DECLARATION OF THE RECORD OF DECISION

SITE NAME AND LOCATION

Naval Air Station Whidbey Island, Seaplane Base
Operable Unit 4, Areas 39, 41, 44, 48, and 49
Oak Harbor, Island County, Washington

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for Operable Unit 4 (Areas 39, 41, 44, 48, & 49) at Naval Air Station (NAS) Whidbey Island, Seaplane Base, developed in accordance with the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the administrative record for Operable Unit 4 (OU 4).

The lead agency for this decision is the United States Navy. The United States Environmental Protection Agency (EPA) approves of this decision and, with the Washington State Department of Ecology (Ecology), has participated in scoping the site investigations and in evaluating alternatives for remedial actions. The State of Washington concurs with the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from OU 4, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDIES

The selected remedial actions at Operable Unit 4 at NAS Whidbey Island Seaplane Base address the threat posed by the site by providing surface soil removal that will permanently reduce the mobility of contamination. The elements of the remedial action include:

- Area 39. Removal of approximately 256 cubic yards of surface soil from the following areas: along the southern swale, a limited area northeast of Building 49, and localized areas adjacent to the culvert in the north drainage ditch. The excavated soil will be disposed at the Area 6 landfill prior to construction of a multilayer cap at that facility.

- Area 41: Removal of approximately 5 cubic yards of shallow soil from two localized areas adjacent to the foundation of Building 25. The excavated soil will be disposed at the Area 6 landfill prior to construction of a multilayer cap at that facility.

- Area 44. Removal, treatment (if needed), and off-station disposal at an approved landfill of approximately 30 cubic yards from the following areas: sediment in the sump, catch basins, and manholes, and surface soil from adjacent to the north apron boundary.

- Area 48. Removal of 1,000 cubic yards of surface soil. Excavation will be limited to the top 2 feet of soil column at this area. The excavated soil will be disposed at the Area 6 landfill prior to construction of a multilayer cap at that facility.

- Area 49. If and when the Navy transfers the property to another owner, the deed will contain a notification that the property contains a past construction and demolition debris landfill.

STATUTORY DETERMINATIONS

The remedial actions will remove soil contamination from OU 4, thereby reducing the potential risk to human health and the environment and complying with state requirements. The selected remedies are protective of human health and the environment, comply with federal and state requirements that are legally applicable or relevant and appropriate to the remedial actions, and are cost-effective. These remedies utilize permanent solutions and alternative treatment technologies to the maximum extent practicable for this site. However, because of the volume of contaminated soil and the types of contaminants present, treatment was not found to be practicable. Therefore, these remedies do not satisfy the statutory preference for treatment as a principal element of the remedy. Contaminated soil will be removed from the site and properly managed. Because these remedies will not leave hazardous substances on-site above health-based levels, the five-year review will not apply to this action.

Signature sheet for the Naval Air Station Whidbey Island Seaplane Base, Operable Unit 4, Record of Decision between the U.S. Navy and the U.S. Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

Captain R.R. Penfold
Commanding Officer, Naval Air Station Whidbey Island
United States Navy

Date

Signature sheet for the Naval Air Station Whidbey Island Seaplane Base, Operable Unit 4, Record of Decision between the U.S. Navy and the U.S. Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

____ ____________________

Gerald A. Emison
Acting Regional Administrator, Region 10
United States Environmental Protection Agency

Date

Signature sheet for the Naval Air Station Whidbey Island Seaplane Base, Operable Unit 4, Record of Decision between the U.S. Navy and the U.S. Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

_______________________________ _______________

Carol Fleskes
Toxics Cleanup Program
Washington State Department of Ecology

Date

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TABLES

ABBREVIATIONS AND ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirement
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COC	chemical of concern
CSR	current situation report
cy	cubic yard
DoD	United States Department of Defense
DW	dangerous waste
Ecology	Washington State Department of Ecology
EFA NW	Engineering Field Activity, Northwest
EHW	extremely hazardous waste
EPA	United States Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
FFA	Federal Facilities Agreement
HEAST	Health Effects Assessment Summary Tables
HI	hazard index
HQ	hazard quotient
HRS	Hazard Ranking System
IAs	Initial Assessment Study
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
MTCA	Model Toxics Control Act (Washington State)
NACIP	Navy Assessment and Control of Installation Pollutants
NAS	Naval Air Station
NAVFACENGCOM	Naval Facilities Engineering Command
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
ppm	parts per million

ABBREVIATIONS AND ACRONYMS (Continued)

RA	risk assessment
RAo	remedial action objectives
RAS	Routine Analytical Service
RCRA	Resource Conservation and Recovery Act
RfC	reference concentration
RfD	reference dose
RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act of 1986
SF	slope factor
Svoc	semivolatile organic compound
TAL	target analyte list
TBC	to be considered
UCL	upper confidence limit
Voc	volatile organic compound
WAC	Washington Administrative Code

DECISION SUMMARY

1.0 INTRODUCTION

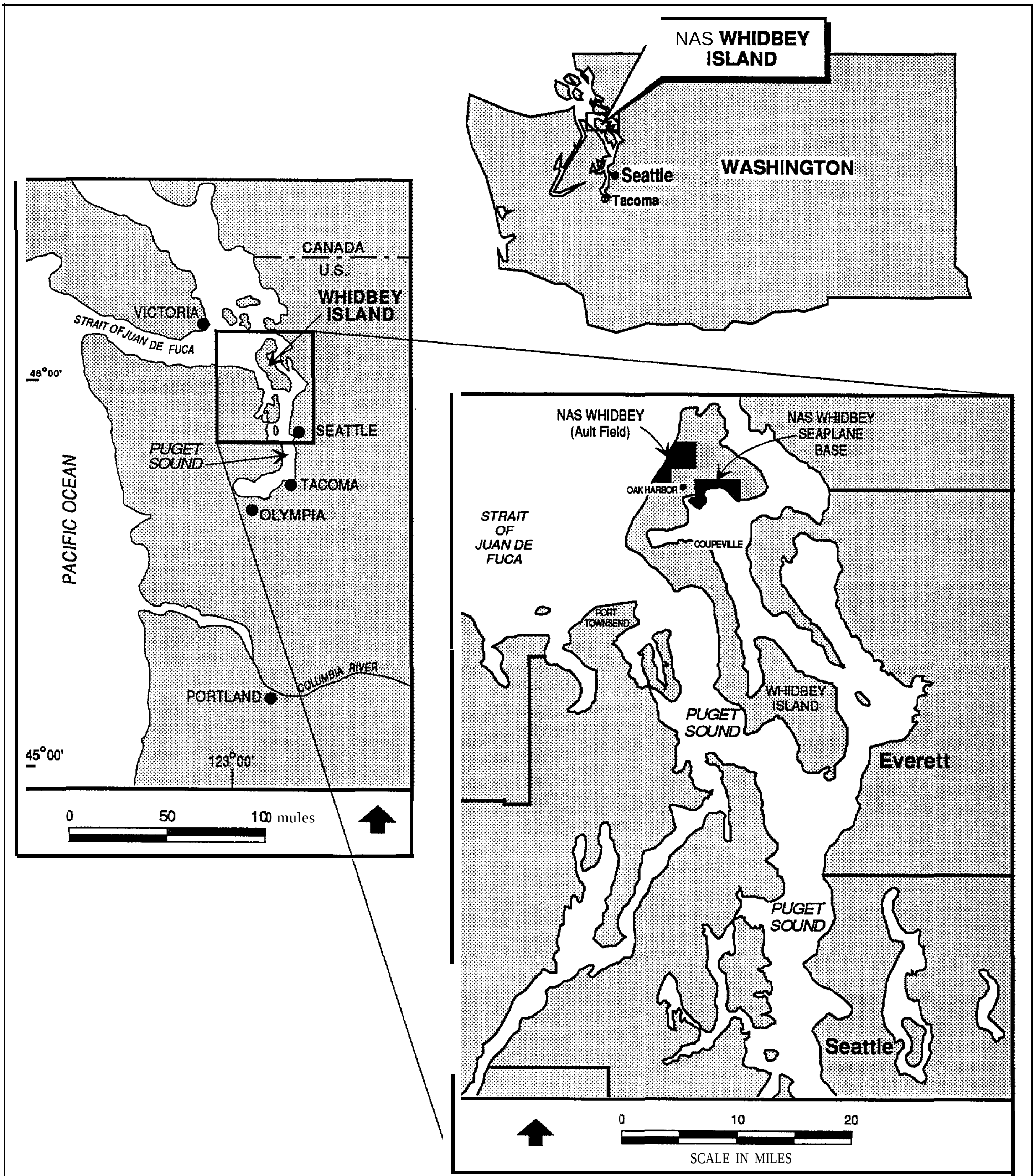
Under the Defense Environmental Restoration Program, it is the U.S. Navy's policy to address contamination at Navy installations in a manner consistent with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). The selected remedial action will comply with applicable or relevant and appropriate requirements (ARARs) promulgated by the U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology).

2.0 SITE NAME, LOCATION, AND DESCRIPTION

Naval Air Station (NAS) Whidbey Island is located in Island County, Washington, at the northern end of Puget Sound and the eastern end of the Strait of Juan de Fuca (Figure 1). The NAS Whidbey Island is divided into two facilities–the Seaplane Base and Ault Field. The Seaplane Base is located in the northern portion of the island adjacent to the city of Oak Harbor. Operable Unit (OU) 4, the sole operable unit at Seaplane Base, consists of five study areas (Figure 2):

- Area 39: Auto Repair and Paint Shop
- Area 41: Building 25 and Building 26 Disposal Area
- Area 44: Seaplane Base Nose Hangar
- Area 48: Seaplane Base Salvage Yard
- Area 49: Seaplane Base Landfill

Portions of the Seaplane Base have been converted to base housing-related activities. However, no actual housing is located in the immediate vicinity of the areas addressed in this Record of Decision (ROD). Residential housing is located approximately 200 yards to three-quarters of a mile away. The property adjacent to the areas addressed in this ROD is used for administration offices, storage, and housing support facilities, a lawn mower shop and gardening facility, boat and recreational vehicle storage, and a boat marina.



CLEAN COMPREHENSIVE LONG TERM ENVIRONMENTAL ACTION NAVY	**Figure 1** **Location Map**	CTO 0042 OPERABLE UNIT 4 NAS WHIDBEY, WA RECORD OF DECISION

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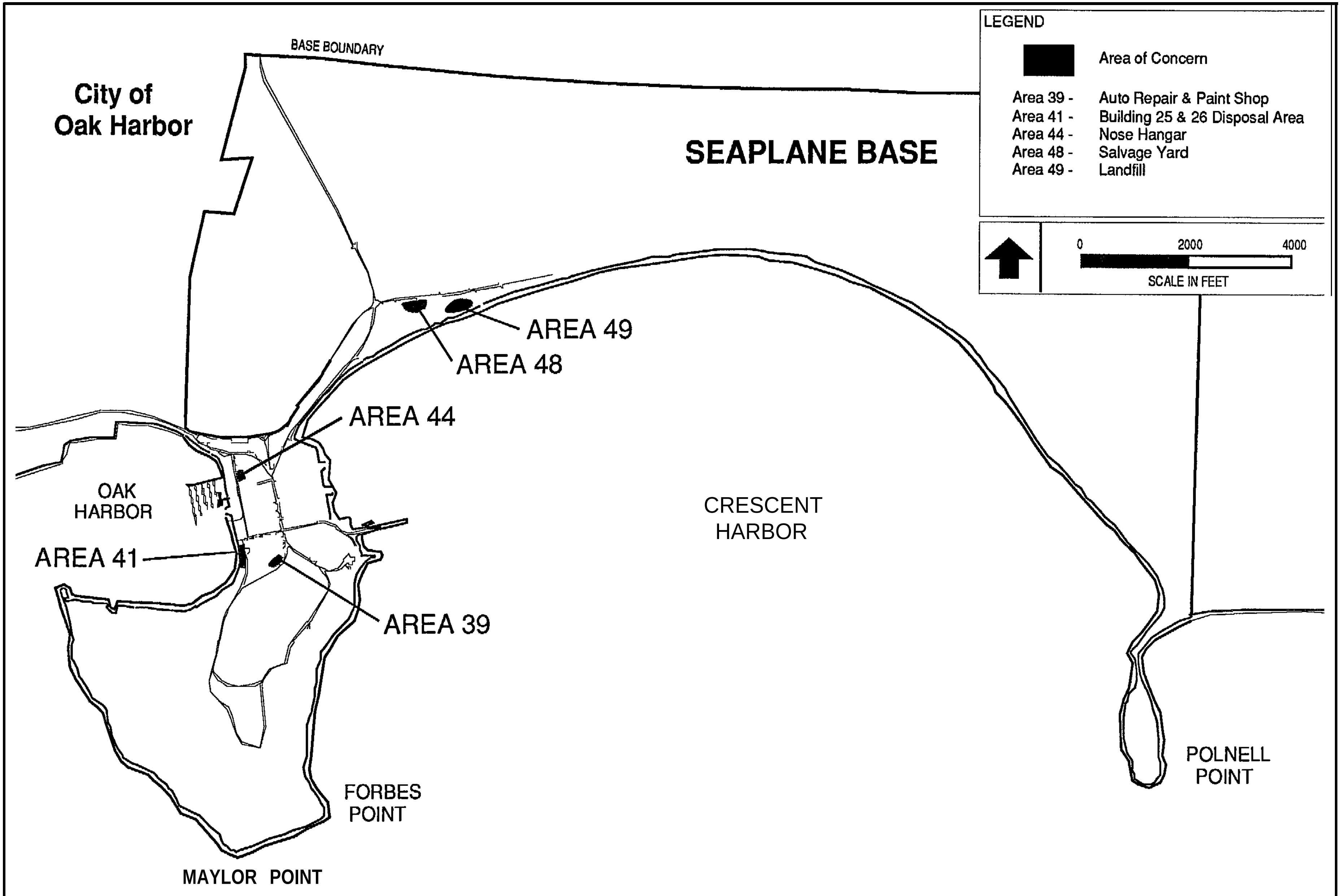

CLEAN COMPREHENSIVE LONG TERM ENVIRONMENTAL ACTION NAVY	**Figure 2** Operable Unit 4	CTO 0042 OPERABLE UNIT 4 NAS WHIDBEY, WA RECORD OF DECISION

The Seaplane Base is located on a peninsula that was built up with material dredged from Oak and Crescent Harbors in 1942. The original connection between Maylor Point and the mainland of Whidbey Island was a narrow sand spit. Most of the subsurface soils present are from past dredging operations. The groundwater immediately below the site is brackish; potable water is piped in from Anacortes. Surface runoff flows into Oak Harbor or Crescent Harbor.

2.1 AREA 39: AUTO REPAIR AND PAINT SHOP

Area 39 was the location of a former auto repair and paint shop that was housed in Building 49, located north of West Coral Avenue (Figure 3). From 1961 to 1965, an estimated 1,000 to 2,000 gallons of caustic radiator solvents were spilled on the ground northeast of Building 49. Approximately 2,000 gallons of radiator test tank water containing traces of sealant, antifreeze, soldering compounds, and acid were reportedly poured onto the ground south of Building 49 during the same period. From 1956 until 1982, wastewater from an 800-gallon paint booth was reportedly discharged up to once a week to the drainage ditch north of Building 49. The wastewater probably contained paint residues. Currently, the building is used as a lawn mower shop and self-service facility for base personnel.

2.2 AREA 41: BUILDING 25 AND BUILDING 26 DISPOSAL AREA

Area 41 is just west of Area 39 (Figure 4). It includes Building 25 (now demolished, with concrete foundation intact), Building 26, and the rock seawall located immediately west of the buildings. These buildings were used as paint shops in the 1940s and 1950s and later housed the pest control shop in the 1960s. Personnel reportedly discharged waste paint, thinners, solvents, and pesticides onto the seawall. No visible evidence of these activities remains today. Building 26 is currently used for flammable materials storage.

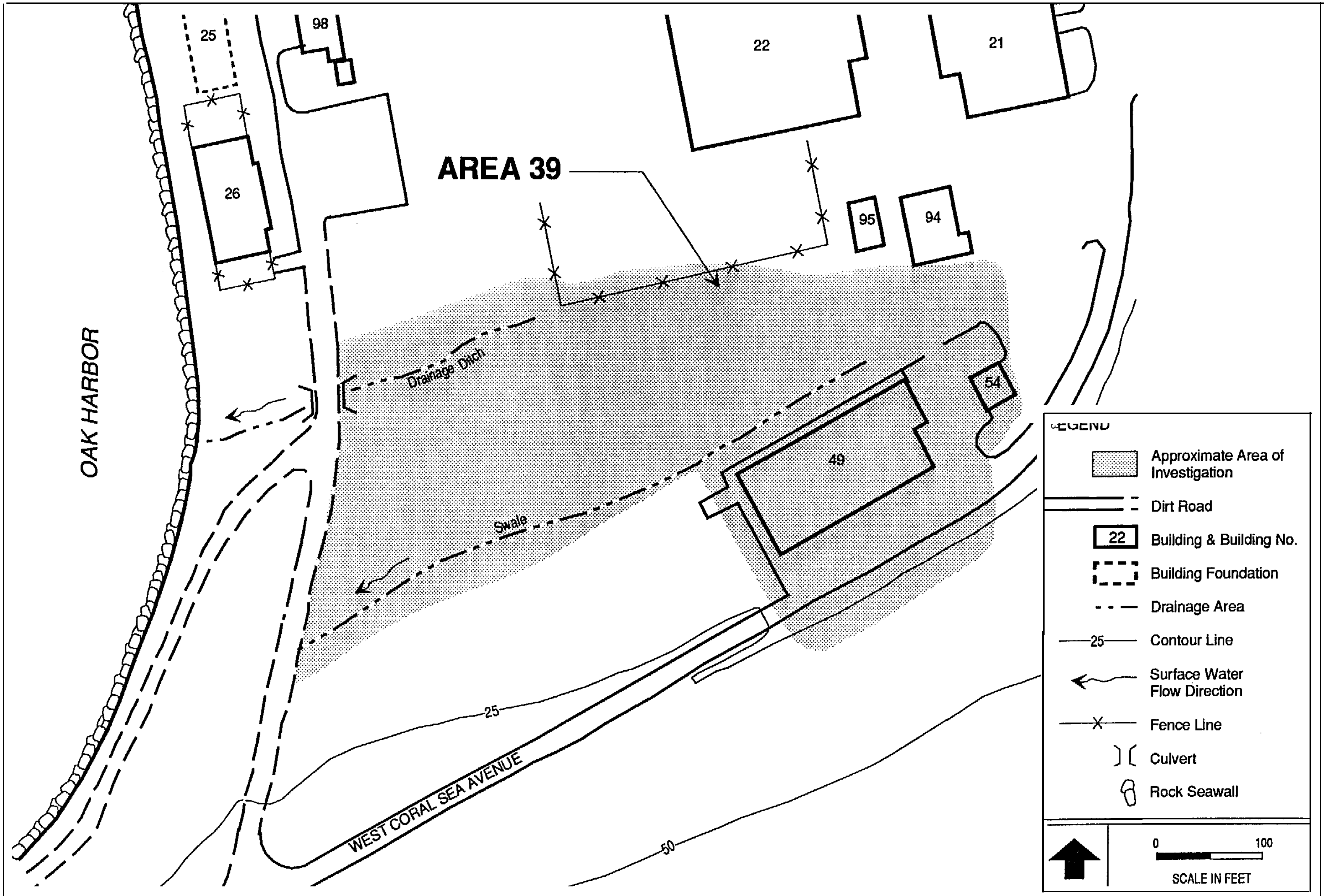

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Figure 3
Area 39 - Auto Repair and Paint Shop

