water flow (m3/yr)

(i) Calculating ground water flow volume. The following equation shall be used under this method to calculate the volume of ground water flow (Qa):

[Equation 747-4]
Qa = K x A x I
Where:

Qa = Ground water flow volume (m3/year)
K = Hydraulic conductivity (m/year). Site-specific measurements shall be used to derive this parameter.
A = Aquifer mixing zone (m2). The aquifer mixing zone thickness shall not exceed 5 meters in depth and be equal to a unit width of 1 meter, unless it can be demonstrated empirically that the mixing zone thickness exceeds 5 meters.
I = Gradient (m/m). Site-specific measurements shall be used to derive this parameter.

(A) Equation 747-4 assumes the ground water concentrations of hazardous substances of concern upgradient of the site are not detectable. If this assumption is not true, the dilution factor may need to be adjusted downward in proportion to the upgradient concentration.

(B) Direct measurement of the flow velocity of ground water using methods approved by the department may be used as a substitute for measuring the ground water hydraulic conductivity and gradient.

(ii) Calculating or estimating infiltration. The following equation shall be used under this method to calculate the volume of water infiltrating (Qp):

[Equation 747-5]
Qp = L x W x Inf
Where:
Qp = Volume of water infiltrating (m3/year)
L = Estimated length of contaminant source area parallel to ground water flow (m)
W = Unit width of contaminant source area (1 meter)
Inf = Infiltration (m/year)

(A) If a default annual infiltration value (Inf) is used, the value shall meet the following requirements. For sites west of the Cascade Mountains, the default annual infiltration value shall be 70 percent of the average annual precipitation amount. For sites east of the Cascade Mountains, the default annual infiltration value shall be 25 percent of the average annual precipitation amount.

(B) If a site-specific measurement or estimate of infiltration (Inf) is made, it shall be based on site conditions without surface caps (e.g., pavement) or other structures that would control or impede infiltration. The presence of a cover or cap may be considered when evaluating the protectiveness of a remedy under WAC 173-340-350 through 173-340-360. If a site-specific measurement or estimate of infiltration is made, then it must comply with WAC 173-340-702 (14), (15) and (16).

WAC 173-340-747 (7) Leaching tests.

(a) Overview. This subsection specifies the procedures and requirements for deriving soil concentrations through the use of leaching tests. Leaching tests may be used to establish soil concentrations for the following specified metals: Arsenic, cadmium, total chromium, hexavalent chromium, copper, lead, mercury, nickel, selenium, and zinc (see (b) and (c) of this subsection). Leaching tests may also be used to establish soil concentrations for other hazardous substances, including petroleum hydrocarbons, provided sufficient information is available to correlate leaching test results with ground water impacts (see (d) of this subsection). Testing of soil samples from the site is required for use of this method.

(b) **Leaching tests for specified metals.** If leaching tests are used to establish soil concentrations for the specified metals, the following two leaching tests may be used:

(i) EPA Method 1312, Synthetic Precipitation Leaching Procedure (SPLP). Fluid #3 (pH = 5.0), representing acid rain in the western United States, shall be used when conducting this test. This test may underestimate ground water impacts when acidic conditions exist due to significant biological degradation or for other reasons. Underestimation of ground water impacts may occur, for example, when soils contaminated with metals are located in wood waste, in municipal solid waste landfills, in high sulfur content mining wastes, or in other situations with a pH <6. Consequently, this test shall not be used in these situations and the TCLP test should be used instead.

(ii) **EPA Method 1311, Toxicity Characteristic Leaching Procedure (TCLP).** Fluid #1 (pH = 4.93), representing organic acids generated by biological degradation processes, shall be used when conducting this test. This test is intended to represent situations where acidic conditions are present due to biological degradation such as in municipal solid waste landfills. Thus, it may underestimate ground water impacts where this is not the case and the metals of interest are more soluble under alkaline conditions. An example of this would be arsenic occurring in alkaline (pH >8) waste or soils. Consequently, this test shall not be used in these situations and the SPLP test should be used instead.

(c) **Criteria for specified metals.** When using either EPA Method 1312 or 1311, the analytical methods used for analysis of the leaching test effluent shall be sufficiently sensitive to quantify hazardous substances at concentrations at the ground water cleanup level established under WAC 173-340-720. For a soil metals concentration derived under (b) of this subsection to be considered protective of ground water, the leaching test effluent concentration shall meet the following criteria:

(i) For cadmium, lead and zinc, the leaching test effluent concentration shall be less than or equal to ten (10) times the applicable ground water cleanup level established under WAC 173-340-720.

(ii) For arsenic, total chromium, hexavalent chromium, copper, mercury, nickel and selenium, the leaching test effluent concentration shall be less than or equal to the applicable ground water cleanup level established under WAC 173-340-720.

ATTACHMENT C

WAC 173-201A-040

WAC 173-201A-040 Toxic substances. (1) Toxic substances shall not be introduced above natural background levels in waters of the state which have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic toxicity to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by the department.
(2) The department shall employ or require chemical testing, acute and chronic toxicity testing, and biological assessments, as appropriate, to evaluate compliance with subsection (1) of this section and to ensure that aquatic communities and the existing and characteristic beneficial uses of waters are being fully protected.
(3) The following criteria shall be applied to all surface waters of the state of Washington for the protection of aquatic life. The department may revise the following criteria on a statewide or waterbody-specific basis as needed to protect aquatic life occurring in waters of the state and to increase the technical accuracy of the criteria being applied. The department shall formally adopt any appropriate revised criteria as part of this chapter in accordance with the provisions established in chapter 34.05 RCW, the Administrative Procedure Act. The department shall ensure there are early opportunities for public review and comment on proposals to develop revised criteria. Values are µg/L for all substances except Ammonia and Chloride which are mg/L:

Substance	Freshwater Acute	Freshwater Chronic	Marine Water Acute	Marine Water Chronic
Aldrin/Dieldrin	2.5a	0.0019b	0.71a	0.0019b
Ammonia (un-ionized NH3) hh	f,c	g,d	0.233h,c	0.035h,d
Arsenic dd	360.0c	190.0d	69.0c,ll	36.0d, cc,ll
Cadmium dd	i,c	j,d	42.0c	9.3d
Chlordane	2.4a	0.0043b	0.09a	0.004b
Chloride (Dissolved) k	860.0h,c	230.0h,d	-	-
Chlorine (Total Residual)	19.0c	11.0d	13.0c	7.5d
Chlorpyrifos	0.083c	0.041d	0.011c	0.0056d
Chromium (Hex) dd	15.0c,l,ii	10.0d,jj	1,100.0c,l,ll	50.0d,ll
Chromium (Tri) gg	m,c	n,d	-	-
Copper dd	o,c	p,d	4.8c,ll	3.1d,ll
Cyanide ee	22.0c	5.2d	1.0c,mm	-
DDT (and metabolites)	1.1a	0.001b	0.13a	0.001b
Dieldrin/Aldrin e	2.5a	0.0019b	0.71a	0.0019b
Endosulfan	0.22a	0.056b	0.034a	0.0087b
Endrin	0.18a	0.0023b	0.037a	0.0023b
Heptachlor	0.52a	0.0038b	0.053a	0.0036b
Hexachlorocyclohexane (Lindane)	2.0a	0.08b	0.16a	-
Lead dd	q,c	r,d	210.0c,ll	8.1d,ll
Mercury s	2.1c,kk,dd	0.012d,ff	1.8c,ll,dd	0.025d,ff
Nickel dd	t,c	u,d	74.0c,ll	8.2d,ll
Parathion	0.065c	0.013d	-	-
Pentachlorophenol (PCP)	w,c	v,d	13.0c	7.9d
Polychlorinated Biphenyls (PCBs)	2.0b	0.014b	10.0b	0.030b
Selenium	20.0c,ff	5.0d,ff	290c,ll,dd	71.0d,x,ll,dd
Silver dd	y,a	-	1.9a,ll	-

AR 012642

Toxaphene	0.73c,z	0.0002d	0.21c,z	0.0002d
Zinc dd	aa,c	bb,d	90.0c,ll	81.0d,ll

Notes to Table:

a. An instantaneous concentration not to be exceeded at any time.

b. A 24-hour average not to be exceeded.

c. A 1-hour average concentration not to be exceeded more than once every three years on the average.

d. A 4-day average concentration not to be exceeded more than once every three years on the average.

e. Aldrin is metabolically converted to Dieldrin. Therefore, the sum of the Aldrin and Dieldrin concentrations are compared with the Dieldrin criteria.

f. Shall not exceed the numerical value given by:

$$0.52 \div (FT)(FPH)(2)$$

where:

$FT = 10^{[0.03(20-TCAP)]}$; $TCAP \leq T \leq 30$

$FT = 10^{[0.03(20-T)]}$; $0 \leq T \leq TCAP$

$FPH = 1$; $8 \leq pH \leq 9$

$FPH = (1 + 10^{(7.4-pH)}) \div 1.25$; $6.5 \leq pH \leq 8.0$

$TCAP$ = 20°C; Salmonids present.

