FINAL
RECORD OF DECISION

OPERABLE UNIT 7
NAVAL SUBMARINE BASE, BANGOR
SILVERDALE, WASHINGTON

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April 1996

DECLARATION OF THE RECORD OF DECISION

SITE NAME AND LOCATION

Naval Submarine Base, Bangor
Operable Unit 7
Silverdale, Washington

STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents the selected actions for Operable Unit 7 (OU 7) at the Naval Submarine Base (SUBASE), Bangor in Silverdale, Washington. These actions were chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practical, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The decisions documented in this ROD are based on the Administrative Record for OU 7. OU 7 was created for miscellaneous sites that were not related to sites in other operable units. OU 7 consists of 10 sites: Sites B, 2, 4, 7, 10, 18, 26, 30, E, and 11. Although not part of OU 7 as defined in the Federal Facility Agreement (FFA), a decision was made to study three ecological areas—Cattail Lake, Hunter's Marsh, and Devil's Hole—in conjunction with the 10 sites.

The lead agency for these decisions is the U.S. Navy (Navy). The U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) have participated in scoping the site investigations and in evaluating alternatives for remedial action. The EPA and Ecology concur with the selected remedies.

ASSESSMENT OF THE SITE

The no-action alternative was determined most appropriate for Sites 4, 7, 18, and 30, and the three ecological areas (Cattail Lake, Hunter's Marsh, and Devil's Hole) because associated site risks are within the acceptable risk range established by the EPA. Because of some uncertainties in the risk results, Sites 10 and 26 require monitoring only. Further action alternatives were evaluated for the remaining Sites B, 2, E, and 11. Actual or threatened releases of hazardous substances from the action sites, if not addressed by implementing the response actions selected in this ROD, may pose a current or potential threat to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDIES

The selected remedy for the action and monitoring sites are the following:

- Site B—The selected remedy is to provide a vegetative soil cover for preventing direct contact with contaminated soil by site visitors and to determine whether groundwater discharge into Hood Canal is affecting marine sediments or ecological receptors.

- Site 2—The selected remedy for the stockpiled soil is to screen the metallic debris from the soil and reclaim or properly dispose of the debris to prevent direct contact with and ingestion of contaminated soil by humans and to protect ecological receptors. The screened stockpiled soil will be tested and used on site for backfill or properly disposed of off site based on the analytical results.

- Site 10—The selected remedy includes maintenance of the asphalt pavement, institution of groundwater use limitations, and groundwater monitoring.

- Site 26—The selected remedy is sediment and clam tissue monitoring to track the detected chemicals that exceeded Sediment Management Standards and to establish trends.

- Sites E and 11—The selected remedy is to transport the stockpiled soil off site for proper disposal to prevent direct contact with and ingestion of the soil. The groundwater is being remediated by a pump-and-treat system installed at a contiguous operable unit.

DECLARATION

No-Action Sites:

No remedial action is necessary to ensure protection of human health and the environment at the no-action sites. No further monitoring or investigative studies will be conducted for these sites. A 5-year review is not required.

The Navy used EPA guidelines and the information developed during the remedial investigation to evaluate the potential adverse effects on human health and the environment associated with exposure to site chemicals. The potential exposure of workers and residents to chemicals detected at each site was estimated for current and future scenarios. The evaluation, performed according to EPA's NCP and policy guidance, indicated that no action is necessary to be protective of human health and the environment and that calculated risks from exposure to chemicals detected at the sites are within the EPA's acceptable risk range.

Action/Monitoring Sites:

Each selected remedy for the action sites is protective of human health and the environment, is in compliance with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. To the maximum extent practicable, these remedies use permanent on-site solutions and innovative treatment or resource recovery technologies. The selected remedy for Site 2 involves on-site treatment of debris-contaminated soil and therefore satisfies the statutory preference for remedies employing treatment that reduces toxicity, mobility, and volume. At Sites B, 10, and 26, and for the stockpiled soil at Sites E and 11, treatment was found to be not practicable, and the remedies do not satisfy the statutory preference for treatment as a principal element. The groundwater at Sites E and 11 is to be included in the pump-and-treat program conducted under OU 2. The OU 2 remedy satisfies the statutory preference for remedies that employ treatment as a principal element to reduce toxicity, mobility, and volume. At those sites where the selected remedial action results in hazardous substances, pollutants, or contaminants remaining at the site, each remedial action will be reviewed no less often than every 5 years to ensure that human health and the environment are being protected.

Signature sheet for the foregoing SUBASE, Bangor Operable Unit 7, Remedial Action, 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 Michael J. Landers SUBASE, Bangor Commanding Officer United States Navy	4-12-96 Date

Signature sheet for the foregoing SUBASE, Bangor Operable Unit 7, Remedial Action, Record of Decision between the U.S. Navy and the U.S. Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

Randall F. Smith — April 16, 1996

for Chuck Clarke
Regional Administrator, Region 10
U.S. Environmental Protection Agency

Date

Signature sheet for the foregoing SUBASE, Bangor Operable Unit 7, Remedial Action, Record of Decision between the U.S. Navy and the U.S. Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

Mary E. Burg ______________________ Date 12 April 1996

Mary Burg, Program Manager
Toxics Cleanup Program
Washington State Department of Ecology

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ABBREVIATIONS AND ACRONYMS

ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BH	boring hole
CAD	computer-aided design
CCA	chromated copper arsenate
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
cm	centimeter
cm/s	centimeters per second
cm/yr	centimeters per year
COC	chemical of concern
COI	chemical of interest
COPC	chemical of potential concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSL	Cleanup Screening Level
CWA	Clean Water Act
2,4-D	2,4-dichlorophenoxyacetic acid
DDT	dichlorodiphenyltrichloroethane
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FFA	Federal Facility Agreement
FR	Federal Regulation
FS	feasibility study
ft	foot
gpm	gallons per minute
GPR	ground-penetrating radar
HI	hazard index
HPAH	high molecular weight PAH
HQ	hazard quotient
IRIS	Integrated Risk Information System
kVA	kilovoltampere
LPAH	low molecular weight PAH
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MLLW	mean lower low water
mg/kg	milligrams per kilogram
mg/kg-dw	milligrams per kilogram dry weight
mg/kg-oc	milligrams per kilogram carbon normalized
μg/kg	micrograms per kilogram
μg/L	micrograms per liter
MS	monitoring station

ABBREVIATIONS AND ACRONYMS (Continued)

MSL	mean sea level
MTCA	Model Toxics Control Act
MW	monitoring well
NAD	Naval Ammunition Depot
Navy	U.S. Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NTS	Naval Torpedo Station
NUWC	Naval Undersea Warfare Center
NUWES	Naval Undersea Warfare Engineering Station
OU	operable unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PSAPCA	Puget Sound Air Pollution Control Agency
ppm	parts per million
RAO	remedial action objective
RBSC	risk-based screening concentration
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RDX	Royal Demolition Explosive
RfD	reference dose
RI	remedial investigation
RME	reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act of 1986
SMS	Sediment Management Standards
SQS	Sediment Quality Standards
SUBASE	Naval Submarine Base
SVOC	semivolatile organic compound
2,4,5-T	2,4,5-trichlorophenoxyacetic
TBC	to be considered
TCLP	toxicity characteristics leaching procedure
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TNT	trinitrotoluene
UCL	upper confidence limit
USC	U.S. Code
VOC	volatile organic compound
WAC	Washington Administrative Code
WWQC	Washington State Water Quality Criteria

DECISION SUMMARY

1.0 INTRODUCTION

It is the policy of the U.S. Navy (Navy) to address contamination at its installations, under the Defense Environmental Restoration Program, 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). At Naval Submarine Base (SUBASE), Bangor remedial action will be implemented where necessary at Operable Unit 7 (OU 7) to minimize potential health risks associated with soil and groundwater contamination. The remedial action will comply with federal and state applicable or relevant and appropriate requirements (ARARs).

2.0 SITE NAME, LOCATION, AND DESCRIPTION

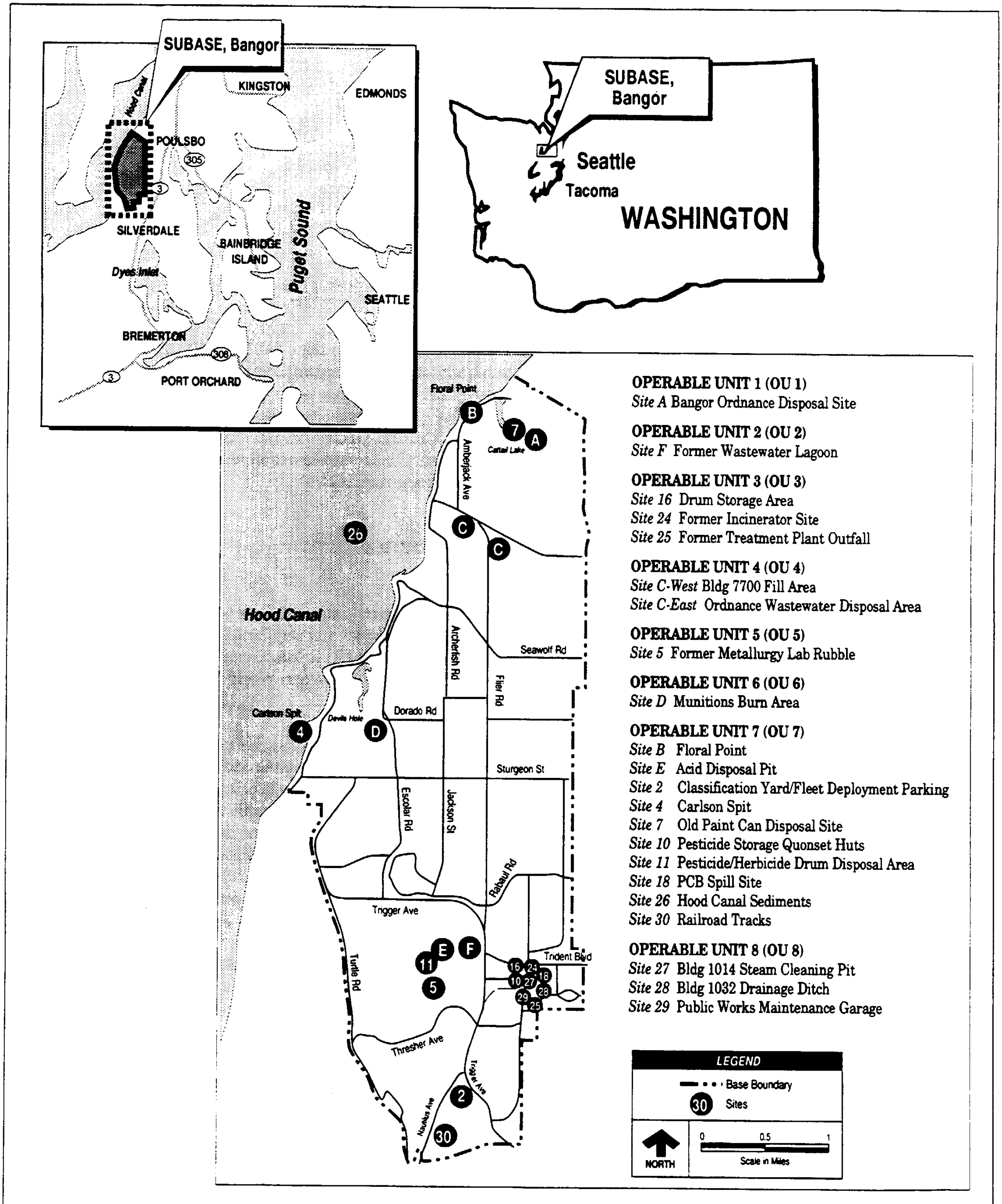
SUBASE, Bangor is located on Hood Canal in Kitsap County, Washington, approximately 10 miles north of Bremerton (Figure 1). Land surrounding SUBASE, Bangor is generally undeveloped or supports limited residential uses. Naval activities began at Bangor on June 4, 1944, when the U.S. Naval Magazine, Bangor was officially established as a Pacific shipment point for ammunition and explosives. When World War II ended, the Bangor Naval Complex became available for the storage of ordnance.

In 1950, the Naval Magazine facility was consolidated with the Naval Torpedo Station (NTS), Keyport to form the Naval Ordnance Depot, Keyport. In 1952, the facility returned to independent status and became the Naval Ammunition Depot (NAD), Bangor. In 1963, the Polaris Missile Facility, Pacific became an active tenant of NAD, Bangor. During the late 1960s, conventional weapons used in the Vietnam conflict were loaded on ships from the Bangor Marginal Wharf. NAD, Bangor was responsible for about one third of all weapons sent to Vietnam between 1965 and 1970. In October 1970, NAD, Bangor was disestablished and became NTS, Keyport. No munitions were shipped from NTS, Keyport between 1970 and early 1972. When bombing runs were stepped up in Vietnam, NAD, Bangor returned to active status. The last shipment to Vietnam was loaded in January 1973.

On November 29, 1973, the Secretary of the Navy announced that the Bangor Naval Complex had been selected as the West Coast home port for the Trident Submarine Launched Ballistic Missile System. SUBASE, Bangor was commissioned in February 1977, and the first submarine arrived in August 1982.

On July 22, 1987, Site A was listed on the U.S. Environmental Protection Agency's (EPA) National Priorities List (NPL) of hazardous waste sites. On August 30, 1990, the remainder of the SUBASE, Bangor facility was listed on the NPL.

On January 29, 1990, a cooperative three-party Federal Facility Agreement (FFA) was signed by the Navy, the EPA, and the Washington State Department of Ecology (Ecology) for study and cleanup of possible contamination on the SUBASE, Bangor property. The potentially contaminated sites at Bangor were grouped into eight operable units based on geographic location, suspected contamination, or other factors



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 1** **General Location Map**	CTO 0058 SUBASE, Bangor Washington ROD

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(see Figure 1). A separate study is being conducted for each operable unit to determine appropriate cleanup actions.

OU 7 comprises 10 known or suspected former waste sites. Although not part of OU 7 as defined in the FFA, three lake or wetland areas were included for study with the 10 sites: Cattail Lake, Hunter's Marsh, and Devil's Hole. These ecological areas have been potentially affected by upgradient sites. Three additional sites (27, 28, and 29), which were originally included in OU 7, were placed in OU 8 following the detection of contaminants in surrounding or nearby properties. The OU 7 sites and ecological areas (Figure 2) are as follows:

- Site B, Floral Point
- Site 2, Classification Yard/ Fleet Deployment Parking
- Site 4, Carlson Spit
- Site 7, Old Paint Can Disposal Site
- Site 10, Pesticide Storage Quonset Huts
- Site 18, PCB Spill Site
- Site 26, Hood Canal Sediments
- Site 30, Railroad Tracks
- Site E, Acid Disposal Pit
- Site 11, Pesticide/Herbicide Drum Disposal Area
- Cattail Lake Ecological Area
- Hunter's Marsh Ecological Area
- Devil's Hole Ecological Area

3.0 SITE HISTORY

3.1 SITE B, FLORAL POINT

Site B, Floral Point, is located at the northern end of SUBASE, Bangor (Figure 3). Amberjack Avenue, which runs northeast to southwest along the shoreline, provides access to the site, and a gravel road extends through the site, circling the point parallel to the shoreline. The only structures on the site are a small observation hut facing Hood Canal and an L-shaped concrete foundation located in the approximate center of the point. The interior of the point is vegetative with some trees and heavy underbrush. The area is forested above and around the point, except where it has been cleared for roads and SUBASE, Bangor facilities.

Pyrotechnic testing was reportedly conducted both for quality assurance and for research and development during the 1950s and 1960s (U.S. Navy 1983). In 1953, Buildings 263 and 264 (now demolished) were designated for the purpose of handling and storing pyrotechnics. Various materials tested included star signals, smoke cans (aluminum types), smoke pots, and hand grenades. Black powder also was reportedly burned at Site B. Floral Point was used for station dumping from approximately 1950 to 1968. Pit disposal, landfilling, and trash burning all were reported activities during this time period. For a short duration (1966 to 1967), the site was used for open burning of Royal Demolition Explosives (RDX) and trinitrotoluene (TNT) residuals removed from the segregation facility leachate pit (U.S. Navy 1983). Garbage from Keyport also was reportedly disposed of at this location (circa 1967 to 1972).

SITE NO.	SITE NAME	REPORTED ACTIVITIES	REPORTED WASTES
SITES			
B	Floral Point	Pyrotechnics testing, municipal waste disposal	Explosives, organics, demolition debris
7	Old Paint Can Disposal Site	Disposal of paint cans	Paint wastes
26	Hood Canal Sediments	Pier and wharf activities, runoff from upland areas	Fuels, pesticides
4	Carlson Spit	Detonation area for old fuses	Metals, explosives
E and 11	Acid Disposal Pit and Pesticide/Herbicide Drum Disposal Area	Disposal of liquid wastes, drums, and containers	Electroplating wastes, Otto fuels, pesticides and herbicides
10	Pesticide Storage Quonset Huts	Management of pesticides	Pesticides and herbicides
18	PCB Spill Site	Repair and storage of electrical transformers	Transformer oils containing PCBs
30	Railroad Tracks	Disposal of pesticide rinse water	Chlorinated pesticides and herbicides
2	Classification Yard/ Fleet Deployment Parking	Disposal of small-caliber shells, drums, and miscellaneous metal debris	Small-caliber projectiles, organic wastes, drums, metal debris
ECOLOGICAL AREAS			
Cattail Lake		Runoff from Site 7 and off-site areas	None known
Hunter's Marsh		Runoff from a site in OU 4	None known
Devil's Hole		Runoff from a site in OU 6	None known

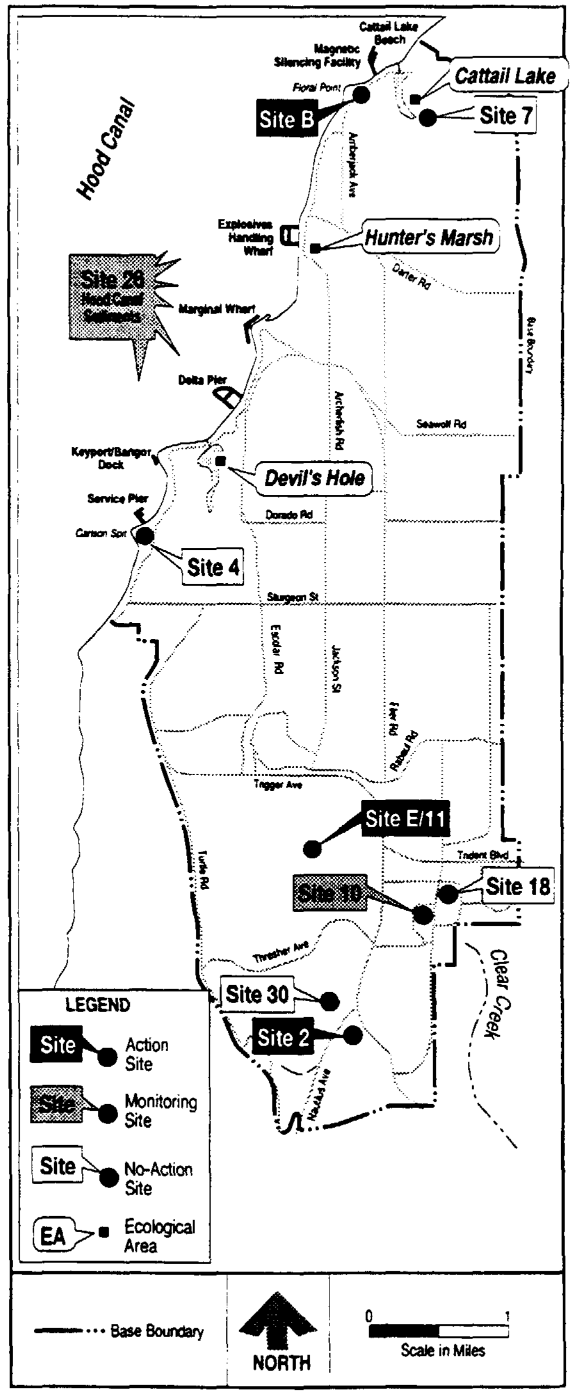

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Figure 2
Locations of Sites and Ecological Areas in Operable Unit 7

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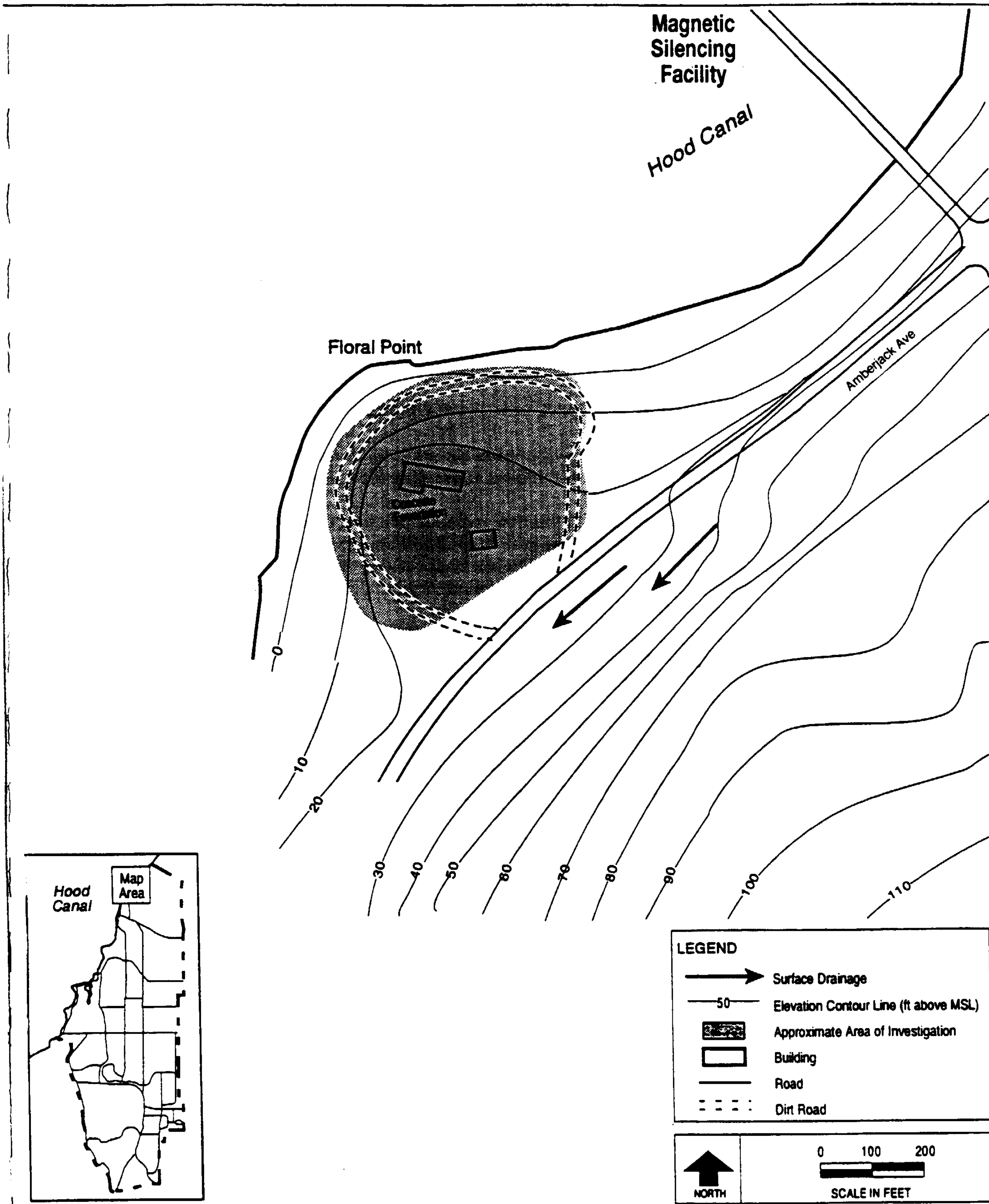

CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 3** **Site B - Floral Point**	CTO 0058 SUBASE, Bangor Washington ROD

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In recent times, chromated copper arsenate (CCA)-treated lumber (to replace creosote cross timbers at Magnetic Silencing Facility at the request of the Department of Fisheries) and other construction materials have been stored at Floral Point for limited periods.