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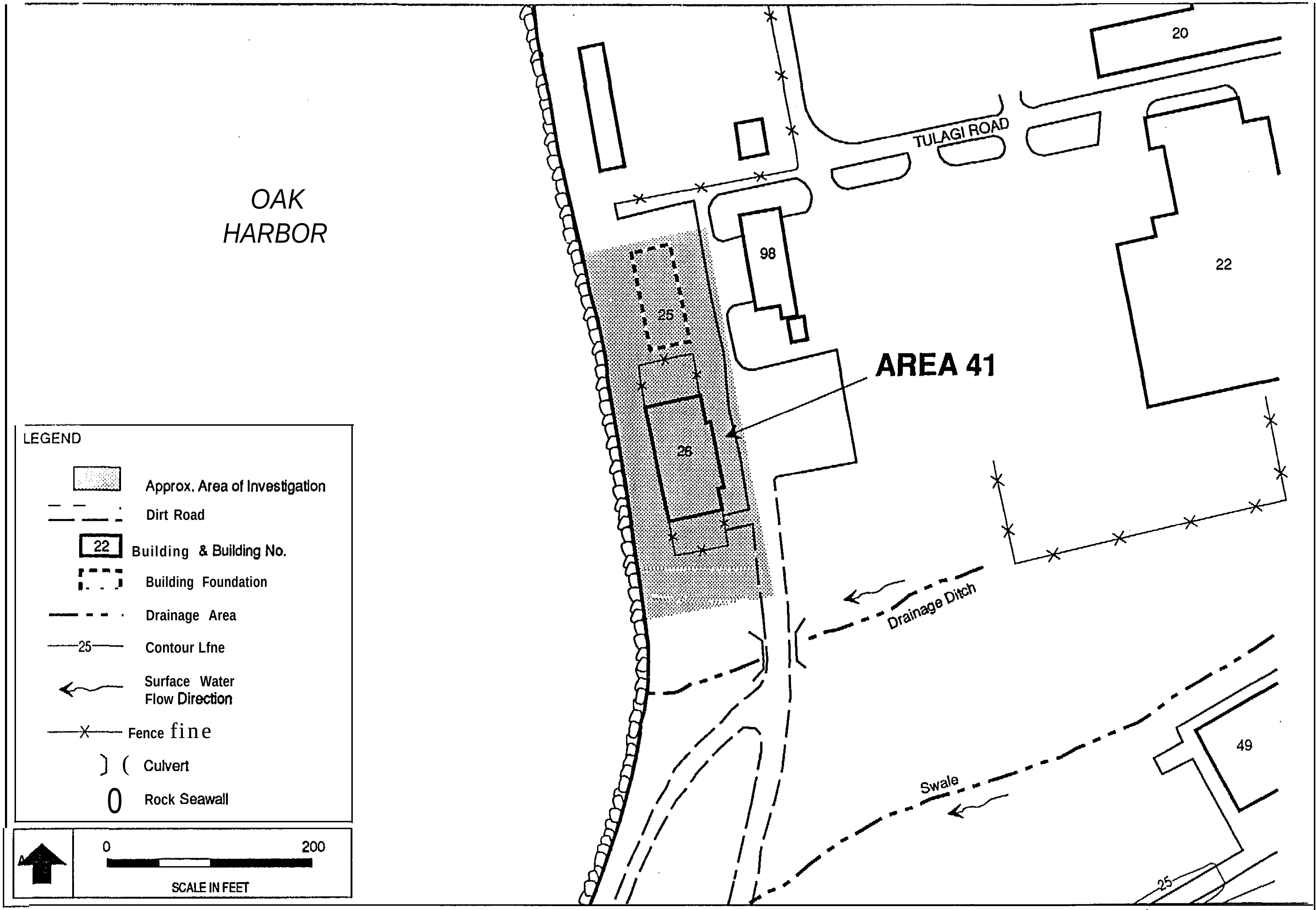

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Figure 4
Area 41. Buildings 25 and 26 Disposal Area

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2.3 AREA 44: SEAPLANE BASE NOSE HANGAR

The Nose Hangar was located at the northern end of a large paved apron area east of Marina Drive (Figure 5). In the 1940s and 1950s, the Nose Hangar was used as a service and maintenance center for seaplanes. Operations included steam cleaning and washing, fueling, lubricating, and parts cleaning. Numerous 1- to 100-gallon aviation gas spills were reported that may have been washed into Oak Harbor through the Area 44 storm drain system. The Nose Hangar has since been demolished and only the foundation and concrete apron remain. It is now used as a storage area for recreational boats and vehicles.

2.4 AREAS 48 AND 49: SEAPLANE BASE SALVAGE YARD AND LANDFILL

Areas 48 and 49 were investigated and evaluated together in the Remedial Investigation and Feasibility Study (RI/FS). They are located to the east of the main seaplane base next to Crescent Harbor (see Figure 6). Area 48 was a salvage yard for the Seaplane Base and was used from the 1940s until the late 1960s or early 1970s. It was located southeast of the intersection of Torpedo Road and East Pioneer Way. In the mid-1960s there was a fire of flammable materials stored there, which reportedly resulted in unknown quantities of solvents, thinners, strippers, and paints being spilled onto the ground and marsh. There is no visual evidence of the fire or storage yard activities.

Area 49 was a 3- to 4-acre landfill that was located farther east along Crescent Harbor. The landfill was used between 1945 and 1955 and reportedly all of the solid waste from Seaplane Base operations was disposed of there in that period. Seaplane repair and maintenance operations may have disposed of solvents, degreasers, paints, thinners, and strippers at this landfill. No visible evidence can be found of the landfill. Both areas are covered with native grasses and are presently used for occasional recreational purposes.

There is a wetlands area just north of Areas 48 and 49. A 20-acre wastewater stabilization lagoon is located in the wetlands, operated by the City of Oak Harbor. The outfall from the lagoon runs east of the landfill and extends some 3,000 feet offshore. Historically, the wetland was a saltwater marsh. The beachline has been built up with riprap, cutting off the saltwater marsh. The wetland is hydrogeologically upgradient of the site and is fed by off-site streams. The groundwater is brackish and is tidally

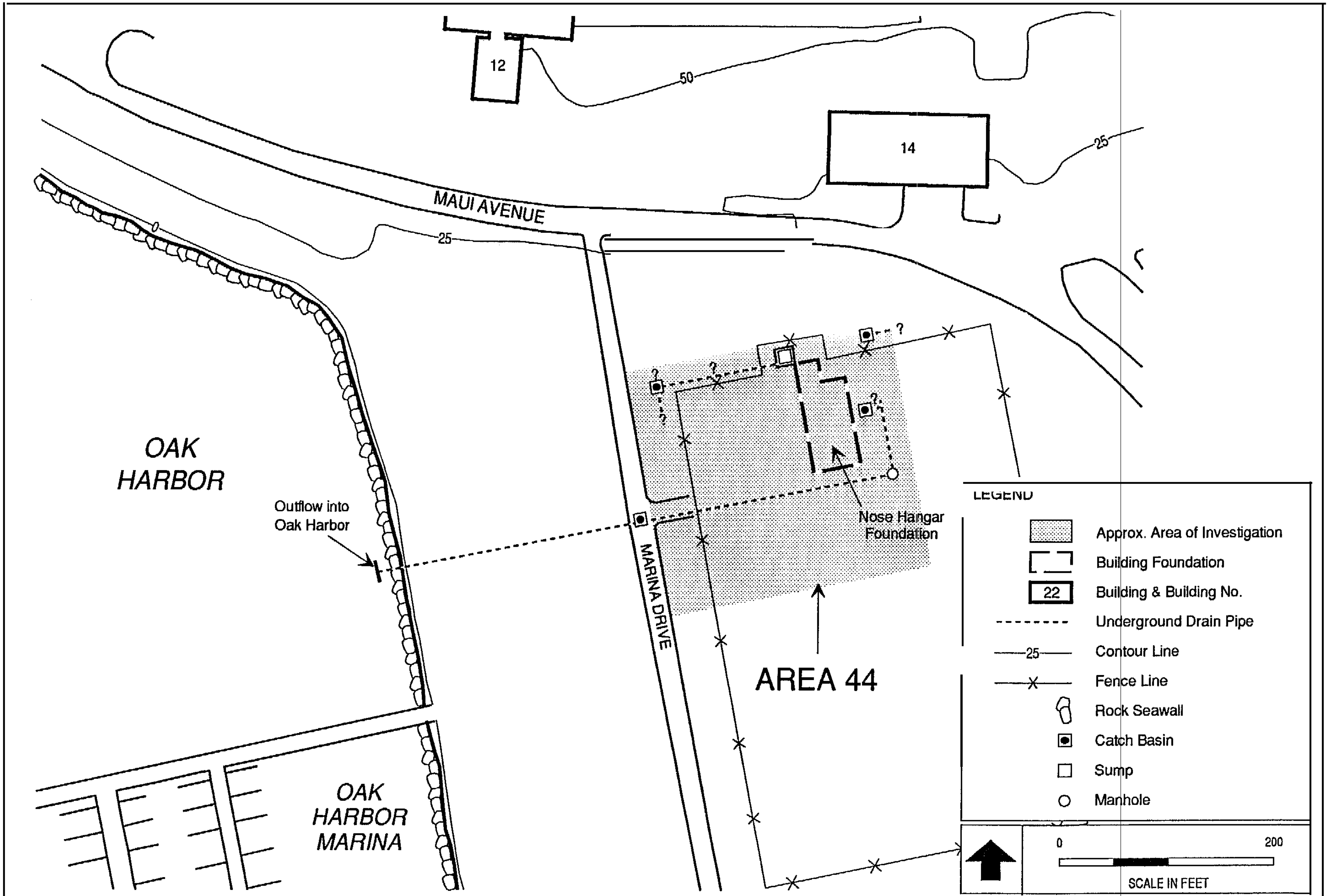

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Figure 5
Area 44 - Seaplane Nose Hangar

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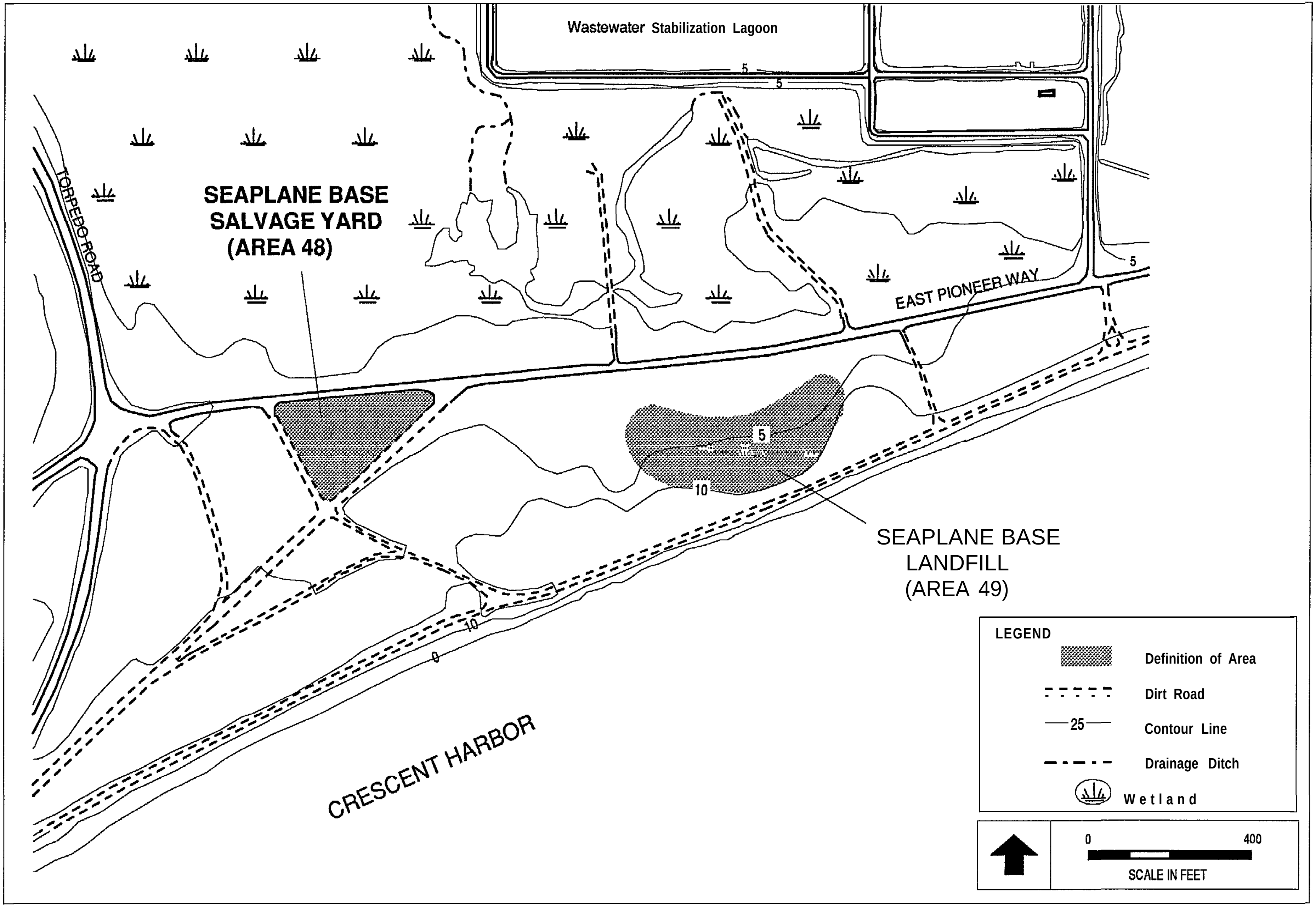

CLEAN COMPREHENSIVE LONG TERM ENVIRONMENTAL ACTION NAVY	Figure 6 Area 48= Salvage Yard and Area 49- Base Landfill	CTO 0042 OPERABLE UNIT 4 NAS WHIDBEY, WA RECORD OF DECISION

influenced. The ground slopes from the built-up area along the seawall toward East Pioneer Way. There is no drainage nor are there culverts across the road. In Areas 48 and 49, rainwater ponds during heavy rains, and eventually infiltrates into the ground.

3.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

NAS Whidbey Island was commissioned in 1942. The station was placed on reduced operating status at the end of the war. In December 1949 a continuing program to increase the capabilities of the station was begun. The station's current mission is to maintain and operate Navy aircraft and aviation facilities and provide associated support.

Since the 1940s, operations at NAS Whidbey Island have generated a variety of hazardous wastes. These wastes were disposed of with practices that were considered acceptable at the time.

In response to the requirements of CERCLA, the U.S. Department of Defense (DoD) established the Installation Restoration Program (IRP). From 1980 until early 1987, the Navy's program was called the Navy Assessment and Control of Installation Pollutants (NACIP) program. In spring 1988, the Navy (through OPNAVINST 5090.1) adopted EPA terminology and procedures and dropped those of NACIP. Consequently, all continuing studies at NAS Whidbey Island and other Navy facilities follow EPA guidelines established for National Priorities List (NPL) sites.

Responsibility for the implementation and administration of the IRP has been assigned to the Naval Facilities Engineering Command (NAVFACENGCOM). The Engineering Field Activity, Northwest (EFA NW), a part of NAVFACENGCOM, has responsibility for investigations at NAS Whidbey Island and other Navy installations in the Pacific Northwest and Alaska.

The Navy conducted an Initial Assessment Study (IAS) at NAS Whidbey Island under the NACIP program. The IAS, which consisted primarily of a records search, was completed in September 1984. A more detailed report, the NAS Whidbey Island Current Situation Report (CSR), was completed by the Navy in January 1988. Data on shellfish and marine sediment collected from the Seaplane Base were presented in the CSR.

While the CSR was being prepared, EPA Region 10 performed preliminary assessments at NAS Whidbey Island to evaluate risks to public health and the environment. EPA used the Hazard Ranking System (HRS) to evaluate Seaplane Base and Ault Field.

In late 1985, EPA proposed that Ault Field and the Seaplane Base be nominated to the NPL. In February 1990, these sites were officially listed on the NPL, based on several factors:

- The number of waste disposal and spill sites discovered
- The types and quantities of hazardous constituents used and disposed of at the sites (including petroleum products, solvents, paints, thinners, jet fuel, pesticides, and other wastes)
- Potential impacts on domestic wells and local shellfish beds

In response to the NPL designation, the Navy, EPA, and Ecology entered into a Federal Facilities Interagency Agreement (FFA) in October 1990. The FFA established a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions at NAS Whidbey Island.

Following CERCLA and SARA guidelines, various sites and areas at NAS Whidbey Island were later grouped into "operable units." The term "operable unit" (OU) is used to designate specific areas undergoing RI/FS investigations. The five areas at the Seaplane Base (Areas 39, 41, 44, 48 and 49) were collectively identified as OU 4. The purpose of the RI/FS was to characterize the site, determine the nature and extent of contamination, assess human and ecological risks, and evaluate remedial alternatives.

4.0 COMMUNITY RELATIONS

In accordance with Section 117(a) of CERCLA, as amended by SARA, the Proposed Plan for OU 4 was released to the public via the Whidbey News *Times* on August 14, 1993. Public comments have been considered in the remedy selection process.

Community relations for the Seaplane Base OU 4 investigation included the following activities:

- Creation of a Community Relations Plan (finalized January 10, 1992)
- Quarterly Technical Review Committee meetings with representatives from the public and from other governmental agencies
- Issuance of the final Proposed Plan (issued on August 9, 1993)
- Public meeting to present the final Proposed Plan (held on September 1, 1993)
- Issuance of a fact sheet summarizing the Record of Decision, concurrent with the signing of this document

Information repositories to make available details of OU 4 RI/FS activities were established at the following locations:

Oak Harbor Library
7030 70th N.E.
Oak Harbor, Washington, 98278
Phone: (206) 675-5115

Sno-Isle Regional Library System
Coupeville Library
788 N.W. Alexander
Coupeville, Washington 98239
Phone: (206) 678-4911

For anyone with access to NAS Whidbey Island:

Naval Air Station Whidbey Island
Station Library
1115 West Lexington Street
Oak Harbor, Washington 98278
Phone: (206) 257-2702

The administrative record is located at:

Engineering Field Activity, Northwest
Naval Facilities Engineering Command
1040 NE Hostmark Street
Olympic Place 1
Poulsbo, Washington 98370
Phone: (206) 396-5984

The mailing address for the Administrative Record is:

Engineering Field Activity, Northwest
Naval Facilities Engineering Command
3505 N. W. Anderson Hill Road
Silverdale, Washington 98383

Notice of the availability of the Proposed Plan, plus notice of a public meeting on the Proposed Plan and of the public comment period, were published in the Whidbey *News Times* on August 14, 1993, and the plan was distributed to the public on August 15, 1993. The public comment period was from August 16, 1993, to September 15, 1993. A public meeting to present the Proposed Plan to concerned citizens was held at the Chief Petty Officer's Club on Ault Field Road on September 1, 1993, at 7:00 pm. No citizens attended, but representatives of the Navy, EPA, and Ecology were present.

No comments were received by the Navy at that meeting concerning the Proposed Plan, but two letters were submitted on the Proposed Plan and are presented in the "Responsiveness Summary" (Attachment A) appended to this Record of Decision.

5.0 SCOPE AND ROLE OF OPERABLE UNITS

NAS Whidbey Island comprises two main facilities, Ault Field and the Seaplane Base. These two facilities are geographically separated. There are three operable units at Ault Field (OU 1, OU 2, and OU 3) and one operable unit at the Seaplane Base (OU 4). This Record of Decision addresses OU 4 at the Seaplane Base. The operable units at Ault Field are addressed separately and not in this Record of Decision.

The proposed remedial actions at the Seaplane Base address surface soil contamination detected above established state and federal health-based andregulatory levels. Surface soils at Area 39, 41, 44, and 48, and sediments in the storm drain at Area 44 are the only environmental media that required remedial action.

The results of the RI indicate that lead, arsenic, chromium, polycyclic aromatic hydrocarbons (PAHs), and pesticides are the contaminants of concern at Areas 39, 41, 44, and 48. Some of these compounds are present only in discrete locations. The Navy will undertake removal actions in the areas listed above.

The proposed remedial actions of soil removal and disposal address the only threat to human health and the environment at OU 4 and fulfill the Navy's goal ofremediating this operable unit to the fullest extent practicable.

6.0 SUMMARY OF SITE CHARACTERISTICS

This section presents a summary of site conditions, including a discussion of the geologic and hydrogeologic characteristics and the nature and extent of contaminants.

6.1 SITE GEOLOGY, HYDROGEOLOGY, AND SURFACE WATER HYDROLOGY

Whidbey Island lies within the Puget Lowland, a topographic and structural depression between the Olympic Mountains and the Cascade Range. Previous investigations report that the geologic units on Whidbey Island consist of a sequence of Quaternary-age (less than 2 million years old) glacial and interglacial deposits that may be more than 3,000 feet thick. Most of the near-surface deposits on Whidbey Island are glacial sediments of the Fraser glaciation (20,000 to 10,000 years old). At the height of the most recent glaciation, about 15,000 years ago, ice probably reached a thickness of about 4,500 feet in the Oak Harbor area. Ice flow direction in the vicinity of OU 4 was generally southward. The north-south elongation of the island is a result of this flow pattern.