$TCAP$ = 25°C; Salmonids absent.

g. Shall not exceed the numerical value given by:

$$0.80 \div (FT)(FPH)(RATIO)$$

where:

$RATIO = 13.5$; $7.7 \leq pH \leq 9$

$RATIO = (20.25 \times 10^{(7.7-pH)}) \div (1 + 10^{(7.4-pH)})$; $6.5 \leq pH \leq 7.7$

where: FT and FPH are as shown in (f) above except:

TCAP = 15°C; Salmonids present.

TCAP = 20°C; Salmonids absent.

h. Measured in milligrams per liter rather than micrograms per liter.

i. $\leq (0.944)(e(1.128[\ln(\text{hardness})]-3.828))$ at hardness= 100. Conversion factor (CF) of 0.944 is hardness dependent. CF is calculated for other hardnesses as follows: CF= 1.136672 - [(ln hardness)(0.041838)].

j. $\leq (0.909)(e(0.7852[\ln(\text{hardness})]-3.490))$ at hardness= 100. Conversions factor (CF) of 0.909 is hardness dependent. CF is calculated for other hardnesses as follows: CF= 1.101672 - [(ln hardness)(0.041838)].

k. Criterion based on dissolved chloride in association with sodium. This criterion probably will not be adequately protective when the chloride is associated with potassium, calcium, or magnesium, rather than sodium.

l. Salinity dependent effects. At low salinity the 1-hour average may not be sufficiently protective.

m. $\leq (0.316)e^{(0.8190[\ln(\text{hardness})]+3.688)}$

n. $\leq (0.860)e^{(0.8190[\ln(\text{hardness})]+1.561)}$

o. $\leq (0.960)(e^{(0.9422[\ln(\text{hardness})]-1.464)})$

p. $\leq (0.960)(e^{(0.8545[\ln(\text{hardness})]-1.465)})$

q. $\leq (0.791)(e^{(1.273[\ln(hardness)] -1.460)})$ at hardness= 100. Conversion factor (CF) of 0.791 is hardness dependent. CF is calculated for other hardnesses as follows: CF= 1.46203 - [(ln hardness)(0.145712)].

r. $\leq (0.791)(e^{(1.273[\ln(hardness)] -4.705)})$ at hardness= 100. Conversion factor (CF) of 0.791 is hardness dependent. CF is calculated for other hardnesses as follows: CF= 1.46203 - [(ln hardness)(0.145712)].

s. If the four-day average chronic concentration is exceeded more than once in a three-year period, the edible portion of the consumed species should be analyzed. Said edible tissue concentrations shall not be allowed to exceed 1.0 mg/kg of methylmercury.

t. $\leq (0.998)(e^{(0.8460[\ln(hardness)] +3.3612)})$

u. $\leq (0.997)(e^{(0.8460[\ln(hardness)] +1.1645)})$

v. $\leq e^{[1.005(pH) -5.290]}$

w. $\leq e^{[1.005(pH) -4.830]}$

x. The status of the fish community should be monitored whenever the concentration of selenium exceeds 5.0 ug/l in salt water.

y. $\leq (0.85)(e^{(1.72[\ln(hardness)] -6.52)})$

z. Channel Catfish may be more acutely sensitive.

aa. $\leq (0.978)(e^{(0.8473[\ln(hardness)] +0.8604)})$

bb $\leq (0.986)(e^{(0.8473[\ln(hardness)] +0.7614)})$

cc. Nonlethal effects (growth, C-14 uptake, and chlorophyll production) to diatoms (Thalassiosira aestivalis and Skeletonema costatum) which are common to Washington's waters have been noted at levels below the established criteria. The importance of these effects to the diatom populations and the aquatic system is sufficiently in question to persuade the state to adopt the USEPA National Criteria value (36 µg/L) as the state threshold criteria, however, wherever practical the ambient concentrations should not be allowed to exceed a chronic marine concentration of 21 µg/L.

dd These ambient criteria in the table are for the dissolved fraction. The cyanide criteria are based on the weak acid dissociable method. The metals criteria may not be used to calculate total recoverable effluent limits unless the seasonal partitioning of the dissolved to total metals in the ambient water are known. When this information is absent, these metals criteria shall be applied as total recoverable values, determined by back-calculation, using the conversion factors incorporated in the criterion equations. Metals criteria may be adjusted on a site-specific basis when data are made available to the department clearly demonstrating the effective use of the water effects ratio approach established by USEPA, as generally guided by the procedures in USEPA Water Quality Standards Handbook, December 1983, as supplemented or replaced. Information which is used to develop effluent limits based on applying metals partitioning studies or the water effects ratio approach shall be identified in the permit fact sheet developed pursuant to WAC 173-220-060 or 173-226-110, as appropriate, and shall be made available for the public comment period required pursuant to WAC 173-220-050 or 173-226-130(3), as appropriate.

ee. The criteria for cyanide is based on the weak and dissociable method in the 17th Ed. Standard Methods for the Examination of Water and Wastewater, 4500-CN I, and as revised (see footnote dd, above).

ff. These criteria are based on the total-recoverable fraction of the metal.

gg Where methods to measure trivalent chromium are unavailable, these criteria are to be represented by total-recoverable chromium.

hh Tables for the conversion of total ammonia to un-ionized ammonia for freshwater can be found in the USEPA's Quality Criteria for Water, 1986. Criteria concentrations based on total ammonia for marine water can be found in USEPA Ambient Water Quality Criteria for Ammonia (Saltwater)-1989, EPA440/5-88-004, April 1989.

ii. Conversion factor to calculate dissolved metal concentration is 0.982.

jj. Conversion factor to calculate dissolved metal concentration is 0.962.

ATTACHMENT E

WAC 173-340-7490 (February 15, 2001)

WAC 173-340-7490
Terrestrial ecological evaluation procedures.

(1) **Purpose.**
(a) WAC 173-340-7490 through 173-340-7494 define the goals and procedures the department will use for:
(i) Determining whether a release of hazardous substances to soil may pose a threat to the terrestrial environment;
(ii) Characterizing existing or potential threats to terrestrial plants or animals exposed to hazardous substances in soil; and (iii) Establishing site-specific cleanup standards for the protection of terrestrial plants and animals.
(b) Information collected during a terrestrial ecological evaluation shall also be used in developing and evaluating cleanup action alternatives and in selecting a cleanup action under WAC 173-340-350 through 173-340-390. WAC 173-340-7490 through 173-340-7494 do not necessarily require a cleanup action for terrestrial ecological protection separate from a human health-based cleanup action. Where appropriate, a terrestrial ecological evaluation may be conducted so as to avoid duplicative studies of soil contamination that will be remediated to address other concerns, as provided in WAC 173-340-350 (7)(c)(iii)(F)(II).
(c) These procedures are not intended to be used to evaluate potential threats to ecological receptors in sediments, surface water, or wetlands. Procedures for sediment evaluations are described in WAC 173-340-760, and for surface water evaluations in WAC 173-340-730. Procedures for wetland evaluations shall be determined by the department on a case-by-case basis.

(2) **Requirements.** In the event of a release of a hazardous substance to the soil at a site, one of the following actions shall be taken:
(a) Document an exclusion from any further terrestrial ecological evaluation using the criteria in WAC 173-340-7491;
(b) Conduct a simplified terrestrial ecological evaluation as set forth in WAC 173-340-7492; or
(c) Conduct a site-specific terrestrial ecological evaluation as set forth in WAC 173-340-7493.