Currently, Floral Point is an active recreational area used by base personnel. Recreational boating is restricted within 500 feet of mean lower low water (MLLW).

3.2 SITE 2, CLASSIFICATION YARD/FLEET DEPLOYMENT PARKING

Site 2, Classification Yard/Fleet Deployment Parking, is located in the north-south trending ravine between Nautilus Avenue and Trigger Avenue, north of the Trident Lakes Recreation Area (Figure 4).

The site has been divided into two subareas designated Sites 2A and 2B, based on known historical uses and types of potential contaminants. Site 2A is situated at the head of the ravine in an area sloping gently to the south and into the ravine. Site 2B occupies much of the remainder of the ravine, particularly the western side, along a steep embankment and gully that were once heavily vegetative but that were deforested in 1992 to accommodate site cleanup and drum removal activities.

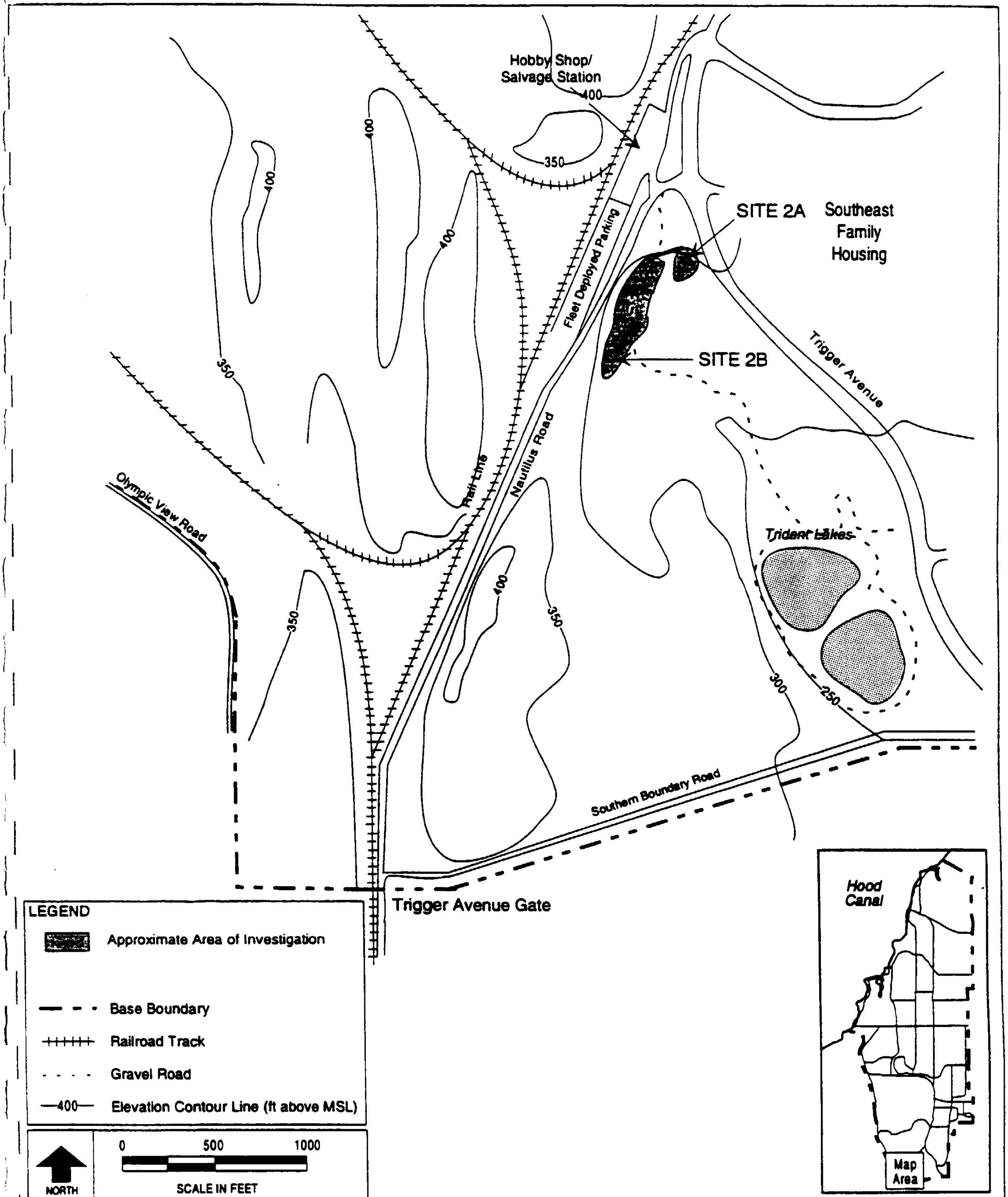
Subarea 2A was a disposal area for small-caliber projectiles. These projectiles were disarmed, except for a few tracer rounds in which the incendiary compound remains. Subarea 2B was an unauthorized disposal area. Some of the wastes included paint sludge, waste oil, and drums. A cleanup of the surface debris at Subarea 2A was conducted in 1986 and 1987. Old furniture, signs, empty ammunition boxes, cans, bottles, and partially buried drums were removed during a time-critical removal action completed in 1993. The time-critical removal action was started in 1992. Exploratory work discovered hazardous material in some of the drums, and a second phase was completed the following years.

3.3 SITE 4, CARLSON SPIT

Carlson Spit (Figure 5) is located on Hood Canal just south of the Service Pier. The only structure on the spit is an observation hut (Building 7041) facing Hood Canal. The area of investigation is the forested slope above the spit and below Wahoo Road. There are no permanent surface hydrologic features or visible contaminated areas. Currently the area is used for picnicking, fishing, and recreation. Historical air photographs from the vicinity of the site allegedly showed scattered round holes in the area, which were alleged to be the result of the disposal of ordnance ignition devices (Figure 5).

3.4 SITE 7, OLD PAINT CAN DISPOSAL SITE

Site 7, Old Paint Can Disposal Site, is a wooded area on the hillside above the south end of Cattail Lake (Figure 6). There are no structures on the site. In the mid-1970s, during demolition of the old paint shop (Building 1032) located in the Public Works Industrial Area, the contents of the shop were transported and discarded over the embankment below Tinosa Road, at the south end of Cattail Lake. Approximately 25 containers, ranging from 1-gallon cans to 55-gallon drums, were disposed of empty or partially filled with



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	Figure 4 Site 2 - Classification Yard/Fleet Deployment Parking	CTO 0058 SUBASE, Bangor Washington ROD

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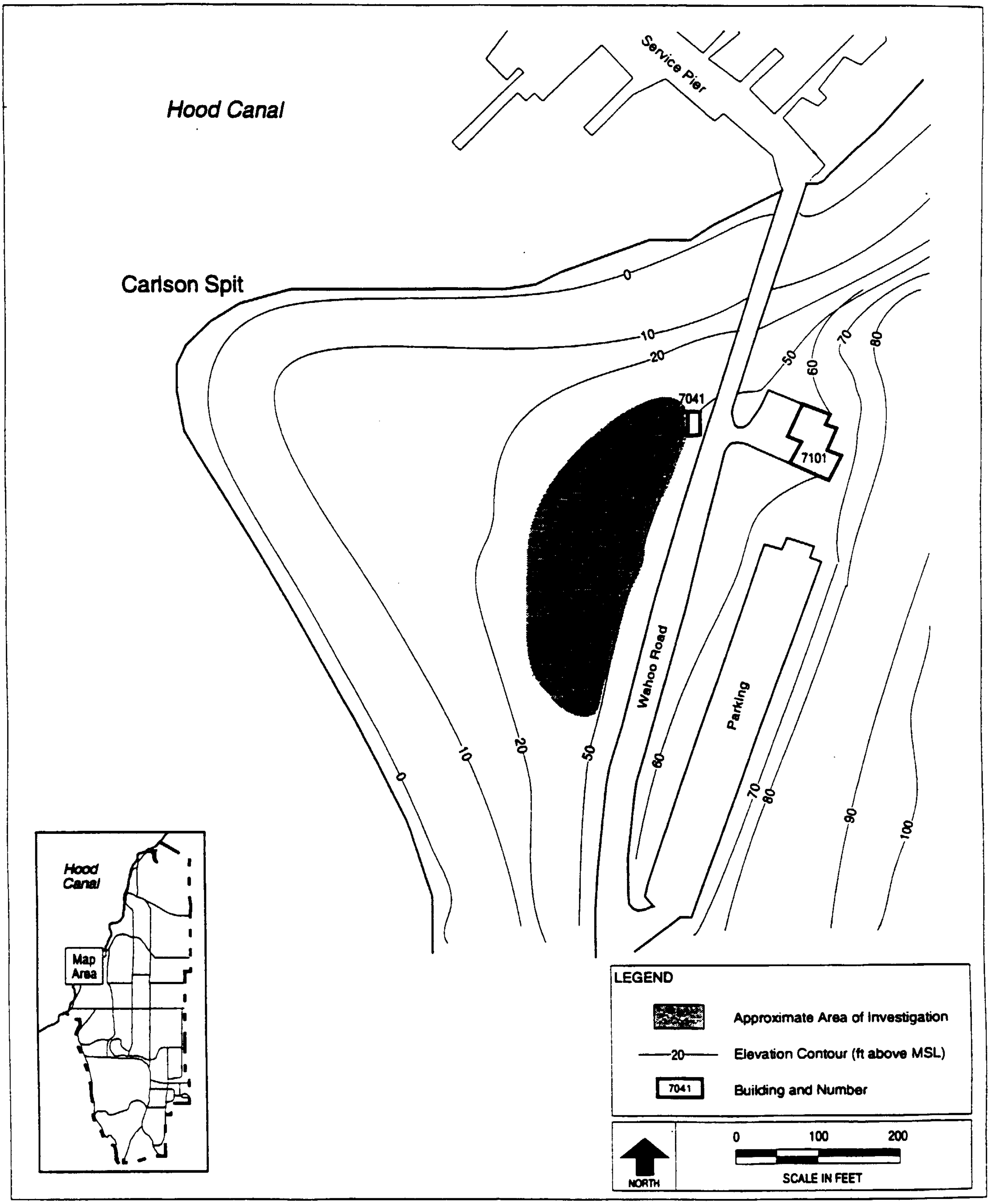

CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 5** **Site 4 - Carlson Spit**	CTO 0058 SUBASE, Bangor Washington ROD

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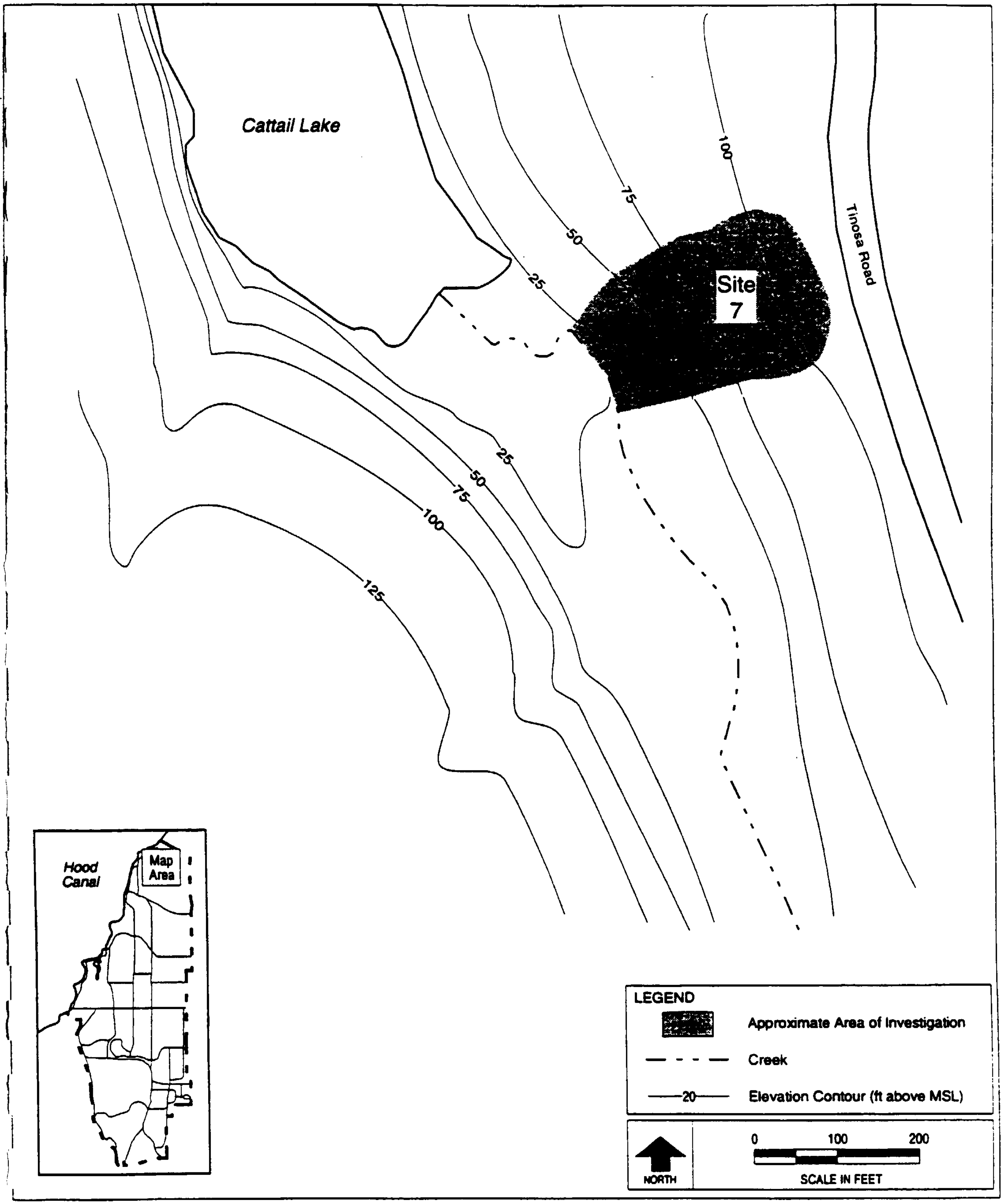

CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 6** **Site 7 - Old Paint Can Disposal Site**	CTO 0058 SUBASE, Bangor Washington ROD

CTO58\FIG-1-6.DRW 3/15/93

various amounts of paint, thinner, and solvents. The cans and drums were removed from the site in 1981. No visible evidence of spills or disposal activities remains at the site.

3.5 SITE 10, PESTICIDE STORAGE QUONSET HUTS

Site 10 is located just west of the Public Works Industrial Area proper, across Scorpion Avenue, on the west side of Guardfish Street (Figure 7). The site is the former location of two wooden floor Quonset huts (demolished in 1983) that were used prior to 1979 to store pesticides and herbicides. This site is currently the paved parking area for Buildings 2011 and 2012. Access to the parking area is from Guardfish Street, east of Scorpion Avenue. The entire area has been extensively and repeatedly excavated, leveled, and developed. Chemicals known to have been stored in the Quonset huts included Hyvar X, bromacil, 2,4-dichlorophenoxyacetic acid (2,4-D), and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T). The materials from the demolished buildings were reportedly disposed of in the former barricaded railroad siding area (U.S. Navy 1983).

A cement-floored auto hobby shop was located in a Quonset hut adjacent to Site 10. The hazardous waste management history at the hobby shop is not well documented.

3.6 SITE 18, PCB SPILL SITE

Site 18 is located within the Public Works Industrial Area of the base. The site consists of an area underneath and north of Building 1016 and an area on the north side of the railroad tracks, south of Building 1201 (Figure 8). From the 1940s until the 1970s, electrical transformers were repaired at the electrical shop in Building 1016. A leaking 5- to 10-kVA transformer was transferred here from Battle Point on Bainbridge Island in 1966 or 1967. Approximately 5 to 10 gallons of polychlorinated biphenyl (PCB) fluid was reportedly spilled on the ground at the northwest corner of Building 1016. The entire area is now paved, and a small portion of the extension of Building 1016 may cover the spill area.

3.7 SITE 26, HOOD CANAL SEDIMENTS

Site 26, the Hood Canal Sediments, consists of eight small areas along the western shore of the base where all the service piers are located. These areas are known as Cattail Lake Beach/Magnetic Silencing Facility, Floral Point, Explosives Handling Wharf, Marginal Wharf, Delta Pier, Devil's Hole Beach, Keyport/Bangor Dock, and Service Pier/Carlson Spit (Figure 9). Marginal Wharf was used for loading and offloading ammunition during World War II and again when conventional weapons were shipped to Vietnam from the late 1960s to 1973. The Keyport/Bangor small craft dock was built in 1951. Delta Pier, Service Pier, Explosives Handling Wharf, and Magnetic Silencing Facility were built in the early 1980s to support submarine base activities. Delta Pier, Service Pier, and Explosives Handling Wharf were built as self-contained piers that piped stormwater runoff to shore through an oil/water separator. There is a diesel fueling facility at Service Pier. Activities include boat servicing and maintenance operations.

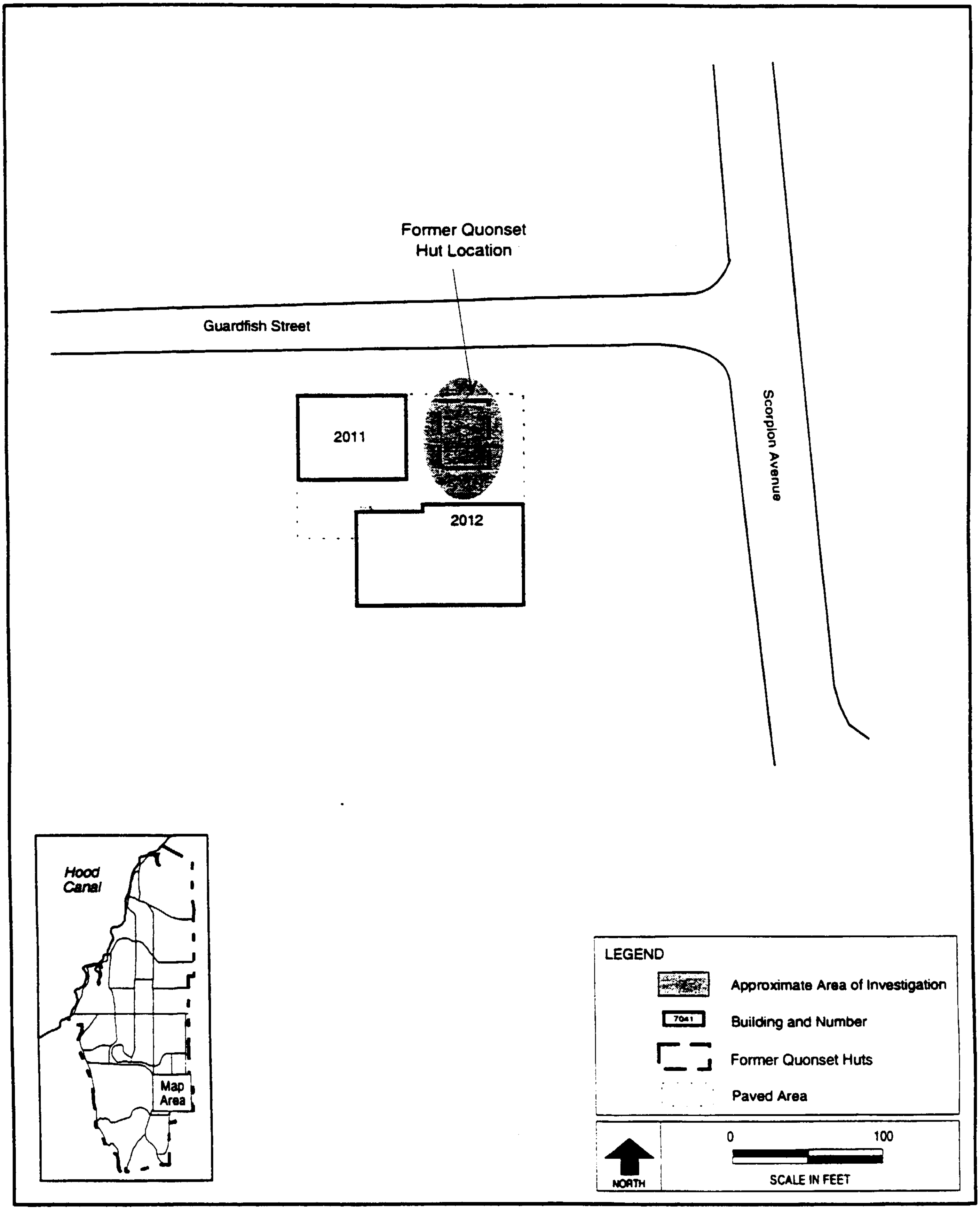

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Figure 7
Site 10 - Pesticide Storage Quonset Huts

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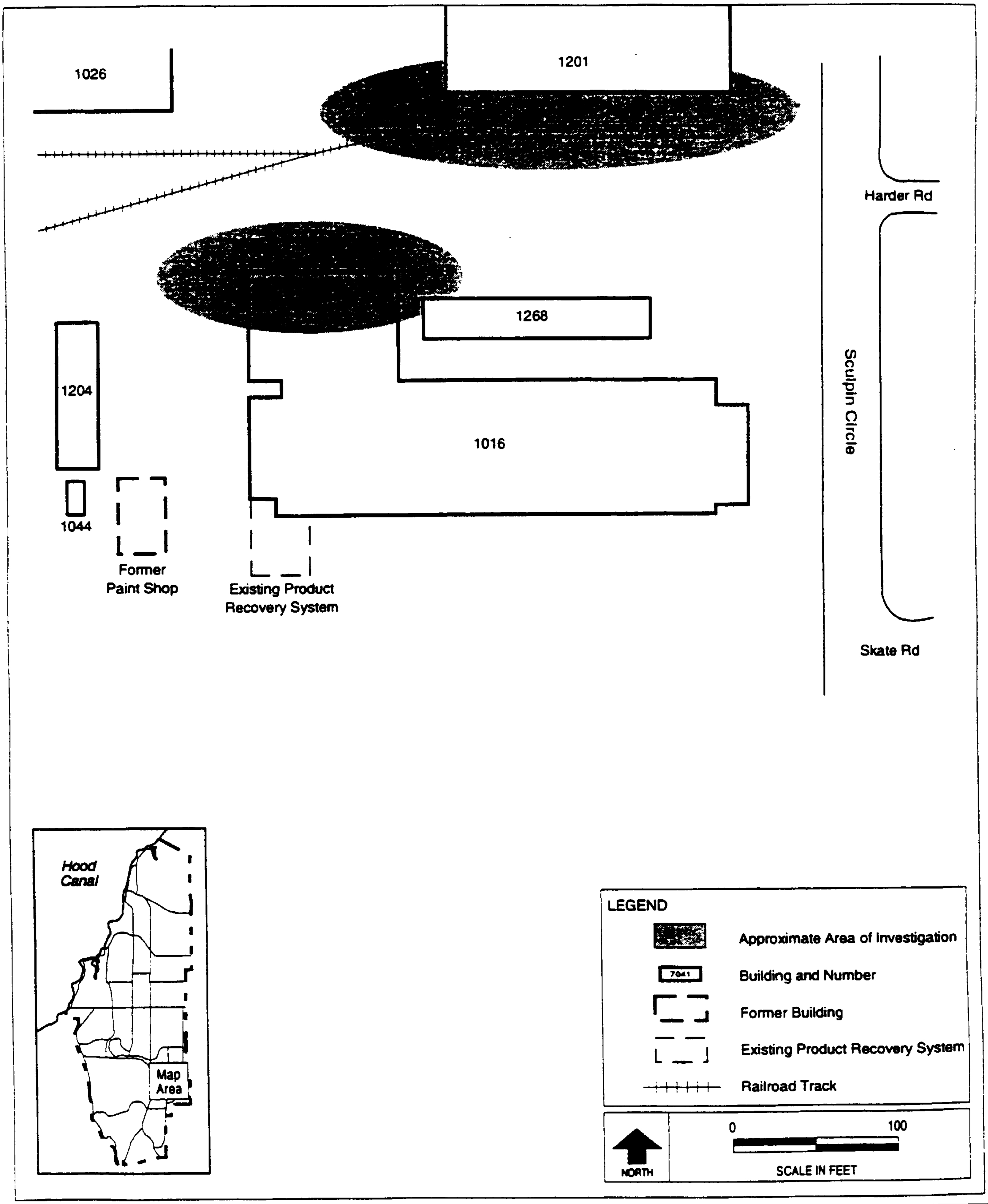

CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	Figure 8 Site 18 - PCB Spill Site	CTO 0058 SUBASE, Bangor Washington ROD

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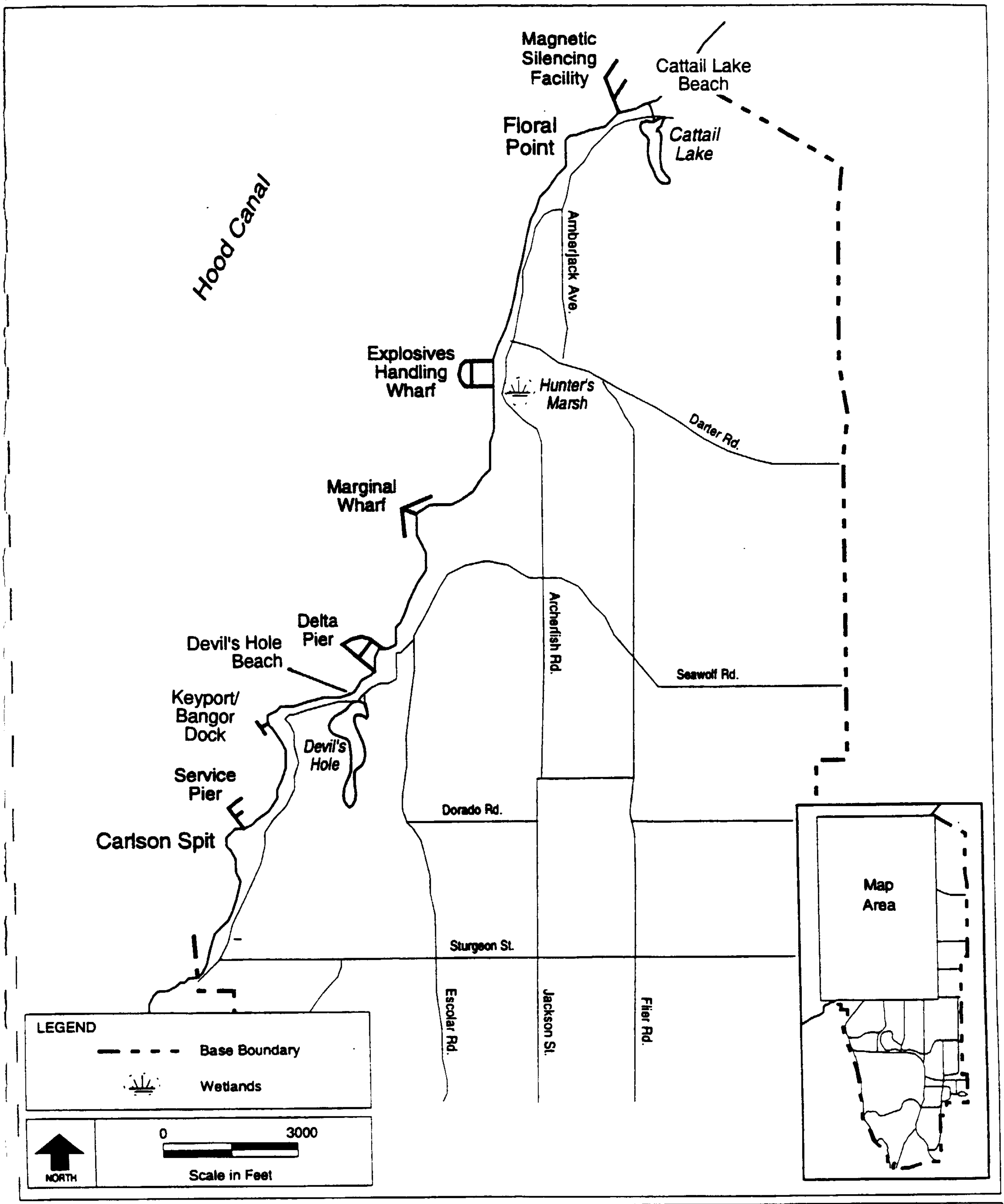


CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	Figure 9 Site 26 - Hood Canal Sediments	CTO 0058 SUBASE, Bangor Washington ROD

CTO58\SEC01\FIG1-14.DRW 3/24/93

3.8 SITE 30, RAILROAD TRACKS

Site 30 (Figure 10) is a portion of the railroad tracks north of Trigger Avenue Gate and on the west side of Nautilus Road. The area of investigation includes the railroad tracks and a steep drainage ditch adjacent to the tracks. The ditch drains to the south, and the roadbed has been leveled and filled with ballast to accommodate the tracks. This site was reportedly used from 1977 to 1985 for the disposal of rinsewater from a triple rinsing process that used Nutra-sol to clean large tank sprayers and holding tanks of pesticides and herbicides. The quantity of materials disposed of at this site is unknown.

3.9 SITE E, ACID DISPOSAL PIT; SITE 11, PESTICIDE/HERBICIDE DRUM DISPOSAL AREA

Site E and Site 11 (Figure 11) are situated in the south-central portion of SUBASE, Bangor one half mile north of Thresher Avenue. Several unpaved roads provide access to and around the sites. During the course of removal action at the sites, a fence with gates on the east and south sides was installed to control access to the work areas.

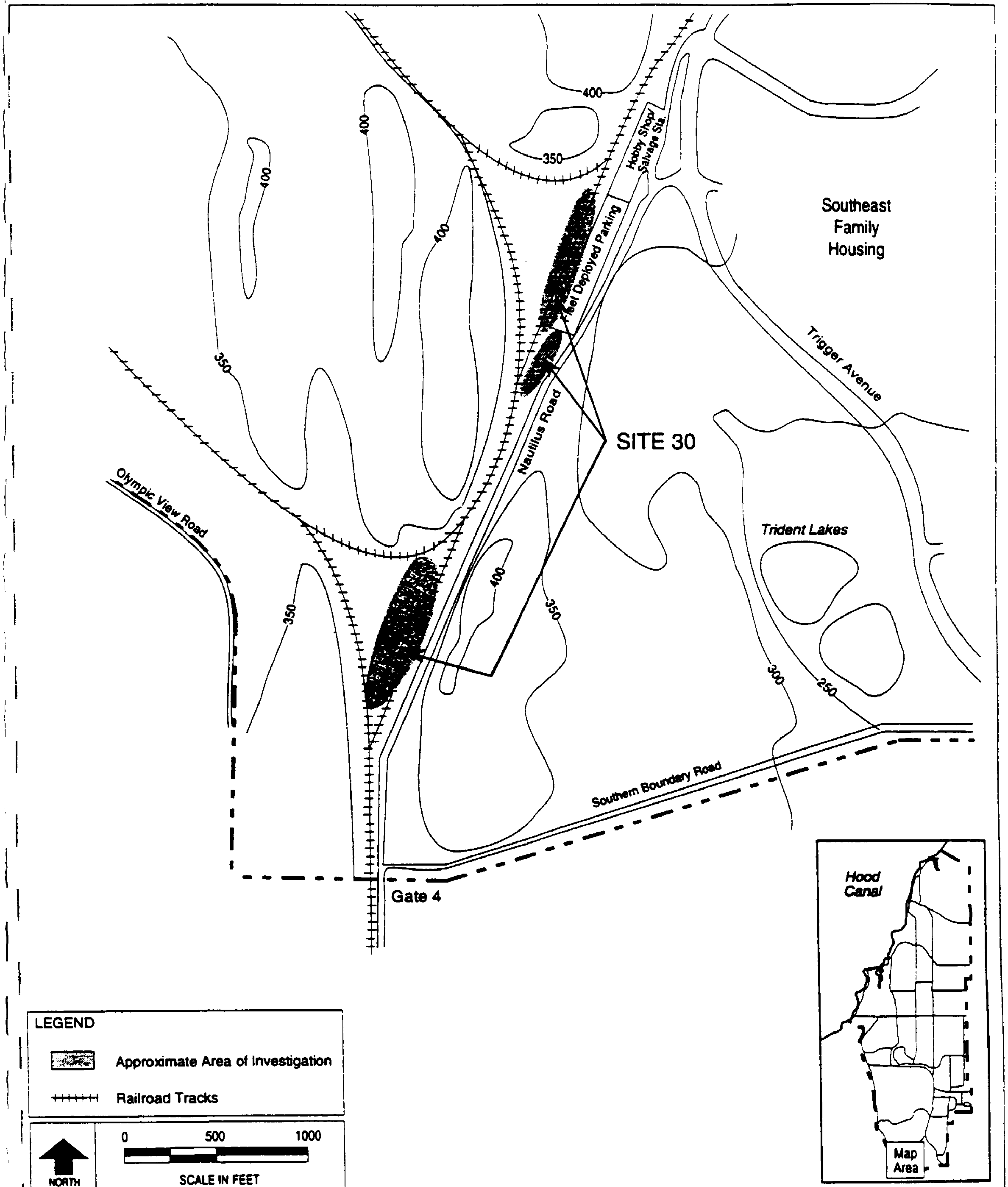
Site E was reportedly used as an acid disposal site for electroplating wastes and Otto fuel from 1960 to 1973. Reportedly, 1,500 to 2,000 gallons of electroplating wastes originating from Naval Undersea Warfare Engineering Station (NUWES), Keyport were disposed of quarterly, and in 1970 a minimum of two truckloads of an undetermined volume of Otto fuel were disposed of at this site (U.S. Navy 1983). The former pit was approximately 10 by 15 feet wide and 3 to 5 feet deep. The pit was lined with gravel, and there is no record that an impermeable barrier or liner was placed beneath the gravel.

Site 11 is a pesticide/herbicide drum disposal area. In 1968 or 1969, empty pesticide containers were buried between two barricaded railroad siding areas. The burial pit was not lined and was approximately 10 to 20 feet deep and of unknown width and length. The drums and cans reportedly contained 2,4-D, dichlorodiphenyltrichloroethane (DDT), and Tordon (U.S. Navy 1983). According to the former Pest Control Manager, at the time of disposal the original containers were triple-rinsed and dried prior to disposal. To confirm what was at Site 11, a drum removal action was initiated in 1992. Seventy-two 1- to 5-gallon containers and thirteen 55-gallon drums were removed along with approximately 400 cubic yards of soil containing pesticides.

Site E was combined with Site 11 into one investigation program because the two sites are contiguous and because there was concern that drums at Site 11 had also been disposed of at Site E. Because of this joint investigation program, these two sites will be discussed together throughout the ROD.

3.10 CATTAIL LAKE ECOLOGICAL AREA

Cattail Lake is located between Amberjack Avenue and Tinosa Road (Figure 12) and was created by the construction of the waterfront road. Cattail Lake was investigated for potential ecological impact from surface water runoff from Site 7.



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 10** **Site 30 - Railroad Tracks**	CTO 0058 SUBASE, Bangor Washington ROD

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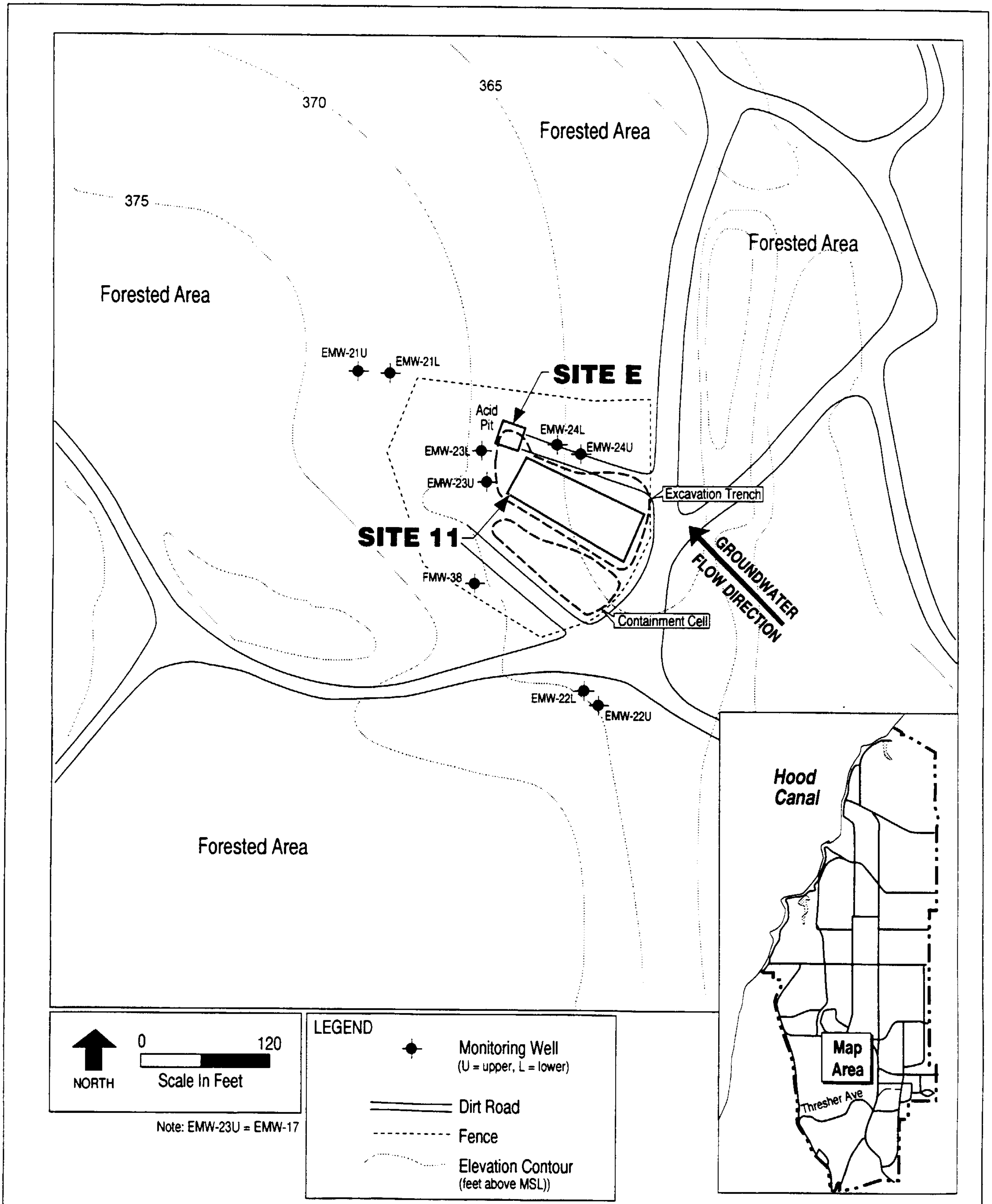
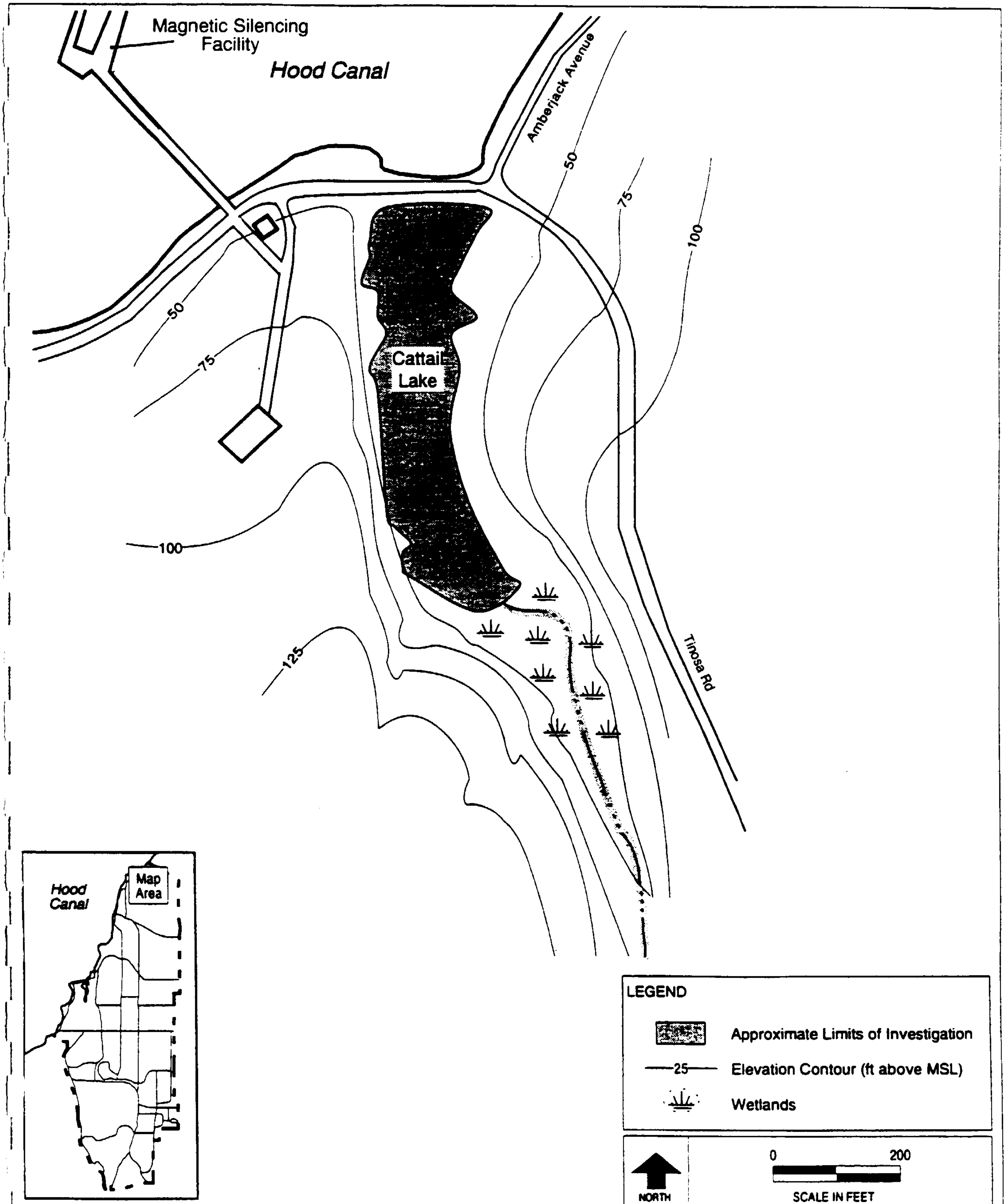


CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 11** **Site E - Acid Disposal Pit** **Site 11 - Pesticide/Herbicide Drum Disposal Area**	CTO 0058 SUBASE, Bangor Washington ROD



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 12** **Cattail Lake Ecological Area**	CTO 0058 SUBASE, Bangor Washington ROD

CTO58\SEC01\FIG-1-17.DRW 3/24/93

3.11 HUNTER'S MARSH ECOLOGICAL AREA

Hunter's Marsh (Figure 13) is a shallow pond and wetland area located near Tang Road, created as a result of road construction. It is downgradient from OU 4 (Site C) and was investigated for potential ecological impacts from that site. Hunter's Marsh is just east of the Explosives Handling Wharf and drains to the shoreline.

3.12 DEVIL'S HOLE ECOLOGICAL AREA

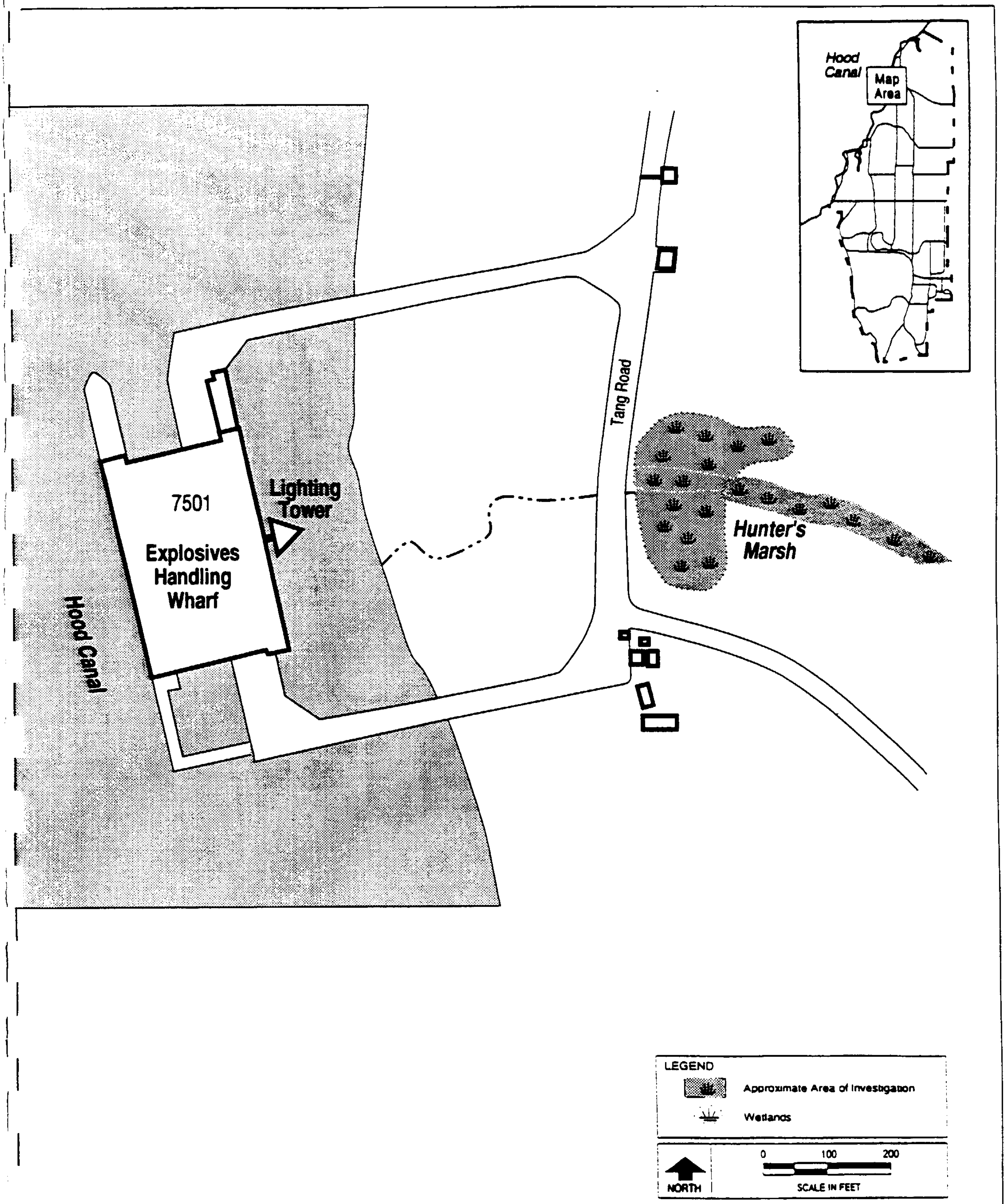
Devil's Hole (Figure 14), located south of Sealion Road, was created when an existing bridge was filled in to construct a road. The tributary that drains into Devil's Hole at its south end receives surface runoff from OU 6 (Site D).