Features of the glacial and interglacial geologic units have been identified from surface exposures and in boreholes on northern Whidbey Island and from data collected during the recent environmental investigation at NAS Whidbey Island. Low-permeability

Cretaceus or Tertiary bedrock (older than 30 million years) underlies the unconsolidated Quaternary deposits. The Everson and Vashon units of the Fraser glaciation, post-glacial sediment, and artificial fill make up most of the surface and near-surface soil underlying the Seaplane Base. Recent organic-rich silt and clay, as well as artificial fill consisting of dredged marine sediment, cover the Maylor Peninsula. The narrow northern part of the peninsula was originally a neck of land connecting Whidbey Island with Maylor Point; it was filled in the mid- 1940s to construct the buildings and facilities of the Seaplane Base. The fill material consists of sediment dredged from the surrounding harbors. The stratigraphy over the remainder of the base generally consists of glaciomarine drift overlying Vashon till and advance outwash. The wetland north of Areas 48 and 49 contains organic-rich silt and clay.

The results of the RI showed that groundwater beneath Areas 39, 41, and 44 generally flows west toward Oak Harbor at a gradient ranging from 0.011 to 0.012 (ft/ft) (Figure 7). The direction of groundwater flow in Areas 48 and 49, located north of Crescent Harbor, is variable owing to tidal influence. Some water level measurements indicated that the groundwater flow direction is to the northeast. However, continuous water level measurements over a tidal cycle show that the net groundwater flow direction was south toward Crescent Harbor (Figure 8).

The hydrogeologic investigation revealed that a near-surface, unconfined aquifer exists in Areas 39, 41, 44, and 48 and 49. The deepest monitoring well drilled during the RI/FS was to a depth of 67 feet below ground surface (bgs) at Areas 48 and 49. No confining units were encountered in this well. The unconfined aquifer extends at least to the depth of the bottom of this boring.

Groundwater at the Seaplane Base is not considered a potential drinking water source because the groundwater in this area is brackish. Surface runoff from the Seaplane Base discharges into either Crescent Harbor or Oak Harbor. Surface soils at the Seaplane Base are generally low permeability silty sand, accounting for common pending in lower-relief areas during high rainfall events and throughout the winter. This is especially common in Areas 39, 48, and 49.

Oak Harbor is the eventual surface water discharge site for Areas 39, 41, and 44. Surface water drainage for Area 39 is influenced by a 100-foot-high hill a few hundred feet south of the area. This topographic high directs surface water across Area 39 to a swale and a drainage ditch, which trend in a southwesterly direction. Surface water

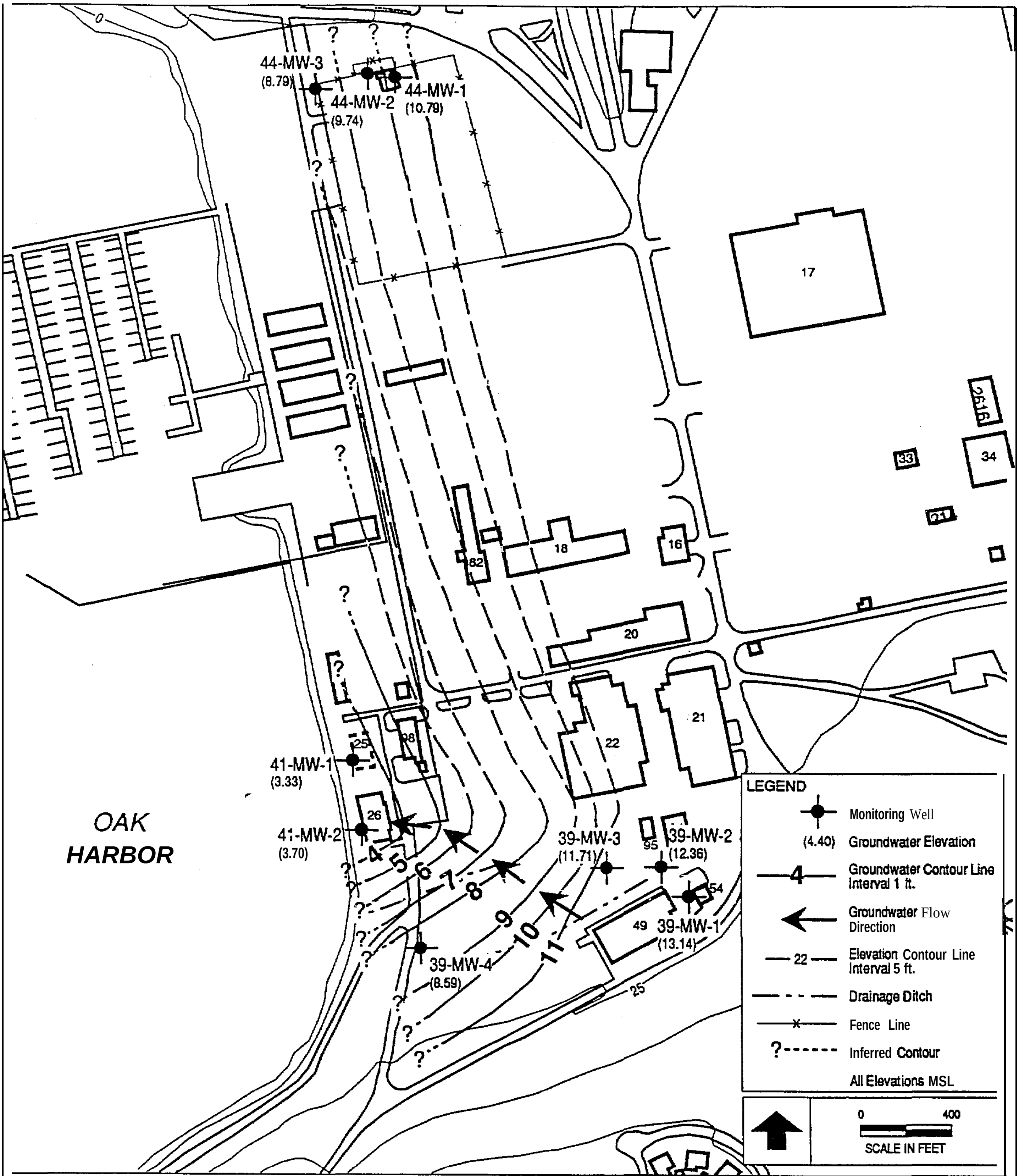

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Figure 7
Areas 39, 41, and 44 Potentiometric Surface Contour Map
April 14, 1992

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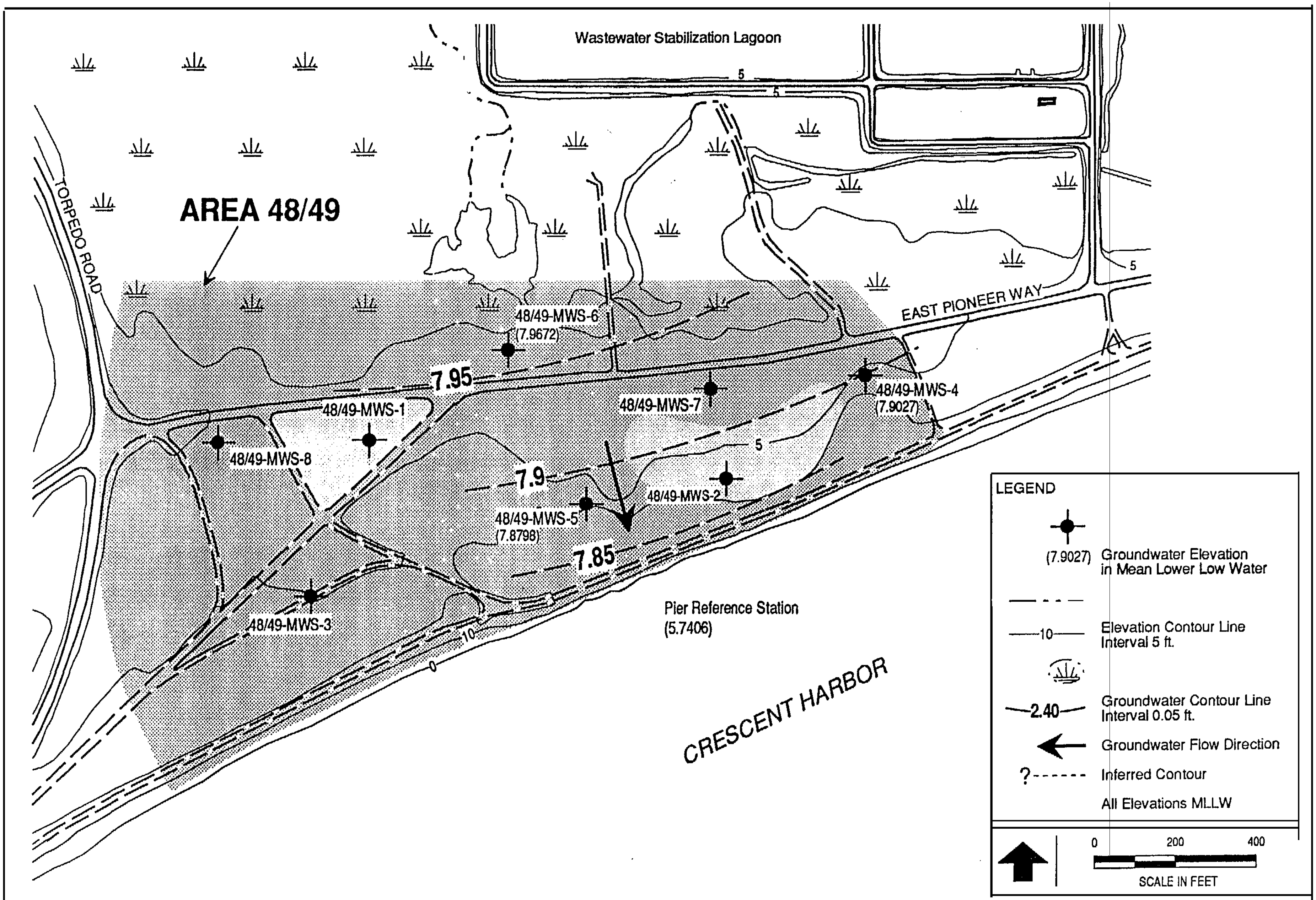

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Figure 8
Area 48/49 Tidal Study Net Flow Direction
Source: Serfes, 1991

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following the swale drains to a nearly level field west of the area, where it infiltrates into the ground. The ditch extends under a gravel road and discharges directly into Oak Harbor.

In Area 41, most of the surface water flows across paved areas and into storm drains before discharging into Oak Harbor. Elsewhere, surface water drains across nearly level, unpaved areas that surround Building 26, down the riprap seawall embankment, and into the Oak Harbor.

Area 44 is a paved storage area; one sump and four catch basins are located in the northern part of the area. A drain pipe connects the sumps and the outfall of the drain is located directly west in the riprap bordering Oak Harbor.

Areas 48 and 49 lie on fairly level ground, with Crescent Harbor to the south and wetlands to the north. The topography slopes gently toward the wetlands. However, the surface water flow to the north is impeded by a slightly elevated road bed (East Pioneer Way), which prohibits direct discharge into the wetlands. Surface water in the wetlands is recharged mostly by precipitation and from a natural spring located approximately 2 miles north of the wetlands. Surface water in the wetlands area was not present at three of the four planned sampling locations during the Phase I RI field program.

There is no evidence (i.e., ditches or drainage swales) of any surface water flow in Areas 48 and 49. Surface water does not enter Crescent Harbor from Areas 48 and 49 because of the elevated dike bordering the harbor.

A large wetland area (approximately 250 acres) lies to the north of Areas 48 and 49. The wetland is an old saltwater marsh that is hydrologically upgradient of OU 4. It is a non-tidal, freshwater wetland, seasonally flooded and dominated by emergent vegetation. The vegetation consists of grasses, scrub and shrub vegetation, and trees in early and middle stages of succession. A municipal wastewater lagoon system occupies about 24 acres in the middle of the wetland. A surface drainage enters the wetland from the north and drains through a tidegate just east of the road access to the wastewater lagoon.

6.2 NATURE AND EXTENT OF CONTAMINANTS

Surface and subsurface soil, marine sediment, groundwater, and surface water samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds

(SVOCS), and target analyte list (TAL) inorganic. In Areas 39, 41, 48, and 49, soil samples were also analyzed for chlorinated pesticides and polychlorinated biphenyls (PCBs). In Area 41, where former activities included a pest control shop, additional analyses for organophosphorus pesticides and chlorinated herbicides were performed. Marine tissue samples (mussels) were analyzed for SVOCS, chlorinated pesticides, PCBs, chlorinated herbicides, and inorganic adjacent to Areas 41, 44, 48 and 49. Background concentration levels for inorganic were established from soil, groundwater, marine sediment, and mussel tissue samples collected at OU 4 outside the areas of suspected contamination for all media.

The following paragraphs describe the nature and extent of contamination for chemicals of concern (COCs) identified in soil, groundwater, marine sediment, mussel tissue, freshwater sediment, and surface water for each area. COCS are defined as chemicals that exceed human health and ecological risk threshold concentrations based on federal or state criteria. Inorganic chemicals that were at or below background concentrations were not considered a COC. Table 1 lists the COCS for soil.

6.2.1 Soil

- Area '39

Surface soils and sediments in Area 39 had concentrations of chromium, lead, polycyclic aromatic hydrocarbons (PAHs), and 4,4'-DDE and 4,4'-DDD (pesticides) that exceeded background concentrations and risk-based criteria. Lead and PAHs were the most widespread COCs. They were detected northeast of Building 49 and in the southern swale north of the building. The pesticide concentrations were detected in the drainage ditch next to a road culvert. Figure 9 shows these locations. The estimated volume of soil containing COCS is approximately 260 cubic yards.

The COCS have not migrated off site or infiltrated into groundwater. They are detected only in the upper 1 or 2 feet of the soil column.

- **Area 41**

At Area 41, pesticides (4,4′-DDE and 4,4′-DDT) were detected above state cleanup levels in two localized shallow areas around the foundation of Building 25. Figure 10 shows these areas. The estimated volume of contaminated soil containing contaminants of concern is 2 to 5 cubic yards.

Table 1
Chemicals of Concern in Surface Soil of Seaplane Base

Area	Chemical	Concentration			Frequency of Detections[a]	Background Concentration (mg/kg)
		Minimum (mg/kg)	Maximum (mg/kg)	Mean (mg/kg)		
39	Arsenic	**1.4**	**8.5**	**4.02**	**17/40**	**2.7**
	Chromium	18.3	523	115.10	21/54	43.3
	Lead	**2.9**	**736**	**233.14**	**22/44**	**26.5**
	Benzo(a)anthracene	0.017	2.6	0.434	10/49	—
	Benzo(a)pyrene	0.022	0.65	0.205	7/49	—
	Benzo(b)fluoranthene	0.043	0.43	0.169	5/48	—
	Benzo(k)fluoranthene	0.046	2.3	0.47	8/49	—
	Chrysene	0.014	0.9	0.233	9/49	·
	Indeno(1,2,3-cd) pyrene	0.012	0.23	0.102	5/49	—
	4,4'-DDD	0.0046	4.0	0.677	7/8	—
	4,4'-DDE	0.00078	4.8	0.528	12/12	
41	Lead	3	298	76.46	11/21	26.5
	4,4'-DDE	0.00057	4.1	0.50	13/21	
	4,4'-DDT	0.0038	41.0	3.43	14/20	—
44	Arsenic	1.7 (surface soil)	25.7 (surface soil)	7.17	9/12	2.7
		2.1 (manhole)	48.3 (manhole)	48.3	1/1	2.7
	Lead	3,625 (sump)	3,625 (sump)	3,625	1/1	26.5
		3,370 (manhole)	3,370 (manhole)	3,370	1/1	26.5
		14.5 (catch basin)	2,180 (catch basin)	2,180	1/2	26.5
		6.1 (surface soil)	3,150 (surface soil)	781	6/12	26.5

Table 1 (Continued)
Chemicals of Concern in Surface Soil of Seaplane Base

Area	Chemical	Concentration Minimum (mg/kg)	Concentration Maximum (mg/kg)	Concentration Mean (mg/kg)	Frequency of Detections[a]	Background Concentration (mg/kg)
48 and 49	Benzo(a)anthracene	0.01	1.7	0.392	6/41	—
	Benzo(a)pyrene	0.006	2.2	0.37	8/41	—
	Benzo(b)fluoranthene	0.029	4.9	0.75	9/41	—
	Benzo(k)fluoranthene	0.033	4.9	0.811	7/40	—
	Chrysene	0.018	2.0	0.33	9/41	—
	Dibenzo(a,h)anthracene	0.054	0.28	0.131	3/41	—
	Indeno(1,2,3-cd)pyrene	0.062	0.93	0.284	5/41	—

[a]Detections/number of samples taken
— = Background levels were not determined for organic chemicals.
Note:
Chemicals of concern were identified as those chemicals exceeding federal and state threshold concentrations.