(3) **Goal.** The goal of the terrestrial ecological evaluation process is the protection of terrestrial ecological receptors from exposure to contaminated soil with the potential to cause significant adverse effects. For species protected under the Endangered Species Act or other applicable laws that extend protection to individuals of a species, a significant adverse effect means an impact that would significantly disrupt normal behavior patterns that include, but are not limited to, breeding, feeding, or sheltering. For all other species, significant adverse effects are effects that impair reproduction, growth or survival.
(a) The simplified terrestrial ecological evaluation process has been developed to be protective of terrestrial ecological receptors at most qualifying sites, while the site-specific terrestrial ecological evaluation process is intended to be highly likely to be protective at any site.
(b) The following policy on terrestrial ecological receptors to be protected applies to all terrestrial ecological evaluations. For land uses other than industrial or commercial, protectiveness is evaluated relative to terrestrial plants, wildlife, and ecologically important functions of soil biota that affect plants or wildlife.
For industrial or commercial properties, current or future potential for exposure to soil contamination need only be evaluated for terrestrial wildlife protection. Plants and soil biota need not be considered unless:
(i) The species is protected under the federal Endangered Species Act; or
(ii) The soil contamination is located on an area of an industrial or commercial property where vegetation must be maintained to comply with local government land use regulations.
(c) For the purposes of this section, "industrial property" means properties meeting the definition in WAC 173-340-200. "Commercial property" means properties that are currently zoned for commercial property use and that are characterized by or are committed to traditional commercial uses such as offices, retail and wholesale sales, professional services, consumer services, and, warehousing.
(d) Any terrestrial remedy, including exclusions, based at least in part on future land use assumptions shall include a completion date for such future development acceptable to the department.

(4) **Point of compliance.**
(a) **Conditional point of compliance.** For sites with institutional controls to prevent excavation of deeper soil, a conditional point of compliance may be set at the biologically active soil zone. This zone is assumed to extend to a depth of six feet. The department may approve a site-specific depth based on a demonstration that an alternative depth is more appropriate for the site. In making this demonstration, the following shall be considered:
(i) Depth to which soil macro-invertebrates are likely to occur;

(ii) Depth to which soil turnover (bioturbation) is likely to occur due to the activities of soil invertebrates;
(iii) Depth to which animals likely to occur at the site are expected to burrow; and
(iv) Depth to which plant roots are likely to extend.
(b) **Standard point of compliance.** An institutional control is not required for soil contamination that is at least fifteen feet below the ground surface. This represents a reasonable estimate of the depth of soil that could be excavated and distributed at the soil surface as a result of site development activities, resulting in exposure by ecological receptors.

(5) **Additional measures.** The department may require additional measures to evaluate potential threats to terrestrial ecological receptors notwithstanding the provisions in this and the following sections, when based upon a site-specific review, the department determines that such measures are necessary to protect the environment.

Table 749-2

Priority Contaminants of Ecological Concern for sites that Qualify for the Simplified Terrestrial Ecological Evaluation Procedure.[a]

Priority contaminant	Soil concentration (mg/kg) Unrestricted land use[b]	Industrial or commercial site
METALS[c]		
Antimony	See note d	See note d
Arsenic III	20 mg/kg	20 mg/kg
Arsenic V	95 mg/kg	260 mg/kg
Barium	1,250 mg/kg	1,320 mg/kg
Beryllium	25 mg/kg	See note d
Cadmium	25 mg/kg	36 mg/kg
Chromium (total)	42 mg/kg	135 mg/kg
Cobalt	See note d	See note d
Copper	100 mg/kg	550 mg/kg
Lead	220 mg/kg	220 mg/kg
Magnesium	See note d	See note d
Manganese	See note d	23,500 mg/kg
Mercury, inorganic	9 mg/kg	9 mg/kg
Mercury, organic	0.7 mg/kg	0.7 mg/kg
Molybdenum	See note d	71 mg/kg
Nickel	100 mg/kg	1,850 mg/kg
Selenium	0.8 mg/kg	0.8 mg/kg
Silver	See note d	See note d
Tin	275 mg/kg	See note d
Vanadium	26 mg/kg	See note d
Zinc	270 mg/kg	570 mg/kg
PESTICIDES		
Aldicarb/aldicarb sulfone (total)	See note d	See note d
Aldrin	0.17 mg/kg	0.17 mg/kg
Benzene hexachloride (including lindane)	10 mg/kg	10 mg/kg
Carbofuran	See note d	See note d
Chlordane	1 mg/kg	7 mg/kg
Chlorpyrifos/chlorpyrifos-methyl (total)	See note d	See note d
DDT/DDD/DDE (total)	1 mg/kg	1 mg/kg
Dieldrin	0.17 mg/kg	0.17 mg/kg
Endosulfan	See note d	See note d
Endrin	0.4 mg/kg	0.4 mg/kg
Heptachlor/heptachlor epoxide (total)	0.6 mg/kg	0.6 mg/kg
Hexachlorobenzene	31 mg/kg	31 mg/kg
Parathion/methyl parathion (total)	See note d	See note d
Pentachlorophenol	11 mg/kg	11 mg/kg
Toxaphene	See note d	See note d

OTHER CHLORINATED ORGANICS		
Chlorinated dibenzofurans (total)	3E-06 mg/kg	3E-06 mg/kg
Dioxins (total)	5E-06 mg/kg	5E-06 mg/kg
Hexachlorophene	See note d	See note d
PCB mixtures (total)	2 mg/kg	2 mg/kg
Pentachlorobenzene	168 mg/kg	See note d
OTHER NONCHLORINATED ORGANICS		
Acenaphthene	See note d	See note d
Benzo(a)pyrene	30 mg/kg	300 mg/kg
Bis (2-ethylhexyl) phthalate	See note d	See note d
Di-n-butyl phthalate	200 mg/kg	See note d
PETROLEUM		
Gasoline Range Organics	200 mg/kg	12,000 mg/kg except that the concentration shall not exceed residual saturation at the soil surface.
Diesel Range Organics	460 mg/kg	15,000 mg/kg except that the concentration shall not exceed residual saturation at the soil surface.

Footnotes:

a Caution on misusing these chemical concentration numbers. These values have been developed for use at sites where a site-specific terrestrial ecological evaluation is not required. They are not intended to be protective of terrestrial ecological receptors at every site. Exceedances of the values in this table do not necessarily trigger requirements for cleanup action under this chapter. The table is not intended for purposes such as evaluating sludges or wastes.
This list does not imply that sampling must be conducted for each of these chemicals at every site. Sampling should be conducted for those chemicals that might be present based on available information, such as current and past uses of chemicals at the site.

b Applies to any site that does not meet the definition of industrial or commercial.

c For arsenic, use the valence state most likely to be appropriate for site conditions, unless laboratory information is available. Where soil conditions alternate between saturated, anaerobic and unsaturated, aerobic states, resulting in the alternating presence of arsenic III and arsenic V, the arsenic III concentrations shall apply.

d Safe concentration has not yet been established.

of the eight RCRA metals (Attachment E). These concentrations are developed to protect wildlife through direct ingestion of soil using a robin/shrew food chain model, two surrogate receptors meant to represent highly exposed species. Soil concentrations were also developed for plants and soil invertebrates using toxicity values from the published literature. The most restrictive value was then placed into Table 749-2.

Generally, the Method A concentrations are less than or similar to Table 749-2 (see Table 1). However, the MTCA Method A standards list does not include values for barium, total chromium or selenium. For these constituents, the Table 749-2 ecological standards listed in Table 1 (adjusted for background and PQLs) will be used as screening criteria for the top three feet of embankment fill.

3. The Port of Seattle will monitor the seepage water from the rock underdrain for contaminants. Monitoring shall be for a period of 10 years, on a monthly basis. Based on the monitoring results, the monitoring schedule may be modified by FWS.

The Port of Seattle shall prepare a water quality monitoring plan to track the quality of seepage from the drainage layer beneath the Third Runway embankment fill. Such a plan shall be prepared to address the amount of monitoring in a tiered or phased approach. For example, if it is determined that water flowing through the new embankment is exceeding designated surface water quality criteria, new monitoring points may be established between the embankment and Miller Creek to evaluate the fate and transport of the impacted fill water. Monitoring Miller Creek would represent the final phase of a monitoring program if it were determined that constituents in embankment fill water were reaching the creek. The Port shall develop a monitoring plan in consultation with FWS. The Port shall submit a draft monitoring plan to FWS for its review and approval within 120 days after FWS' issuance of a biological opinion or concurrence letter. The monitoring plan shall provide for a minimum of three years of monthly monitoring, with the monitoring period commencing upon detection of seepage from the drainage layer of the completed embankment. At the end of the three-year monitoring period, the Port and FWS shall reevaluate the need to modify or continue the monitoring program. In the event seepage is not detected within six years after completion of embankment construction, the Port and FWS shall likewise reevaluate the need to modify or continue the monitoring program. In the event monitoring detects unforeseen adverse impacts to aquatic life in the project area, the Port shall reinitiate consultation as appropriate and implement measures to address such impacts.

4, 5. If material is used which is known to have contaminants, this material shall be distributed over a large area to avoid creating a "hot spot" in the embankment. The Port of Seattle will request FWS approval for those fill materials proposed that do not meet MTCA Method A standards, at a minimum. Information on why these materials are to be used and proof that their chemical constituents/levels will not result in environmental impacts to aquatic organisms needs to be provided.