4.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

A SUBASE, Bangor Community Relations Plan for the remedial activity on the base was prepared and is available for review at the information repositories. Community relations activities have established communication among citizens living near the site, the Navy, the EPA, and Ecology. Actions taken to satisfy the requirements of federal law are listed below.

The remedial investigation and feasibility study (RI/FS) reports and the Proposed Plan for OU 7 at SUBASE, Bangor were released to the public in April 1995. These two documents were made available to the public by means of the Administrative Record and information repositories. The Proposed Plan was mailed to all known interested parties on April 12, 1995. Notice of the availability of the Proposed Plan, plus notice of a public meeting on the Proposed Plan and public comment period, was published in *The Sun* (Bremerton, Washington) on April 13, 1995. A public comment period was held from April 14 to May 14, 1995. A public meeting was held on April 25, 1995, at Breidablik Hall, in Poulsbo, Washington. At this meeting, representatives from the Navy answered questions about the proposed actions at OU 7. The Responsiveness Summary at the end of this Record of Decision (ROD) summarizes the comments and responses.

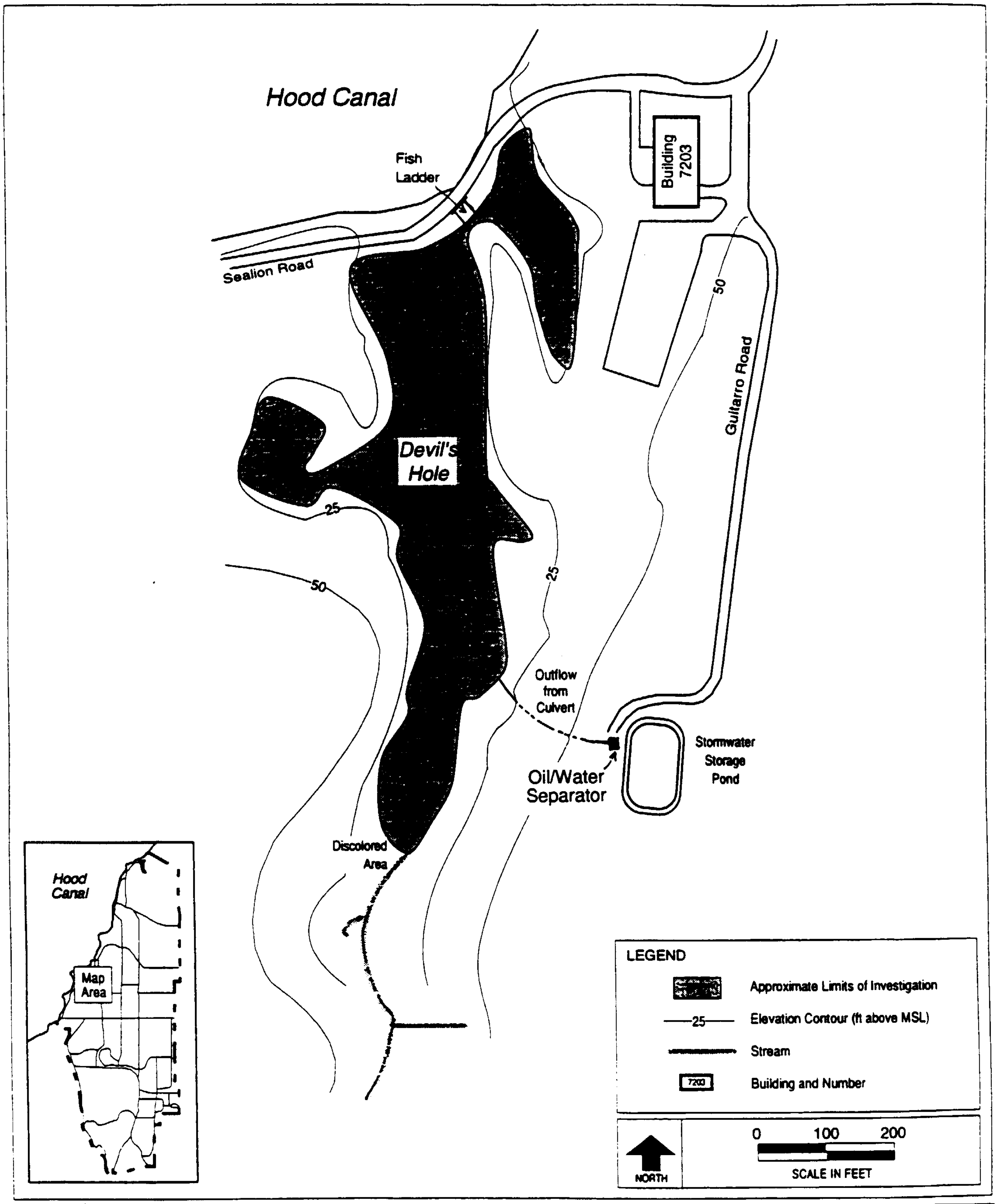
In addition, a number of other public participation activities took place during the RI. A fact sheet on OU 7 was mailed to the community in 1992. Two action memoranda regarding the time-critical removal actions at Sites 2 and 11 were announced in the local newspaper in 1992 and 1993. A public comment period was held on the two actions and no comments were received on either action. Information on these two removal actions is available in the Administrative Record. Four technical review meetings were held with public groups to discuss project status and the removal actions. The level of community interest in OU 7 has been relatively low.



CLEAN
COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

Figure 13
Hunter's Marsh Ecological Area

CTO 0058
SUBASE, Bangor
Washington
ROD



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	Figure 14 Devil's Hole Ecological Area	CTO 0058 SUBASE, Bangor Washington ROD

The Administrative Record is on file in the following location:

Engineering Field Activity, Northwest
Naval Facilities Engineering Command
19917 Seventh Avenue N.E.
Poulsbo, Washington 98370
(360) 396-0857

The information repositories are in the following locations:

Central Kitsap Regional Library
1301 Sylvan Way
Bremerton, Washington
(206) 377-7601

SUBASE, Bangor Branch Library
Naval Submarine Base, Bangor
(Base access is required)
(206) 779-9274

5.0 SCOPE AND ROLE OF OPERABLE UNITS

The sites listed in the SUBASE, Bangor FFA were organized into eight operable units based on geographic location, suspected contamination, or other factors. A separate study was planned for each operable unit to determine appropriate cleanup actions. During the RI of OU 5, buried drums at Site 11 were located and excavated in a time-critical removal action. To prevent delay in the release of the final ROD for OU 5, Site 11 and adjacent Site E were transferred from OU 5 to OU 7.

This ROD is the seventh final remedial action decision document for SUBASE, Bangor. RODs have been signed for the following OUs:

ROD	Date Signed
OU 1	December 1991
OU 2	September 1994
OU 3	April 1994
OU 4	July 1994
OU 5	September 1993
OU 6	September 1994

Other expedited decision documents include an interim remedial action ROD for Site F for the containment of contaminant migration in groundwater; a time-critical removal action memorandum for Site 2 to excavate buried drums from a road embankment; a time-critical removal action memorandum for Site 11 to excavate buried, empty pesticide containers; and a time-critical removal action memorandum for OU 8 to provide an alternative water supply to residents in the Mountain View Road area and to identify the nature and extent of volatile organic contamination in the shallow aquifer.

This ROD addresses OU 7, which consists of 10 sites (Sites B, 2, 4, 7, 10, 18, 26, 30, E, and 11) and three ecological areas (Cattail Lake, Hunter's Marsh, and Devil's Hole). Figure 2 depicts the sites and ecological areas. Further action is recommended for four of these sites, no action with monitoring for two sites, and no further action for the remaining four sites and three ecological areas.

6.0 SUMMARY OF SITE CHARACTERISTICS

6.1 REGIONAL CHARACTERISTICS

SUBASE, Bangor is located on the west side of Kitsap Peninsula. The Kitsap Peninsula separates Puget Sound from Hood Canal, a long and narrow fjord-like embayment of marine water that joins the main body of Puget Sound at Admiralty Inlet (Figure 1).

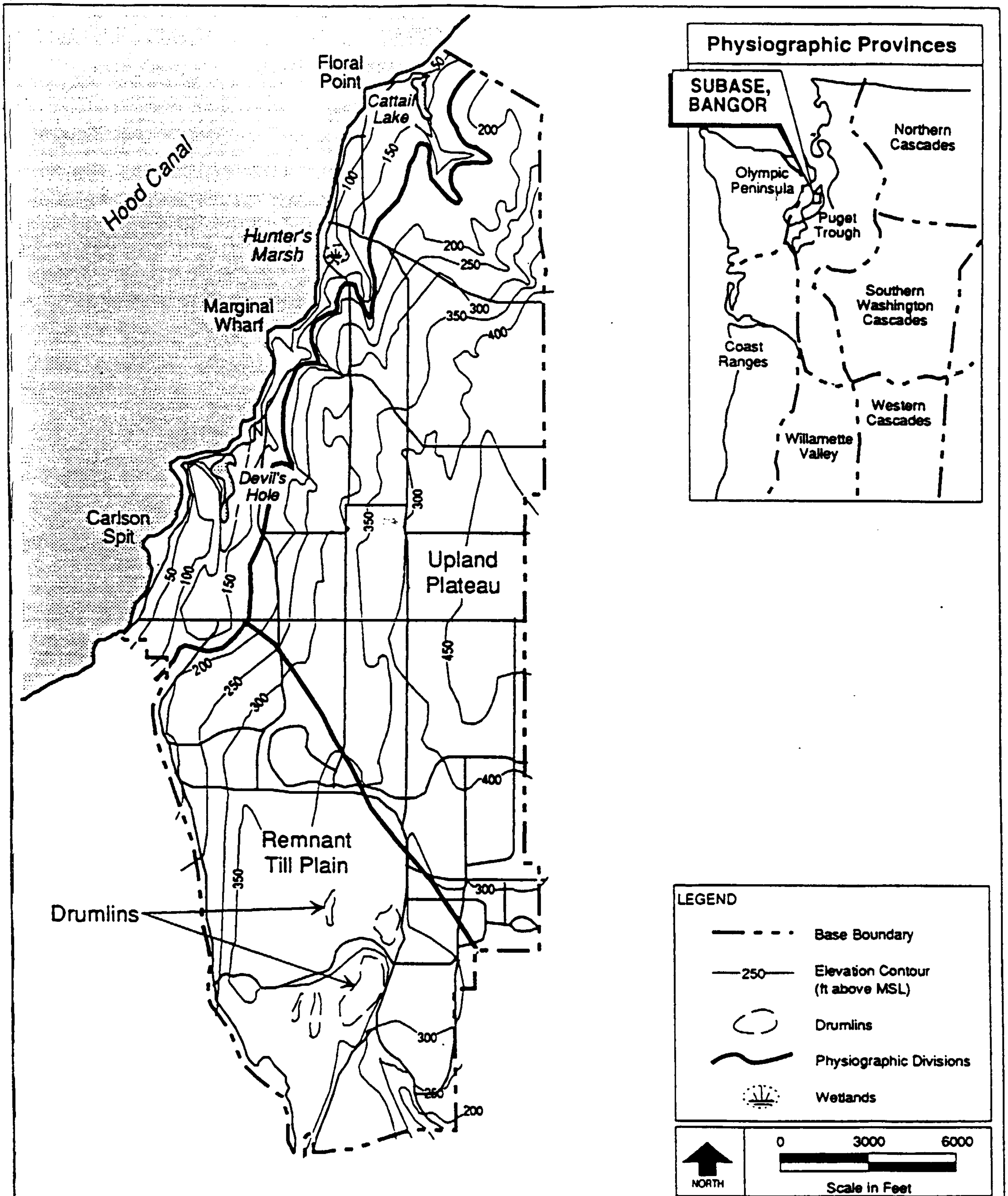
SUBASE, Bangor can be divided into three physiographic areas: the upland plateau of the northern part of the base, the remnant glacial till plain at the southern end of the base, and the marine environment of Hood Canal (Figure 15). SUBASE, Bangor consists of mixed coniferous forests, recovering logged areas and grasslands, freshwater wetlands, freshwater lakes and ponds, and marine intertidal and subtidal zones. The RI/FS reports (URS 1994a, 1994b) give detailed descriptions of the regional characteristics. Figure 16 illustrates surface water drainage system boundaries within SUBASE, Bangor.

6.2 SITE-SPECIFIC CHARACTERISTICS

6.2.1 Site B, Floral Point

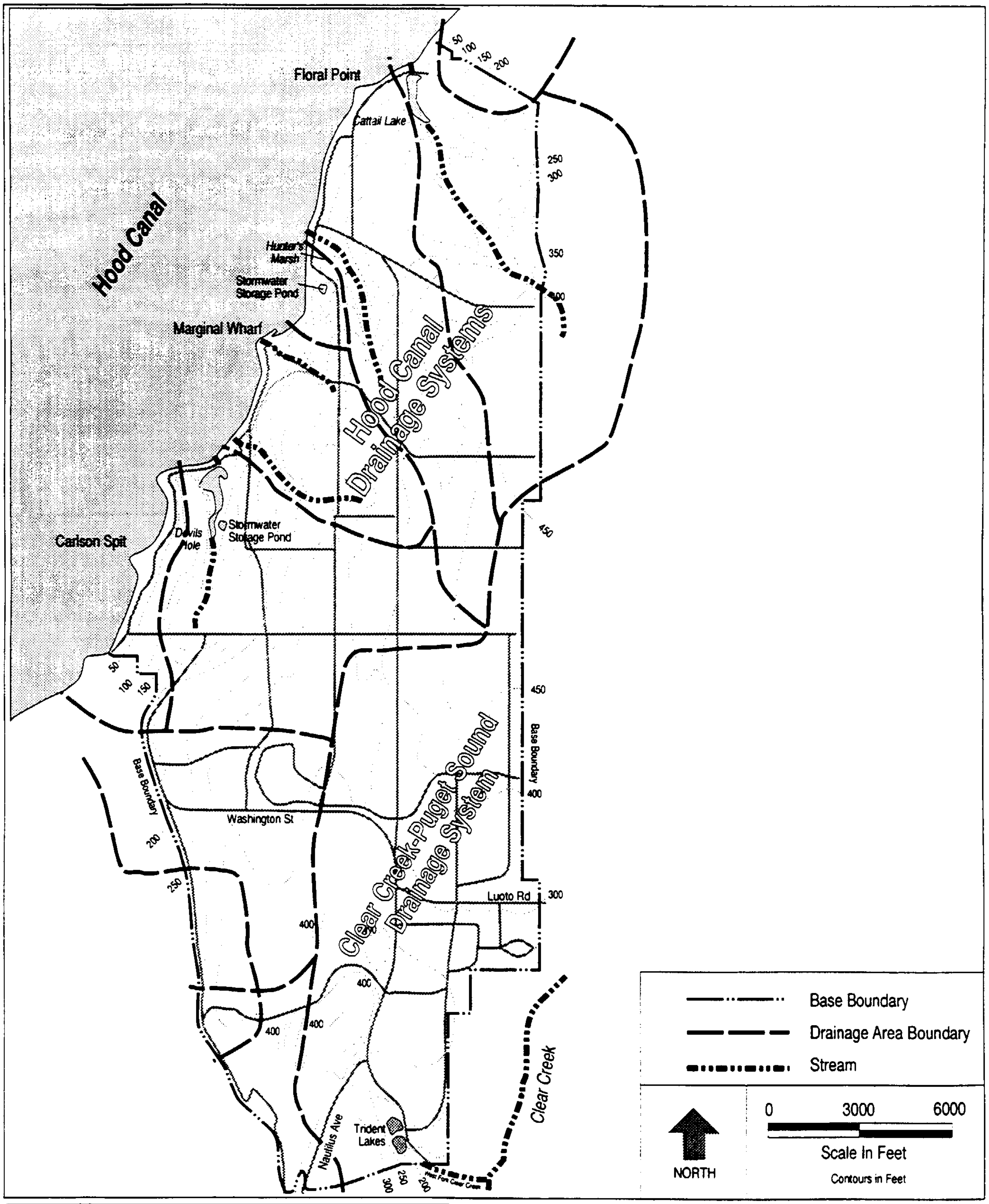
Composed of approximately 5 acres, Floral Point is a natural shoreline bordered by Hood Canal to the north and west (Figure 3). The area is relatively flat, with a gravel surface in the southeast area and a gravel road circling an interior vegetative area. With an average elevation of 14 feet, the site slopes gently up toward the center, at which point the site's highest elevation reaches 25 feet. Amberjack Avenue, which runs northeast to southwest along the shoreline, provides access to the site, and a gravel road extends through the site, circling the point parallel to the shoreline. The land east of Amberjack Avenue slopes downward to Floral Point, and there is a small unnamed surface drainage that empties into a low area near the southeast corner of Floral Point.

There are no surface drainages at Site B. Due to the high permeability of the soils at this site, precipitation infiltrates quickly and runoff is minimal (URS 1991). However, hydrogeologic data have demonstrated a strong tidal influence on the groundwater, particularly at Floral Point. The groundwater in the coarse-grained beach deposits that constitute the unconfined aquifer under Floral Point flows parallel to topography outward into Hood Canal with a slight vertical downward gradient. Both a tidal study and field water quality data indicate that fresh groundwater is subject to saltwater encroachment, particularly at shallower depths. Hydraulic conductivity tests suggest high permeability of the formation (10^{-1} to 10^{-2} cm/s).



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 15** **Area Physiography**	CTO 0058 SUBASE, Bangor Washington ROD

CTO58\SEC03\FIG3-1.DRW 1/1/93



CLEAN
COMPREHENSIVE
LONG-TERM
ENVIRONMENTAL
ACTION NAVY

Figure 16
Surface Water Hydrology

CTO 0058
SUBASE, Bangor
Washington
ROD

6.2.2 Site 2, Classification Yard/Fleet Deployment Parking

Site 2 is located in a north-south trending ravine north of the Trident Lakes Area (Figure 4). The ravine originally was heavily forested and had a steeper western slope and a more gentle eastern slope, but it was extensively deforested and excavated during the site investigation and subsequent removal action in 1992 and 1993. The total relief between the top of the site along Nautilus Avenue and the lower, southern end is approximately 80 feet. At the southern portion of the site, the ravine widens and opens out onto the Trident Lakes Area, which has been cleared and, in places, leveled for sports fields.

Surface water drainage from Site 2 is included in the Clear Creek drainage system. Site 2 surface water flows southward through an artificial channel into the Trident Lakes, and into the western branch of Clear Creek (URS 1991).

At Site 2, the Vashon Advance Outwash forms the shallow unconfined aquifer under the site. Static water is usually at or near the elevation of the top of this unit where it underlies the hard clayey sands and gravels of the Vashon Till. Fresh, chemically neutral water flows generally southwestward under a gentle gradient trending roughly parallel to the topographic gradient.

6.2.3 Site 4, Carlson Spit

Site 4, Carlson Spit, is located on Hood Canal south of the Service Pier (Figure 5) and consists of a gravelly shoreline spit and adjacent shoreline. Wahoo Road provides access to the area and a gravel track descends from the paved road out onto the point. Below Wahoo Road, at an elevation of about 60 feet, the land drops steeply down a heavily forested slope and out onto the spit. The body of the spit is a broad, flat area generally clear of vegetation, with an average elevation of approximately 15 feet.

There are no surface drainages at Site 4. Due to the high permeability of the soils at this site, precipitation infiltrates quickly and runoff is minimal (URS 1991).

6.2.4 Site 7, Old Paint Can Disposal Site

Site 7 is located on a hillside above the south end of Cattail Lake (Figure 6). The lake is located at the north end of SUBASE, Bangor with access from Amberjack Avenue. The area is heavily vegetative and slopes downward to a small stream and marsh area, which then drains into Cattail Lake. Site 7 occupies an area approximately 200 by 300 feet on the gentle wooded slope between Tinosa Road and the creek that flows into the south end of Cattail Lake.

6.2.5 Site 10, Pesticide Storage Quonset Huts

Site 10 (Figure 7) lies within the Public Works Industrial Area of the base and is located on an outcrop of the Vashon Till. Surface elevation is approximately 300 feet above sea level, and the area is heavily vegetative to the west and south.

Groundwater flows generally southeastward under a gentle gradient trending roughly parallel to the area topographic gradient.

6.2.6 Site 18, PCB Spill Site

Site 18 (Figure 8) is also located within the Public Works Industrial Area, on an outcrop of the Vashon Till. Groundwater flows generally southeastward under a gentle gradient trending roughly parallel to the area topographic gradient.

6.2.7 Site 26, Hood Canal Sediments

The shore of Hood Canal bordered by SUBASE, Bangor trends north-northeast. This site consists of eight small areas along the western shore of the base (Figure 9). Immediately east of the shoreline, the relief becomes relatively steep, as a bluff runs nearly the entire length of the base. The headlands consist of unconsolidated to poorly cemented glacial deposits.

The *Puget Sound Environmental Atlas* (Evans-Hamilton 1987) indicates that marine surficial sediments in the SUBASE, Bangor region of Hood Canal consist primarily of silts and sands. Inshore regions around the Keyport/Bangor Dock, Marginal Wharf, and Delta Pier are predominantly sand (90 percent). Marine sediments in the area of the Explosives Handling Wharf and the Magnetic Silencing Facility, including Floral Point, are gravelly sands with 30 percent gravel (Evans-Hamilton 1987). A sediment boring was taken in the intertidal drainage region within the Explosives Handling Wharf to evaluate the nature and extent of any chemicals of potential concern associated with the wharf and Hunter's Marsh. Four feet of fine sands and gravelly fine sands were found to overlie dense clayey sands and gravels believed to be Vashon Till. Surficial sediments at Cattail Lake Beach are silty sands with origins primarily from fluvial sedimentation from Cattail Lake. The relatively low-gradient deltaic deposit radiates northward from the lake. Sediment investigations in the Cattail Lake Beach area reveal predominantly sands with minor amounts of fines.

Sediments in the SUBASE, Bangor area may be derived from several sources including seasonal runoff from five local streams entering Hood Canal, stormwater discharges, and shoreline erosion from areas not protected by bulkheads. Three of these streams pass through small lakes into Hood Canal (Cattail Lake, Hunter's Marsh, and Devil's Hole). Overland flow from much of the western portion of SUBASE, Bangor is routed to Hood Canal through a series of stormwater outfalls. The Marginal Wharf (built in 1945), the Keyport/Bangor Dock (built in 1951), and the submarine base piers (built in the late 1970s and early 1980s) act to limit the potential for local erosion and result in local trapping of sediments transported from other areas. Recent sediment deposits in the Bangor area may also be derived from sources to the south, as inferred from the direction and speed of surface and subsurface currents in Hood Canal (Evans-Hamilton 1987).