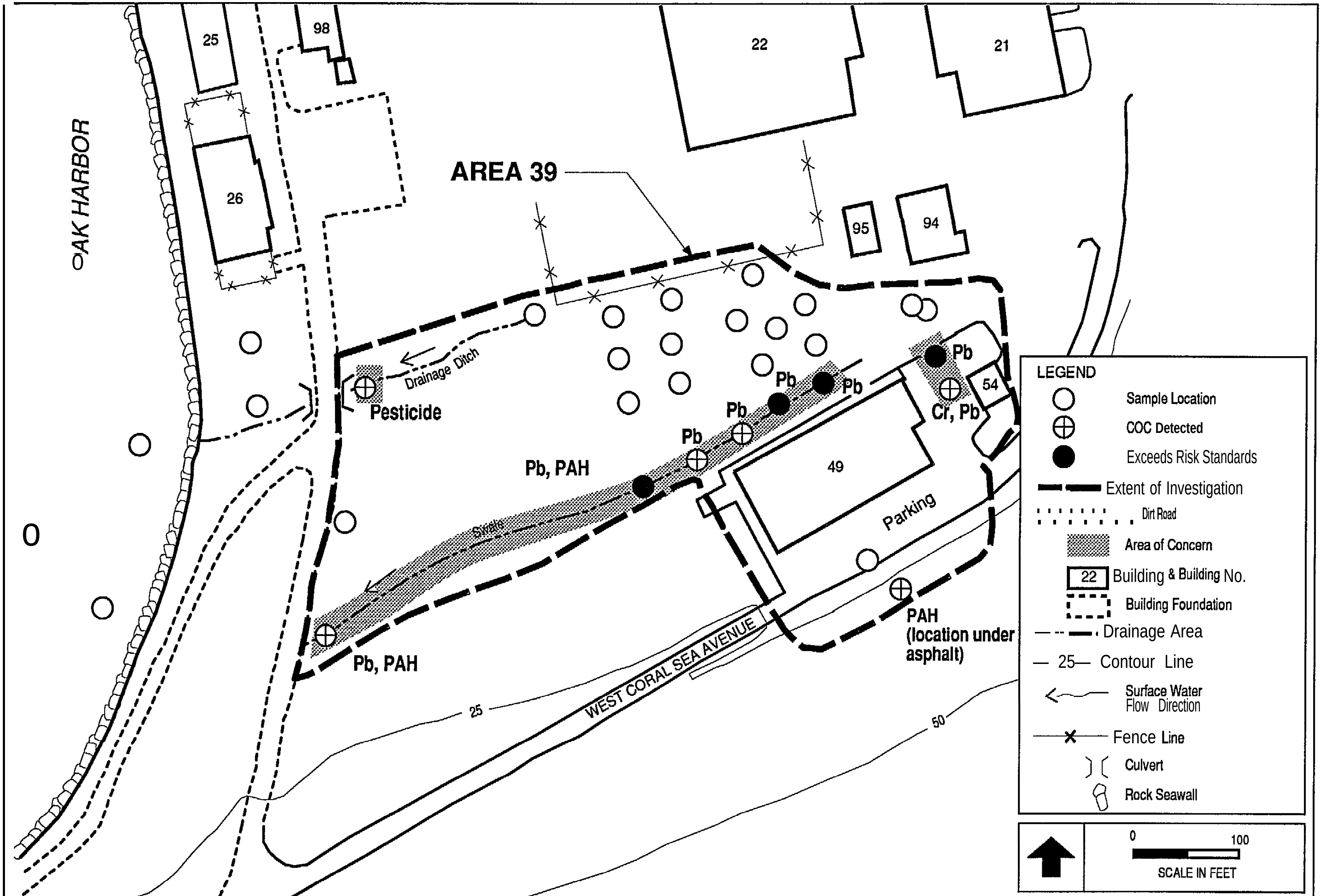

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Figure 9
Area 39- Spatial Distribution of COCS Detected in Surface **Soil**

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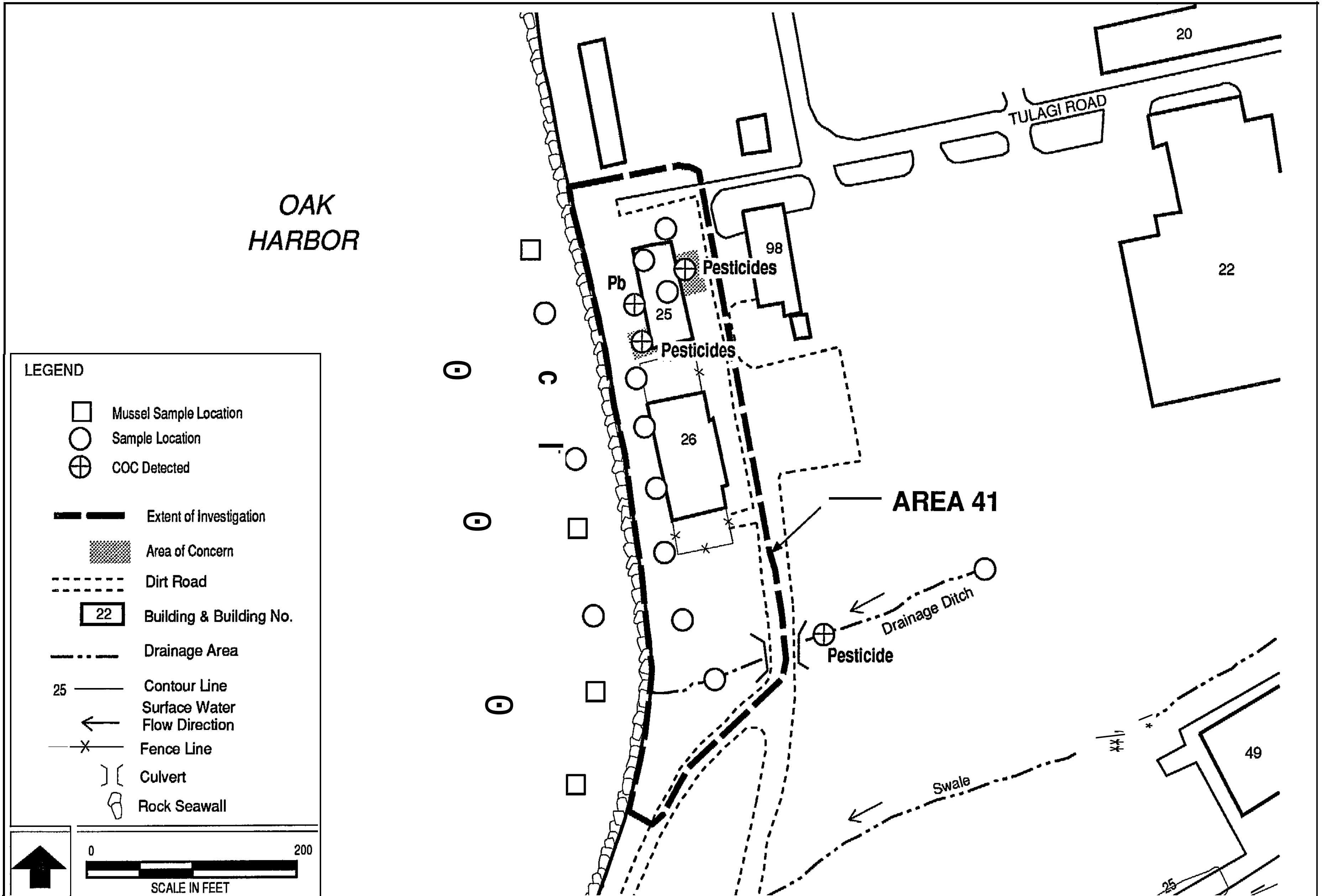


CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 10** **Area 41 S Distribution of COCs Detected in Surface Soil and Marine Sediments**	CTO 0042 OPERABLE UNIT 4 NAS WHIDBEY, WA RECORD OF DECISION

These COCS were not detected at depth in the soil column or in the groundwater. Pesticides were detected in the marine sediments, but only in buried sediments at a depth greater than 4 to 8 inches, below the biologically active zone. None were detected in mussel tissue.

- **Area 44**

The sediments in the storm drain system (catch basin, sump, and a manhole) contained high levels of lead and arsenic. Surface soils adjacent to the sump at the north edge of the concrete apron also contain lead and arsenic. Figure 11 shows the locations of these areas. These COCs were found only in the surface soils and have not migrated downward in the soil column, nor were they detected in the groundwater. The storm drain discharges into Oak Harbor; however, no concentration exceeding background levels of lead or arsenic was detected in the sediments near the outfall. Therefore, transport to the marine environment was not substantiated. The volume of soil and storm drain sediments containing elevated levels of lead and arsenic is estimated to be 20 to 30 cubic yards.

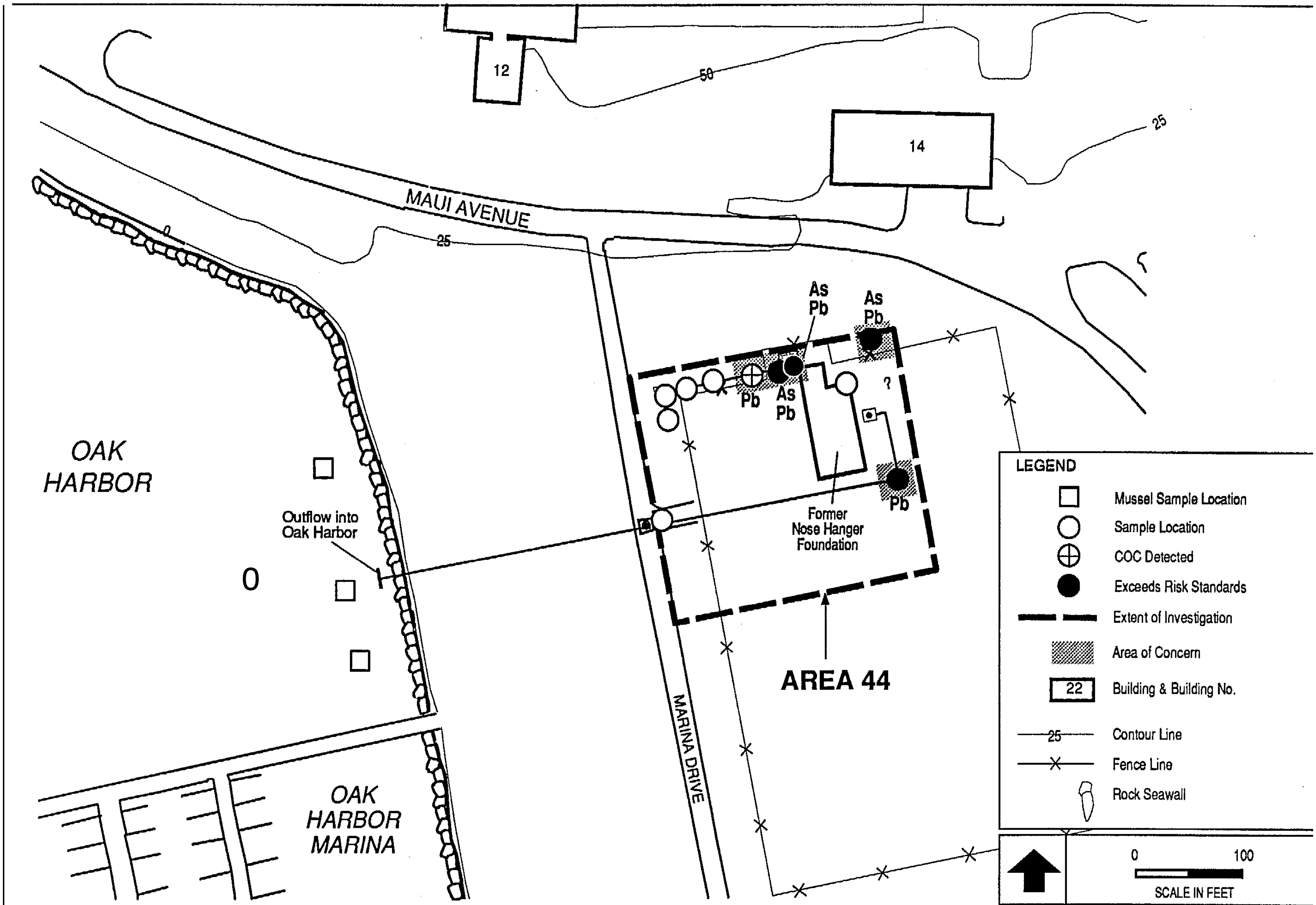
- **Areas 4S and 49**

The principal COCs detected in Area 48 were PAHs at the salvage yard (Area 48), where a fire occurred in the 1960s. No COCS were detected above federal or state standards in Area 49. PAHs are not highly mobile in the soil column; however, a number of PAHs were detected in the groundwater. PAHs were detected in one marine sediment sample (O to 4-inch depth).

The soils at Area **48** that contain the elevated concentrations of PAHs are shown in Figure 12. The volume of contaminated soil to be removed is estimated to be 1,000 cubic yards.

6.2.2 Groundwater

Inorganic and organic chemicals were detected in groundwater at all areas (Table 2). The groundwater is not considered potable. Although organic and inorganic analytes were detected in groundwater in all areas, the potential for exposure to contaminants in groundwater near the shore is low. The groundwater is not considered potable because coastal waterbearing strata on Whidbey Island are at a high risk of saltwater intrusion,



CLEAN COMPREHENSIVE LONG TERM ENVIRONMENTAL ACTION NAVY	Figure 11 Area 44= Spatial **Distribution** of **COCs** Detected In Surface Soils, Storm Drain Sediments, and Marine Sediments	CTO 0042 OPERABLE UNIT 4 NAS WHIDBEY, WA RECORD OF DECISION

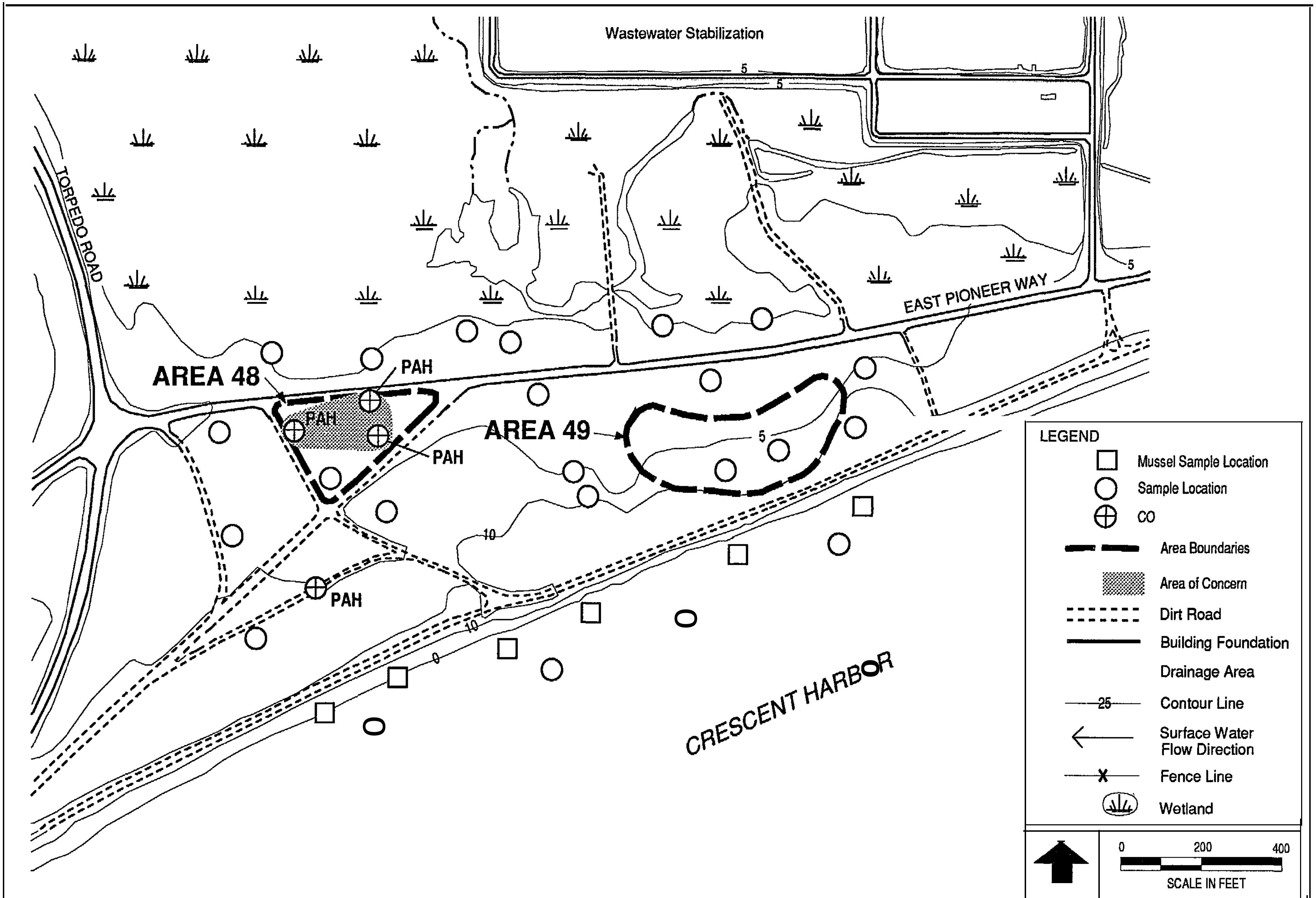


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Figure 12
Area 48/49 - Spatial Distribution of COCs Detected S S M S m

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Table 2
Chemicals of Concern in Groundwater of Seaplane Base

Area	Chemical	Concentration Minimum (µg/L)	Concentration Maximum (µg/L)	Concentration Mean (µg/L)	Frequency of Detections[a]	Background Concentration (µg/L)
39	Arsenic	2	11.9	5.3	3/4	2.0
	Manganese	113	889	468	4/4	16.7
	Chloromethane	4.42	4.42	4.42	1/2	
	Tetrachloroethene	1.87	1.87	1.87	1/3	—
	1,3-Dichloropropane	1.04	1.04	1.04	1/3	—
	Carbon tetrachloride	0.55	0.55	0.55	1/3	—
	Benzo(k)fluoranthene	6.5	6.5	6.5	1/4	
	Aldrin	0.03	0.03	0.03	1/1	—
41	Manganese	1,610	2,630	2,120	2/2	16.7
	1,2-Dichloroethane	5.8	5.8	5.8	1/1	
	1,3-Dichloropropene	13.8	13.8	13.8	1/1	
	Vinyl chloride	4.0	4.0	4.0	1/1	—
	Benzo(k)fluoranthene	7.4	7.4	7.4	1/2	—
	Aldrin	0.01	0.01	0.01	1/1	
44	Manganese	114	269	176	3/3	16.7
	1,1,2-Trichloroethane	0.96	0.96	0.96	1/1	
	Chloromethane	36.9	36.9	36.9	1/2	—
	Methylene chloride	10.0	10.0	10.0	1/1	
48 and 49	Arsenic	2.1	2.5	2.3	2/3	2.0
	1,1,2-Trichloroethane	5.87	5.87	5.87	1/5	—
	1,2-Dichloroethane	2.74	2.74	2.74	1/4	—
	Chloromethane	13.9	13.9	13.9	1/6	—
	Benzo(a)anthracene	5.5	5.5	5.5	1/9	
	Benzo(k)fluoranthene	5.2	5.2	5.2	1/9	—
	Chrysene	6.0	8.2	7.1	2/9	
	Indeno(1,2,3-cd) pyrene	33.0	33.0	33.0	1/1	—
	Aldrin	0.01	0.01	0.01	2/2	—
	Dieldrin	0.02	0.02	0.02	1/1	
	Heptachlor	0.44	0.44	0.44	1/11	

[a]Detections/number of samples taken
— = Background levels were not determined for organic chemicals.

which would prevent it from being used as a potable water supply. Salinity profiles developed for the monitoring wells in the areas of concern verify this is an area of high risk for salt water intrusion. Also, Island County Department of Health regulations prohibit the development of private or public drinking water wells within 100 feet of the mean high tide level.

6.2.3 Marine Sediment and Mussel Tissue

- **Marine Sediment**

Marine sediment was collected from 11 stations in Area 41 (Figure 10), 4 stations from Area 44 (see Figure 11), and 10 stations from Areas 48 and 49 (see Figure 12). Sediment samples were collected from three depths at each station (O to 4 inches, 4 to 20 inches, and 20 to 36 inches).

A summary of COCs detected in marine sediments is presented in Table 3 and 4. Table 3 compares the number of COCS detected above the sediment quality standards in the surface sediments (O to 4 inches) with those in the subsurface sediments (4 to 36 inches). Beta-BHC, delta-BHC, and fluoranthene were the only identified COCS found in the surficial sediments where the greatest exposure to aquatic organisms occurs. The number of COC detections above the state standards is significantly higher in the subsurface sediments.

Table 4 compares the carbon-normalized values of the COCS detected in the surface (top), mid, and bottom sediment samples taken at each sampling station with the sediment management standard cleanup levels. All of the surface and mid-depth sample COC concentrations were below the cleanup levels. At only three stations, one off of Area 44 and two off of Areas 48 and 49, were COC detections above the state cleanup value. These three detections (highlighted with shading in Table4) occurred in the bottom samples taken at 1.5- to 3-foot depth.

- **Mussel Tissue**

Mussel tissue was collected from five stations in Area 41, three stations in Area 44, and three stations in Areas 48 and 49. Mussel tissue sampling stations are shown in Figure 10 for Area 41, Figure 11 for Area 44, and Figure 12 for Areas 48 and 49.

Arsenic was the only COC detected in mussel tissue.

Table 3
Comparison of Chemicals of Concern Detected in Surface and Subsurface Marine Sediment in Areas 41, 44, 48, and 49 (mg/kg)

Area	Chemical	Surficial Sediment (0- to 4-inch stratum)				Subsurface Sediment (4- to 36-inch stratum)			
		Minimum Detection	Maximum Detection	Mean[a] Concentration	Detection Frequency[b]	Minimum Detection	Maximum Detection	Mean[a] Concentration	Detection Frequency[b]
41	gamma-BHC	—	—	—	0/11	0.0005	0.0005	0.0005	1/21
	delta-BHC	0.0021	0.0021	0.0021	1/11	–	–	–	0/21
	4,4′-DDD	0.00045	0.0093	0.0038	4/11	0.00062	0.08	0.017	12/21
	4,4′-DDT	0.0029	0.0042	0.0036	2/11	0.00073	0.052	0.015	10/22
	Di-n-octyl phthalate	0.023	0.037	0.027	5/12	0.023	0.23	0.066	11/16
	Endosulfan II	—	—	—	0/11	0.00087	0.00087	0.00087	1/21
	Fluoranthene	0.02	0.22	0.093	3/11	0.016	0.150	0.085	6/15
	Heptachlor epoxide	—	—	—	0/11	0.0011	0.0011	0.0011	1/21
44	Bis(2-ethylhexyl) phthalate	0.62	0.62	0.62	1/4	0.21	0.75	0.48	2/7
48 and 49	Aroclor-1254	—	—	—	0/9	0.54	0.54	0.54	1/9
	beta-BHC	0.00057	0.00057	0.00057	1/9	—	—	—	0/10
	delta-BHC	0.00068	0.00091	0.0008	2/10	0.00082	0.0021	0.0015	2/10
	gamma-Chlordane	—	—	—	0/9	0.0027	0.0027	0.0027	119
	Di-n-octyl phthalate	—	—	—	0/7	0.36	0.36	0.36	1/8
	Bis(2-ethylhexyl) phthalate	—	—	—	0/7	0.59	0.59	0.59	1/8

‘Means were calculated using detected concentrations only.
[b]Frequency of detection is defined as the number of samples with detected concentrations of a chemical/total number of samples.
— = COCS not detected in this stratum.