The use of MTCA Method A as a screening standard for incoming fill material will avoid the creation of "hot spots" in the embankment. In the event that the Port from numerous sources in the region. Thus, in column 7, a range of screening criteria between background levels, when available, and Method A standards is shown. In the event the Port desires to establish site-specific background criteria, it will discuss proposed criteria with FWS and reinitiate consultation as appropriate. If the suppliers wish to place soil in the drainage cover layer that exceed background concentrations, the Port will confirm the acceptability of the material by requiring suppliers using that source to conduct sufficient SPLP testing to show that Method A criteria are protective of baseline conditions for surface water receptors.

(iv) To confirm the protectiveness of the Method A standards and the Three Phase Partitioning Model, SPLP testing will be used as a laboratory method to ensure that leaching of metals through potential embankment soil will not occur at unacceptable levels. SPLP testing according to the procedures contained in WAC 173-340-747(7) and SPLP methodology are shown in Attachments B and D respectively. SPLP results will be compared, as an initial screening tool, to freshwater ambient water quality criteria according to guidelines outlined at WAC 173-201A-040 (Attachment C). If the SPLP results indicate that metals in the proposed fill material *do not leach* at levels above the freshwater ambient water quality criteria, adjusted for PQLs as appropriate, the material will be considered suitable for placement. If the SPLP indicates that metals in the proposed fill material *leach* at levels above ambient water quality criteria, the Port will either reject the material ~~or discuss the results of the SPLP with~~ or obtain FWS' approval before acceptance of the material, through a reinitiated consultation. The Port shall submit to FWS for its review and approval a plan describing the Port's SPLP protocol. The FWS shall approve this plan prior the Port's implementation of the SPLP protocol.

(c) Organochlorines: The Port will employ the following standards and protocols concerning the placement of fill in the drainage layer cover:

(i) The Port will require testing for organochlorines on those sites where such compounds may be present, including sites with potential commercial pesticide applications, and sites with historic wood preserving operations. The supplier, with Port review, will identify sites potentially containing such compounds through the process discussed above under Response 1 (i.e., Phase I and II Environmental Site Assessments). The Port will update guidelines provided to suppliers to clearly state that testing for additional constituents must be conducted as appropriate based on current and historical site land uses.

(ii) As with the remainder of the embankment fill, sources of fill proposed for placement in the drainage layer cover which have detectable levels of organochlorines will not exceed MTCA Method A criteria.

kk Conversion factor to calculate dissolved metal concentration is 0.85.

ll. Marine conversion factors (CF) used for calculating dissolved metals concentrations. Conversion factors are applicable to both acute and chronic criteria for all metals except mercury. CF for mercury is applicable to the acute criterion only. Conversion factors are already incorporated into the criteria in the table. Dissolved criterion= criterion x CF

Metal	CF
Arsenic	1.000
Cadmium	0.994
Chromium (VI)	0.993
Copper	0.83
Lead	0.951
Mercury	0.85
Nickel	0.990
Selenium	0.998
Silver	0.85
Zinc	0.946

m The cyanide criteria are: 9.1µg/l chronic and 2.8µg/l acute and are applicable only to waters which are east of a line from
m. Point Roberts to Lawrence Point, to Green Point to Deception Pass; and south from Deception Pass and of a line from Partridge Point to Point Wilson.

(4) USEPA Quality Criteria for Water, 1986 shall be used in the use and interpretation of the values listed in subsection (3) of this section.
(5) Concentrations of toxic, and other substances with toxic propensities not listed in subsection (3) of this section shall be determined in consideration of USEPA Quality Criteria for Water, 1986, and as revised, and other relevant information as appropriate. Human health-based water quality criteria used by the state are contained in 40 CFR 131.36 (known as the National Toxics Rule).
(6) Risk-based criteria for carcinogenic substances shall be selected such that the upper-bound excess cancer risk is less than or equal to one in one million.
[Statutory Authority: Chapter 90.48 RCW and 40 CFR 131. 97-23-064 (Order 94-19), § 173-201A-040, filed 11/18/97, effective 12/19/97. Statutory Authority: Chapter 90.48 RCW. 92-24-037 (Order 92-29), § 173-201A-040, filed 11/25/92, effective 12/26/92.]
NOTES:

Reviser's note: The brackets and enclosed material in the text of the above section occurred in the copy filed by the agency.

C

Natural Background Soil Metals Concentrations in Washington State

Publication #94-115

October 1994

Executive Summary

This report contains information on the natural background concentrations of metals in surficial soil throughout Washington State. The objective of this study was to define a range of values that represent the natural concentration of metals in surficial soils throughout Washington. The results of this study represent the culmination of a seven-year effort by Ecology (Toxics Cleanup Program) and its co-sponsor, the USGS Water Resources Division (Tacoma Office).

Upon the completion of a small pilot project (Big Soos Creek Drainage Basin, King County, 1987), Washington was divided into 24 distinct regions based on differences in geology, soils, and climate. Twelve of these 24 regions were then selected for a statewide assessment of Washington. ***These 12 regions were selected because they represent the major urban, industrial, and highly developed core areas in Washington, which is where most cleanup sites are located.*** Soil samples were then collected from the predominant soil series in each of the 12 regions, with a total of 490 soil samples collected from 166 locations throughout Washington. An effort was made to collect samples from undisturbed or undeveloped areas. Samples were collected from the "A," "B," and "C" soil horizons at each sampling location (ground surface to a depth of 3 ft.). Each sample was analyzed for total metals content.

The results of this study found that the soil metals concentrations in Western Washington were on average slightly higher than Eastern Washington. The population, climate, and vegetation of Western Washington are thought to be the primary reasons for this variation. The variation in west-to-east data are more pronounced when the 90th percentile values are compared (see **Table 1** below). The one exception was arsenic, whose east-side 90th percentile value was 15% higher than the west. Statewide and regional 90th percentile values are presented in **Table 1** below.

Table 1: Statewide & Regional 90th Percentile Values1

	Al	As2	Be	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Zn
State Wide	37,200	7	2	1	42	36	42,100	17	1,100	0.07	38	86
Puget Sound	32,600	7	0.6	1	48	36	58,700	24	1,200	0.07	48	85
Clark County	52,300	6	2	1	27	34	36,100	17	1,500	0.04	21	96
Yakima Basin	33,400	5	2	1	38	27	51,500	11	1,100	0.05	46	79
Spokane Basin	21,400	9	0.8	1	18	22	25,000	15	700	0.02	16	66

1 **All Values = mg/kg and represent total-recoverable analysis.**

2 **Graphite furnace atomic absorption (GFAA) analysis.**

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WAC 173-340-747
Wash. Admin. Code 173-340-747
WASHINGTON ADMINISTRATIVE CODE
TITLE 173. ECOLOGY, DEPARTMENT OF
CHAPTER 173-340. MODEL TOXICS CONTROL ACT--CLEANUP--CLEANUP
PART VII--CLEANUP STANDARDS
Current with amendments adopted through 07-18-2001.

173-340-747. Deriving soil concentrations for ground water protection. (Effective August 15, 2001)

(1) Purpose. The purpose of this section is to establish soil concentrations that will not cause contamination of ground water at levels that exceed the ground water cleanup levels established under WAC 173-340-720. Soil concentrations established under this section are used to establish either Method B soil cleanup levels (see WAC 173-340-740 (3)(b)(iii)(A) or Method C soil cleanup levels (see WAC 173-340-745 (5)(b)(iii)(A).

For the purposes of this section, 'soil concentration' means the concentration in the soil that will not cause an exceedance of the ground water cleanup level established under WAC 173-340-720.

(2) General requirements. The soil concentration established under this section for each hazardous substance shall meet the following two criteria:

(a) The soil concentration shall not cause an exceedance of the ground water cleanup level established under WAC 173-340-720. To determine if this criterion is met, one of the methodologies specified in subsections (4) through (9) of this section shall be used; and

(b) To ensure that the criterion in (a) of this subsection is met, the soil concentration shall not result in the accumulation of nonaqueous phase liquid on or in ground water. To determine if this criterion is met, one of the methodologies specified in subsection (10) of this section shall be used.

(3) Overview of methods. This subsection provides an overview of the methods specified in subsections (4) through (10) of this section for deriving soil concentrations that meet the criteria specified in subsection (2) of this section. Certain methods are tailored for particular types of hazardous substances or sites. Certain methods are more complex than others and certain methods require the use of site-specific data. The specific requirements for deriving a soil concentration under a particular method may also depend on the hazardous substance.