Studies of currents around SUBASE, Bangor piers by the U.S. Navy (1982) and studies by Shi (1978) indicated that localized eddies are established in the vicinity of the Delta and Service Piers during both flood and ebb tides. Cyclonic (clockwise) eddies form south of Delta Pier during ebb tides, and anticyclonic (counterclockwise) eddies form north of the pier during flood tide. Maximum flows measured within ebb eddies were 24.4 cm/s, whereas maximum flows within a flood eddy were 21.3 cm/s (Shi 1978).

The only information available on sediment deposition rates measured in the vicinity of SUBASE, Bangor is recent work in Dabob Bay. Sedimentation rates in Dabob Bay, located approximately 4.5 miles west of the Bangor site, have been estimated at 0.27 ± 0.12 cm/yr (Carpenter et al. 1985). The low accumulation rates for Dabob Bay and probably most locations in Hood Canal including SUBASE, Bangor are explained by the distance from major rivers.

An exception to the low sedimentation rate is the estimated 15 ± 8 cm/yr for the south side of Keyport/Bangor Dock based on 1986 and 1991 pre- and post-dredging survey data obtained from the Navy. Sediment accumulation in the Keyport/Bangor Dock area may be explained by storm events from the southwest and net northerly longshore currents; the pier tends to trap sediments that are moving along the shore in a northerly direction. Sediment may accumulate in a similar fashion along the south sides of Delta Pier, Marginal Wharf, and Explosives Handling Wharf.

A boring taken near the northwest corner of Keyport/Bangor Dock showed loose, gravelly sands. The thickness of these loose sediments was greater than the 12-foot total depth of the boring. In shallow inshore regions of Hood Canal, variable tidal eddies appear to be the dominant force in the sediment depositional trends.

Sediment stratigraphy at Service Pier, located south of Keyport/Bangor Dock and north of Carlson Spit, revealed sediment deposition to be less than that at Keyport/Bangor Dock and more in line with that in Dabob Bay. Borings taken at Service Pier North indicated 6 feet of sands and gravel overlying Vashon Till. Service Pier South borings indicated the sand and gravel layer to be 10 feet in thickness, and only 2 feet thick near shore.

Dredging was conducted at the northern end of Delta Pier for maintenance of the Trident Refit Facility dry dock. Much of the sediment around Delta Pier originates from the Devil's Hole outfall. Borings indicate a layer of loose, gravelly, slightly silty sand overlying very dense gravelly sand. This layer was 8 feet in thickness close to the pier, and further north, away from the pier, 2 feet thick. Low-gradient deltaic deposits have formed by fluvial sedimentation at Devil's Hole Beach.

Dredging was conducted in 1984 along the seaward side of Marginal Wharf. Subtidal regions are variable in stratigraphic composition. A boring drilled between the shore and the wharf indicated surficial silt overlying layers of loose sand, wood particles, and gravel.

6.2.8 Site 30, Railroad Tracks

Site 30 (Figure 10) is located at the southern boundary of SUBASE, Bangor. The terrain to the west is fairly level, although it is marked by several of the drumlins that characterize the till plain at the southern end of the base. The land immediately to the west is forested with undergrowth that is returning in areas formerly cleared for other rail lines (now abandoned). To the east, across Nautilus Road, the land surface drops steeply into the ravine that contains Site 2. Site 30 is characterized by gravel and large cobbles used as railroad ballast. The groundwater is more than 100 feet below ground surface (bgs).

Surface water from the southern portion of Site 30 runs through a culvert and eventually drains into Hood Canal.

6.2.9 Site E and Site 11

Site E and Site 11 are located in the south-central portion of the base (Figure 11). The terrain at the sites generally slopes downward to the northeast with a slight depression at the northwest end of Site 11. The area surrounding the sites is undulating and is predominantly wooded. There is no defined drainage from the sites to the West Fork of Clear Creek. The sites are between two north/south barricaded railroad sidings. Sites 11 and E are located on the upper slopes of the Clear Creek system near the divide.

Regionally, the Vashon Till contains locally interbedded lenses of silt and sand that collect water during the wet season. Borings at Site E and Site 11 in the Vashon Till indicate that it ranges between 6 to 25 feet in thickness. A typical vertical hydraulic conductivity value for the regional till unit is 0.003 ft/day (1×10^{-6} cm/s) (Hart Crowser 1989).

Local precipitation is the primary source of water recharging the aquifers in the study area. Most of the precipitation occurs during the months of November through April. Precipitation and subsequent infiltration recharges the shallow aquifer by downward percolation through the till.

The groundwater flow direction in the shallow aquifer at Site E is to the northwest.

6.2.10 Ecological Areas

Five short, straight post-glacial drainages incise the margins of the upland plateau in the northern half of SUBASE, Bangor (USGS 1953a, 1953b) (Figure 16). These drainages lack tributary systems and have a typical length of just over 1 mile. Their outlets into Hood Canal are spaced approximately 0.5 to 1 mile apart. Three of these drainages have been dammed by shoreline road construction, creating Devil's Hole, Hunter's Marsh, and Cattail Lake.

Cattail Lake

Cattail Lake (Figure 12) is fed by a stream that originates outside of the base boundary, and only a small portion flows through the base. The lake is fairly shallow with depths that range from approximately 4 feet near the inlet at its south end to approximately 12 feet near the outlet at the north end. The lake is surrounded by steeply sloping areas to the west and southwest and relatively gently sloping areas to the east. Tinosa Road borders the northern side of the lake, while the southern portion of the lake is surrounded by a mosaic of palustrine emergent and palustrine scrub-scrub wetlands.

The Cattail Lake wetlands area is classified as Category II according to the Washington State four-tier rating system (PRC 1991) and provides habitat for the indigenous three-spine stickleback (*Gasterosteus aculeatus*) and freshwater sculpin (family *Cottidae*), as well as German brown trout (*Salmo trutta*), brook trout (*Salvelinus fontinalis*), and large mouth bass (*Micropterus salmoides*) (URS 1992). It is fed by perennial streams and supports rainbow and cutthroat trout (*Salmo gairdneri* and *clarki*). Cattail Lake and Devil's Hole have supported reproducing pairs of osprey since the early 1980s. A beaver family also inhabits the stream draining into Cattail Lake.

Hunter's Marsh

Hunter's Marsh (Figure 13) is located at the bottom of the drainages that incise the upland plateau in the northern part of SUBASE, Bangor just above the discharge point into Hood Canal. The marsh was created as a result of road construction and is classified as a Category II wetland according to the Washington State four-tier rating system (PRC 1991). Hunter's Marsh consists of open water, cattails, large areas of scrub-scrub wetland dominated by willows and salmonberry, and forested areas dominated by red alder. It supports a large population of spiders, insects, tree frogs, and waterfowl (URS 1992).

The depth of Hunter's Marsh ranges from approximately 0.5 foot to 5 feet at the outlet near its western shore. To the east of the marsh, the topography is gently sloping, whereas to the west, north, and south of the marsh, the relief is more pronounced.

Devil's Hole

Devil's Hole (Figure 14) is located at the bottom of the drainages that incise the upland plateau in the northern part of SUBASE, Bangor just above the discharge point into Hood Canal. It was created when an existing bridge was filled in to construct a road.

Devil's Hole includes a variety of wetland habitats and a shallow impoundment with depths ranging from approximately 4 feet near the inlet at its southern shore to approximately 9 feet at the outlet at its northern shore. Classified as a Category I wetland according to the Washington State's four-tier rating system (PRC 1991), Devil's Hole provides habitat for released salmon (*Oncorhynchus*) to mature before they migrate into Hood Canal (URS 1992). The area surrounding the lake slopes upward at a rate of approximately 25 feet per 100 feet. The wetlands are associated with the eastern and southern drainages of the lake.

7.0 NATURE AND EXTENT

The RI for OU 7 (URS 1994a) included sampling and chemical analysis, geophysical investigations (Sites B, 2, E, and 11), soil vapor screening (Sites B and 7), and field screening for ordnance (Site B). Soil borings were drilled at most of the sites to collect subsurface soil samples, and some were completed as monitoring wells for groundwater characterization. At Site 26, shellfish and marine sediment samples were collected. In general, samples were analyzed for concentrations of all compounds on the EPA target compound list, i.e., volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, and PCBs; for analytes on the EPA target analyte list (metals and cyanide); and for ordnance compounds, herbicides, and water quality parameters.

Sampling results for each site were screened against the most stringent ARAR (and for inorganics against background values) and are provided in this section in tabular format. A complete listing of all sampling results is provided in the RI report, Section 4, Nature and Extent of Detected Chemicals.

The tables in this section indicate the number of samples collected, number of detections, minimum and maximum detected concentrations, calculated background concentration (inorganics only), and most stringent

ARAR. For chemicals with no established ARAR, cleanup standards are based on to-be-considered (TBC) guidance. Background concentrations for inorganic chemicals were established from samples collected at locations outside suspected areas of contamination. Background concentrations for organic chemicals are assumed to be zero because these chemicals are not naturally occurring. It is believed that the groundwater sampling techniques caused elevated turbidity in the samples and that the results of *total inorganics* analyses are thus not representative of groundwater characteristics. Therefore, groundwater data for *dissolved inorganics* are presented because they are most representative of actual groundwater conditions. The chemicals of interest (COIs) listed in the tables of this section are those chemicals that are present in a particular medium at concentrations above background values and above the most stringent ARAR. Chemicals in soil were not considered to be COIs if (1) they were detected in less than 10 percent of the samples, (2) the maximum detected concentration was less than twice the larger of the background value or ARAR, and (3) the 95 percent upper confidence limit (UCL) was less than the ARAR. All chemicals found at concentrations above background values were evaluated in the risk assessment (Section 8).

7.1 SITE B, FLORAL POINT

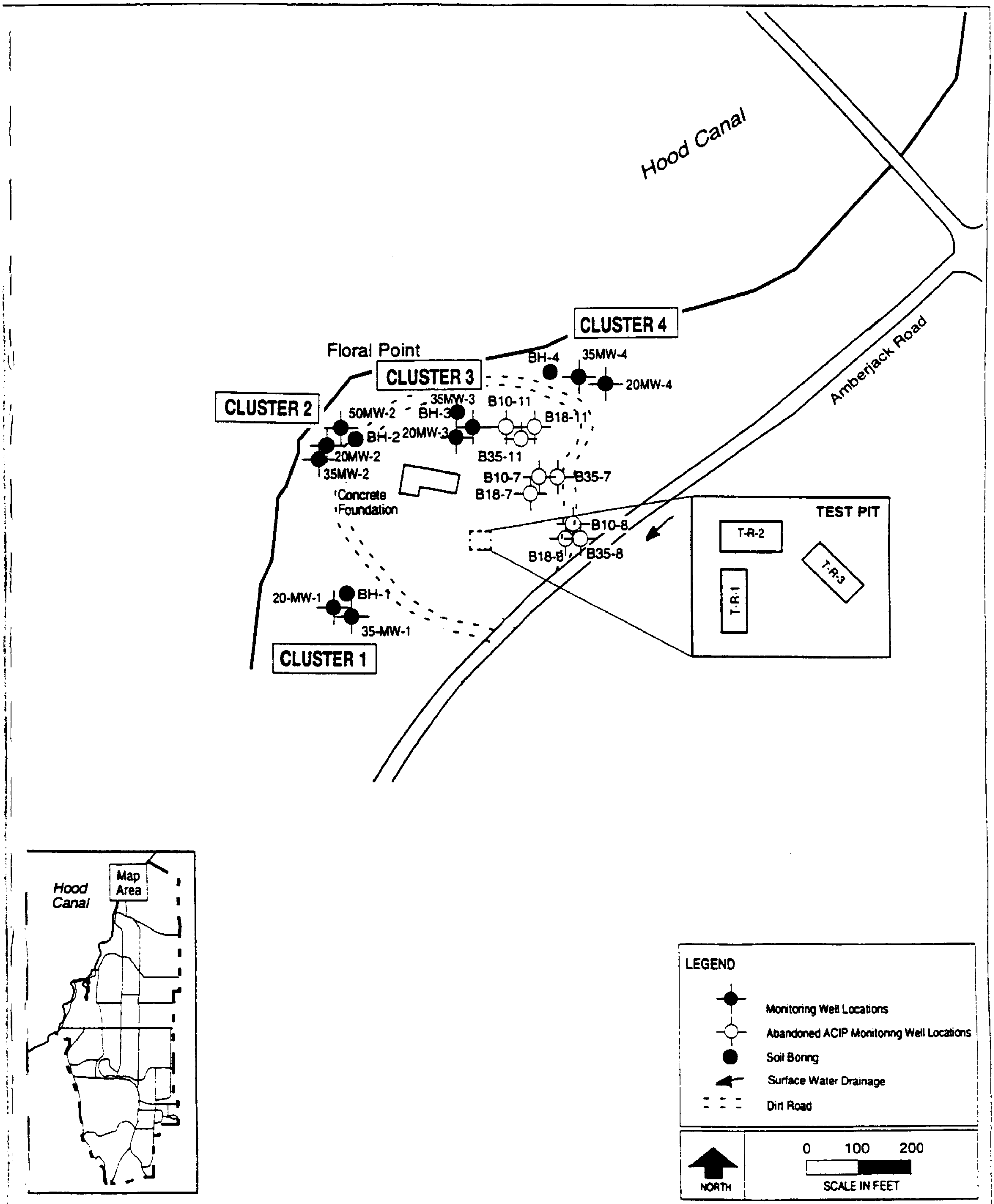
RI field work at Site B consisted of Phase I and Phase II investigations that included magnetic, electromagnetic, and ground-penetrating radar (GPR) geophysical surveys; soil vapor screening; ordnance screening; installation and sampling of nine new and two existing monitoring wells; and excavation and sampling of three test pits (Figure 17). The magnetic and electromagnetic geophysical surveys were performed in November 1992. The GPR survey was performed in November 1991. Sampling at Floral Point was conducted from January to April 1992 (Phase I) and August to November 1992 (Phase II).

Phase I sampling included a 30-point soil vapor survey, a 20-point field screening for ordnance in surface soil, collection of subsurface soil samples from four boreholes and from the deepest borehole of the monitoring well pair, and collection of groundwater samples (three rounds) from 11 wells. The water and soil samples were analyzed for metals, VOCs, SVOCs, PCBs, total petroleum hydrocarbons (TPH), pesticides, chlorinated herbicides, and ordnance compounds.

Phase II sampling included collection of shallow subsurface soil samples from three test pits, subsurface soil samples from four boreholes, and groundwater samples (four rounds) from nine monitoring wells. Groundwater samples were collected from four different clusters of monitoring wells, referred to as Clusters 1 through 4. Soil samples were collected from each of these clusters as well as from three test pits. Phase II sampling included drilling and sampling four boreholes to replace rejected Phase I soil data. Three test pits, located approximately in the center of Floral Point, were excavated to investigate an identified geophysical anomaly. The test pit observations indicated the presence of buried waste debris, including metal fragments tentatively described by SUBASE, Bangor personnel as possibly inert missile body panels or water heaters (URS 1994a). The water and soil samples were analyzed for metals, VOCs, SVOCs, PCBs, TPH, pesticides, chlorinated herbicides, and ordnance compounds.

7.1.1 Geophysical Investigations

The magnetic and electromagnetic surveys indicated that most of Site B has been disturbed to various degrees. The anomalies found imply past trench and fill activities and the presence of buried ferromagnetic



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 17** **Site B - Floral Point** **Soil Boring, Sampling, and Monitoring Well Locations**	CTO 0058 SUBASE, Bangor Washington ROD

CTO58\SEC02\FIG2-8.DRW 10/3/94

debris. The GPR survey identified numerous areas that showed evidence of buried cylindrical ferromagnetic items and disturbed areas that could be classified as former landfill sites.

7.1.2 Soil Vapor Survey

The soil vapor survey showed only a single detection of 0.3 parts per million (ppm) total organic vapors at a depth of approximately 6 inches at Soil Vapor Station 18, just north of Well Cluster 1. Survey results indicate that concentrated VOC sources are not present in the near subsurface.

7.1.3 Field Screening for Ordnance

Field screening for ordnance in surface soil near the concrete foundation showed no detections in 20 samples.

7.1.4 Shallow Soil Sampling and Analysis

Nine chemicals have been identified as COIs in shallow subsurface soil (0 to 3 feet bgs): seven SVOCs and two PCBs (Table 1). Concentrations of beryllium and Aroclor 1260 were detected above ARARs but exceeded ARARs in less than 10 percent of the samples, the maximum detected concentration was less than twice the larger of the background value or Model Toxics Control Act (MTCA) Method B, and the 95 percent UCL was less than the MTCA Method B value. Beryllium and Aroclor 1260 were therefore not retained as COIs.

The seven SVOCs are all polycyclic aromatic hydrocarbons (PAHs): benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, and dibenz(a,h)anthracene. PAH exceedances occurred primarily in Borehole 3, Test Pit 2, and Test Pit 3. Concentrations of PAHs were highest in Test Pit 3, exceeding concentrations in Borehole 3 and Test Pit 2 by more than an order of magnitude. The two PCBs identified as COIs—Aroclor 1248 and 1254—were found in Test Pits 2 and 3 and Borehole 1.

7.1.5 Subsurface Soil Sampling and Analysis

COIs identified in subsurface soil (3 to 55 feet bgs) include two inorganics (arsenic and copper), five SVOCs (the PAHs benzo[a]anthracene, chrysene, benzo[k]fluoranthene, benzo[a]pyrene, and indeno[1,2,3-cd]pyrene), and one PCB (Aroclor 1242). Beryllium and benzo(b)fluoranthene concentrations were above ARARs, but these chemicals were not retained as COIs for the same reasons listed in Section 7.1.4 for beryllium and Aroclor 1260.

The concentration of arsenic exceeded ARARs in four samples from 35-MW-1 and 35-MW-4, at depths of 5 to 17.5 feet. Copper concentrations exceeded ARARs in one sample collected at 35-MW-1, at a depth of 5 to 7.5 feet bgs. PAH exceedances occurred at 35-MW-3 and Boreholes 1 and 3, at depths of 5 to 12 feet bgs. Concentrations of Aroclor 1242 exceeded ARARs in two samples collected at Borehole 4, at depths of 5 and 12 feet bgs.

Table 1
Chemicals of Interest Detected at Site B

COI	Number of Samples	Number of Detections	Minimum Detected Conc.	Maximum Detected Conc.	Calculated Background Conc.	Potential ARARs	
						Value	Reference
SHALLOW SOIL (0 - 3 feet bgs)							
Semivolatile Organic Compounds (µg/kg)							
Benzo(a)anthracene	12	4	62 J	6,400	N/A	137	MTCA
Chrysene	12	7	38 J	7,550	N/A	137	MTCA
Benzo(b)fluoranthene	12	5	29 J	4,350	N/A	137	MTCA
Benzo(k)fluoranthene	12	4	73 J	4,150	N/A	137	MTCA
Benzo(a)pyrene	12	5	63 J	4,100	N/A	137	MTCA
Indeno(1,2,3-c,d)pyrene	12	2	81 J	1,200 J	N/A	137	MTCA
Dibenz(a,h)anthracene	12	1	320 J	320 J	N/A	137	MTCA
Pesticides/PCBs (µg/kg)							
Aroclor 1248	10	1	1,800	1,800	N/A	130	MTCA
Aroclor 1254	10	2	250	650	N/A	130	MTCA
SUBSURFACE SOIL (3 - 55 feet bgs)							
Metals (mg/kg)							
Arsenic	30	4	6.40 J	11.30 J	4.40	1.43	MTCA
Copper	30	7	41.1 J	7,440	30.7	2,960	MTCA
Semivolatile Organic Compounds (µg/kg)							
Benzo(a)anthracene	60	3	66 J	360 J	N/A	137	MTCA
Chrysene	60	4	42 J	460 J	N/A	137	MTCA
Benzo(k)fluoranthene	60	3	30 J	400 J	N/A	137	MTCA
Benzo(a)pyrene	60	4	53 J	560 J	N/A	137	MTCA
Indeno(1,2,3-cd)pyrene	60	2	60 J	350 J	N/A	137	MTCA
Pesticides/PCBs (µg/kg)							
Aroclor 1242	47	8	6.10 J	6,400	N/A	130	MTCA
GROUNDWATER							
Dissolved Metals (µg/L)							
Arsenic	49	6	2.40	4.10	2.30	0.05	MTCA
Cadmium	52	4	2.80	120 J	2.51	5	MCL
Lead	58	2	2.60 J	14.60 J	1.70	5	MTCA-A
Manganese	58	3	228 J	426	215	80	MTCA
Thallium	39	2	2 J	2.30 J	1.06	1.12	MTCA
Volatile Organic Compounds (µg/L)							
Tetrachloroethene	58	20	0.40 J	1	N/A	0.858	MTCA
Semivolatile Organic Compounds (µg/L)							
Chrysene	57	1	5 J	5 J	N/A	0.012	MTCA
Bis(2-ethylhexyl)phthalate	58	15	1 J	30	N/A	6	MCL

Table 1 (Continued)
Chemicals of Interest Detected at Site B

COI	Number of Samples	Number of Detections	Minimum Detected Conc.	Maximum Detected Conc.	Calculated Background Conc.	Potential ARARs	
						Value	Reference
GROUNDWATER (CONTINUED)							
Pesticides/PCBs (µg/L)							
Aroclor 1016	58	1	0.81	0.81	N/A	1.12	MTCA
Total Petroleum Hydrocarbons (µg/L)							
Total petroleum hydrocarbons	18	1	7,000 J	7,000 J	N/A	1,000	MTCA

Notes:
MTCA refers to Model Toxics Control Act Method B, except where noted by MTCA-A (Method A).
ARAR Applicable or relevant and appropriate requirement
bgs Below ground surface
COI Chemical of interest
J Estimated value
MCL Maximum contaminant level
N/A Not applicable—background concentrations assumed to be zero
PCB Polychlorinated biphenyl

Source: URS 1994a

7.1.6 Groundwater Sampling and Analysis

COIs identified in groundwater at Site B include five inorganics (arsenic, cadmium, lead, manganese, and thallium), one VOC (tetrachloroethene), two SVOCs (chrysene and bis[2-ethylhexyl]phthalate), one PCB (Aroclor 1016), and TPH.

Groundwater samples were analyzed for both total and dissolved inorganics. Total inorganics were detected much more frequently and at much higher concentrations than dissolved inorganics. The groundwater at this site contains high concentrations of seawater, which affects the levels of some of the inorganics. Because of the turbidity of many of the samples, dissolved metals concentrations were used to make decisions regarding inorganics. The dissolved inorganics above ARARs were found scattered across the site at B18-7, B35-7, 20MW-1, 20MW-4, 35MW-1, 35MW-3, and 50MW-2.

Tetrachloroethene was detected in the groundwater sampling approximately 35 percent of the time, in the western portion of the site in two 35-foot wells (Well Clusters 1 and 2) and at both the 20- and 35-foot depths in the eastern portion of the site (Well Cluster 4).

Bis(2-ethylhexyl)phthalate was detected above ARARs in 6 of 58 samples and in each of the five well clusters. Chrysene, PCB (total), and TPH were detected once above ARARs (at 20MW-2, 20MW-4, and 35MW-2, respectively).

Because the groundwater at Floral Point flows into the marine waters of Hood Canal, the chemical concentrations were also compared to marine Water Quality Standards. Five inorganics (cadmium, copper, lead, nickel, and zinc) and three pesticides (endrin, heptachlor, and gamma-chlordane) exceeded state surface water standards.