Table 4
Marine Sediment Risk Summary

Area	Detected Chemicals	Normalized Sediment Concentration (mg/kgOC) TOP (0-0.33')	MID (0.33-1.67')	BOT (1.67-3.0')	SMS Table III Values CSL (mg/kgOC)
Area 41					
41-MS-1	Bis(2-ethylhexyl) phthalate	23.0	27.6	ND	78
	DDD	0.3	0.4	1.4	NA
	DDT	ND	0.4	6.3	NA
	Heptachlor	0.4	ND	0.5	NA
	Methoxychlor	ND	ND	0.5	NA
41-MS-2	Di-n-butyl phthalate	ND	39.2	ND	1,700
	DDD	0.9	1.5	ND	NA
	DDT	ND	13.3	0.7	NA
	Endosulfan II	ND	0.6	ND	NA
41-MS-3	Bis(2-ethylhexyl) phthalate	13.2	ND	ND	78
	Di-n-butyl phthalate	9.0	ND	43.5	1,700
	DDD	1.2	41.8	9.8	NA
	DDE	0.1	3.5	0.9	NA
	DDT	0.6	9.9	2.1	NA
41-MS-4	2-Methylnaphthalene	ND	10.0	1.9	64
	Anthracene	ND	ND	2.8	1,200
	Phenanthrene	ND	36.5	3.2	480
	Benzo(a)anthracene	33.0	27.4	ND	270
	Benzo(a)pyrene	14.7	ND	ND	210
	Total Benzofluoranthenes	68.2	157.1	18.6	450
	Chrysene	32.6	39.3	ND	460
	Di-n-butyl phthalate	5.5	31.1	15.5	1,700
	Di-n-octyl phthalate	13.6	100.5	8.7	4,500
	Fluoranthene	47.6	91.3	10.7	1,200
	Pyrene	36.6	46.6	9.9	1,400
	Phenol	ND	ND	62.0'	1,200[a]
	DDD	ND	15.5	2.5	NA
	DDE	ND	ND	0.5	NA
	DDT	ND	23.7	8.2	NA
	Endrin aldehyde	ND	1.8	ND	NA
	Heptachlor epoxide	ND	1.0	ND	NA

Table 4 (Continued)
Marine Sediment Risk Summary

Area	Detected Chemicals	Normalized Sediment Concentration (mg/kgOC)			SMS Table III Values CSL (mg/kgOC)
		TOP (0-0.33')	MID (0.33-1.67')	BOT (1.67-3.0')	
41-MS-5	Phenanthrene	ND	4.5	ND	4s0
	Benzo(a)anthracene	8.0	ND	22.4	270
	Bis(2-ethylhexyl) phthalate	ND	34.5	ND	78
	Total Benzofluoranthenes	33.3	ND	138.8	450
	Chrysene	14.2	ND	44.8	460
	Di-n-butyl phthalate	13.6	16.7	19.2	1,700
	Di-n-octyl phthalate	16.0	34.5	103.0	4,500
	Fluoranthene	12.3	41.2	30.4	1,200
	Pyrene	13.6	8.2	24.6	1,400
	Phenol	50.0[a]	50.0[a]	ND	1,200[a]
	DDD	2.8	4.9	1.8	NA
	DDE	ND	0.5	0.7	NA
	DDT	1.8	1.8	1.8	NA
41-MS-6	Total Benzofluoranthenes	203.0	ND	ND	450
	Chrysene	78.4	ND	ND	460
	Fluoranthene	203.0	ND	ND	1,200
	Pyrene	129.2	ND	ND	1,400
	DDD	ND	1.7	3.2	NA
	DDE	ND	0.6	0.7	NA
	Phenanthrene	38.7	ND	ND	480
	Benzo(a)pyrene	28.6	ND	ND	210
	Di-n-octyl phthalate	22.1	ND	ND	4,500
	2-Methylnaphthalene	ND	ND	10.6	64
	Naphthalene	ND	ND	9.7	170
	Phenol	ND	ND	200.0’	1,200[a]
41-MS-7	Phenanthrene	ND	11.1	29.5	480
	Total Benzofluoranthenes	ND	35.0	100.1	450
	Chrysene	ND	ND	65.2	460
	Di-n-butyl phthalate	17.4	19.1	6.2	1,700
	Di-n-octyl phthalate	ND	41.3	15.8	4,500
	Fluoranthene	ND	25.4	102.9	1,200
	Pyrene	ND	36.6	85.7	1,400
	DDD	ND	2.2	ND	NA
	gamma-BHC	ND	0.8	ND	NA
41-MS-8	delta-BHC	2.1	ND	ND	NA

Table 4 (Continued)
Marine Sediment Risk Summary

Area	Detected Chemicals	Normalized Sediment Concentration (mg/kgOC)			SMS Table III Values CSL (mg/kgOC)
		TOP (0-0.33')	MID (0.33-1.67')	BOT (1.67-3.0')	
41-MS-9	Di-n-butyl phthalate	ND	ND	7.1	1,700
	Di-n-octyl phthalate	ND	17.3	ND	4,500
	Phenol	74.0[a]	ND	48.0[a]	1,200
	gamma-Chlordane	ND	ND	<0.1	NA
	Heptachlor	ND	ND	0.2	NA
41-MS-10	Di-n-butyl phthalate	ND	10.2	ND	1,700
	Di-n-octyl phthalate	15.2	43.6	ND	4,500
	Phenol*	32.0	16.0	ND	1,200
	Heptachlor	0.4	ND	ND	NA
41-MS-11	Di-n-octyl phthalate	11.8	17.2	16.6	4,500
	Diethyl phthalate	9.2	ND	ND	110
	Pyrene	ND	ND	12.8	1,400
	Phenol	38.0[a]	ND	ND	1,200[a]
	gamma-Chlordane	ND	ND	0.4	NA
	Heptachlor	ND	0.1	0.5	NA
Area 44					
44-MS-1	Total Benzofluoranthenes	ND	252.7	ND	450
44-MS-2	No Detections				
44-MS-3	Total Benzofluoranthenes	5.8	ND	ND	450
	Bis(2-ethylhexyl) phthalate	17.9	25.6	85	78
	Chrysene	7.3	ND	ND	460
	Di-n-octyl phthalate	35.8	ND	ND	4,500
	Pyrene	ND	19.5	7.7	1,400
44-MS-4	Phenol	72.0[a]	ND	ND	1,200[a]
Area 48 and 49					
48/49-MS-1	Bis(2-ethylhexyl) phthalate	ND	ND	577	78
	Di-n-octyl phthalate	ND	ND	351.9	4,500
48/49-MS-2	delta-BHC	ND	6.5	1.6	NA
	Dieldrin	ND	1.5	ND	NA
	Endosulfan II	ND	1.9	ND	NA
48/49-MS-3	No Detections				
48/49-MS-4	No Detections				

Table 4 (Continued)
Marine Sediment Risk Summary

Area	Detected Chemicals	Normalized Sediment Concentration (mg/kgOC)			SMS Table III Values CSL (mg/kgOC)
		TOP (0-0.33')	MID (0.33-1.67')	BOT (1.67-3.0')	
48/49-MS-5	delta-BHC	ND	ND	1.9	NA
	gamma-Chlordane	ND	ND	2.5	NA
	PCB-1254	ND	ND	743	65
48/49-MS-6	2-Methyhraphthalene	ND	ND	31.4	64
	Naphthalene	ND	ND	29.0	170
	Phenanthrene	30.3	ND	ND	480
	Benzo(a)pyrene	22.4	ND	ND	210
	Total Benzofluoranthenes	158.8	ND	ND	450
	Chrysene	61.4	ND	ND	460
	Di-n-octyl phthalate	17.3	ND	ND	4,500
	Phenol	ND	ND	200.0[a]	1,200[a]
	Di-n-butyl phthalate	43.3	ND	229.5	1,700
	Fluoranthene	158.8	ND	ND	1,200
	Pyrene	101.1	ND	ND	1,400
48/49-MS-7	Di-n-butyl phthalate	74.1	ND	ND	1,700
48/49-MS-8	Di-n-butyl phthalate	77.6	91.6	ND	1,700
	beta-BHC	0.3	ND	ND	NA
	delta-BHC	0.4	ND	ND	NA
	Endosulfan II	2.3	ND	ND	NA
	Endosulfan sulfate	0.7	ND	ND	NA
48/49-MS-9	delta-BHC	ND	0.6	ND	NA
	Dieldrin	0.4	ND	ND	NA
48/49-MS-10	Di-n-butyl phthalate	ND	62.5	45.6	1,700
	delta-BHC	0.6	ND	ND	NA

‘Phenol concentrations presented in $\mu g/kg$ dry weight
Notes:
ND = Not detected
NA = Not available
OC = Normalized to organic carbon
SMS = Washington State Sediment Management Standards, Chapter 173-204 WAC
CSL = Cleanup Screening Levels from SMS Table III
Shaded values represent exceedance of SMS Table III Sediment Cleanup Levels.

6.2.4 Wetland Sediments and Surface Water

Freshwater sediment was collected from four stations on the southern border of the wetland (see Figure 12). Sediment samples were collected from three depths at each station (O to 2 inches, 2 to 15 inches, and 15 to 36 inches). Nine chemicals were identified as COCS in wetland sediments; summary data for these chemicals are presented in Table 5.

Table 5
Summary Data for Chemicals of Concern in Wetland Sediment
(Areas 48 and 49) (mg/kg)

Chemical	Wetland Sediment			
	Minimum Detection	Maximum Detection	Mean[a] Concentration	Frequency of Detection[b]
Arsenic	1.40	6.75	2.56	7/8
Cadmium	0.77	0.77	0.77	1/8
Chromium	9.00	36.40	18.71	8/8
Copper	2.3	38.90	11.01	8/8
Lead	1.10	91.20	17.88	8/8
Nickel	11.00	55.6	23.80	6/8
4,4'-DDD	0.006	0.065	0.035	2/2
4,4'-DDE	0.004	0.79	0.216	4/4
4,4'-DDT	0.013	0.013	0.013	1/2

'Means were calculated by using detected concentrations only.
[b]Frequency of detection defined as number of samples with detected concentrations of a chemical/total number of acceptable samples.
Note: Data represent samples from two depths (O to 2 inches and 2 to 15 inches) from four stations along the southern boundary of the freshwater wetland.

Inorganic substances showed relatively wide distribution (a frequency of detection of 6/8 to 8/8 samples), except for cadmium, which was detected once. Mean concentrations of inorganic chemicals ranged from 0.77 mg/kg (cadmium) to 23.80 mg/kg (nickel). 4,4'-DDD, 4,4'-DDE, and 4,4'-DDT were detected at mean concentrations ranging from 0.013 mg/kg (4,4' -DDT) to 0.216 mg/kg (4,4' -DDE). Too few data were available to enable conclusions on the spatial extent of these pesticides.

A single surface water sample was collected from the wetland north of Areas 48 and 49. COCS identified in this sample included aluminum (16,700 μg/L), chromium (92.6 μg/L), copper (158 μg/L), iron (91,500 μg/L), lead (146 μg/L), mercury (0.38 μg/L), zinc (260 μg/L), 4,4'-DDD (0.1 μg/L), 4,4'-DDE (0.1 μg/L), 4,4'-DDT (O. 1 μg/L), and benzo(a)anthracene (5.5 μg/L).

7.0 SUMMARY OF SITE RISKS

The baseline risk assessment provides the basis for taking action and indicates the exposure pathways that need to be addressed by the remedial action. The identification of the chemicals of concern, exposure assessment, toxicity assessment, and risk characterization comprises the baseline risk assessment. This assessment serves as the baseline assessment indicating what risks could exist if no action was taken at the OU 4. This section of the ROD reports the results of the baseline risk assessment conducted for this site.

Both human health and ecological baseline risk assessments (RAs) were performed for OU 4 to determine the potential risks associated with chemicals identified at the site. The human health assessments were conducted in accordance with EPA's *Risk Assessment Guidance for Superfund,* Volume I: *Human Health Evaluation Manual (Part A),* EPA *Region 10 Supplemental Risk Assessment Guidance,* and the *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. The* ecological risk assessment followed federal guidance. The RA methods and results are summarized in the following paragraphs.

7.1 HUMAN HEALTH RISKS

The human health risk assessment evaluated potential risks associated with exposure to chemical contaminants from OU 4. All chemicals that were detected at least once were carried through the risk assessment. The assessment considered potential exposure to chemicals in groundwater, soil, sediment, and mussel tissues. Air (i. e., volatile chemicals released from soil) and surface water were not evaluated. Emissions of volatile chemicals from soil into outdoor air was not evaluated because the results of the soil vapor survey indicated there was no source of volatile chemicals in soil. Inhalation of volatile chemicals released into indoor air while showering, and inhalation of particulate in outdoor air, was evaluated. Surface water was not evaluated because only one of the four planned sampling locations contained surface water. It was determined that one sample station would not be an adequate representation of surface water conditions at OU 4.

7.1.1 Exposure Assessment

The purpose of the exposure assessment is to quantify contact with chemicals of potential concern identified at the site. This is accomplished by identifying the exposure media, potentially exposed populations (based on current and future land use), the routes of exposure, and quantification of human intake of chemical. Table 6 presents the populations, media, and routes of exposure that were evaluated for each area.

- **Exposed Populations**

Both current and future land uses have been considered in identifying potentially exposed populations for each area. Three populations—current recreational, current worker, and future residential—were considered. Populations evaluated for each area were as follows:

- Area 39: Current recreational visitor
  Future resident
- Area 41: Current occupational worker
  Future resident
- Area 44: Current occupational worker
  Future resident
- Areas 48 and 49: Current recreational visitor
  Future resident

Table 6
Populations, Media, and Routes of Exposure Evaluated at Areas 39, 41, 44, 48, and 49

Medium	Current Recreational			Current Worker			Future Residential		
	Ingestion	Inhalation	Dermal Contact	Ingestion	Inhalation	Dermal Contact	Ingestion	Inhalation	Dermal Contact
Area 39									
Soil	YES	YES	YES	—	—	—	YES	YES	YES
Groundwater	—	—	—	—	—	—	YES	YES	YES
Sediment	—	—	—	—	—	—	—	—	—
Mussels	—	—	—	—	—	—	—	—	—
Area 41									
Soil	—	—	—	YES	YES	YES	YES	YES	YES
Groundwater	—	—	—	—	—	—	YES	YES	YES
Sediment	—	—	—	NO	NO	NO	YES	NO	YES
Mussels	—	—	—	—	—	—	YES	—	—
Area 44									
Soil	—	—	—	YES	YES	YES	YES	YES	YES
Groundwater	—	—	—	—	—	—	YES	YES	YES
Sediment	—	—	—	NO	NO	NO	YES	YES	YES
Mussels	—	—	—	—	—	—	YES	—	—
Areas 48 and 49									
Soil	YES	YES	YES	—	—	—	YES	YES	YES
Groundwater	—	—	—	—	—	—	YES	YES	YES
Sediment	NO	NO	NO	—	—	—	YES	NO	YES
Mussels	NO	NO	NO	—	—	—	YES	—	—

Notes:
NO = Pathway not evaluated
YES = Pathway evaluated
— = Pathway is not applicable for this receptor.

- **Exposure Media and Pathways**

The following media were evaluated:

• *Area 39:*	Soil and groundwater
• Area 41:	Soil, marine sediments, mussel tissue, groundwater
• Area 44:	Soil, marine sediments, mussel tissue, groundwater, sump sediments (treated as soils)
• Areas 48 and 49:	Soil, marine sediments, mussel tissue, groundwater

Although groundwater was evaluated, groundwater exposures are highly unlikely because of hydrogeological limitations that would affect any drinking water supply wells. Because OU 4 is adjacent to marine tidal waters, the aquifer has high salinity.

For these media, the following pathways were evaluated:

• soil:	Ingestion, dermal contact, and inhalation of suspended particulate
• Groundwater:	Ingestion, inhalation of volatiles, dermal contact while bathing
• Marine Sediments:	Ingestion and dermal contact
• Mussel Tissue:	Ingestion

- **Exposure Point Concentrations**

The exposure point concentration (EPC) is calculated at the point the receptor (i.e., potentially exposed human) can come into contact with a chemical (Table 7). Average and reasonable maximum exposure point concentrations were estimated for all media. The soil values listed in Table 7 combine both surface and subsurface soils.

Table 7 presents exposure point concentrations and summary statistics for chemicals that have been found to present a potential risk of concern (i.e., cancer risk greater than 10^{-4}, a noncancer risk greater than 1, and, for lead, blood level concentrations greater than 10 μg Pb/dL for more than 5 percent of the population). The list of chemicals presented in this table is different from those identified as COCs in Section 6.2, Nature and Extent of Contaminants, which also included chemicals that exceeded state risk criteria. Table 7

Table 7
Exposure Point Concentrations for Chemicals of Potential Human Health Risk for All Media in Areas 39, 41, 44, 48, and 49

Chemical Area	Concentration (ppm)			
	Mean	95% UCL	Maximum Detected	RME
Area 39				
Soil				
Arsenic	6.6	6.6	8.5	6.6
Chromium	103	231	523	231
Lead	122	170	736	170
Groundwater				
Manganese	0.47	0.88	0.89	0.88
Area 41				
Soil				
Lead	41.8	65	298	65
Groundwater				
Benzo(k)fluoranthene	0.005	0.01	0.007	0.007
1,3-Dichloropropene	0.007	0.03	0.014	0.014
Manganese	2.1	4.4	2.6	2.6
Vinyl chloride	0.002	0.01	0.004	0.004
Area 44				
Soil				
Lead	395	834	3,150	834
Sediment				
Arsenic	29	50	48	48
Lead	2,297	3,976	3,625	3,625
Groundwater				
Manganese	0.18	0.29	0.27	0.27
Areas 48 and 49				
Groundwater				
Benzo(a)anthracene	0.002	0.003	0.006	0.003
Benzo(k)fluoranthene	0.002	0.003	0.005	0.003
Indeno(1,2,3-cd)pyrene	0.006	0.01	0.033	0.01

Notes:
95% UCL = 95% upper confidence limit of the arithmetic mean of the untransformed data set
RME = Reasonable Maximum Exposure
ppm = part per million

includes all the chemicals identified as posing a potential risk of concern in the human health risk assessment, as well as those chemicals that, when added together, posed a risk greater than 10^{-4} or 1.

- **Chemical Intake by Exposure Pathway**

Chemical intakes for each exposure pathway were calculated by combining the EPCS with other exposure parameters such as water ingestion rates, inhalation rates, soil ingestion rates, dermal absorption rates, body weights, and exposure frequencies and durations in accordance with EPA guidance.

7.1.2 Toxicity Assessment

The purposes of the toxicity assessment are (1) to weigh the available evidence regarding the potential for chemicals to have adverse effects on exposed individuals (i.e., hazard identification) and (2) to provide a quantitative estimate of the relationship between the magnitude of exposure and the likelihood or severity of adverse effects (i.e., dose response assessment). Toxicity values are derived from epidemiological or animal studies to which uncertainty factors are applied (to account for the use of animal data to predict effects on humans). The primary sources for toxicity values are EPA's *Integrated Risk Information System* (IRIS) database and the Health Effects Assessment Summary Tables (HEAST). Table 8 lists the toxicity values identified for the chemicals presenting risks of concern.

Slope factors (SFs) have been developed by EPA for estimating excess lifetime cancer risks associated with exposure to potential carcinogens. SFS are expressed in units of $(mg/kg\text{-}day)^{-1}$ and are multiplied by the estimated daily intake rate of a potential carcinogen, in mg/kg-day, to provide an upper-bound estimate of the excess lifetime cancer risk associated with exposure at that intake level. The term "upper bound" reflects the conservative estimate of the risks calculated from the SF. Use of this approach makes underestimation of the actual cancer risk highly unlikely. Slope factors are derived from the results of human epidemiological studies or chronic animal bioassays to which animal-to-human extrapolation and uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans).