(a) Fixed parameter three-phase partitioning model. The three-phase partitioning model with fixed input parameters may be used to establish a soil concentration for any hazardous substance. Site-specific data are not required for use of this model. See subsection (4) of this section.

(b) Variable parameter three-phase partitioning model. The three-phase partitioning model with variable input parameters may be used to establish a soil concentration for any hazardous substance. Site-specific data are required for use of this model. See subsection (5) of this section.

(c) Four-phase partitioning model. The four-phase partitioning model may be used to derive soil concentrations for any site where hazardous substances are present in the soil as a nonaqueous phase liquid (NAPL). The department expects that this model will be used at sites contaminated with petroleum hydrocarbons. Site-specific data are required for use of this model. See subsection (6) of this section.

(d) Leaching tests. Leaching tests may be used to establish soil concentrations for certain metals. Leaching tests may also be used to establish soil concentrations for other hazardous substances, including petroleum hydrocarbons, provided sufficient information is available to demonstrate that the leaching test can accurately predict ground water impacts. Testing of soil samples from the site is required for use of this method. See subsection (7) of this section.

(e) Alternative fate and transport models. Fate and transport models other than those specified in subsections (4) through (6) of this section may be used to establish a soil concentration for any hazardous substance. Site-specific data are required for use of such models. See subsection (8) of this section.

(f) Empirical demonstration. An empirical demonstration may be used to show that measured soil concentrations will not cause an exceedance of the applicable ground water cleanup levels established under WAC 173-340-720. This empirical demonstration may be used for any hazardous substance. Site- specific data (e.g., ground water samples and soil samples) are required under this method. If the required demonstrations cannot be made, then a protective soil concentration shall be established under one of the methods specified in subsections (4) through (8) of this section. See subsection (9) of this section.

(g) Residual saturation. To ensure that the soil concentration established under one of the methods specified in subsections (4) through (9) of this section will not cause an exceedance of the ground water cleanup level established under WAC 173-340-720, the soil concentration must not result in the accumulation of nonaqueous phase liquid (NAPL) on or in ground water. The methodologies and procedures specified in subsection (10) of this section shall be used to determine if this criterion is met.

(4) Fixed parameter three-phase partitioning model.

(a) Overview. This subsection specifies the procedures and requirements for establishing soil concentrations through the use of the fixed parameter three- phase partitioning model. The model may be used to establish soil concentrations for any hazardous substance. The model may be used to calculate both unsaturated and saturated zone soil concentrations.

This method provides default or fixed input parameters for the three-phase partitioning model that are intended to be protective under most circumstances and conditions; site-specific measurements are not required. In some cases it may be appropriate to use site-specific measurements for the input parameters. Subsection (5) of this section specifies the procedures and requirements to establish site-specific input parameters for use in the three-phase partitioning model.

(b) Description of the model. The three-phase partitioning model is described by the following equation:

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Where:

C subs =	Soil concentration (mg/kg)
C subw =	Ground water cleanup level established under WAC 173-340-720 (ug/l)
UCF =	Unit conversion factor (1mg/1,000 ug)
DF =	Dilution factor (dimensionless: 20 for unsaturated zone soil; see (e) of this subsection for saturated zone soil)
K subd =	Distribution coefficient (L/kg; see (c) of this subsection)
&thgr; subw =	Water-filled soil porosity (ml water/ml soil: 0.3 for unsaturated zone soil; see (e) of this subsection for saturated zone soil)
&thgr; suba =	Air-filled soil porosity (ml air/ml soil: 0.13 for unsaturated zone soil; see (e) of this subsection for saturated zone soil)
H subcc =	Henry's law constant (dimensionless; see (d) of this subsection)
&rgr; subb =	Dry soil bulk density (1.5 kg/L)

(c) Distribution coefficient (K subd). The default K subd values for organics and metals used in Equation 747-1 are as follows:

(i) Organics. For organic hazardous substances, the K subd value shall be derived using Equation 747-2. The K suboc (soil organic carbon-water partition coefficient) parameter specified in Equation 747-2 shall be derived as follows:

(A) Nonionic organics. For individual nonionic hydrophobic organic hazardous substances (e.g., benzene and naphthalene), the K suboc values in Table 747-1 shall be used. For hazardous substances not listed in

Table 747-1, K subd values may be developed as provided in subsection (5) of this section (variable three-phase partitioning model).

(B) Ionizing organics. For ionizing organic hazardous substances (e.g., pentachlorophenol and benzoic acid), the K suboc values in Table 747-2 shall be used. Table 747-2 provides K suboc values for three different pHs. To select the appropriate K suboc value, the soil pH must be measured. The K suboc value for the corresponding soil pH shall be used. If the soil pH falls between the pH values provided, an appropriate K suboc value shall be selected by interpolation between the listed K suboc values.

```
Equation 747-2
K subd =        K suboc x f suboc
Where:
K subd =        Distribution coefficient (L/kg)
K suboc =       Soil organic carbon-water partitioning coefficient (ml/g). See
                  (c)(i) of this subsection.
f suboc =       Soil fraction of organic carbon (0.1% or 0.001 g/g)
```

(ii) Metals. For metals, the K subd values in Table 747-3 shall be used. For metals not listed in Table 747-3, K subd values may be developed as provided in subsection (5) of this section (variable three-phase partitioning model).

(d) Henry's law constant. For petroleum fractions, the values for Henry's law constant in Table 747-4 shall be used in Equation 747-1. For individual organic hazardous substances, the value shall be based on values in the scientific literature. For all metals present as inorganic compounds except mercury, zero shall be used. For mercury, either 0.47 or a value derived from the scientific literature shall be used. Derivation of Henry's law constant from the scientific literature shall comply with WAC 173-340-702 (14), (15) and (16).

(e) Saturated zone soil concentrations. Equation 747-1 may also be used to derive concentrations for soil that is located at or below the ground water table (the saturated zone). The following input parameters shall be changed if Equation 747-1 is used to derive saturated zone soil concentrations:

(i) The dilution factor shall be changed from 20 to 1;

(ii) The water-filled soil porosity value shall be changed from 0.3 ml water/ml soil to 0.43 ml water/ml soil; and

(iii) The air-filled soil porosity value shall be changed from 0.13 ml air/ml soil to zero.

(5) Variable parameter three-phase partitioning model.

(a) Overview. This section specifies the procedures and requirements to derive site-specific input parameters for use in the three-phase partitioning model. This method may be used to establish soil concentrations for any hazardous substance. This method may be used to calculate both unsaturated and saturated zone soil concentrations.

This method allows for the substitution of site-specific values for the default values in Equation 747-1 for one or more of the following five input parameters: Distribution coefficient, soil bulk density, soil volumetric water content, soil air content, and dilution factor. The methods that may be used and the requirements that shall be met to derive site-specific values for each of the five input parameters are specified in (b) through (f) of this subsection.

(b) Methods for deriving a distribution coefficient (K subd). To derive a site-specific distribution coefficient, one of the following methods shall be used:

(i) Deriving K subd from soil fraction of organic carbon (foc) measurements. Site-specific measurements of soil organic carbon may be used to derive distribution coefficients for nonionic hydrophobic organics using Equation 747- 2. Soil organic carbon measurements shall be based on uncontaminated soil below the root zone (i.e., soil greater than one meter in depth) that is representative of site conditions or in areas through which contaminants are likely to migrate.

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The laboratory protocols for measuring soil organic carbon in the Puget Sound Estuary Program (March, 1986) may be used. Other methods may also be used if approved by the department. All laboratory measurements of soil organic carbon shall be based on methods that do not include inorganic carbon in the measurements.

(ii) Deriving K subd from site data. Site-specific measurements of the hazardous substance concentrations in the soil and the soil pore water or ground water may be used, subject to department approval, to derive a distribution coefficient. Distribution coefficients that have been derived from site data shall be based on measurements of soil and ground water hazardous substance concentrations from the same depth and location. Soil and ground water samples that have hazardous substances present as a nonaqueous phase liquid (NAPL) shall not be used to derive a distribution coefficient and measures shall be taken to minimize biodegradation and volatilization during sampling, transport and analysis of these samples.

(iii) Deriving K subd from batch tests. A site-specific distribution coefficient may be derived by using batch equilibrium tests, subject to department approval, to measure hazardous substance adsorption and desorption. The results from the batch test may be used to derive K subd from the sorption/desorption relationship between hazardous substance concentrations in the soil and water. Samples that have hazardous substances present as a nonaqueous phase liquid (NAPL) shall not be used to derive a distribution coefficient and measures shall be taken to minimize biodegradation and volatilization during testing.

(iv) Deriving K subd from the scientific literature. The scientific literature may be used to derive a site-specific distribution coefficient (K subd) for any hazardous substance, provided the requirements in WAC 173-340-702 (14), (15) and (16) are met.