7.2 SITE 2, CLASSIFICATION YARD/FLEET DEPLOYMENT PARKING

Investigation sampling conducted at Site 2 included subsurface soil, Trident Lakes sediment, surface water including Trident Lakes, and groundwater. Site 2 media were sampled during both Phase I (August to October 1992) and Phase II (August to October 1993). During Phase I field activities, a buried drum was accidently ruptured. Samples were collected of the drum's contents, runoff from the drum area, and shallow soil to determine possible impacts on the vicinity of the ruptured drum. A drum removal action was initiated as a time-critical (or emergency) action because the buried drum contained hazardous substances. The work on the removal action was halted in October 1992 because the excavation was beginning to undermine the embankments supporting Nautilus Avenue. A second removal action was started in May 1993 to continue the excavation under the embankment. More buried drums were discovered and removed in this second removal action. Remediation included digging drum trenches and test pits and stockpiling contaminated soil for disposal. A significant amount of metallic debris—including shells, projectiles, and steel banding—was found during the removal actions. Information and results of the site cleanup and drum removal activities can be found in the removal action report (URS 1993c, 1994c; IT Corporation 1994). The Phase II investigation was conducted in conjunction with the removal actions.

The soil and metal debris were excavated during the drum removal action in June and September of 1993 (IT Corporation 1994). Containment Cell No. 1 was constructed for potentially contaminated soil and debris. Containment Cell No. 2, which was used for noncontaminated excavated soil and debris, contained approximately 15,000 cubic yards of soil; the soil in Cell No. 2 was used as backfill for the drum trench excavation. The total volume remaining in both cells is approximately 5,000 cubic yards.

Groundwater and soil sampling data were collected from five monitoring wells, and sediment and water samples were taken from Trident Lakes. No shallow soil samples were collected at Site 2. The locations of the sampling points are shown in Figure 18. The water, soil, and sediments were analyzed for metals, VOCs, SVOCs, PCBs, TPH, pesticides, chlorinated herbicides, and ordnance compounds.

7.2.1 Geophysical Investigations

To identify potential drum locations prior to the drum removal, GPR and electromagnetic geophysical surveys were conducted at Site 2. The surveys indicated a number of subsurface anomalies that were tentatively identified as buried drums. The results of the surveys were used to designate excavation areas for the removal action.

7.2.2 Stockpiled Soil Sampling and Analysis

Aroclor 1260 was the only COI identified in stockpiled soil (Table 2). Aroclor 1260 was detected in 5 of 10 samples from Containment Cell No. 1 at concentrations up to 2,700 μg/kg. No COIs were identified in soils from Containment Cell No. 2.

The metallic debris was not sampled and analyzed and therefore is not listed in Table 2 as a COI.

7.2.3 Subsurface Soil Sampling and Analysis

No chemicals were detected above background and ARARs in the subsurface soil; thus, none were retained as COIs.

7.2.4 Surface Water Sampling and Analysis

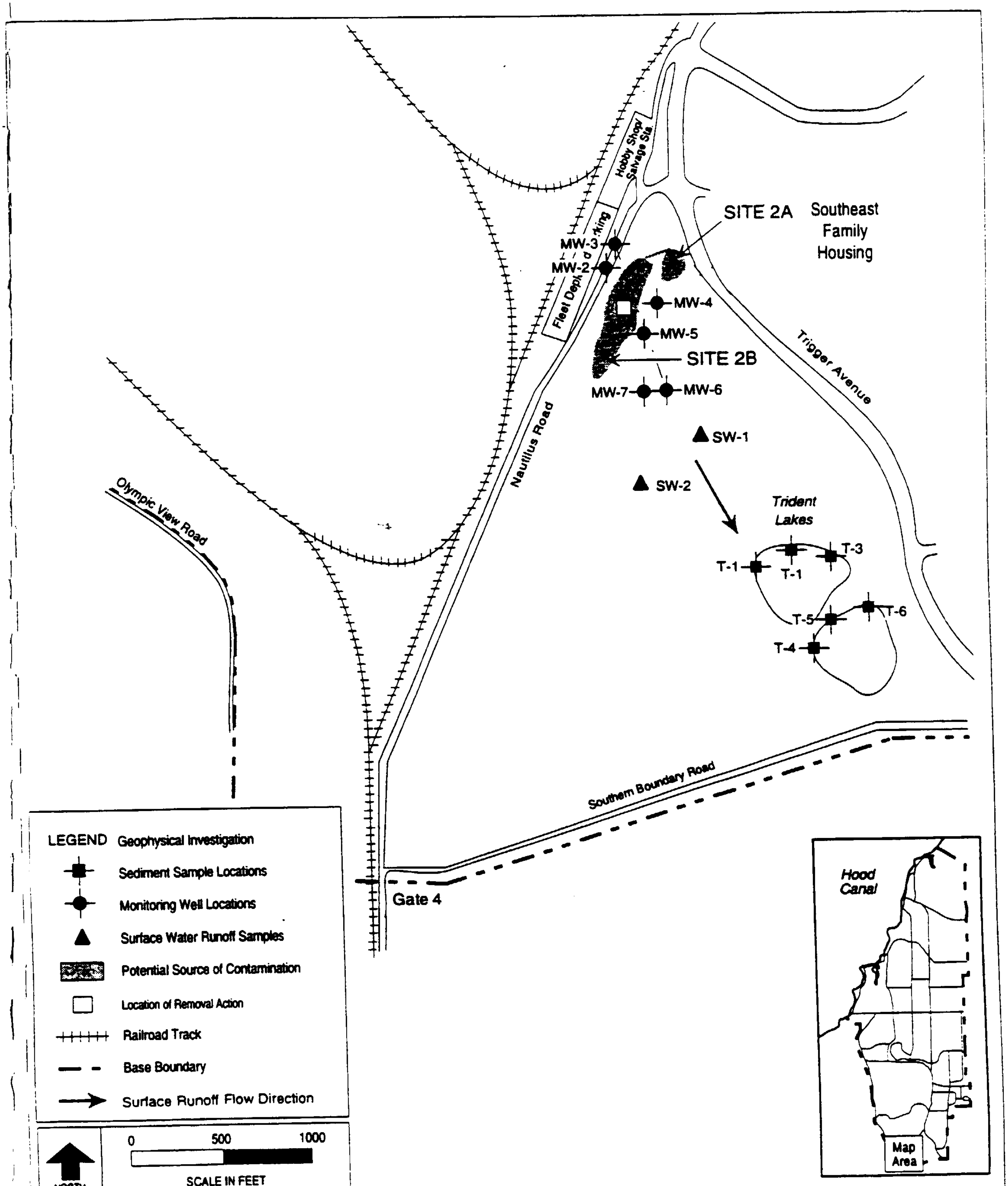
No COIs were identified in surface water from Trident Lakes.

7.2.5 Freshwater Sediment Sampling and Analysis

No COIs were identified in freshwater sediment from Trident Lakes.

7.2.6 Groundwater Sampling and Analysis

Table 2 lists the two COIs detected in groundwater samples collected at Site 2. Arsenic was detected at 2.40 μg/L at MW-3, and manganese at 255 μg/L at MW-5.



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 18** **Site 2 - Classification Yard/Fleet Deployment Parking Sampling and Monitoring Well Locations**	CTO 0058 SUBASE, Bangor Washington ROD

0CTO58\FIG2-9.DRW 4/6/93

Table 2
Chemicals of Interest Detected at Site 2

COI	Number of Samples	Number of Detections	Minimum Detected Conc.	Maximum Detected Conc.	Calculated Background Conc.	Potential ARARs	
						Value	Reference
CONTAINMENT CELL NO. 1 STOCKPILED SOIL							
Pesticides/PCBs (µg/kg)							
Aroclor 1260	10	5	670 J	2,700 J	N/A	130	MTCA
GROUNDWATER							
Dissolved Metals (µg/L)							
Arsenic	13	2	2.40 J	2.40 J	2.30	0.05	MTCA
Manganese	16	1	255	255	215	80	MTCA

Notes:
ARAR Applicable or relevant and appropriate requirement
COI Chemical of interest
J Estimated value
MTCA Model Toxics Control Act Method B
N/A Not applicable—background concentrations assumed to be zero
PCB Polychlorinated biphenyl

Source: URS 1994a

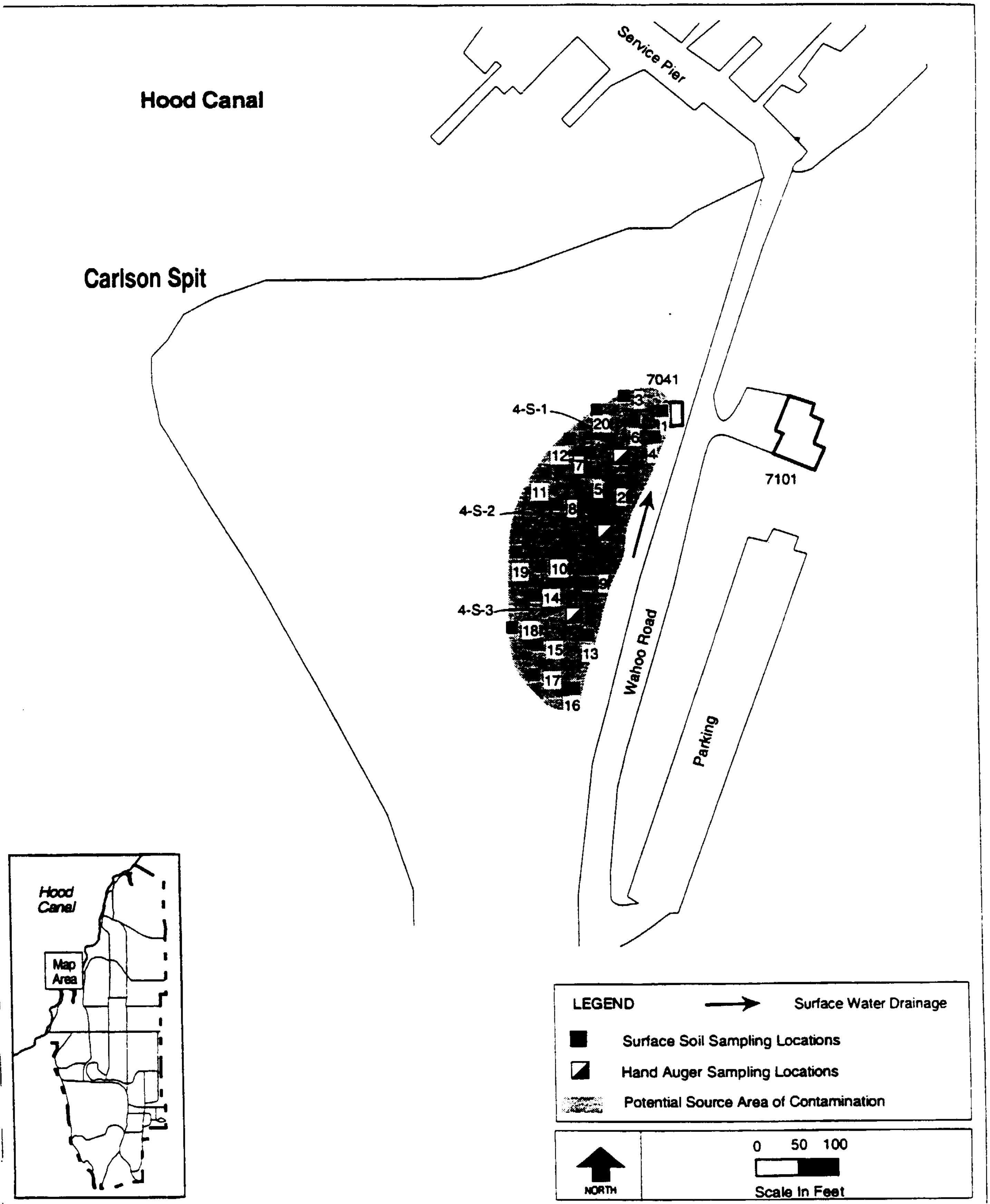
7.3 SITE 4, CARLSON SPIT

Twenty surface (0 to 6 inches bgs) and three subsurface (about 3 feet bgs) soil samples were collected from Site 4 (Figure 19). Ordnance screening was performed on the surface soil samples. The subsurface soil samples were analyzed for inorganics and ordnance compounds.

No inorganic chemicals were identified as COIs. No ordnance compounds were detected.

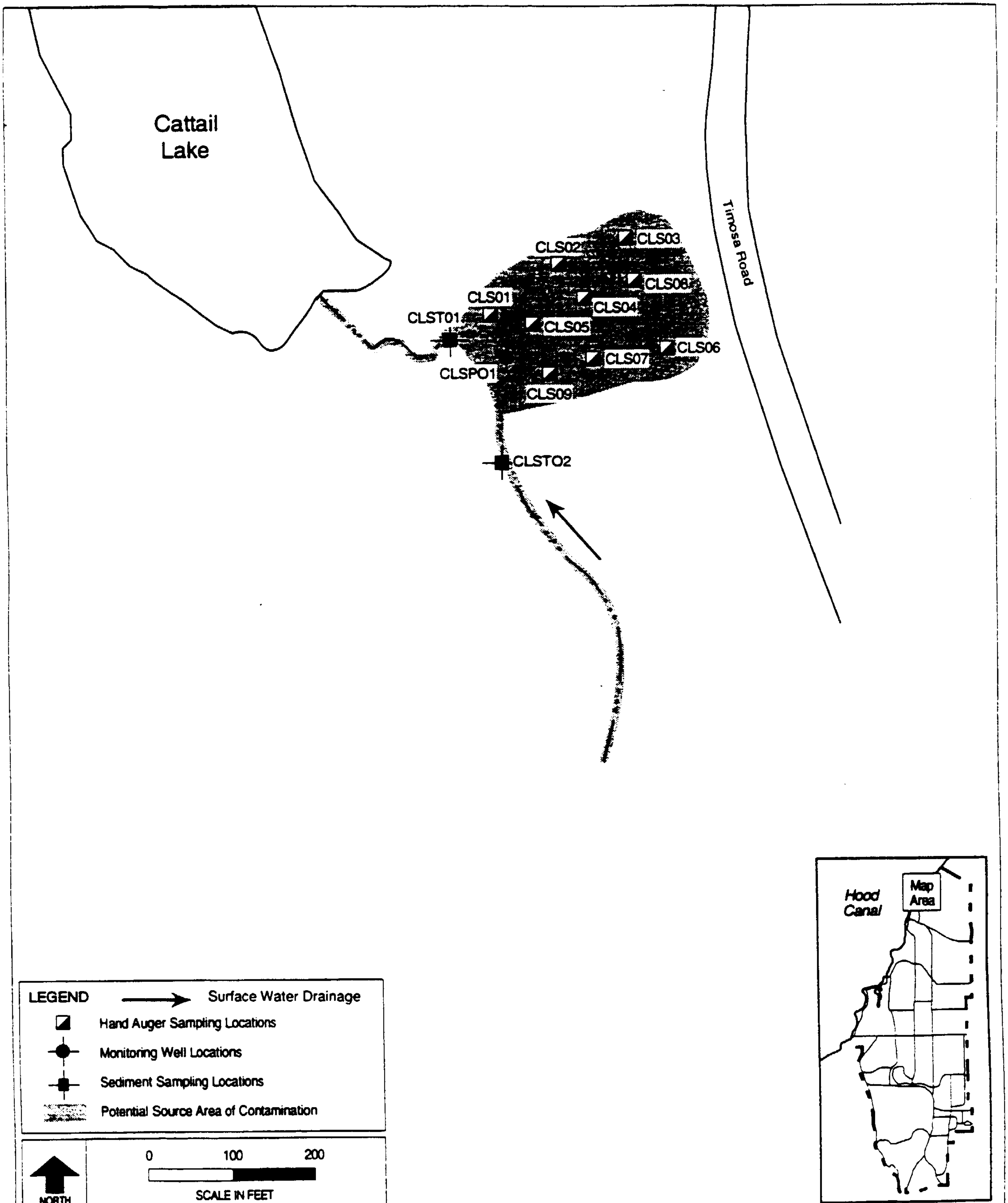
7.4 SITE 7, OLD PAINT CAN DISPOSAL SITE

RI field work at Site 7 included a soil vapor survey and sampling of a variety of media. The soil vapor survey for total VOC concentrations was conducted on a 15-point grid. Sampling at Site 7 included surface and subsurface soil, freshwater stream sediment, surface water, and groundwater (Figure 20). Nine surface and subsurface soil samples were collected. Two stream sediment and surface water samples were collected from the tributary stream to Cattail Lake. Three groundwater samples were collected from the monitoring well at Site 7. Samples were tested primarily for metals and VOCs to determine possible effects of paints and solvents disposed of at the site.



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 19** **Site 4 - Carlson Spit Sampling Locations**	CTO 0058 SUBASE, Bangor Washington ROD

CTO58\FIG 2-10.DRW 3/15/93



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 20** **Site 7 - Old Paint Can Disposal Site** **Sampling and Monitoring Locations**	CTO 0058 SUBASE, Bangor Washington ROD

CTO58FIG2-11.DRW 3/15/93

Impacts to soil and groundwater from the use of Site 7 as a paint and solvent disposal area are minimal. The detections of metals were commonly found at concentrations close to background values.

7.4.1 Soil Vapor Survey

The soil vapor survey showed low-level detections of total organic vapor, ranging from 0.1 and 0.3 ppm, from five stations on the east side of the site. These results indicate that concentrated VOC sources are not present in the near subsurface.

7.4.2 Surface Soil Sampling and Analysis

As shown in Table 3, two inorganic COIs were identified in surface soils: arsenic (6.10 mg/kg) and beryllium (0.83 mg/kg). Both inorganics were detected in only one sample of nine, at concentrations less than 1.5 times the background value. No VOCs were detected above ARARs.

7.4.3 Shallow Subsurface Soil Sampling and Analysis

One inorganic COI was identified in shallow subsurface soil—beryllium, at 0.92 mg/kg (Table 3). Beryllium was detected in three of nine samples, at concentrations less than 1.5 times the background value.

7.4.4 Stream Sediment Sampling and Analysis

Two stream sediment samples were collected from the tributary stream (which originates off base) to Cattail Lake; the samples were analyzed for total metals and VOCs. Because no ARARs exist for chemicals in freshwater sediment, MTCA Method B soil cleanup levels were used as a TBC concentration for comparison. Only beryllium exceeded both background and the TBC concentration. Beryllium was detected in both sediment samples, at concentrations less than 1.5 times the background value.

7.4.5 Groundwater Sampling and Analysis

Manganese was reported above the background value and ARARs in the one sample analyzed for inorganics and thus was retained as a COI. Manganese was found in this sample at a concentration less than 2 times the background value.

7.4.6 Surface Water Sampling and Analysis

No COIs were identified in surface water.

7.5 SITE 10, PESTICIDE STORAGE QUONSET HUTS

Soil samples were collected at Site 10 and analyzed for pesticides and herbicides. Groundwater samples were collected and analyzed for pesticides, herbicides, total and dissolved inorganics, VOCs, SVOCs, and TPH. Phase I environmental sampling included installing and sampling one monitoring well and drilling and sampling four soil borings. In the soil borings, soil samples were collected at three different levels down to

Table 3
Chemicals of Interest Detected at Site 7

COI	Number of Samples	Number of Detections	Minimum Detected Conc.	Maximum Detected Conc.	Calculated Background Conc.	Potential ARARs	
						Value	Reference
SURFACE SOIL (0 - 1.5 feet bgs)							
Total Metals (mg/kg)							
Arsenic	9	1	6.10 J	6.10 J	4.40	1.43	MTCA
Beryllium	9	1	0.83 J	0.83 J	0.80	0.233	MTCA
SHALLOW SUBSURFACE SOIL (1.5 - 3 feet bgs)							
Total Metals (mg/kg)							
Beryllium	9	3	0.82 J	0.92 J	0.80	0.233	MTCA
SEDIMENT							
Total Metals (mg/kg)							
Beryllium	2	2	0.565	0.74 J	0.50	0.233	MTCA[a]
GROUNDWATER							
Dissolved Metals (μg/L)							
Manganese	1	1	407	407	215	80	MTCA

[a]MTCA Method B soil cleanup levels used as a TBC guidance concentration.

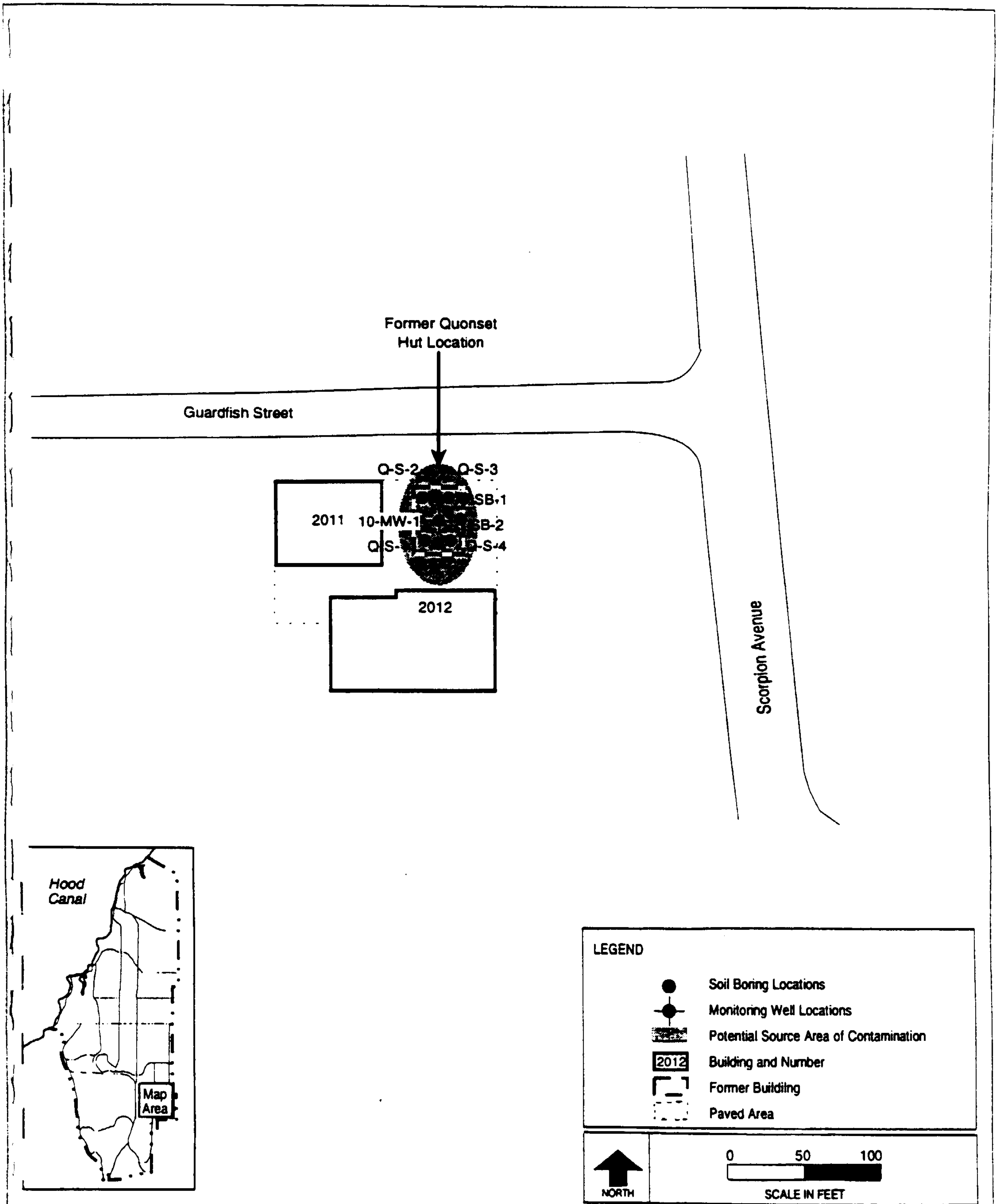
Notes:
ARAR Applicable or relevant and appropriate requirement
bgs Below ground surface
COI Chemical of interest
J Estimated value
MTCA Model Toxics Control Act Method B

Source: URS 1994a

5 feet bgs. In the monitoring well, soil samples were collected at 5 feet bgs and at the water table (approximately 35 feet bgs). Three groundwater samples were collected from the well during Phase I. During Phase II, two additional soil borings were drilled and analyzed for pesticides and herbicides. Phase II work also included the collection and analysis of a single groundwater sample from the well. Figure 21 shows the sampling and monitoring well locations for Site 10. Table 4 lists the COIs at Site 10.