Reference doses (RfDs) have been developed by EPA for evaluating the potential for adverse health effects associated with exposure to noncarcinogenic chemicals. RfDs are expressed in units of mg/kg-day, and are estimates of acceptable lifetime daily exposure

Table 8
Toxicity Values for Chemicals of Concern

Carcinogenic Effects

Chemical	Slope Factor $(mg/kg\text{-}day)^{-1}$			
	Oral	Source	Inhalation	Source
Arsenic	1.75	IRIS	51	HEAST
Benzo(a)anthracene	7.3E-1	A	6.1E-1	A
Benzo(k)fluoranthene	7.3E-1	A	6.1E-1	A
Chromium VI	—	—	4.1E+1	HEAST
1,3-Dichloropropene	1.8E-1	IRIS	1.3E-1	IRIS
Indeno(1,2,3-cd)pyrene	7.3E-1	A	6.1E-1	A
Vinyl chloride	1.9	HEAST	3.0E-1	HEAST

Noncarcinogenic Effects

Chemical	Chronic Reference Dose (RfD) (mg/kg-day)				Uncertainty Factor		Critical Effect
	Oral	Source	Inhalation	Source	Oral	Inhalation	
Arsenic	3E-4	IRIS	—	—	3		Skin, keratosis, hyperpigmentation
Chromium	5E-3	IRIS		—	500	—	None
1,3-Dichloropropene	3E-4	IRIS	5.71E-3	IRIS	10,000	30	oral-increased weight inh-nasal mucosa
Manganese (water)	5E-3	IRIS		—	1	—	oral-CNS effects inh-respiratory psychomotor

Notes:
A = The cancer slope factor for this compound has been estimated by multiplying the cancer slope factor for benzo(a)pyrene by a toxic equivalency factor taken from the new Region IV Guidance Document, U.S. EPA, 1992.
IRIS = Integrated Risk Information System (U.S. EPA database)
HEAST = Health Effects Assessment Summary Tables (U.S. EPA)

levels for humans, including sensitive individuals. Estimated intakes of chemicals of concern from environmental media (the amount of a chemical ingested from contaminated drinking water) are compared with the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied (e.g., to account for the use of animal data to predict effects on humans).

Toxicity values are only available for the oral and inhalation pathways. EPA has not published toxicity values for evaluating the dermal pathway. The agency recommends using the oral toxicity values to evaluate dermal exposure.

Because of its unique toxicity, lead does not have a verified reference dose. Instead, EPA recommends an alternative approach to evaluating lead toxicity. This approach involves using EPA's LEAD 0.5 model to estimate blood lead levels resulting from multipathway exposures. The results of this model are used to determine whether the lead present in different media at the site pose a potential risk to children.

7.1.3 Risk Characterization

The risk characterization integrates the information developed in the toxicity assessment and exposure assessment to develop carcinogenic and noncarcinogenic risks. The National Contingency Plan has determined a target for cleanup levels in the range of 10^{-6} to 10^{-4} risks. Any risks greater than 10^{-4} requires remedial action. In this section, chemicals (or a combination of chemicals in the same media) with a cancer risk greater than EPA's acceptable risk range will be discussed.

A noncarcinogenic risk greater than 1 suggests that exposure to a site chemical exceeds the reference dose and therefore may present a potential health threat.

For inorganic compounds that have been identified as chemicals of concern, a comparison with background concentrations was conducted to determine the contribution that naturally occurring levels may make to site risks. (The complete range of chemicals in different media at the site are presented in the Final RI and is part of the Administrative Record).

Tables 9 through 12 present noncancer and cancer risk summaries for each area at OU 4. Risks that exceed the EPA acceptable levels were found only for the future resident scenario. Risks are presented for groundwater; however, as discussed previously, the groundwater is not suitable for drinking because of naturally occurring salinity.

The CERCLA-based human health risk assessment showed concentrations of arsenic in mussel tissue at the upper limit of acceptability of the EPA Target Risk Range. However, the concentrations of arsenic found in mussel tissue were identical to those taken from background reference stations in both Oak and Crescent Harbors. Further, an EPA study of shellfish in Puget Sound concluded that 99 percent of the total concentration of arsenic found in shellfish is organic, which is the nontoxic form of arsenic. The remaining concentration of inorganic arsenic found in mussel tissue would show a risk below the EPA Target Risk Range. Organic chemicals (primarily PAHs) in mussel tissue were elevated relative to background mussel tissue collected from adjacent reference stations but show a carcinogenic risk only at the 10^{-6} range and no ecological risk.

The following summarizes the risks found at the five areas.

- **Area** *39*

Soil. Lead was found to pose a potential risk when the reasonable maximum exposure point concentration was used in EPA's LEAD 0.5 model. Chromium and arsenic together were found to produce the noncancer risk.

Groundwater. Arsenic and manganese were found to produce a noncancer risk. However, arsenic risks were primarily attributed to naturally occurring concentrations of arsenic.

- **Area 41**

Soil. No CERCLA risks were found.

Groundwater. Manganese was found to produce a noncancer risk. Vinyl chloride, benzo(k)fluoranthene, and 1,3-dichloropropene were found to produce cancer risks.

Table 9
Area 39—Summary of Cancer and Noncancer Risks

Medium	Route	Current Land Use				Future Land Use	
		Recreational		Occupational		Residential	
		Noncancer	Cancer	Noncancer	Cancer	Noncancer	Cancer
Soil[a]	Ingestion	2.4E-02 B	5.1E-07 B		—	1.4E+00 E	2.5E-05 R
	Inhalation	4.1E-05 B	6.0E-09 B		—	1.9E-03 B	4.8E-07 B
	Dermal	3.1E-03 B	1.5E-07 B		—	3.1E-02 B	7.4E-07 B
	Combined	2.7E-02 B	6.7E-07 B	—	—	1.4E+00 E	2.7E-05 R
Groundwater	Ingestion	—	—		—	6.7E+00 E	2.0E-05 R
	Inhalation	—	—		—	1.6E-04 B	1.3E-07 B
	Dermal	—	—		—	3.9E-02 B	6.6E-07 B
	Combined	—			—	6.7E+00 E	2.1E-05 R
Sediment	Ingestion	—	—		—	—	—
	Dermal	—	·		—	—	
	Combined			—	—		—
AU Media Total	Combined	2.7E-02 B	6.7E-07 B		—	8.1E+00 E[b]	4.8E-05 R[b]

[a]Evaluated using the child/adult integrated approach per U.S. EPA (1991) Region 10 Guidance.
[b]Excluding risk from groundwater, which is subject to saltwater intrusion, the total noncarcinogenic risk is 1.4, the total carcinogenic risk is 2.7E-05.
Notes:
B - Below or at limit of target noncancer Hazard Index (HI ≤ 1), or cancer risk (Exceeds Lifetime Cancer Risk ELCR ≤ 1×10^{-6})
E - Exceeds EPA target for noncancer Hazard Index (HI > 1), or cancer risk (ELCR > 1×10^{-4})
R - Within EPA target cancer risk range (ELCR > 1×10^{-6} and < 1×10^{-4})
— - Not evaluated.

Table 10
Area 41—Summary of Cancer and Noncancer Risks

		Current Land Use				Future Land Use	
		Recreational		Occupational		Residential	
Medium	Route	Noncancer	Cancer	Noncancer	Cancer	Noncancer	Cancer
Mussel	Ingestion	—	—	—	—	3.0E-1 B	5.3E-05 R[a]
Soil[b]	Ingestion			2.6E-02 B	1.7E-06 R	1.0E+00 E	2.5E-05 R
	Inhalation			1.6E-04 B	5.2E-06 B	4.2E-06 B	3.8E-10 B
	Dermal			5.8E-03 B	4.1E-07 B	2.2E-02 B	7.4E-07 B
	Combined	—	·	3.2E-02 B	7.3E-06 R	1.0E+ 00 E	2.6E-05 R
Ground-water	Ingestion	—	—	—	—	1.6E + 01 E	1.9E-04 E
	Inhalation	—	—	—	—	3.2E-03 B	1.6E-06 R
	Dermal	—	—	—	—	9.3E-02 B	2.2E-06 R
	Combined	—	—		—	1.6E+01 E	2.0E-04 E
Sediment	Ingestion	—	·	—	—	9.0E-04 B	1.2E-07 B
	Dermal	—				1.8E-04 B	2.4E-08 B
	Combined			—	—	1.1E-03 B	1.5E-07 B
All Media Total	Combined	—	—	3.2E-02 B	7.3E-06 R	1.7E+01 E'	2.8E-04 E'

Notes:
'Risk is due to background arsenic levels. This risk is based on the assumption that 100 percent of the arsenic that was detected in tissue is present in its inorganic form. However, research indicates that 99 percent of arsenic in seafood occurs primarily as a complex methylated or organic species and that the organic form of arsenic is less toxic and more readily excreted than inorganic arsenic. Therefore, when adjusting this risk to represent the more toxic, inorganic form of arsenic, the risk is 5.3E-07.
devaluated by using the child/adult integrated approach, per U.S. EPA 1991) Region 10 guidance.
'Excluding risk from groundwater, which is subject to saltwater intrusion, the total noncarcinogenic risk is 1.3, the total carcinogenic risk is 2.7E-05.
B = Below or at limit of target noncancer Hazard Index (HI ≤ 1), or cancer risk (Exceeds Lifetime Cancer Risk ELCR ≤ 1 X 10^{-6})
E = Exceeds EPA target for noncancer Hazard Index (HI > 1), or cancer risk (ELCR > 1 x 10^{4})
R = Within EPA target cancer risk range (ELCR > 1 x 10^{-6} and < 1 x 10^{-4})
— = Not evaluated or applicable

Table 11
Area 44—Summary of Cancer and Noncancer Risks

Medium	Route	Current Land Use				Future Land Use	
		Recreational		Occupational		Residential	
		Noncancer	Cancer	Noncancer	Cancer	Noncancer	Cancer
Mussel	Ingestion			·	—	3.1E-01 B	5.6E-05 R[a]
soil	Ingestion	—	—	2.5E-02 B	3.0E-06 R	1.3E+00 E	4.5E-05 R
	Inhalation			1.2E-04 B	2.6E-08 B	4.5E-04 B	7.8E-08 B
	Dermal	—	—	2.5E-03 B	2.9E-07 B	2.8E-02 B	1.3E-06 R
	Combined		—	2.8E-02 B	3.3E-06 R	1.3E+00 E	4.6E-05 R
Ground-water	Ingestion	—	—		·	1.7E+00 E	1.3E-05 R
	Inhalation		—	—	—	1.0E-04 B	1.3E-07 B
	Dermal	—	—		—	1.0E-02 B	6.0E-07 B
	Combined		—	—		1.7E+00 E	1.4E-05 R
Sediment	Ingestion	—	—	—	—	9.8E-07 B	1.4E-10 B
	Dermal	—	—	—	—	2.0E-04 B	2.8E-06 B
	Combined	—	—		—	2.0E-04 B	2.8E-06 B
All Media Total	Combined		—	2.8E-02 B	3.3E-06 R	3.3E-00 E'	1.1E-4[c]
sump Sediment (as soil)"	Ingestion	—		1.4E-01 B	1.5E-05 R	4.0E +00 E	1.4E-04 E
	Inhalation	—	—	4.1E-04 B	1.1E-07 B	2.7E-02 B	1.2E-07 B
	Dermal	—	—	1.5E-02 B	1.5E-06 R	9.0E-02 B	4.4E-06 R
	Combined	—	—	1.5-01 B	1.6E-05 R	4.1E+00 E	1.5E-04 E

'Risk is due to background arsenic levels. This risk is based on the assumption that 100 percent of the arsenic that was detected in tissue is present in its inorganic form. However, research indicates that 99 percent of arsenic in seafood occurs primarily as a complex methylated or organic species and that the organic form of arsenic is less toxic and more readily excreted than inorganic arsenic. Therefore, when adjusting this risk to represent the more toxic, inorganic form of arsenic, the risk is 5.6E-07.

[b]Sump sediments have been evaluated as soils in an independent, highly hypothetical assessment.

[c]Excluding risk from gronndwater, which is subject to saltwater intrusion, the total noncarcinogenic risk is 1.6, the total carcinogenic risk is 4.9E-05.

Notes:

B = Below or at limit of target noncancer Hazard Index (HI $\leq$ 1), or cancer risk (Exceeds Lifetime Cancer Risk ELCR $\leq$ 1 X 10"')

E = Exceeds EPA target for noncancer Hazard Index (HI > 1), or cancer risk (ELCR > 1 x 10^{4})

R = Within EPA target cancer risk range (ELCR > 1 x 10-' and < 1 x 10^{-4})

— = Not evaluated or applicable

Table 12
Areas 48 and 49—Summary of Cancer and Noncancer Risks

Medium	Route	Current Land Use				Future Land Use	
		Recreational		Occupational		Residential	
		Noncancer	Cancer	Noncancer	Cancer	Noncancer	Cancer
Mussel	Ingestion	–	–	–	–	4.0E-01 B	7.5E-05 R[a]
soil	Ingestion	1.5E-02 B	4.3E-07 B	–	–	4.4E-01 B	1.2E-05 R
	Inhalation	2.5E-05 B	2.5E-09 B	—		1.8E-06 B	1.8E-1OE
	Dermal	1.4E-03 B	5.6E-08 B	–		1.0E-02 B	1.0E-06 R
	Combined	1.7E-02 B	4.9E-07 B	–	–	4.5E-01 B	1.3E-05 R
Ground-water	Ingestion	—				1.2E+00 E	2.2E-04E
	Inhalation	—	.	—		2.8E-03 B	5.4E-06 R
	Dermal				—	8.0E-02 B	6.4E-07B
	Combined	—	—	—		1.3E+00 E	2.3E-04 E
Sediment	Ingestion	—	—	—		5.6E-04 B	8.7E-06 B
	Dermal	–	–	–	–	1.5E-05 B	1.8E-06 B
	Combined	—	—	—	—	5.8E-04 B	1.0E-07 B
AU Media Total	Combined	1.7E-02 B	4.9E-07 B	—	—	2.15E + OO[b]	3.1E-04 E[b]

‘Risk is principally due to background levels of arsenic. This risk is based on the assumption that 100 percent of the arsenic that was detected in tissue is present in its inorganic form. However, research indicates that 99 percent of arsenic in seafood occurs primarily as a complex methylated or organic species and that the organic form of arsenic is less toxic and more readily excreted than inorganic arsenic. Therefore, when adjusting this risk to represent the more toxic, inorganic form of arsenic, the risk is 6.1E-06.
‘Excluding risk from groundwater, which is subject to saltwater intrusion, the total noncarcinogenic risk is 0.85, the total carcinogenic risk is 1.9E-05.

Notes:
B = Below or at limit of target noncancer Hazard Index (HI ≤ 1), or cancer risk (Exceeds Lifetime Cancer Risks ELCR ≤ 1 x 10”^{6})
E = Exceeds EPA target for noncancer Hazard Index (HI > 1), or cancer risk (ELCR > 1 x 10^{4})
R = Within EPA target cancer risk range (ELCR > 1 x 10-’ and <1 x 10^{4})

- **Area** *44*

Soil and Sediment (Sumps). Arsenic was found to produce noncancer and cancer risks. In addition, lead was found to produce a human health risk.

Groundwater. Manganese was found to produce a noncancer risk. However, manganese risks were primarily attributed to naturally occurring concentrations of manganese.

- **Areas** 48 and 49

Soil. No CERCLA risks were found.

Groundwater. Manganese and arsenic were found to produce noncancer risks. However, risks from on-site manganese concentrations are similar to risks associated with background concentrations of manganese.

7.1.4 Uncertainty

Some degree of uncertainty is associated with each step of the risk assessment. Sources of uncertainty are discussed below.

- **Toxicity Assessment**

There are many toxicity assessment uncertainties associated with the database (e.g., differences in study design, species, sex, route) that is used to develop the toxicity value. The magnitude and direction of uncertainty associated with the toxicity values are unknown.

As discussed in the toxicity assessment, oral toxicity values have been used for evaluating dermal exposures. The magnitude and direction of uncertainty associated with this approach are unknown.

Although the speciation of chromium was not identified, the toxicity values used to evaluate chromium are based on the carcinogenic form of chromium (chromium VI). Using this value will probably result in an overestimate of risk, since it is unlikely that all the chromium detected on site is in its carcinogenic form.

The toxicity value for arsenic is overly conservative. The Puget Sound Estuarine Program study showed that 99 percent of the arsenic found in Puget Sound shellfish is in a nontoxic form. The arsenic analysis was for total arsenic, and it did not distinguish between the toxic and nontoxic forms. A new evaluation, assuming that one percent of the arsenic found in mussels is toxic, shows that mussel consumption up to 10 times the ingestion rate evaluated in the RI is acceptable.

- **Exposure Assessment**

The exposure assumptions used in the risk assessment are default values recommended by EPA. These values are not site-specific and are intended to be overly conservative. They are used to insure that site risks are not underestimated.

Since the groundwater is not potable, ingestion of groundwater is not likely. Thus, while the groundwater was evaluated to calculate a worst-case scenario, the result is an overestimation of total site risk.

- **Risk Characterization**

Some uncertainty is associated with the summation of risks for multiple chemicals. For example, not all noncarcinogenic chemicals have toxic effects on the same organ. Therefore, combining individual chemical noncancer risks may yield a conservative estimate.

7.2 ECOLOGICAL RISKS

A screening-level ecological risk assessment was conducted to evaluate potential toxicological threats to ecological receptors associated with contamination from OU 4.

7.2.1 Exposure Assessment

- **Terrestrial Habitat**

Areas 39, 41, and 44 are largely urbanized or industrialized and do not contain sufficient habitat to sustain ecologically functional plant or animal communities. Therefore, an ecological risk assessment of terrestrial habitats in Areas 39, 41, and 44 was not performed. The terrestrial portion of Areas 48 and 49 is dominated by a grass and brushland plant community utilized by small mammals, carnivorous mammals, and raptors. Animals primarily become exposed to chemicals present in soil by incidental ingestion of soil, consumption of plants that accumulate chemicals from soil, and ingestion of prey that accumulate chemicals from ingestion of soil and plants.

- **Marine Habitat**

The near-shore marine habitat adjacent to Areas 41, 44, 48, and 49 was also sampled to determine whether contamination had migrated to the marine sediments. The substrate of Crescent and Oak Harbors is principally mud and silt with some fine sand, coarse sand and cobble, and rocks. Organisms using the intertidal zone include algae, some benthic invertebrates (crustaceans and mussels), fish, shorebirds, waterfowl, and mammals. The substrate is not conducive to clams and only a very limited number were observed during field sampling. Organisms are exposed to sediment-borne chemicals through ingestion of sediment, direct uptake of chemicals from sediment and overlying water, ingestion of water, and ingestion of plants and prey that accumulate chemicals ii-em sediment and water.

- **Wetland Habitat**

The wetland north of Areas 48 and 49 was sampled to determine whether contamination at Areas 48 and 49 had migrated off site. The wetland is freshwater, with a semipermanent, seasonal water regime. Organisms inhabiting the wetlands include hydrophytic plants, plankton, invertebrates (insects, worms, crustaceans), waterfowl, shorebirds, amphibians, raptors, and mammals (otter, muskrat, mink, raccoon). Animals are exposed to chemicals in water and sediment through ingestion of water and sediment, ingestion of plants that accumulate chemicals from soil and water, and ingestion of prey that accumulate chemicals.

7.2.2 Toxicity Assessment

The screening-level risk assessment of potential ecological risks compared concentrations of chemicals in sediment with sediment quality values, and surface water with ambient water quality criteria. Potential exposures of terrestrial receptors to chemicals detected in the soils were compared with toxicity reference values. Toxicity reference values were selected to be protective of target organisms following chronic and continuous exposure to chemicals.

Toxicity reference values for mammals and birds were expressed as a dose and were obtained from a review of available mammalian and avian toxicological data. Toxicity values for marine sediments were either the Sediment Quality Standards (Washington State Sediment Management Standards), values obtained from other sediment toxicological data, or values derived from equilibrium partitioning for non-ionic organic chemicals. Freshwater sediment toxicity reference values were either obtained from toxicological information compiled by the Washington State Department of Ecology or derived from equilibrium partitioning for non-ionic organic chemicals. Freshwater toxicity values were either federal ambient water quality criteria or obtained from a review of available aquatic toxicity data.