(c) Deriving soil bulk density. ASTM Method 2049 or other methods approved by the department may be used to derive soil bulk density values.

(d) Deriving soil volumetric water content using laboratory methods. ASTM Method 2216 or other methods approved by the department may be used to derive soil volumetric water content values.

(e) Estimating soil air content. An estimate of soil air content may be determined by calculating soil porosity and subtracting the volumetric water content.

(f) Deriving a dilution factor from site-specific estimates of infiltration and ground water flow volume. Site-specific estimates of infiltration and ground water flow volume may be used in the following equation to derive a site-specific dilution factor:

```
Equation 747-3
DF =           (Q subp + Q suba )/Q subp
Where:
DF =           Dilution factor (dimensionless)
Q subp =       Volume of water infiltrating (m super3 /yr)
Q suba =       Ground water flow (m super3 /yr)
```

(i) Calculating ground water flow volume. The following equation shall be used under this method to calculate the volume of ground water flow (Q suba):

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Q suba =  K x A x I
Where:
Q suba =  Ground water flow volume (m super3 /year)
K =       Hydraulic conductivity (m/year). Site-specific measurements shall be
            used to derive this parameter.
A =       Aquifer mixing zone (m super2 ). The aquifer mixing zone thickness
            shall not exceed 5 meters in depth and be equal to a unit width of
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1 meter, unless it can be demonstrated empirically that the mixing zone thickness exceeds 5 meters.

I = Gradient (m/m). Site-specific measurements shall be used to derive this parameter.

(A) Equation 747-4 assumes the ground water concentrations of hazardous substances of concern upgradient of the site are not detectable. If this assumption is not true, the dilution factor may need to be adjusted downward in proportion to the upgradient concentration.

(B) Direct measurement of the flow velocity of ground water using methods approved by the department may be used as a substitute for measuring the ground water hydraulic conductivity and gradient.

(ii) Calculating or estimating infiltration. The following equation shall be used under this method to calculate the volume of water infiltrating (Q subp):

Equation 747-5

Q subp = L x W x Inf

Where:

Q subp = Volume of water infiltrating (m super3 /year)

L = Estimated length of contaminant source area parallel to ground water flow (m)

W = Unit width of contaminant source area (1 meter)

Inf = Infiltration (m/year)

(A) If a default annual infiltration value (Inf) is used, the value shall meet the following requirements. For sites west of the Cascade Mountains, the default annual infiltration value shall be 70 percent of the average annual precipitation amount. For sites east of the Cascade Mountains, the default annual infiltration value shall be 25 percent of the average annual precipitation amount.

(B) If a site-specific measurement or estimate of infiltration (Inf) is made, it shall be based on site conditions without surface caps (e.g., pavement) or other structures that would control or impede infiltration. The presence of a cover or cap may be considered when evaluating the protectiveness of a remedy under WAC 173-340-350 through 173-340-360. If a site-specific measurement or estimate of infiltration is made, then it must comply with WAC 173-340- 702 (14), (15) and (16).

(6) Four-phase partitioning model.

(a) Overview. This subsection specifies the procedures and requirements for establishing soil concentrations through the use of the four-phase partitioning model. This model may be used to derive soil concentrations for any site where hazardous substances are present in the soil as a nonaqueous phase liquid (NAPL). The model is described in (c) of this subsection. Instructions on how to use the model to establish protective soil concentrations are provided in (d) of this subsection.

(b) Restrictions on use of the model for alcohol enhanced fuels. The four- phase partitioning model may be used on a case-by-case basis for soil containing fuels (e.g., gasoline) that have been enhanced with alcohol. If the model is used for alcohol enhanced fuels, then it shall be demonstrated that the effects of cosolvency have been adequately considered and, where necessary, taken into account when applying the model. Use of the model for alcohol enhanced fuels without considering the effects of cosolvency and increased ground water contamination is prohibited.

(c) Description of the model. The four-phase partitioning model is based on the following three equations:

(i) Conservation of volume equation.

Equation 747-6

n = &thgr; subw + &thgr; suba + &thgr; subNAPL

Where:

n = Total soil porosity (ml total pore space/ml total soil volume). Use a default value of 0.43 ml/ml or use a value determined from site-specific measurements.

&thgr; subw = Volumetric water content (ml water/ml soil). For unsaturated soil use a default value of 0.3 or a value determined from site-specific measurements. For saturated soil this value is unknown and must be solved for. Volumetric water content equals the total soil porosity minus volume occupied by the NAPL.

&thgr; suba = Volumetric air content (ml air volume/ml total soil volume). For unsaturated soil this value is unknown and must be solved for. Volumetric air content equals the total soil porosity minus the volume occupied by the water and NAPL. For saturated soil this value is zero.

&thgr; subNAPL = Volumetric NAPL content (ml NAPL volume/ml total soil volume). For both unsaturated and saturated soil this value is unknown and must be solved for.

(ii) Four-phase partitioning equation.

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Where:

M superi subT = Total mass of each component in the system (mg). This value is derived from site-specific measurements.

m subsoil = Total soil mass (kg).

x subi = Mole fraction (at equilibrium) of each component (dimensionless). This value is unknown and must be solved for.

S subi = Solubility of each component (mg/l). See Table 747-4 for petroleum hydrocarbons; see the scientific literature for other hazardous substances.

P subb = Dry soil bulk density (1.5 kg/l).

K superi suboc = Soil organic carbon-water partitioning coefficient for each component (l/kg). See Table 747-4 for petroleum hydrocarbons; see subsection (4)(b) of this section for other hazardous substances.

f suboc = Mass fraction of soil natural organic carbon (0.001 g soil organic/g soil).

H superi subcc = Henry's law constant for each component (dimensionless). See Table 747-4 for petroleum hydrocarbons; see subsection (4)(c) of this section for other hazardous substances.

GFW subi = Gram formula weight, or molecular weight of each component (mg/mol). See Table 747-4 for petroleum hydrocarbons; see the scientific literature for other hazardous substances.

&rgr;NAPL = Molar density of the mixture (mol/l). See Equation 747-8.

Component = For petroleum mixtures, this means the petroleum fractions, and organic hazardous substances with a reference dose; for other hazardous substances, this means each organic hazardous substance that is found in the NAPL.

(iii) Molar density equation.

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Where:

GFW subi =	Gram formula weight, or molecular weight of each component (mg/mol). See Table 747-4 for petroleum hydrocarbons; see the scientific literature for other hazardous substances.
x subi =	Mole fraction (at equilibrium) of each component (dimensionless). This value is unknown and must be solved for.
&rgr; subi =	Density of each component (mg/l). See Table 747-4 for petroleum hydrocarbons; see the scientific literature for other hazardous substances.
Component =	For petroleum mixtures, this means the petroleum fractions plus organic hazardous substances with a reference dose; for other hazardous substances, this means each organic hazardous substance that is found in the NAPL.

(d) Instructions for using the model. This subsection provides instructions for using the four-phase partitioning model to predict ground water concentrations and to establish protective soil concentrations. The model uses an iterative process to simultaneously solve multiple equations for several unknowns (see step 4 for the number of equations). To predict a ground water concentration, the mole fraction of each component (at equilibrium) must be known. The predicted ground water concentration is obtained by multiplying the water solubility of each component by the equilibrated mole fraction (Equation 747-7).

(i) Step 1: Measure hazardous substance soil concentrations. Collect and analyze soil samples and, if appropriate, samples of the product released, for each component. For petroleum hydrocarbons, see Table 830-1 for a description of what to analyze for.

(ii) Step 2: Derive physical/chemical data. For each of the components, determine the Henry's law constant, water solubility, soil organic carbon-water partitioning coefficient, density and molecular weight values. For petroleum hydrocarbons, see Table 747-4.

(iii) Step 3: Derive soil parameters. Derive a value for each of the following soil parameters as follows:

(A) Soil organic carbon content. Use the default value (0.001 g soil organic/g soil) or a site-specific value derived under subsection (5)(b)(i) of this section.

(B) Soil volumetric water content. Use the default value (0.43 minus the volume of NAPL and air) or a site-specific value derived under subsection (5)(d) of this section.

(C) Soil volumetric air content. Use the default value (0.13 ml/ml for unsaturated zone soil; zero for saturated zone soil) or a site-specific value derived under subsection (5)(e) of this section.

(D) Soil bulk density and porosity. Use the default values of 1.5 kg/l for soil bulk density and 0.43 for soil porosity or use site-specific values. If a site-specific value for bulk density is used, the method specified in subsection (5)(c) of this subsection shall be used. If a site-specific bulk density value is used, a site-specific porosity value shall also be used. The site-specific soil porosity value may be calculated using a default soil specific gravity of 2.65 g/ml or measuring the soil specific gravity using ASTM Method D 854.