7.5.1 Soil Sampling and Analysis

From the six soil borings and one monitoring well, 20 soil samples were collected. Dieldrin was detected once in 14 samples at concentrations above MTCA Method B. However, the detection constituted less than 10 percent of the samples, the value was less than 2 times MTCA Method B, and the 95 percent UCL was less than the MTCA Method B value. No COIs were identified in Site 10 soil samples.



CLEAN
COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

Figure 21
Site 10 - Pesticides Storage Quonset Huts
Sampling and Monitoring Well Locations

CTO 0058
SUBASE, Bangor
Washington
ROD

CTO58\FIG2-13.DRW 3/15/93

Table 4
Chemicals of Interest at Site 10

COI	Number of Samples	Number of Detections	Minimum Detected Conc.	Maximum Detected Conc.	Calculated Background Conc.	Potential ARARs	
						Value	Reference
GROUNDWATER							
Semivolatile Organic Compounds (µg/L)							
Bis(2-ethylhexyl)phthalate	2	2	3 J	9 J	N/A	6	MCL
Total Petroleum Hydrocarbons (µg/L)							
Total petroleum hydrocarbons	1	1	3,100	3,100	N/A	1,000	MTCA

Notes:
ARAR Applicable or relevant and appropriate requirement
COI Chemical of interest
J Estimated value
MCL Maximum contaminant level
MTCA Model Toxics Control Act Method B
N/A Not applicable—background concentrations assumed to be zero

Source: URS 1994a

7.5.2 Groundwater Sampling and Analysis

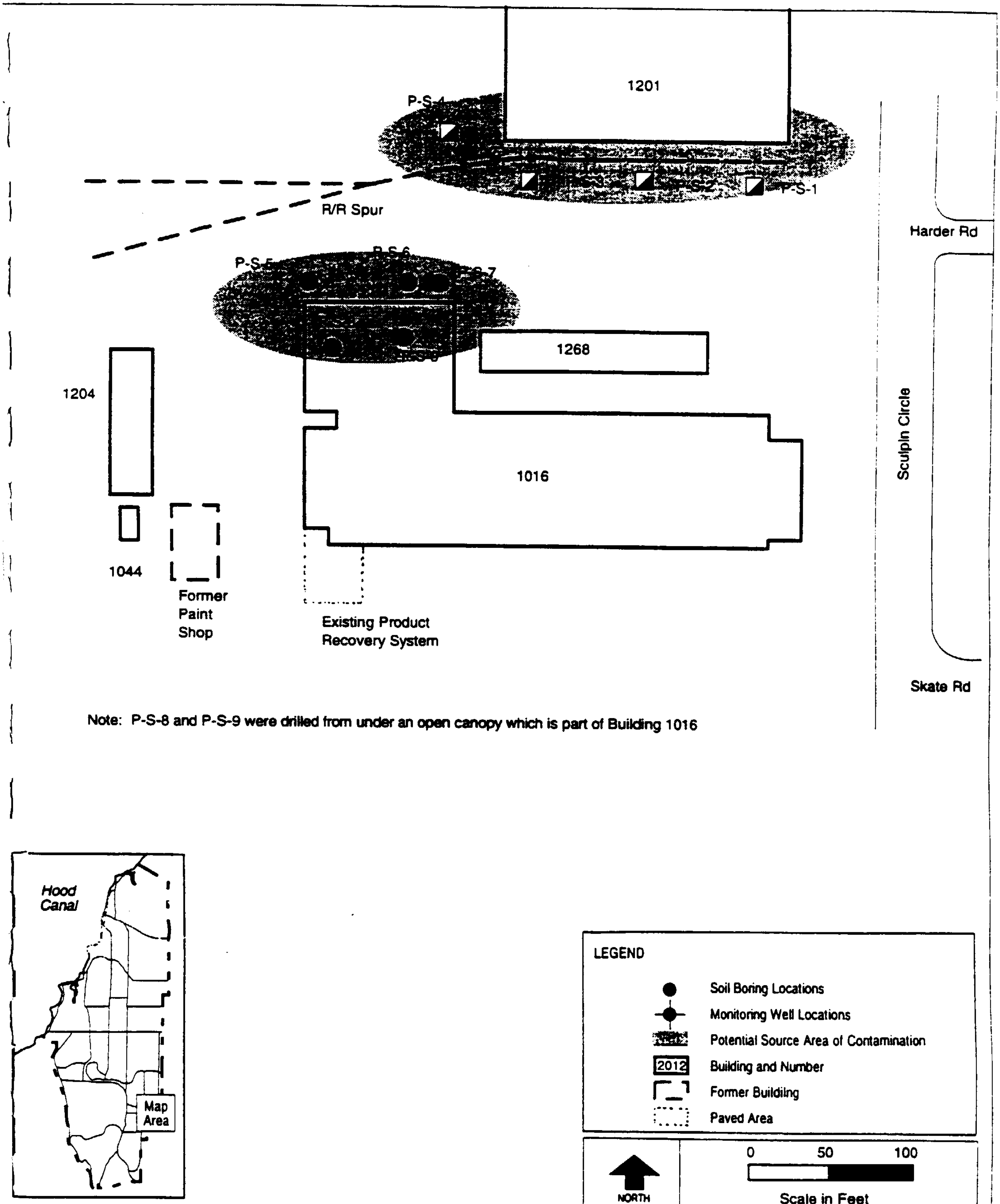
Two organic compounds were identified as COIs in Site 10 groundwater: bis(2-ethylhexyl)phthalate and TPH. Bis(2-ethylhexyl)phthalate and TPH were each detected at concentrations above ARARs in one sample from the single monitoring well at Site 10.

7.6 SITE 18, PCB SPILL SITE

Nine soil samples were collected between the ground surface and 3.4 feet bgs and analyzed for pesticides and PCBs. Figure 22 shows the sampling locations for Site 18. No pesticide or PCB concentrations were detected above ARARs in the soils collected from Site 18 and therefore none were retained as COIs.

7.7 SITE 26, HOOD CANAL SEDIMENTS

A total of 171 intertidal and subtidal sediment samples were collected at Site 26. Shellfish samples were collected at Cattail Lake Beach, Floral Point Beach, Explosives Handling Wharf, Marginal Wharf, Keyport/Bangor Dock, and Service Pier. Bioassay samples were collected from 32 stations. Chemical concentrations in sediment samples were compared with background values and the Sediment Quality Standards (SQS) chemical criteria found in the Sediment Management Standards (SMS). Chemicals that exceeded both were considered COIs. Inorganic concentrations detected in shellfish tissues were compared with background values. A summary of the results by site from north to south (Area A through Area D) is provided in the following subsections.



CLEAN
COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY

Figure 22
Site 18 - PCB Spill Site
Soil Boring, Sampling, and Monitoring Well Locations

CTO 0058
SUBASE, Bangor
Washington
ROD

CTO58\FIG2-14.DRW 3/23/93

The primary chemical groups detected in Hood Canal sediments were PAHs, phthalates, phenols, and chlorinated pesticides. The highest chemical concentrations were detected in Area C, Marginal Wharf, and Area D including both Keyport/Bangor Dock and Service Pier.

7.7.1 Area A, Cattail Lake Beach/Magnetic Silencing Facility

Cattail Lake Beach, located between the northern SUBASE boundary and the Magnetic Silencing Facility, receives sediments primarily from the Cattail Lake drainage. Seven surface (intertidal) sediment samples were collected during the Phase I sampling program. During Phase II, six subsurface samples were collected from four locations. Three composite clam tissue samples were also collected in the intertidal zone. All samples were analyzed for total metals, SVOCs, pesticides, PCBs, and ordnance compounds. Sediment samples were also analyzed for VOCs, total organic carbon (TOC), grain size, and additional conventional parameters. Tissue samples were also evaluated for lipid content. The lipid content is used to "normalize" non-ionic and nonpolar organic compounds that accumulate in fat tissues. Sediment toxicity tests and benthic infauna were evaluated at one station (MS03). Biological results were used with the evaluation of sediments for comparison with the Washington State SMS discussed in the marine ecological risk assessment (see under Section 8.2.2, *SMS Comparison*).

Sediment Sampling and Analysis

The locations of the sampling stations for Cattail Lake Beach and Magnetic Silencing Facility are shown in Figure 23. No chemicals detected in the sediments were reported at concentrations above SQS.

Tissue Sampling and Analysis

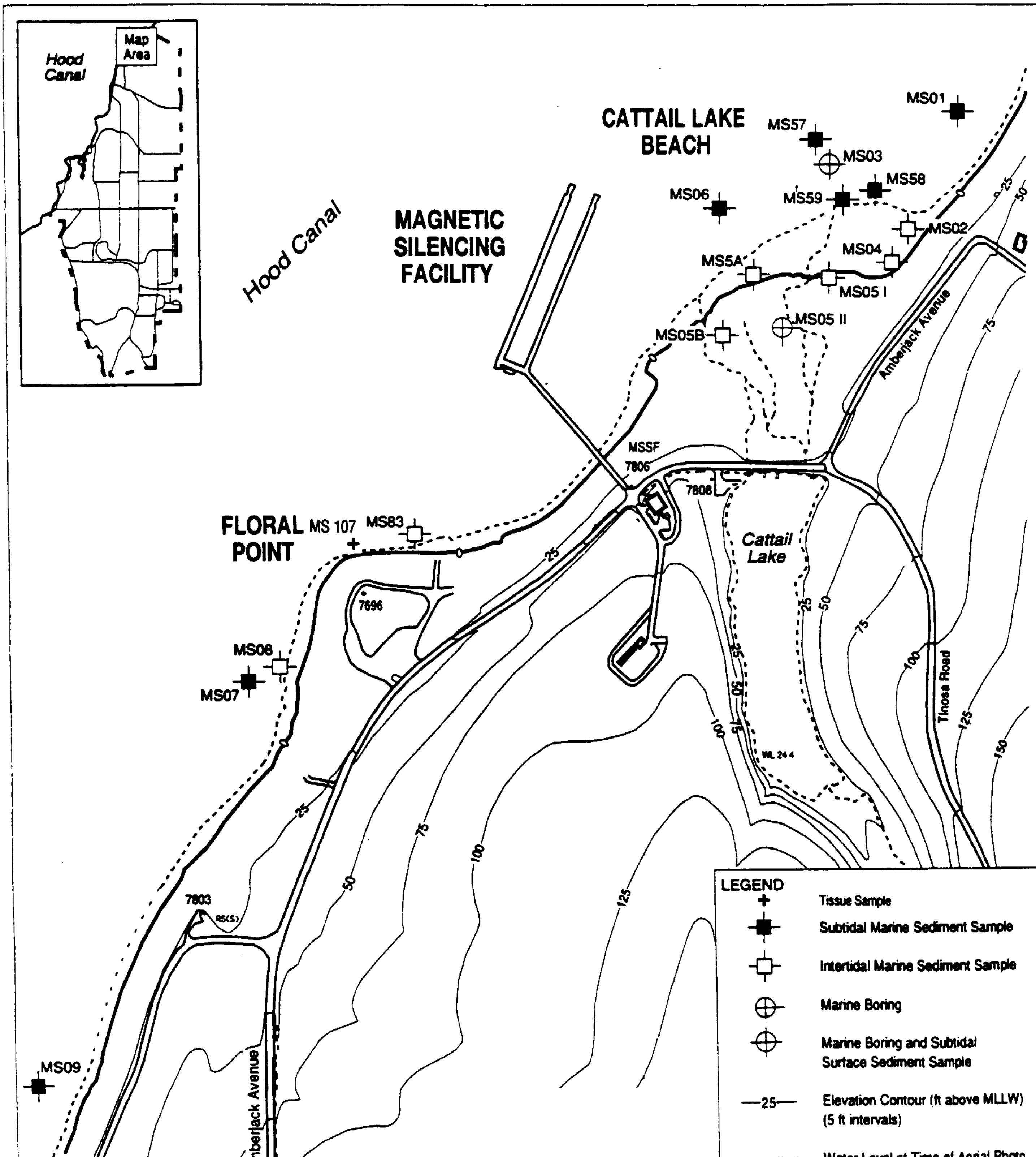
Nine inorganics were detected in all clam tissue samples at concentrations similar to or slightly above background values. Picric acid, the only organic, was detected in one of three tissue samples.

7.7.2 Area A, Floral Point

Floral Point (southern portion of Figure 23) is a natural shoreline that has undergone extensive reworking by the Navy for pyrotechnics testing, dumping of miscellaneous solid and liquid wastes, and landfilling from Naval Undersea Warfare Center (NUWC) Division Keyport. Currently, the beach south of Floral Point is used by base personnel for shellfish harvesting and fishing every 3 to 5 years, on a rotational basis with other beaches on the base. The beach at Floral Point and north is not used for shellfishing because of the lack of proper sediment substrate.

Sediment Sampling and Analysis

Intertidal and subtidal sediment samples were collected at Floral Point during the Phase I and Phase II marine sampling programs. Surface sediment samples were collected during Phase I from one intertidal station (MS08) and two subtidal stations (MS07 and MS09). In Phase II, additional surface sediment and clam tissue samples were collected from intertidal Stations MS83 and MS107, respectively. All samples were analyzed for total metals, SVOCs, pesticides, PCBs, and ordnance compounds. Sediment samples were also



NOTE:
Vertical Datum Mean Lower Low Water (6.146 ft below 1929 Sea Level Datum)
Washington State Plane Coordinate System (Zone 5801 North)
Compiled by CAD Drawing Methods from Aerial Photograph dated 3/31/86
Supplied by SUBASE Bangor

CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 23** **Area A - Marine Sediment Sampling Locations**	CTO 0058 SUBASE, Bangor Washington ROD

CTO58\AREAA.DRW 4/7/93

GIS/cto58/autocad/area_a.plt

analyzed for VOCs (Phase I surface samples only), TOC, and grain size. No chemicals were detected in the intertidal or subtidal sediments sampled at Floral Point Beach at concentrations above the SQS.

Tissue Sampling and Analysis

Ten inorganics were detected slightly above background values, and picramic acid was found in the tissue sample collected at Station MS107 located on the north side of the point.

7.7.3 Area B, Explosives Handling Wharf/Hunter's Marsh Beach

The Explosives Handling Wharf is shown in Figure 24. Hunter's Marsh is located directly east of the Explosives Handling Wharf. North of the Explosives Handling Wharf is a public clamming beach that is accessed by stairs from Tang Road near the intersection of Flier Road. There is also a stormwater outfall that discharges surface water runoff from the roads onto the beach.

Sediment Sampling and Analysis

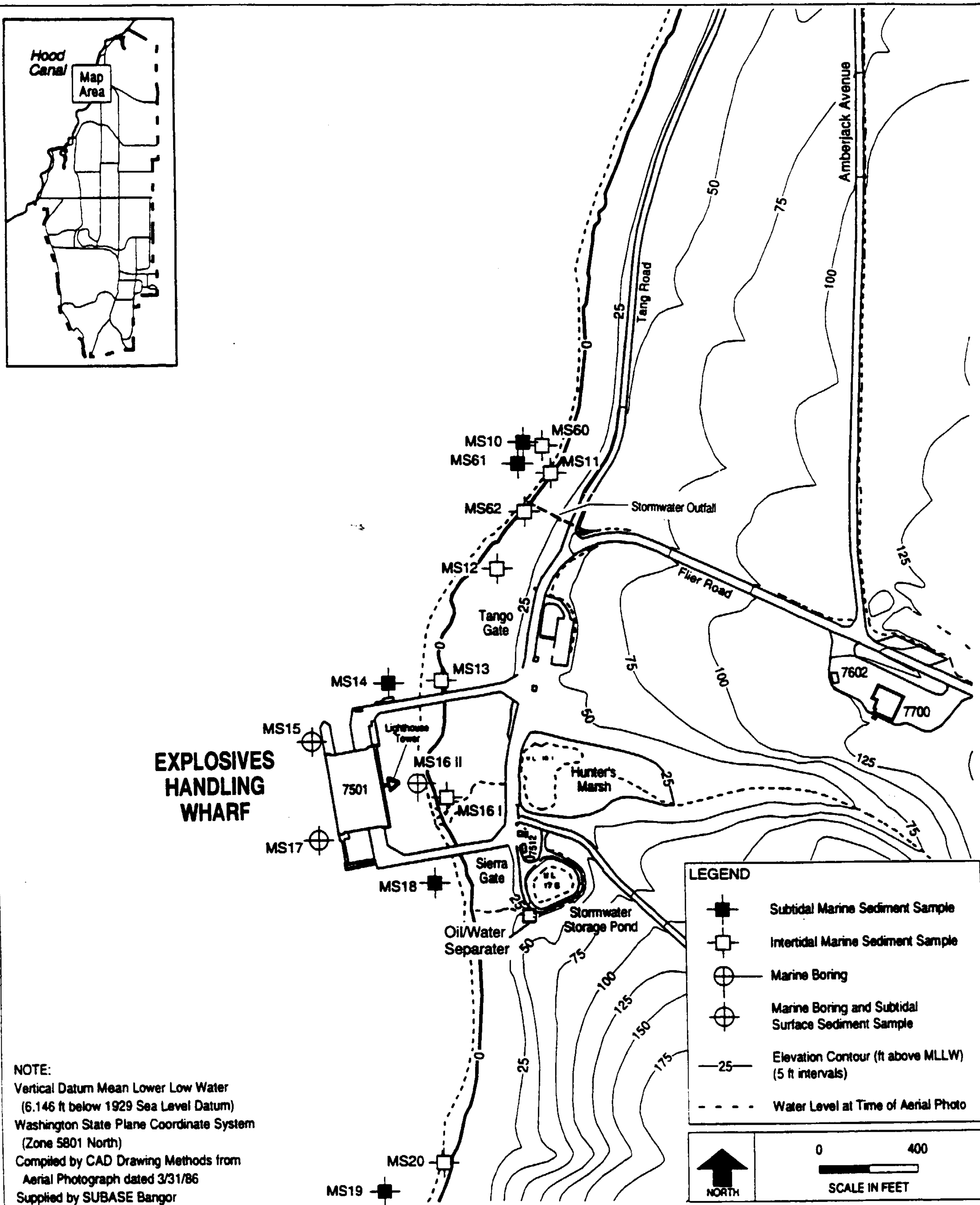
Sediment samples from seven intertidal and seven subtidal stations (including two subtidal marine borings) were collected during Phase I and Phase II. Sediment cores were advanced at three stations and subsamples were collected from a depth of up to 12 feet below mudline. All samples were analyzed for total metals, SVOCs, pesticides, PCBs, and ordnance compounds. Sediment samples were also analyzed for VOCs (Phase I surface samples and Phase II cores only), TOC, and grain size. Table 5 lists the chemicals detected in the sediments sampled at the Explosives Handling Wharf that were above ARARs.

Only two compounds (4-methylphenol and pentachlorophenol) were detected in intertidal sediments at concentrations above the SQS. The highest concentrations of phenols were found at Stations MS11 (4-methylphenol) and MS16-II (pentachlorophenol). At MS16-II, concentrations of pentachlorophenol increased in the subsurface sediments from 0.029 mg/kg (0 to 2 feet) to 2.4 mg/kg (4 to 6 feet). However, the SQS exceedance for pentachlorophenol at the 4- to 6-foot depth is considered to be below the biologically active zone. Pentachlorophenol was not detected below 6 feet, where dense impermeable glacial till was encountered.

Tissue Sampling and Analysis

One composite clam tissue sample was collected at Station MS62 in the intertidal zone north of the Explosives Handling Wharf near the stormwater discharge pipe. This location was selected based on chemicals detected in the sediments during Phase I sampling (e.g., 4-methylphenol). The tissue sample was evaluated for lipid content and for total metals, SVOCs, pesticides, PCBs, and ordnance compounds.

No SVOCs, pesticides, PCBs, or ordnance compounds were detected. The clam tissue sample contained 12 inorganics with concentrations above corresponding background levels. Aluminum, iron, and selenium were present at concentrations approximately 2 times background. There was no obvious relationship between chemicals detected in clam tissue and chemicals detected in either intertidal or subtidal marine sediments.



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 24** **Area B - Marine Sediment Sampling Locations**	CTO 0058 SUBASE, Bangor Washington ROD

CTO58AREAB.DRW 4/7/93

GIS/cto58/autocad/area_b.plt

Table 5
Chemicals of Interest Detected at Site 26, Explosives Handling Wharf

COI	Number of Samples	Number of Detections	Minimum Detected Conc.	Maximum Detected Conc.	Calculated Background Conc.	Potential ARARs	
						Value	Reference
INTERTIDAL MARINE SEDIMENTS							
Semivolatile Organic Compounds (mg/kg-oc)							
4-Methylphenol	13	6	0.009 J	1.2	N/A	0.670	SQS
Pentachlorophenol[a]	13	3	0.029 J	2.4	N/A	0.360	SQS

[a]Exceeded the SQS below the biologically active zone

Notes:
ARAR Applicable or relevant and appropriate requirement
COI Chemical of interest
J Estimated value
mg/kg-oc Milligrams per kilogram carbon normalized
N/A Not applicable—background concentrations assumed to be zero
SQS Sediment Quality Standards of the Washington State Sediment Management Standards (WAC 173-204)

Source: URS 1994a

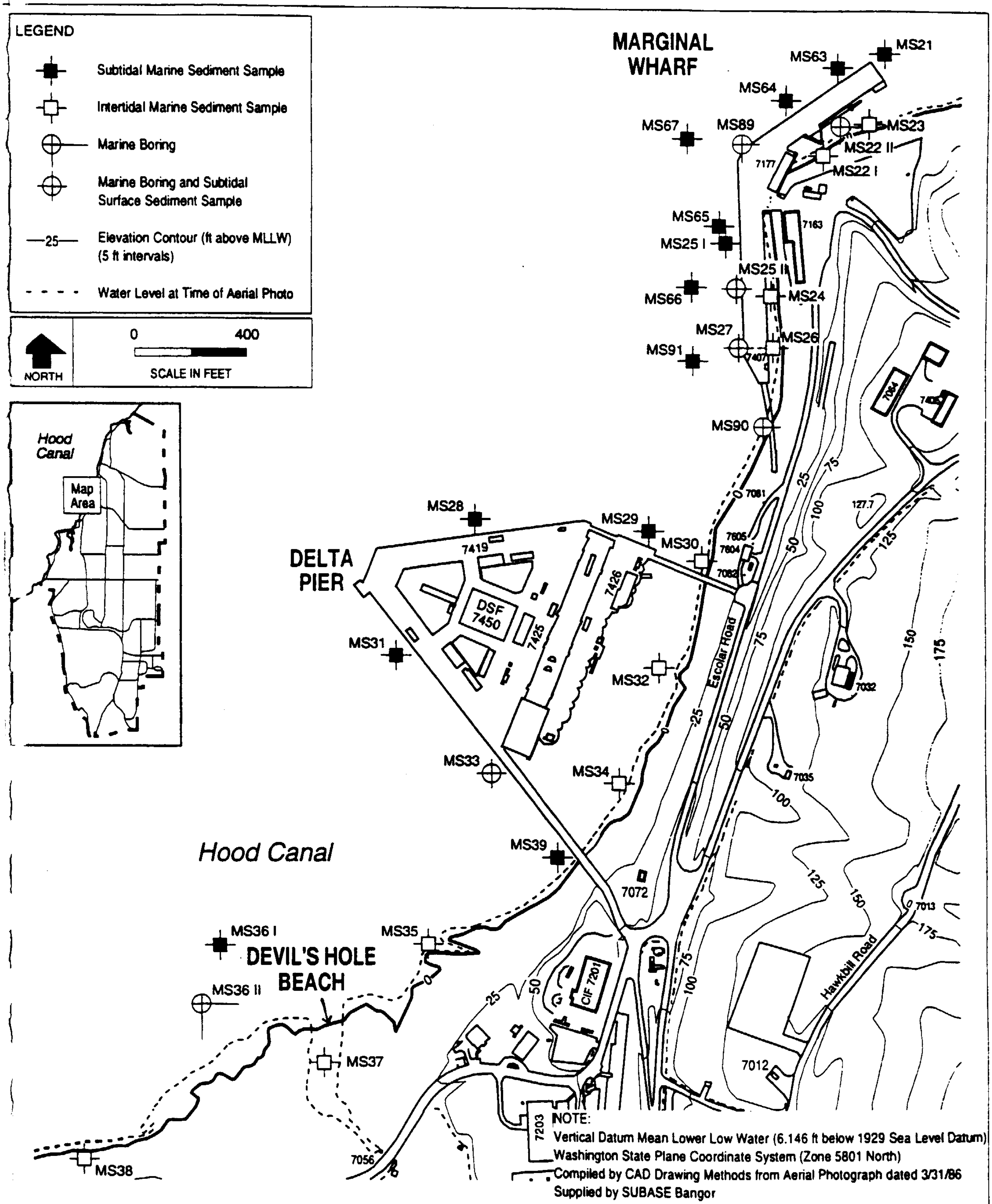
7.7.4 Area C, Marginal Wharf

Surface sediments (0 to 2 cm) were collected at 4 intertidal and 10 subtidal stations (including 2 subtidal marine borings) at Marginal Wharf during Phase I and Phase II sampling (northern portion of Figure 25). Sediment cores were collected during Phase II at five subtidal stations at Marginal Wharf. One composite clam tissue sample was collected in the intertidal zone at Marginal Wharf South. Samples from both media were analyzed for total metals, VOCs, SVOCs, pesticides, PCBs, and ordnance compounds. Sediment samples were also analyzed for VOCs (Phase I surface samples and Phase II cores only), TOC, and grain size. Tissue samples were also evaluated for lipid content.