7.2.3 Risk Characterization

- **Terrestrial Habitat, Areas 48 and 49**

Potential ecological risks from chemicals detected in soil in Areas 48 and 49 were evaluated by using an exposure modeling approach. Modeled receptors included the vole (a small herbivorous mammal), coyote (a carnivorous mammal), and northern harrier (a carnivorous bird). Results of exposure modeling suggest that potential risks were negligible for all chemicals and receptors, with the exception of copper and lead for the vole. However, comparison of site chemical concentrations with background concentrations and available toxicity information indicated that potential risks to vole are primarily due to background concentrations of copper and lead.

- **Marine Habitat Adjacent to Areas 41, 44, 48, and 49**

Potential ecological risks from chemicals detected in marine sediments were evaluated by comparing sediment chemical concentrations with sediment toxicity reference values and by conducting a laboratory toxicity test (e.g., MICROTOX™ chronic bacterial toxicity test). Results of toxicity tests on surficial sediment from each station showed no effect, except for station 48/49-MS-10, which confirmed a low potential for ecological impacts. Exceedance of sediment toxicity reference values was more common in subsurface sediment samples, but evidence suggests that chemical deposition was a historic process and that natural capping with clean sediment is occurring. It is concluded that the potential for adverse impacts on aquatic organisms from chemicals detected in sediments in the intertidal zone adjacent to Areas 41, 44, 48, and 49 is low.

Potential ecological risk from consumption of mussels that accumulate chemicals from the marine habitat was assessed by using an exposure model with a raccoon as the receptor. Negligible potential risk was posed to the raccoon from consumption of mussels from Areas 41, 44, 48, and 49.

- **Wetland Habitat North of Areas 48 and 49**

Potential ecological risks posed by chemicals in freshwater sediments were evaluated by comparing chemical concentrations of area sediments with sediment toxicity reference values. Arsenic, cadmium, chromium, copper, lead, nickel, 4,4' -DDD, 4,4' -DDE, and 4,4'-DDT in the upper sediment stratum (O to 15 inches) posed potential risks to aquatic organisms, whereas only nickel posed a potential risk to aquatic organisms in the subsurface sediment stratum (15 to 36 inches). Virtually all of the risks present in the wetland sediments are in the top stratum.

Ecological risks posed by chemicals in wetland surface water were evaluated by comparing the concentrations of chemicals measured in the single sample with surface water toxicity reference values. Chemicals representing potential risks to aquatic biota include aluminum, chromium, copper, iron, lead, mercury, zinc, 4,4' -DDD, 4,4' -DDE, 4,4'-DDT, and benzo(a)anthracene.

7.2.4 Uncertainty Analysis

The screening-level ecological risk assessment performed on OU 4 was based upon analytical results from soil, freshwater sediment, marine sediment, and mussel tissue and confirmatory biological data (MICROTOX™ marine sediment toxicity test). Major uncertainties associated with this approach are as follows.

- **Exposure Assessment**

    - Conservative uptake and exposure factors were used in exposure models used to evaluate potential risks to animals in the terrestrial habitat in Areas 48 and 49 and to the raccoon from consumption of mussels in Areas 41, 44, 48, and 49. Exposure and potential risk are therefore overestimated.

    - Risks from chemical exposure to terrestrial receptors were based on average and reasonable maximum exposure estimates and assumed that chemicals are uniformly distributed across a site. However, chemicals may be limited to a small portion of a site. Exposure and potential risk may therefore be overestimated.

- Risks to aquatic organisms from chemicals detected in surface water in the wetland north of Areas 48 and 49 is highly uncertain because the evaluation was based upon analytical results from a single water sample. Spatial and temporal variability in concentrations of chemicals in surface water can be great, but the magnitude and direction of this uncertainty is unknown.

- **Toxicity Assessment**

  - Toxicity reference values were not available for all chemicals. Potential risks may therefore be underestimated.

  - Toxicity reference values were often not available for target species. Therefore, values for surrogate species were used. The magnitude and direction of uncertainty associated with extrapolating toxicity values between taxonomic groups is unknown.

  - Toxicity reference values were often selected from a limited database. The magnitude and direction of uncertainty associated with these values is unknown.

  - Toxicity reference values for surface water assumed that the chemical is present in its most biologically available and most toxic form. However, the site-specific characteristics of chemicals are unknown, and chemicals are seldom found in the environment in their most toxic form. Therefore, potential risks are probably overestimated.

8.0 REMEDIAL ACTION OBJECTIVES

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

Sampling results and the risk assessment indicate some human health risk to hypothetical future residents in shallow soils, groundwater, and marine sediments. Remedial action will be conducted at those areas where there are unacceptable CERCLA human health risks and/or where chemicals exceed state standards. Several chemicals exceed Washington State's Model Toxics Control Act (MTCA) criteria at Areas 39, 41, 44, and 48. CERCLA risks were found in Areas 39 and 44.

8.1 SOILS

Remedial action objectives for surface soils in Areas 39, 41, 44, and 48 are to minimize contamination of surface water; to minimize direct contact of humans and animals with COCs; to reduce concentrations of contaminants in the surface soil and Area 44 storm drain system sediments to comply with applicable state and federal regulations; and to prevent further migration of these contaminants. Specific numeric goals for each area are presented in Table 13.

Table 13
State of Washington Cleanup Criteria

Area	Parameter	Remedial Action Objectives (mg/kg)
39	Arsenic	20
	Chromium	4(IO
	Lead	250
	PAHs (carcinogenic)	1
	4,4'-DDD	4.17
	4,4'-DDE	2.94
41	Lead	250
	4,4'-DDE	2.94
	4,4'-DDT	2.94
44	Arsenic	20
	Lead	250
48	PAHs (carcinogenic)	1

- **Area** *39 Soils*

Shallow soils in Area 39 require remedial action because the lead concentration in the southern swale would produce excessive lead concentration in blood for a hypothetical future resident. In addition, arsenic, chromium, PAHs, and pesticides were detected in excess of Washington State cleanup levels. Most of the COCS are in the top 1 to 2 feet of the soils. An isolated PAH exceedance was detected south of Building 49. Because this location is capped beneath the existing asphalt, remediation is not necessary.

- **Area 41 Soils**

Two to five cubic yards of shallow soils in Area 41 require remedial action because pesticides were detected near the foundation of Building 25 in excess of Washington State cleanup levels (see Figure 10). The one exceedance of the MTCA lead cleanup value detected did not pose a health risk. COCS exceeding MTCA cleanup levels are within 1 to 2 feet of the surface.

- **Area** *44* **Soils and Sediments**

Shallow soil and some storm drain sediments in Area 44 require remedial action because arsenic and lead concentrations would constitute a human health risk to hypothetical future residents, and exceed Washington State cleanup levels (see Figure 11).

- **Area** 48 Soils

Shallow soils in Area 48 require remedial action because elevated levels of PAHs were detected in shallow soils. The PAHs above MTCA levels were detected in the top 1 to 2 feet of the soil column.

- **Area** *49* **Soils**

No remediation is planned for Area 49 because the site does not pose a CERCLA risk and no chemicals were detected above MTCA levels.

8.2 GROUNDWATER

Groundwater sampling showed low concentrations of arsenic, manganese, VOCs, and SVOCS at Areas 39, 41, 48, and 49. However, groundwater is not a current or potential future source of drinking water at OU 4 because of saltwater intrusion and the proximity to Oak and Crescent Harbors. The COCs found in the groundwater are not migrating to the marine environment in sufficient concentrations to contribute to any risks. Therefore, there are no recommended action objectives for groundwater.

8.3 MARINE SEDIMENTS

Marine sediments will not be remediated because the marine environment would be harmed more by the cleanup activities than if the chemicals were left in place. Risk analysis has determined that there are human health risks resulting from harvesting and consumption of shellfish found at OU 4 but they are within EPA's target cancer risk range (greater than 10^{-6} and less than 10^{-4}). Some ecological risks were found in the marine sediments, most of these at lower levels in the sediment columns, indicating that a natural capping process was occurring. Screening-level biological testing indicated moderate toxicity at only one marine sediment location in Areas 48 and 49.

8.4 WETLANDS

No remediation is planned for the wetland north of Areas 48 and 49. Some low risks were determined in the wetland; however, a pathway from Areas 48 and 49 could not be found. The wetland is an old saltwater marsh that is hydrologically upgradient of OU 4. The COCs found may be attributable to other sources such as sewage treatment lagoons and upstream agricultural areas. The pesticides detected may be from past basewide spraying activities. Also, damage to the environment from any remediation is considered greater than the potential benefits of such remediation.

In an effort to establish that no pathway exists between Areas 48 and 49 and the wetland, samples will be collected at five surface water locations and four existing groundwater wells. The surface water samples will help clarify whether COCs are transported to the wetland by a stream entering from the north, by a main storm drain discharge located at the southwest corner of the wetland, of by the wastewater lagoons.

Previous sampling data indicate that Areas 48 and 49 are not a source of the metals and pesticides detected in surface water collected from the wetland.

Groundwater samples will be collected from existing monitoring wells (48/49-MWS-1, 48/49-MWS-4, 48/49-MWS-6 and 48/49-MWS-7). One surface water sample will be collected at the existing station (48/49-SW-3). Four surface water samples (48/49-SW-4, 48/49-SW-5, 48/49-SW-6, and 48/49-SW-7) will be collected at new locations. See Figure 13 for surface water and groundwater sampling locations.

All new sampling locations will be surveyed using a base coordinate system to allow relocation of the sampling points if necessary. All water samples will be analyzed for total and dissolved metals and for pesticides. The additional data will help identify potential sources of metals and pesticides exceeding freshwater quality standards and will supply information to confirm the absence of a pathway between Areas 48 and 49 and the wetland.

The current information indicates no need for remediation. Remedial activities are not envisioned as a result of this additional sampling. The potential for darnage to the wetland as a result of remediation is considered greater than the potential benefits of remediation.

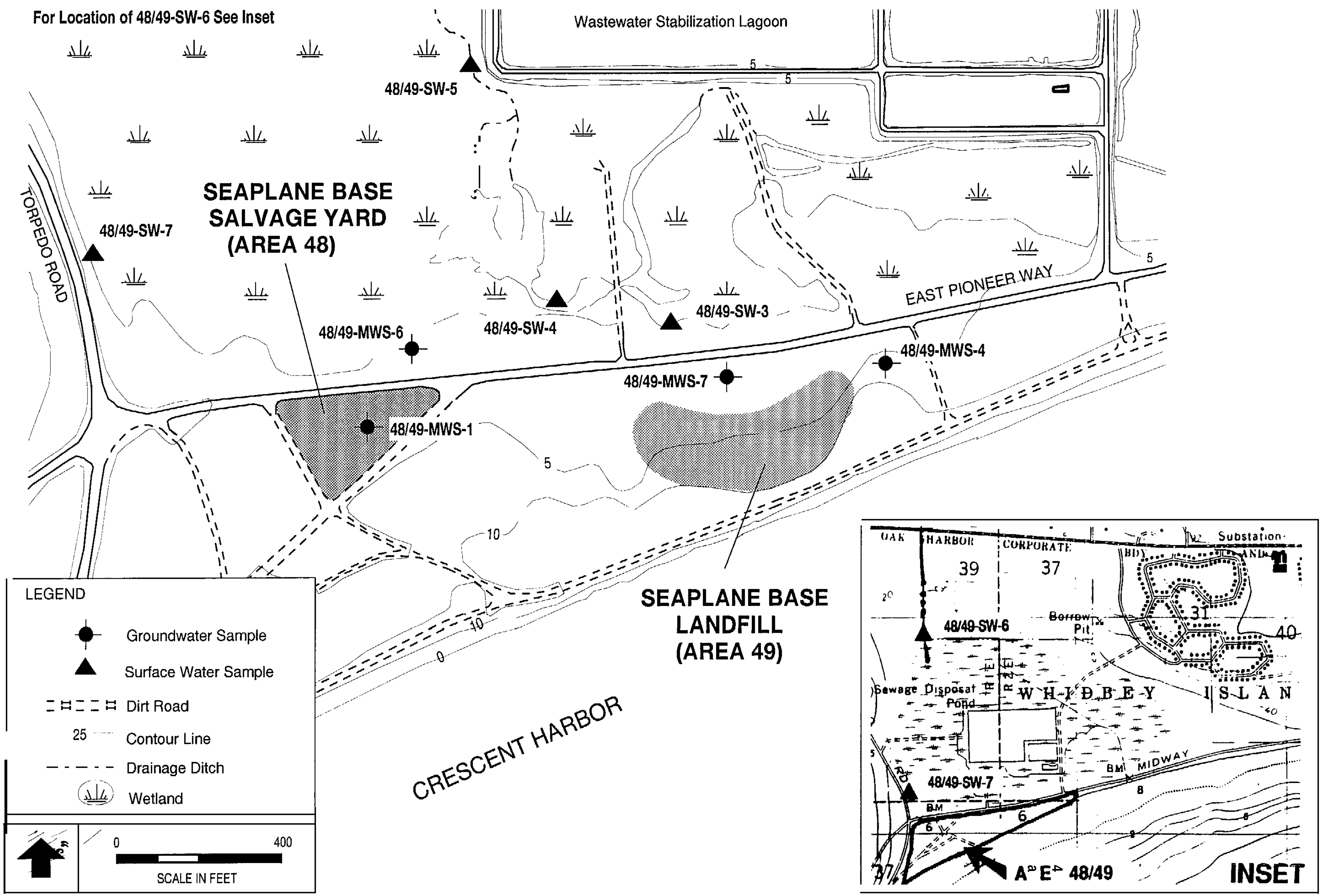
The analysis results will be submitted in a brief report to the appropriate federal and state agencies.

9.0 DESCRIPTION OF ALTERNATIVES

The results of the remedial investigation revealed that four of the five areas in OU 4 have some surface soil concentrations requiring remedial action. The principal ARAR for these remedial actions is MTCA, which lists cleanup standards. Four alternatives were evaluated as possible remedial actions. Alternative 3, soil cover, was only appropriate for Area 39 and was not considered for the other areas.

9.1 ALTERNATIVE 1: NO ACTION—AREAS 39, 41, 44, AND 48

This alternative is included for comparison purposes under CERCLA. Alternative 1 would not require any action. It does not sufficiently protect human health and the



CLEAN
COMPREHENSIVE LONG TERM ENVIRONMENTAL ACTION NAVY

Figure 13
A 48 and 49 - Proposed Surface Water and Groundwater S mp Locations

CTO 0042
OPERABLE UNIT 4
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RECORD OF DECISION

environment nor does it meet state and federal regulations for Areas 39, 41, 44, and 48. It does not remove or remediate potential contaminants detected in the surface soil or sediment at OU 4 and, therefore, results in a risk to human health and the environment.

9.2 ALTERNATIVE 2: LIMITED ACTIONS—AREAS 39, 41, 44, 48, AND 49

Limited actions are physical or administrative controls that could prevent or reduce exposure to chemicals of concern on all of the areas. These actions do not reduce the toxicity, mobility, or volume of contaminated soil or sediment. Limited actions proposed are the installation of fencing to prevent public access, warning signs, and drainage devices to control sediment transport during storm events (sediment traps); restriction of future land use; and monitoring and reporting on the contaminated soil and sediment in the areas. For Areas 39, 41, 44, and 48, this remedy may not be applicable because off-area migration of surface soils may still occur by air or surface water transport. If and when the Navy transfers the Area 49 property to another owner, the deed will contain a notification that the property contains a past construction and demolition debris landfill.

This alternative, with the exception of the Area 49 deed notification, can be commenced within a 15-month period after the ROD is signed.

9.3 ALTERNATIVE 3: SOIL COVER-AREA 39

Soil cover for Area 39 was considered an appropriate method of limiting soil contact around Building 49. The cover would consist of a 6-inch-thick soil layer that is sloped and vegetated to prevent erosion. The cover would be approximately 6,400 square yards in area, covering all of Area 39, including the drainage ditch and swale. Institutional controls would have to be implemented to maintain the integrity of the cover and to prevent its removal. Restrictions would have to be placed on the use of this area. There would be a short-term impact on the flora and fauna at this area until vegetative cover was replaced.

The soil cover was not considered applicable to Areas 41 and 44 because much of the area is paved and each of the locations requiring remediation is less than 10 square yards. At Area 48 a soil cover was not considered because of long-term operations and maintenance cost considerations.

This alternative could commence within a 15-month period after the ROD is signed.

9.4 ALTERNATIVE 4: EXCAVATION, TRANSPORTATION, AND DISPOSAL (ON STATION OR OFF-SITE, WITH OR WITHOUT STABILIZATION) -AREAS 39, 41,44, AND 48

It is a soil removal alternative that disposes of the excavated materials at a location depending on the classification of the material. Controls for dust and accidental release of the excavated soils would be implemented during excavation. The excavated areas would be filled with noncontaminated material and restored to preexcavation condition. In the sumps and catch basins of Area 44, pumping equipment or hand removal would be required to remove trapped sediments.

The excavated soils need to be characterized to ensure that they are disposed of in a manner that is protective of human health and the environment and in compliance with Washington State and federal regulations.

By federal and Washington State definition (40 C.F.R.§ 261.2 and WAC 173-303 - 016(3)(a)), these soils are contaminated media. The State of Washington requires generators of solid waste to determine whether the waste is a "dangerous waste" or an "extremely hazardous waste," using the procedures in WAC 173-303-070 through 103. These procedures will be followed to characterize the soils removed during remediation actions.

If, through testing, it is determined that the excavated soils (and sediments for Area 44) are classified as "dangerous waste" or "extremely hazardous waste," the excavated materials from each area would be disposed of off site at an approved disposal facility. If, on the other hand, the excavated material is not classified as a "dangerous waste" or "extremely hazardous waste," it would be disposed of at the on-station landfill (Area 6) without stabilization. The on-station landfill is presently being closed, and OU 4 soils would be used as subgrade material for the landfill cap.

The transfer of this soil to Area 6 landfill at Ault Field will be done according to the NCP. The preamble of the NCP states that when noncontiguous facilities are reasonably close to one another and wastes at these sites are compatible for a selected treatment or disposal approach, CERCLA section 104(d)(4) allows the lead agency to treat these related facilities as one site for response purposes and, therefore, allows the waste transferred between such noncontiguous facilities without having to obtain a permit (FR 1407; 55 FR 8690-91).

This alternative can be commenced within a 15-month period after the ROD is signed.

The following general methodologies will be used for removal of soil (and, in Area 44, storm drain sediments).

- **Area** *39*

Surficial soils (approximately 256 cubic yards) would be excavated (see Figure 9). Three confirmatory soil samples would be taken from evenly spaced areas at the bottom of the excavation of the southern swale and one sample each at the other areas of concern shown on Figure 9. The samples will be analyzed only for those constituents listed in Table 13 for Area 39. In the event that chemical concentrations are below the remedial action objectives listed in Table 13, excavation will stop and clean fill will be added to the site.

Any sample location that exceeds the remedial action objectives will require further excavation until these objectives are attained. The excavation will be backfilled with clean soil. After filling operations are completed, the area will be graded to conform with surrounding terrain, and revegetated.

- **Area 41**

Up to 5 cubic yards will be excavated from the edges of the Building 25 foundation where remedial action objectives were exceeded (see Figure 10). One confirmatory soil sample will be taken from each of the two excavations and analyzed for the compounds listed in Table 13 for Area 41. The excavations will be backfilled with clean soil. After filling operations are completed, the area will be graded to conform with surrounding terrain.

- **Area** 44

Approximately 20 to 30 cubic yards of surface soils are to be excavated at the northern edge of the old concrete apron and sediments are to be removed from the storm drain sumps, catch basins, and manholes at Area 44 (see Figure 11). Surface soils with lead and arsenic exceedances will be excavated to a depth of 1 to 2 feet. Two confirmatory soil samples will be taken from the excavation and analyzed for the compounds listed in Table 13 for Area 44. The surface soil excavations will be backfilled with clean soil. After filling operations are completed, the area will be graded to conform with surrounding terrain. Sediments from the storm drain will be removed until the sumps, catch basins, and manholes are clean upon visual inspection.