(iv) Step 4: Predict a soil pore water concentration. Equation 747-7 shall be used to predict the soil pore water concentration for each component. To do this, multiple versions of Equation 747-7 shall be constructed, one for each of the components using the associated parameter inputs for K suboc , H subcc , GFW, and S. These equations shall then be combined with Equations 747-6 and 747-8 and the condition that &Sgr;x subi = 1 and solved simultaneously for the unknowns in the equations (mole fraction of each component (X subi), volumetric NAPL content (&thgr; subNAPL), and either the volumetric water content (&thgr; subw) or the volumetric air content (&thgr; suba).

(v) Step 5: Derive a dilution factor. Derive a dilution factor using one of the following two methods:

(A) Use the default value of 20 for unsaturated soils and 1 for saturated soils); or

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(B) Derive a site-specific value using site-specific estimates of infiltration and ground water flow volume under subsection (5)(f) of this section.

(vi) Step 6: Calculate a predicted ground water concentration. Calculate a predicted ground water concentration for each component by dividing the predicted soil pore water concentration for each component by a dilution factor to account for the dilution that occurs once the component enters ground water.

(vii) Step 7: Establishing protective soil concentrations.

(A) Petroleum mixtures. For petroleum mixtures, compare the predicted ground water concentration for each component and for the total petroleum hydrocarbon mixture (sum of the petroleum components in the NAPL) with the applicable ground water cleanup level established under WAC 173-340-720.

(I) If the predicted ground water concentration for each of the components and for the total petroleum hydrocarbon mixture is less than or equal to the applicable ground water cleanup level, then the soil concentrations measured at the site are protective.

(II) If the condition in (d)(vii)(A)(I) of this subsection is not met, then the soil concentrations measured at the site are not protective. In this situation, the four-phase partitioning model can be used in an iterative process to calculate protective soil concentrations.

(B) Other mixtures. For mixtures that do not include petroleum hydrocarbons, compare the predicted ground water concentration for each hazardous substance in the mixture with the applicable ground water cleanup level established under WAC 173-340-720.

(I) If the predicted ground water concentration for each of the hazardous substances in the mixture is less than or equal to the applicable ground water cleanup level, then the soil concentrations measured at the site are protective.

(II) If the condition in (d)(vii)(B)(I) of this subsection is not met, then the soil concentrations measured at the site are not protective. In this situation, the four-phase partitioning model can be used in an iterative process to calculate protective soil concentrations.

(7) Leaching tests.

(a) Overview. This subsection specifies the procedures and requirements for deriving soil concentrations through the use of leaching tests. Leaching tests may be used to establish soil concentrations for the following specified metals: Arsenic, cadmium, total chromium, hexavalent chromium, copper, lead, mercury, nickel, selenium, and zinc (see (b) and (c) of this subsection). Leaching tests may also be used to establish soil concentrations for other hazardous substances, including petroleum hydrocarbons, provided sufficient information is available to correlate leaching test results with ground water impacts (see (d) of this subsection). Testing of soil samples from the site is required for use of this method.

(b) Leaching tests for specified metals. If leaching tests are used to establish soil concentrations for the specified metals, the following two leaching tests may be used:

(i) EPA Method 1312, Synthetic Precipitation Leaching Procedure (SPLP). Fluid #3 (pH = 5.0), representing acid rain in the western United States, shall be used when conducting this test. This test may underestimate ground water impacts when acidic conditions exist due to significant biological degradation or for other reasons. Underestimation of ground water impacts may occur, for example, when soils contaminated with metals are located in wood waste, in municipal solid waste landfills, in high sulfur content mining wastes, or in other situations with a pH <6. Consequently, this test shall not be used in these situations and the TCLP test should be used instead.

(ii) EPA Method 1311, Toxicity Characteristic Leaching Procedure (TCLP). Fluid #1 (pH = 4.93), representing organic acids generated by biological degradation processes, shall be used when conducting this test. This test is intended to represent situations where acidic conditions are present due to biological degradation such as in municipal solid waste landfills. Thus, it may underestimate ground water impacts where this is not the case and the metals of interest are more soluble under alkaline conditions. An example of this would be arsenic occurring in alkaline (pH >8) waste or soils. Consequently, this test shall not be used in these situations and the SPLP test should be used instead.

(c) Criteria for specified metals. When using either EPA Method 1312 or 1311, the analytical methods used for analysis of the leaching test effluent shall be sufficiently sensitive to quantify hazardous substances at concentrations at the ground water cleanup level established under WAC 173-340-720. For a soil metals concentration derived under (b) of this subsection to be considered protective of ground water, the leaching test effluent concentration shall meet the following criteria:

(i) For cadmium, lead and zinc, the leaching test effluent concentration shall be less than or equal to ten (10) times the applicable ground water cleanup level established under WAC 173-340-720.

(ii) For arsenic, total chromium, hexavalent chromium, copper, mercury, nickel and selenium, the leaching test effluent concentration shall be less than or equal to the applicable ground water cleanup level established under WAC 173-340-720.

(d) Leaching tests for other hazardous substances. Leaching tests using the methods specified in this subsection may also be used for hazardous substances other than the metals specifically identified in this subsection, including petroleum hydrocarbons. Alternative leaching test methods may also be used for any hazardous substance, including the metals specifically identified in this subsection. Use of the leaching tests specified in (b) and (c) of this subsection for other hazardous substances or in a manner not specified in (b) and (c) of this subsection, or use of alternative leaching tests for any hazardous substance, is subject to department approval and the user must demonstrate with site-specific field or laboratory data or other empirical data that the leaching test can accurately predict ground water impacts. The department will use the criteria in WAC 173-340-702 (14), (15) and (16) to evaluate the appropriateness of these alternative methods under WAC 173-340- 702 (14), (15) and (16).

(8) Alternative fate and transport models.

(a) Overview. This subsection specifies the procedures and requirements for establishing soil concentrations through the use of fate and transport models other than those specified in subsections (4) through (6) of this section. These alternative models may be used to establish a soil concentration for any hazardous substance. Site-specific data are required for use of these models.

(b) Assumptions. When using alternative models, chemical partitioning and advective flow may be coupled with other processes to predict contaminant fate and transport, provided the following conditions are met:

(i) Sorption. Sorption values shall be derived in accordance with either subsection (4)(c) of this section or the methods specified in subsection (5)(b) of this section.

(ii) Vapor phase partitioning. If Henry's law constant is used to establish vapor phase partitioning, then the constant shall be derived in accordance with subsection (4)(d) of this section.

(iii) Natural biodegradation. Rates of natural biodegradation shall be derived from site-specific measurements.

(iv) Dispersion. Estimates of dispersion shall be derived from either site- specific measurements or literature values.

(v) Decaying source. Fate and transport algorithms may be used that account for decay over time.

(vi) Dilution. Dilution shall be based on site-specific measurements or estimated using a model incorporating site-specific characteristics. If detectable concentrations of hazardous substances are present in upgradient ground water, then the dilution factor may need to be adjusted downward in proportion to the background (upgradient) concentration.

(vii) Infiltration. Infiltration shall be derived in accordance with subsection (5)(f)(ii)(A) or (B) of this section.

(c) Evaluation criteria. Proposed fate and transport models, input parameters, and assumptions shall comply with WAC 173-340-702 (14), (15) and (16).

(9) Empirical demonstration.

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(a) Overview. This subsection specifies the procedures and requirements for demonstrating empirically that soil concentrations measured at the site will not cause an exceedance of the applicable ground water cleanup levels established under WAC 173-340-720. This empirical demonstration may be used for any hazardous substance. Site-specific data (e.g., ground water and soil samples) are required under this method. If the demonstrations required under (b) of this subsection cannot be made, then a protective soil concentration shall be established under one of the methods specified in subsections (4) through (8) of this section.

(b) Requirements. To demonstrate empirically that measured soil concentrations will not cause an exceedance of the applicable ground water cleanup levels established under WAC 173-340-720, the following shall be demonstrated:

(i) The measured ground water concentration is less than or equal to the applicable ground water cleanup level established under WAC 173-340-720; and

(ii) The measured soil concentration will not cause an exceedance of the applicable ground water cleanup level established under WAC 173-340-720 at any time in the future. Specifically, it must be demonstrated that a sufficient amount of time has elapsed for migration of hazardous substances from soil into ground water to occur and that the characteristics of the site (e.g., depth to ground water and infiltration) are representative of future site conditions. This demonstration may also include a measurement or calculation of the attenuating capacity of soil between the source of the hazardous substance and the ground water table using site-specific data.

(c) Evaluation criteria. Empirical demonstrations shall be based on methods approved by the department. Those methods shall comply with WAC 173-340-702 (14), (15) and (16).

(10) Residual saturation.

(a) Overview. To ensure the soil concentrations established under one of the methods specified in subsections (4) through (9) of this section will not cause an exceedance of the ground water cleanup level established under WAC 173- 340-720, the soil concentrations must not result in the accumulation of nonaqueous phase liquid on or in ground water (see subsection (2)(b) of this section). To determine if this criterion is met, either an empirical demonstration must be made (see (c) of this subsection) or residual saturation screening levels must be established and compared with the soil concentrations established under one of the methods specified in subsections (4) through (9) of this section (see (d) and (e) of this subsection). This subsection applies to any site where hazardous substances are present as a nonaqueous phase liquid (NAPL), including sites contaminated with petroleum hydrocarbons.

(b) Definition of residual saturation. When a nonaqueous phase liquid (NAPL) is released to the soil, some of the NAPL will be held in the soil pores or void spaces by capillary force. For the purpose of this subsection, the concentration of hazardous substances in the soil at equilibrium conditions is called residual saturation. At concentrations above residual saturation, the NAPL will continue to migrate due to gravimetric and capillary forces and may eventually reach the ground water, provided a sufficient volume of NAPL is released.

(c) Empirical demonstration. An empirical demonstration may be used to show that soil concentrations measured at the site will not result in the accumulation of nonaqueous phase liquid on or in ground water. An empirical demonstration may be used for any hazardous substance. Site-specific data (e.g., ground water and soil samples) are required under this method. If the demonstrations required under (c)(i) of this subsection cannot be made, then a protective soil concentration shall be established under (d) and (e) of this subsection.

(i) Requirements. To demonstrate empirically that measured soil concentrations will not result in the accumulation of nonaqueous phase liquid on or in ground water, the following shall be demonstrated:

(A) Nonaqueous phase liquid has not accumulated on or in ground water; and

(B) The measured soil concentration will not result in nonaqueous phase liquid accumulating on or in ground water at any time in the future. Specifically, it must be demonstrated that a sufficient amount of time has elapsed for migration of hazardous substances from soil into ground water to occur and that the characteristics of the site (e.g., depth to ground water and infiltration) are representative of future site conditions. This demonstration may also include a measurement or calculation of the attenuating capacity of soil between the source of the hazardous substance and the ground water table using site- specific data.

(iii) Evaluation criteria. Empirical demonstrations shall be based on methods approved by the department. Those methods shall comply with WAC 173-340-702 (14), (15) and (16).

(d) Deriving residual saturation screening levels. Unless an empirical demonstration is made under (c) of this subsection, residual saturation screening levels shall be derived and compared with the soil concentrations derived under the methods specified in subsections (4) through (9) of this subsection to ensure that those soil concentrations will not result in the accumulation of nonaqueous phase liquid on or in ground water. Residual saturation screening levels shall be derived using one of the following methods.

(i) Default screening levels for petroleum hydrocarbons. Residual saturation screening levels for petroleum hydrocarbons may be obtained from the values specified in Table 747-5.

(ii) Site-specific screening levels. Residual saturation screening levels for petroleum hydrocarbons and other hazardous substances may be derived from site- specific measurements. Site-specific measurements of residual saturation shall be based on methods approved by the department. Laboratory measurements or theoretical estimates (i.e., those that are not based on site-specific measurements) of residual saturation shall be supported and verified by site data. This may include an assessment of ground water monitoring data and soil concentration data with depth and an analysis of the soil's texture (grain size), porosity and volumetric water content.

(e) Adjustment to the derived soil concentrations. After residual saturation screening levels have been derived under (d) of this subsection, the screening levels shall be compared with the soil concentrations derived under one of the methods specified in subsections (4) through (9) of this subsection. If the residual saturation screening level is greater than or equal to the soil concentration derived using these methods, then no adjustment for residual saturation is necessary. If the residual saturation screening level is less than the soil concentration derived using these methods, then the soil concentration shall be adjusted downward to the residual saturation screening level.

(11) Ground water monitoring requirements. The department may, on a case-by- case basis, require ground water monitoring to confirm that hazardous substance soil concentrations derived under this section meet the criterion specified in subsection (2) of this section.

Statutory Authority: Chapter 70.105D RCW. 01-05-024 (Order 97-09A), S 173- 340-747, filed 2/12/01, effective 8/15/01.

<General Materials (GM) - References, Annotations, or Tables>

Revisor's note:

WA ADC 173-340-747
END OF DOCUMENT
09/18/01

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E

Exhibit E Revised 9-29-01

Fill Criteria Derivation Chart for Third Runway Embankment

Constituent	Ecology special criteria for drainage layer cover (mg/kg)	FWS drainage layer cover criteria (mg/kg)	Ecology criteria for remainder of embankment and other Port 404 Projects (mg/kg)	**FINAL drainage layer cover criteria (most conservative of FWS and Ecology values) (mg/kg)**	Drainage Layer Cover Meets 3 phase backcalculation from ambient water quality criteria or drinking water quality criteria when AWQC not available?	**FINAL Ecology criteria for remainder of embankment and other Port 404 Projects (mg/kg)**	Remainder of Embankment Meets 3 phase backcalculation from ambient water quality criteria or drinking water quality criteria when AWQC not available?
Antimony		NA	16	**16**	YES, DWQC backcalc, adjusted upward to PS BG	**16**	YES, DWQC backcalc, adjusted upward to PS BG
Arsenic		7	20	**7**	YES, AWQC backcalc, adjusted downward to PS BG	**20**	YES, AWQC backcalc, adjusted downward to MTCA A BG
Barium		460	NA	**460**	YES, set at backcalc from DWQC	**460**	YES, set at backcalc from DWQC
Beryllium		NA	0.6	**0.6**	YES, DWQC backcalc, adjusted downward to PS BG	**0.6**	YES, DWQC backcalc, adjusted downward to PS BG
Cadmium		1	2	**1**	YES, AWQC backcalc, adjusted upward to PS BG	**2**	YES, AWQC backcalc, adjusted upward to MTCA A PQL
Chromium	42	48	2000	**42**	YES, adjusted downward to terrestrial eco criteria	**2000**	YES, set at backcalc from DWQC
Copper		NA	36	**36**	YES, AWQC backcalc, adjusted upward to PS BG	**36**	YES, AWQC backcalc, adjusted upward to PS BG
Lead	220	24	250	**24**	YES, AWQC backcalc, adjusted downward PS BG	**250**	YES, AWQC backcalc, adjusted downward to MTCA A
Mercury		0.07	2	**0.07**	YES, AWQC backcalc, adjusted upward to PS BG	**2**	YES, AWQC backcalc, adjusted upward to backcalc from DWQC
Nickel	100	48	110	**48**	YES, AWQC backcalc, adjusted downward to PS BG	**110**	YES, AWQC backcalc, adjusted upward to MTCA B SW backcalc
Selenium		5	5	**5**	YES, AWQC backcalc, adjusted upward to PQL	**5**	YES, AWQC backcalc, adjusted upward to PQL
Silver		5	5	**5**	YES, AWQC backcalc, adjusted upward to PQL	**5**	YES, AWQC backcalc, adjusted upward to PQL
Thallium		NA	2	**2**	YES, set at backcalc from DWQC	**2**	YES, set at backcalc from DWQC
Zinc		NA	85	**85**	YES, AWQC backcalc, adjusted downward to PS BG	**85**	YES, AWQC backcalc, adjusted downward to PS BG
Gasoline		NA	30	**30**	YES, DWQC 4 phase backcalc	**30**	YES, DWQC 4 phase backcalc
Diesel	460	NA	2000	**460**	YES, DWQC 4 phase backcalc, adjusted downward to eco criteria	**2000**	YES, DWQC 4 phase backcalc, adjusted downward to resid sat
Heavy Oils		NA	2000	**2000**	YES, DWQC 4 phase backcalc, adjusted downward to resid sat	**2000**	YES, DWQC 4 phase backcalc, adjusted downward to resid sat

Notes/Abbreviations:

AWQC	Ambient Water Quality Criteria
DWQC	Drinking Water Quality Criteria
PS BG	Puget Sound Background
backcalc	3 phase backcalculation per WAC 173-340-747(3)(a)
4 phase backcalc	4 phase backcalculation used for petroleum hydrocarbons per WAC 173-340-(3)(c)
Resid sat	Residual Saturation
FWS	US Fish and Wildlife Service