- **Area** *48*

It was agreed that a maximum of 1,000 cubic yards would be removed from Area 48, from the triangle formed by 48/49-MW-5-l, 48/49-S-5, and 48/49-S-6 wells and soil borings. The excavated area is 1,500 square yards; maximum depth is 2 feet. The area of concern is shown in Figure 12. Three confirmatory soil samples would be taken from evenly spaced areas at the bottom of the excavation. The samples will be analyzed for those constituents listed in Table 13 for Area 48. The excavation will be filled to the original height with clean fill, graded to conform with the surrounding terrain, and revegetated. At the option of the Navy, the excavation may be used to form a wetland.

10.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The EPA has established nine criteria for the evaluation of remedial alternatives. The four remedial action alternatives were evaluated against these criteria.

The following section presents a brief discussion of each of the alternatives relative to the evaluation criteria.

10.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The primary risk to human health and the environment is through direct contact or ingestion of contaminants in the soils. Alternative 4 is considered protective of human health and the environment because treatment or disposal in a landfill of contaminated soils reduces the possibility of direct contact or ingestion or release to the surface water, air, or groundwater. Alternative 3 prevents direct contact and ingestion of contaminants in the soils at Area 39 by capping and reduces the possibility of release to the surface water and air but not to groundwater.

Alternatives 1, and 2 would not adequately address this threat because the potential for direct contact, ingestion, or releases to the surface water, air, and groundwater at OU 4 would continue to exist at Areas 39, 41, 44, and 48.

10.2 COMPLIANCE WITH ARARs

Alternative 4 meets all federal and state ARARs.

Alternatives 1, 2, and 3 for Areas 39, 41, 44, and 48 do not remove contaminated soil that exceeds the State of Washington's MTCA Method B cleanup standards for direct exposure to soils.

10.3 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Because of the volume of contaminated soil and the types of contaminants present, treatment options were not found to be practicable and they were not considered in any of the alternatives.

Alternative 4 removes the soils from the site and disposes of the excavated material at controlled landfills, where mobility is reduced. The volume of contaminated material is reduced at OU 4; however, the toxicity of the soil is not reduced.

Alternative 3 reduces the mobility of contaminants through containment; however, it does not reduce toxicity or volume.

Alternatives 1 and 2 do not treat the contamination; therefore, this criterion is not met by these alternatives. There is no reduction of toxicity or volume with either alternative.

10.4 SHORT-TERM EFFECTIVENESS

There are two basic considerations when evaluating alternatives for this criterion: (1) whether the alternative creates human health or environmental concerns during remediation and (2) the length of time the alternative takes to achieve the established objectives.

Alternatives 1 and 2 do not create any adverse human health or environmental concerns during remediation because they include only limited site activities. However, neither alternative accomplishes the established objectives for Areas 39, 41, 44, and 48 of being protective of human health and the environment.

Alternatives 3 and 4 effectively achieve established objectives in a short time period. During remediation, some particulate emissions can be expected from excavation activities in Alternative 4. However, dust control methods and careful implementation of site-specific safety protocols would effectively minimize these risks. No adverse effects are anticipated from implementation of Alternative 3.

10.5 LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 4 is both effective and permanent. With these alternatives, contaminated soil is removed from the location where possible exposure could occur, to a permitted landfill for waste disposal.

Alternative 1 does not establish barriers to possible exposure to contaminated soil and both Alternative 1 and 2 leave contaminated soil at the site following remediation. Therefore, they are not considered effective in mitigating risks from the areas. Alternative 3 is effective in creating a barrier (i.e., the soil cover) to exposure, but the cover could be disturbed, exposing the contaminated soils.

10.6 IMPLEMENTABILITY

All alternatives are readily implementable. There are no known technical or administrative barriers to any of the alternatives.

10.7 COST

The estimated capital and operations and maintenance costs for each alternative are summarized in Table 14. Net present worth costs are also summarized and are based on 10 years of operations and an assumed annual discount rate of 5 percent. The cost estimates provide an accuracy of +50 percent to -30 percent, in accordance with EPA guidelines.

Table 14
Cost Comparison for Each Alternative by Area

	Area Cost			
Alternative	**Area 39**	**Area 41**	**Area 44**	**Area 48**
. No Action	Capital Cost $0 Annual O&M $0 Present Worth $0	Capital Cost $0 Annual O&M $0 Present Worth $0	Capital Cost $0 Annual O&M $0 Present Worth $0	Capital Cost $0 Annual O&M $0 Present Worth $0
:. Limited Action/ Institutional Controls	Capital Cost $94,000 Annual O&M $20,000 Present Worth $248.000	Capital Cost $10,000 Annual O&M $6,000 Present Worth $59.000	Capital Cost $10,000 Annual O&M $6,000 Present Worth $59.000	Capital Cost $18,000 Annual O&M $5,000 Present Worth $57.000
i. Soil Cover	Capital Cost $3,700 Annual O&M $s00 Present Worth $7,800	NA	NA	NA
. . Excavation, Off-Site Transport				
a. Off-Site Disposal with Stabilization	Capital Cost $232,000 Annual O&M $0 Present Worth $232,000	Capital Cost $5,000 Annual O&M $0 Present Worth $5.000	Capital Cost $17,000 Annual O&M $0 Present Worth $17,000	Capital Cost $550,000 Annual O&M $0 Present Worth $550,000
b. On-Station Disposal without Stabilization	Capital Cost $10,000 Annual O&M $0 Present Worth $10,000	Capital Cost $2,000 Annual O&M $0 Present Worth $2,000	Capital Cost $2,000 Annual O&M $0 Present Worth $2,000	Capital Cost $39,000 Annual O&M $0 Present Worth

Note:
NA = not applicable

10.8 STATE ACCEPTANCE

Ecology concurs with the selected remedial action at the Seaplane Base, and has been involved in the development and review of the RI, FS, Proposed Plan, and ROD. Ecology comments have resulted in substantive changes in these documents, and the Agency has been integrally involved in determining which cleanup standards apply to contaminated soil under MTCA.

10.9 COMMUNITY ACCEPTANCE

Comments received during the public comment period (August 15 through September 16, 1993) indicate that the public accepted the Proposed Plan.

11.0 THE SELECTED REMEDIES

Based upon consideration of the requirements of CERCLA, the detailed analysis of the alternatives using the nine criteria, and public comments, both the EPA and State have determined that Alternative 2 (deed restrictions) and Alternative 4 (excavation and on-station or off-site disposal of excavated soils at a landfill) are the most appropriate remedy for Operable Unit 4, Areas 39, 41, 44, 48, and 49 at the Seaplane Base.

The selected remedy for Area 49 is to place a notification of past construction and demolition debris landfill on the deed when and if the Navy disposes of the property (Alternative 2). No COCS were detected above federal or state standards in this Area. Although inorganic and organic chemicals were detected in groundwater, this groundwater is not considered potable because of saltwater intrusion. The remedy therefore meets state and federal regulatory standards. There are no costs, other than normal administrative costs, for the implementation of this remedy.

Excavation of contaminated soils and on-station disposal at the Ault Field landfill in Area 6 (Alternative 4) is the selected remedy for Areas 39, 41, and 48. This involves removal and disposal of approximately 456 cubic yards of surface soil from Area 39, 5 cubic yards of shallow soils from Area 41, and approximately 1,000 cubic yards of surface soil from Area 48. The estimated capital costs of this component of the remedy are: Area 39, $10,000; Area 41, $2,000; Area 48, $39,000. There are no associated annual O&M costs.

For Area 44, the selected remedy (Alternative 4) is excavation, treatment if needed, and off-site disposal at an approved landfill of 1 cubic yard of sediment and approximately 30 cubic yards of surface soil. The estimated capital cost of this component of the remedy is $17,000. There is no associated annual O&M cost.

The soil removal from Areas 39, 41, 44, and 48 will meet regulatory soil cleanup standards established under WAC 173-340 (MTCA) for the COCs. MTCA cleanup standards for individual chemicals correspond to a risk-based cancer risk of 10^{-6} and a Hazard Index less than 1. The storm drain sumps, catch basins, and manhole in Area 44 will be visually inspected to confirm that they are clean following removal of the sediment. The removal will be conducted in compliance with WAC 173-303, which governs the identification and disposal of soils classified as dangerous waste.

Actual or threatened releases of hazardous substances from these Areas could present a potential threat to public health, welfare, or the environment. The removal of the contaminated soils, which will be limited in scope and will be performed in compliance with federal and state regulations, precludes any future water transport of these soils or infiltration of leachate into the groundwater. It will allow unlimited use of these sites with low uncertainty of risk to human health and the environment.

Alternative 4 complies with state and federal regulations and ARARs. It employs permanent solutions and treatment technologies to the maximum extent practicable in achieving the best balance among the evaluation criteria of long-term effectiveness and permanence, reduction in mobility through removal, short-term effectiveness, implementability, and cost. Because of the volume of affected soil and the types of chemicals present, treatment was not found to be practicable.

12.0 STATUTORY DETERMINATION

Under CERCLA, Section 121, the selected remedies must be protective of human health and the environment, comply with applicable or relevant and appropriate requirements, be cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as their principle element. The following sections discuss how the selected remedy meets these statutory requirements. Also, at some of the proposed locations for remedial action, the Navy opted to remove soil to achieve its goal of unrestricted use of the Areas with no future monitoring requirements.

12.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedial actions will protect human health and the environment by removing contamination from the site and disposing of the contaminated soil from Areas 39, 41, 44, and 48 in a controlled landfill. There are no critical habitats, threatened or endangered species, floodplains, or historical preservation sites within OU 4 requiring consideration during the RI/FS process.

12.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The selected remedy of soil removal will comply with all state and federal ARARs.

12.2.1 Action-Specific

Hazardous Waste Management Act, 42 U.S.C. sec. 6901 et seq.; RCRA Subtitle C, 40 C.F.R.§§ 260-268; Washington State Dangerous Waste Regulations, WAC 173-303. These regulations designate waste as hazardous and establish standards for generators of hazardous wastes for treating, storing, and shipping these wastes. This is applicable to soils and sediments that are excavated and designated as hazardous waste.

The Clean Air Act, Section 101, *42* U.S.C. Sections 7405, 7601; Washington General Regulations for Air Pollution Sources, WAC 173-400. These requirements are applicable to sources of fugitive dust that are generated during the remediation efforts and must be controlled to avoid nuisance conditions.

Federal and State of Washington Occupational Safety and Health Regulations 29 C.F.R.§ 1926, WAC 296-62 part P. These requirements establish applicable health and safety standards for workers engaged in hazardous waste investigations.

Hazardous Materials Transportation Act, 49 C.F.R.§ 171-172. These regulations are applicable to the transportation of potentially hazardous materials, including samples and wastes.

12.2.2 Chemical-Specific

RCRA Subtitle C, 40 C.F.R.§ 261. This regulation is applicable in identifying if the soil excavated from the area is considered a hazardous waste for purposes of transporting them off-site for treatment or disposal.

Washington Model Toxics Control Act, WAC 173-340. This regulation is applicable when establishing cleanup standards.

Washington Dangerous Waste Regulations, WAC 173-303. These regulations are applicable in determining whether the soil excavated from the area is considered a dangerous waste for purposes of transporting it off site for disposal or treatment.

12.2.3 Location-Specific

Coastal Zone Management Act, 16 U.S.C. sec. 1451 et seq. and Washington State Shoreline Management Act of 1971, WAC 173-14. This requirement establishes procedures applicable to construction work that occurs within 200 feet of the shoreline.

12.3 COST EFFECTIVENESS

For Areas 39, 41, 44, and 48, Alternative 4 is protective of human health and the environment, and complies with ARARs. For Areas 39, 41, and 48, on-station disposal is less costly than off-site disposal. Area 44 surface soils and storm drain sediments are likely to require off-site disposal with stabilization because of the high concentration of lead in the soil. The quantity of material was too small for other alternatives to be considered. The selected remedies provide an overall effectiveness proportional to their costs, such that it represents a reasonable value for the money that will be spent.

For Area 49, Alternative 2 is protective of human health and the environment, complies with ARARs, and can be implemented at the lowest cost compared to other alternatives.

12.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES OR RESOURCE RECOVERY TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE

The selected remedies represent the best balance of tradeoffs among the alternatives evaluated. They provide a high degree of permanence, use treatment to the maximum extent practicable, do not negatively impact human health or the environment during remediation, can be completed in a short time, and are cost-effective.

The selected remedies were chosen primarily because they comply with MTCA, an applicable regulation.

The selected remedies meet the statutory requirements to use permanent solutions to the maximum extent practicable. Treatment of soil from all areas, except the sumps and catch basins of Area 44, is impractical. Concentrations of chemicals of concern do not warrant treatment prior to disposal, except for lead levels from Area 44.

12.5 PREFERENCE FOR TREATMENT AS PRINCIPAL ELEMENT

Surface soils and sediments from the storm drain system of Area 44 will be treated prior to disposal if they are designated as dangerous or extremely dangerous waste. All other excavated soil will be placed in a controlled environment, the Area 6 landfill, which is being closed.

13.0 DOCUMENTATION OF SIGNIFICANT CHANGES

The only significant change that has taken place for this ROD is the combining of Alternative 4 (excavation, transportation, and off-site disposal with stabilization) and Alternative 5 (identical to Alternative 4 but with on-station disposal and no stabilization). Alternatives 4 and 5 were presented in the *Feasibility Study* and *Proposed Plan*. However, these alternatives were similar enough to combine them in the *ROD*.

Alternatives 4 and 5 have been combined as a single alternative: Alternative 4, Transportation and Disposal (On-Station or Off-Site With or Without Stabilization), Areas 39, 41, and 48.

ATTACHMENT A

RESPONSIVENESS SUMMARY

OVERVIEW

Naval Air Station Whidbey Island Seaplane Base is located in Island County, Washington, at the northern end of Puget Sound and the eastern end of the Strait of Juan de Fuca. It is located on the northern portion of Whidbey Island, adjacent to the City of Oak Harbor. Operable Unit 4 consists of five areas within the Seaplane Base. These five areas are:

- Area 39: former Auto Repair and Paint Shop
- Area 41: former Building 25 and Building 26 Disposal Area
- Area 44: former Seaplane Base Nose Hangar
- Area 48: former Seaplane Base Salvage Yard
- Area 49: former Seaplane Base Landfill

These areas of NAS Whidbey Island Seaplane Base were placed on the NPL in February 1990.

Contaminated materials from Areas 39, 41, 44, and 48 will be removed and disposed of either at the Area 6 landfill or at an off-site landfill. The chemical concentrations of both soils and sediments will be assessed in order to determine if the material should be disposed of on or off site. If chemical concentrations in the excavated materials are classified as “dangerous waste” or “extremely hazardous waste,” following the procedures in WAC 173-303-070 through 103, they will be disposed of off site. In the event that these materials are not classified as “dangerous” or “extremely hazardous,” they will be disposed of at the Ault Field Area 6 Landfill. No action will be taken at Area 49 except to place wording in the deed when and if the Navy disposes of the property stating that the area is the site of a previous construction and demolition debris landfill.

This responsiveness summary addresses public comments on the proposed plan for remedial action at Operable Unit 4. The comments were submitted to the Navy during the public comment period, which opened August 16, 1993, and closed September 15, 1993.

A public meeting was held on September 1, 1993, in Oak Harbor, Washington, at the Chief Petty Officers' Club. No members of the general public attended and no comments were received during the meeting. A transcript of the proceedings of the public meeting is part of the administrative record. Two letters were received during the public comment period. Comments are grouped according to similar concerns or questions and addressed by topic area.

1. RESPONSE TO COMMENTS ON RI/FS

No comments were received on the RI or FS reports.

2. *SUMMARY* OF COMMENTS ON PROPOSED PLAN

There were two letters with comments on the proposed plan. The comments are summarized below, with responses.

Comment

One commenter agreed with the selection of Alternative 4, disposal of excavated soils in Area 6 landfill, but recommended that excavated soils be properly placed in the landfill, an appropriate cap be placed over the soils, and regional groundwater issues for the Area 6 landfill be evaluated.

- **Response**

The soils and sediments excavated from OU 4 will be disposed of according to the State of Washington's Dangerous Waste Regulation, Chapter 173-303 of the Washington State Administrative Code (WAC), Minimum Functional Standards for Solid Waste Handling Chapter 173-304 (WAC), and Title 40 of the Code of Federal Regulations (C.F.R.). A Minimum Functional Standard (MFS) cap will be placed over the Area 6 landfill operations area. The MFS cap consists of a 50-mil flexible membrane liner underneath a layer of vegetated soil. This cap has been chosen because it is a more effective leachate barrier than clay caps and it is easily implemented. It is the standard cover required for closure of solid waste landfills and is considered one of the more advanced capping techniques.

Area 6 groundwater issues are discussed in the Responsiveness Summary section of the ROD for OU 1. Groundwater in the shallow, intermediate, and deep aquifers in Area 6 will continue to be monitored even after the MFS cap is in place.

Comment

A second commenter requested more information on the impacts of Areas 39, 41, and 44 on the adjacent Oak Harbor sediments.

- **Response**

Detailed information on the human health risks of offshore sediments adjacent to Areas 39, 41, and 44 can be found in Section 6.0 of the *Final Remedial Investigation Report.* The risk assessment conducted under CERCLA for the RI/FS, and described in this ROD, indicate that neither offshore sediments nor mussel ingestion pose an unacceptable threat to human health or the environment.

Although some risk in consuming mussels was found, it was due to background levels of arsenic. Further, the Puget Sound Estuarine Program study showed that 99 percent of the arsenic found in Puget Sound shellfish is in a nontoxic form. Mussel consumption, therefore, does not represent an unacceptable risk. Chemicals of concern were found in the marine sediments offshore of the Areas; however, all were detected in concentrations significantly below cleanup levels, except at three stations. These three detections occurred in the deepest sediments and do not pose a problem because they are not in the biologically active zone.

Comment

A request was made to compare results from OU 4 with the Puget Sound Environmental Atlas for Region 4.

- **Response**

The concentrations of the organic compounds PAHs and PCBs and of the metals arsenic, cadmium, copper, mercury, lead and zinc detected in the remedial investigation for the Seaplane Base were compared with the range of concentrations provided in a publication called the Puget *Sound Environmental Atlas for Region 4*, which presents water and sediment quality data for the entire Puget Sound. The maximum concentration of copper (86.7 ppm) in subsurface sediment in Area 44 is slightly higher than the concentration range in the *Atlas* (less than 50 ppm).

Lead was detected at 42.9 ppm in surface sediments and 151 ppm in subsurface sediments in Area 41. The lead concentration range provided in the *Atlas* was less than 30 ppm.

All the other metals and the PAHs and PCBS were within the range of concentrations provided in the *Atlas*.

A prohibited commercial shellfish growing area for Oak Harbor is shown in the *Atlas* as well as a prohibited zone within one-half mile of the sewage outfall in Crescent Harbor.

Comment

The second commenter also asked how the proposed remedies would comply with any possible changes in the water quality or sediment.

- **Response**

With all affected soils and sediments at OU 4 removed, no future impacts on the marine environment due to water transport of these affected soils or infiltration of leachate into the groundwater from these soils can occur. It should be noted that the groundwater at OU 4 is not a source of drinking water.

If, in the future, site conditions change or if new information is discovered, the operable unit can be reevaluated or Washington State can request the Navy to take action and clean up art area.

Comment

The second commenter wanted to know what the potential impacts on tribal people harvesting shellfish in the areas of Oak Harbor and Crescent Harbor would be.

- **Response**

During the remedial investigation, it was determined that harvestable clams do not appear in Oak Harbor and Crescent Harbor; they were found only at Polnell and Forbes Point. These findings have been verified by the Island County Health Department.

The human health risk assessment determined that there is no human health risk from ingestion of mussel tissue from either Oak Harbor or Crescent Harbor. The risk assessment in the RI showed a risk in consuming mussels; however, this risk is due almost solely to arsenic that was found at background levels. Further, the Puget Sound Estuarine Program study showed that 99 percent of the arsenic found in Puget Sound shellfish is in a nontoxic form. The arsenic analysis was for total arsenic, and it did not distinguish between the toxic and nontoxic forms. A subsequent evaluation, assuming that one percent of the arsenic found in mussels is toxic, shows that of the mussel consumption up to 10 times the ingestion rate evaluated in the RI is acceptable.