Sediment toxicity tests were analyzed for seven stations and benthic infauna for one station at Marginal Wharf. Results of the biological testing were used in the evaluation of sediments for comparison with the SMS discussed in the marine environmental risk assessment (Section 8.2.2).

Sediment Sampling and Analysis

As shown in Table 6, one organic compound (bis[2-ethylhexyl]phthalate) was detected at a concentration above the SQS in intertidal sediments. The exceedance occurred in one sample collected at MS24. In subtidal marine sediments, four inorganics (copper, lead, mercury, and zinc) and eight organics (bis[2-ethylhexyl]phthalate, dibenzofuran, and six PAH compounds) were detected at concentrations above both background and the SQS. Inorganics exceeded the SQS at subtidal stations along the face of Marginal



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 25** **Area C - Marine Sediment Sampling Locations**	CTO 0058 SUBASE, Bangor Washington ROD

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GIS\cto58\autocad\area_c.plt

Table 6
Chemicals of Interest Detected at Site 26, Marginal Wharf

COI	Number of Samples	Number of Detections	Minimum Detected Conc.	Maximum Detected Conc.	Calculated Background Conc.	Potential ARARs	
						Value	Reference
INTERTIDAL MARINE SEDIMENTS							
Organics (mg/kg-oc)							
Bis(2-ethylhexyl)phthalate	3	2	20 J	74 J	N/A	47	SQS
SUBTIDAL MARINE SEDIMENTS							
Metals (mg/kg-dw)							
Copper	24	20	12.65	521	8.00	390	SQS
Lead	24	24	1.4	715	5.10	450	SQS
Mercury[a]	24	19	0.02	0.78	0.03 U	0.41	SQS
Zinc[a]	23	23	29	1,900 J	31.40	410	SQS
Organics (mg/kg-oc)							
Acenapthene	24	11	2.8 J	30 J	N/A	16	SQS
Fluorene	24	12	17 J	44	N/A	23	SQS
Phenanthrene	24	20	2.5 J	206	N/A	100	SQS
Total LPAH	—	—	—	401	N/A	390	SQS
Fluoranthene	24	23	2.3 J	490	N/A	160	SQS
Chrysene	24	21	2.9 J	196	N/A	110	SQS
Benzo(a)anthracene	24	19	4.8 J	160	N/A	100	SQS
Total HPAH	—	—	—	1,311	N/A	960	SQS
Bis(2-ethylhexyl)phthalate	24	13	2.2 J	3,177	N/A	47	SQS
Dibenzofuran	24	6	2.2 J	22	N/A	15	SQS

[a]Exceeded the SQS below the biologically active zone

Notes:
ARAR Applicable or relevant and appropriate requirement
COI Chemical of interest
HPAH High molecular weight polycyclic aromatic hydrocarbons
J Estimated value
LPAH Low molecular weight polycyclic aromatic hydrocarbons
mg/kg-oc Milligrams per kilogram carbon normalized
mg/kg-dw Milligrams per kilogram dry weight
N/A Not applicable—background concentrations assumed to be zero
SQS Sediment Quality Standards of the Washington State Sediment Management Standards (WAC 173-204)
U Nondetected value

Source: URS 1994a

Wharf (MS64 and MS25). Similarly, organics exceeded the SQS at subtidal stations along the face of Marginal Wharf (MS27, MS63, MS64, and MS90). Inorganic and organic concentrations decreased with sediment depth.

Tissue Sampling and Analysis

No chemicals were detected in shellfish tissue above background values.

7.7.5 Area C, Delta Pier

Eight surface sediment samples and one field duplicate sample were collected from five subtidal and three intertidal stations at Delta Pier (central portion of Figure 25) during Phase I. During Phase II, an 8-foot core was advanced at Station MS33 along with a surface sediment grab sample (upper 2 cm). Sediment samples were analyzed for total metals, VOCs (Phase I and Phase II cores only) SVOCs, pesticides, PCBs, TOC, grain size, and ordnance compounds. One organic (bis[2-ethylhexyl]phthalate) was detected in subtidal sediments at a concentration exceeding the SQS (Table 7). The exceedance was reported in one sample collected at MS29.

Table 7
Chemicals of Interest Detected at Site 26, Delta Pier

COI	Number of Samples	Number of Detections	Minimum Detected Conc.	Maximum Detected Conc.	Calculated Background Conc.	Potential ARARs	
						Value	Reference
SUBTIDAL SEDIMENTS							
Organics (mg/kg-oc)							
Bis(2-ethylhexyl)phthalate	8	5	6.6	58	N/A	47	SQS

Notes:
ARAR Applicable or relevant and appropriate requirement
COI Chemical of interest
mg/kg-oc Milligrams per kilogram carbon normalized
N/A Not applicable—background concentrations assumed to be zero
SQS Sediment Quality Standards of the Washington State Sediment Management Standards (WAC 173-204)
U Nondetected value

Source: URS 1994a

7.7.6 Area C, Devil's Hole Beach

Marine sediments were collected within the fluvial deposit of sediment discharged from Devil's Hole to assess potential impacts from areas upstream of Devil's Hole (see Figure 25). A total of four surface sediment samples were collected during Phase I from three intertidal stations (MS35, MS37, and MS38) and one subtidal station (MS36). During Phase II, a 12-foot core was advanced at Station MS36. Sediment samples were analyzed for TOC, grain size, total metals, VOCs, SVOCs, pesticides, PCBs, and ordnance compounds. None of the sediment samples reported detections above the SQS.

7.7.7 Area D, Keyport/Bangor Dock

Surface sediments (0 to 2 cm) were collected at two intertidal and eight subtidal stations during Phase I and Phase II sampling at the dock (northern portion of Figure 26). During Phase II, a sediment core was advanced to 12 feet near the seaward face of the dock, and subsamples were collected and analyzed from the upper 6 feet. One composite clam tissue sample was collected inside the dock area (Station MS96). Samples from both media were analyzed for total metals, SVOCs, pesticides, PCBs, and ordnance compounds. Sediment samples were also analyzed for VOCs, TOC, and grain size. Tissue samples were also evaluated for lipid content.

Sediment Sampling and Analysis

No COIs were identified in intertidal sediments at Keyport/Bangor Dock. In subtidal sediments, 1 inorganic (mercury) and 12 organics (bis[2-ethylhexyl]phthalate and 11 PAH compounds) were detected at concentrations above both background and the SQS (Table 8). For all COIs, exceedances occurred at subtidal stations along the face of Keyport/Bangor Dock (MS40, MS41, MS42, and MS70).

Tissue Sampling and Analysis

No SVOCs, pesticides, PCBs, or ordnance compounds were detected. The clam tissue sample contained 16 inorganics at concentrations comparable to or above background levels. Aluminum, magnesium, and sodium were present at concentrations approximately 2 times background.

7.7.8 Area D, Service Pier/Carlson Spit

Surface sediments (0 to 2 cm) were collected at 15 subtidal stations (including 2 subtidal marine borings) during Phase I and Phase II sampling at Service Pier and Carlson Spit (central portion of Figure 26). An additional subtidal sample was collected south of Carlson Spit. No intertidal samples were collected because of the coarse-grained nature of the sediments. During Phase II, six sediment cores were advanced to 12 feet, and subsamples were collected and analyzed from the upper 6 feet. One composite clam tissue sample was collected in the intertidal zone inside the pier area (MS95). Samples from both media were analyzed for total metals, SVOCs, pesticides, PCBs, and ordnance compounds. Sediment samples were also analyzed for VOCs, TOC, and grain size. The tissue sample was also evaluated for lipid content.

Sediment Sampling and Analysis

In subtidal sediments, eight organics (dibenzofuran and seven PAH compounds) were detected at concentrations above the SQS (Table 9). For all COIs, exceedances occurred at subtidal stations immediately adjacent to Service Pier (MS44, MS45, and MS46). Sediment toxicity tests were analyzed for 12 stations and benthic infauna for 1 station at Service Pier. Biological testing results are discussed in the marine environmental risk assessment.

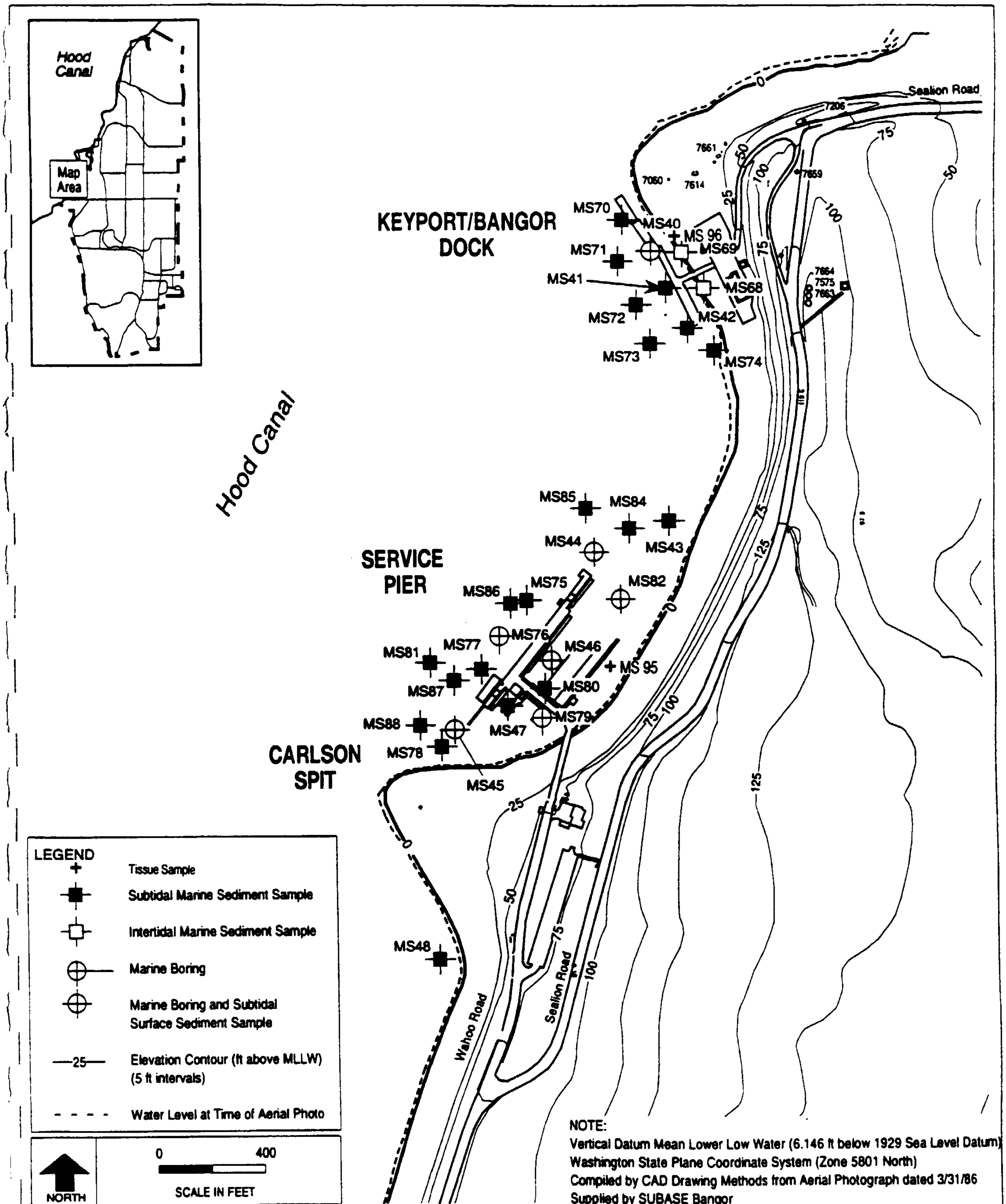

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Figure 26
Area D - Marine Sediment Sampling Locations

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Table 8
Chemicals of Interest Detected at Site 26, Keyport/Bangor Dock

COI	Number of Samples	Number of Detections	Minimum Detected Conc.	Maximum Detected Conc.	Calculated Background Conc.	Potential ARARs	
						Value	Reference
SUBTIDAL MARINE SEDIMENTS							
Metals (mg/kg-dw)							
Mercury	11	8	0.01	0.65	0.03 U	0.41	SQS
Organics (mg/kg-oc)							
Acenapthene	11	7	2.1 J	19	N/A	16	SQS
Fluorene	11	9	1.4 J	34 J	N/A	23	SQS
Phenanthrene	11	11	84 J	295	N/A	100	SQS
Total LPAH	—	—	—	416	N/A	370	SQS
Fluoranthene	11	11	20 J	892	N/A	160	SQS
Benzo(a)pyrene	11	11	4.4 J	147 J	N/A	99	SQS
Chrysene	11	11	11 J	482	N/A	110	SQS
Total benzofluoranthenes	—	—	—	581	N/A	230	SQS
Indeno(1,2,3-cd)pyrene	11	10	3.7 J	67	N/A	34	SQS
Dibenz(a,h)anthracene	11	1	29 J	29 J	N/A	12	SQS
Benzo(g,h,i)perylene	11	9	3.0 J	55	N/A	31	SQS
Benzo(a)anthracene	11	11	6.9 J	241	N/A	110	SQS
Total HPAH	—	—	—	2,976	N/A	960	SQS
Bis(2-ethylhexyl)phthalate	11	4	13 J	72 J	N/A	47	SQS

Notes:

ARAR	Applicable or relevant and appropriate requirement
COI	Chemical of interest
HPAH	High molecular weight polycyclic aromatic hydrocarbons
J	Estimated value
LPAH	Low molecular weight polycyclic aromatic hydrocarbons
mg/kg-oc	Milligrams per kilogram carbon normalized
mg/kg-dw	Milligrams per kilogram dry weight
N/A	Not applicable—background concentrations assumed to be zero
SQS	Sediment Quality Standards of the Washington State Sediment Management Standards (WAC 173-204)
U	Nondetected value

Source: URS 1994a

Table 9
Chemicals of Interest Detected at Site 26, Service Pier

COI	Number of Samples	Number of Detections	Minimum Detected Conc.	Maximum Detected Conc.	Calculated Background Conc.	Potential ARARs	
						Value	Reference
Subtidal Marine Sediments							
Organics (mg/kg-oc)							
Acenapthene	29	14	2.3 J	50 J	N/A	16	SQS
Fluorene	29	15	2.5 J	123 J	N/A	23	SQS
Phenanthrene	29	23	8.3 J	636	N/A	100	SQS
Total LPAH	—	—	—	991	N/A	370	SQS
Fluoranthene	29	24	4.7 J	915	N/A	160	SQS
Total benzofluoranthenes	—	—	—	239	N/A	110	SQS
Chrysene	29	21	10 J	239	N/A	230	SQS
Benzo(a)anthracene	29	21	0.65 J	193	N/A	110	SQS
Total HPAH	—	—	—	2,311	N/A	960	SQS
Dibenzofuran	29	13	2.0 J	50	N/A	15	SQS

Notes:
ARAR Applicable or relevant and appropriate requirement
COI Chemical of interest
HPAH High molecular weight polycyclic aromatic hydrocarbons
J Estimated value
LPAH Low molecular weight polycyclic aromatic hydrocarbons
mg/kg-oc Milligrams per kilogram carbon normalized
N/A Not applicable—background concentrations assumed to be zero
SQS Sediment Quality Standards of the Washington State Sediment Management Standards (WAC 173-204)

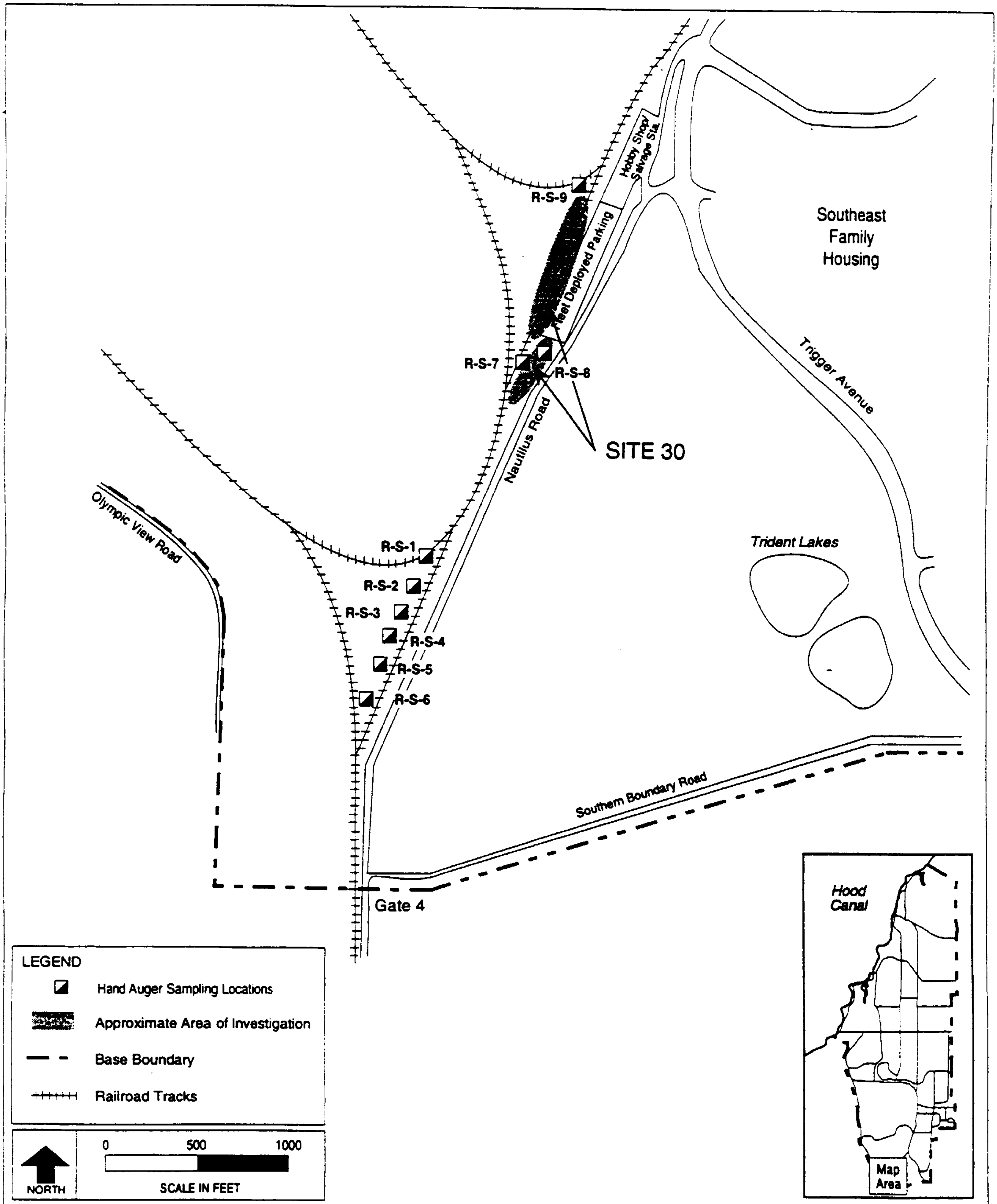
Source: URS 1994a

Tissue Sampling and Analysis

No SVOCs, pesticides, PCBs, or ordnance compounds were detected in the clam tissue sample; however, the sample contained concentrations of 12 inorganics above background levels. These concentrations were similar to background levels with the exception of aluminum (approximately 3 times background).

7.8 SITE 30, RAILROAD TRACKS

Site 30 (Figure 27), located along railroad tracks, is an area suspected of receiving waste pesticide and herbicide rinsates. Eighteen soil samples were collected from Site 30 during Phase I. Six sampling stations (R-S-1 through R-S-6) were sampled at three depths each: surface (0 to 0.5 foot bgs); root zone (0.5 to 1.0 foot bgs); and shallow subsurface (about 3 feet bgs).



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	Figure 27 Site 30 - Railroad Tracks Sampling Locations	CTO 0058 SUBASE, Bangor Washington ROD

CTO58\SEC01\FIG2-18.DRW 4/25/94

During Phase II, nine samples were collected from three sampling locations (R-S-7, R-S-8, and R-S-9). These samples were collected from depths of 0.2 to 0.5 foot bgs, 0.5 to 1.0 foot bgs, and 2.5 to 3 feet bgs, with a duplicate sample collected at location R-S-9 (6 to 12 inches bgs). All shallow subsurface soil samples were analyzed for chlorinated herbicides, pesticides, and PCBs.

Groundwater at this site was not analyzed. The RI proposed groundwater sampling during Phase II if chemicals were detected in soil at elevated concentrations during Phase I. No chemicals were detected in the soil at concentrations above ARARs during the first phase; therefore, the groundwater was not sampled.

No chemicals with concentrations above ARARs were detected at Site 30.

7.9 SITE E AND SITE 11

The RI at Site E and Site 11 included a magnetic and GPR geophysical survey, and environmental sampling of shallow soil, subsurface soil, and groundwater. The magnetic and GPR surveys were conducted in June 1991. Soil sampling was conducted during the first phase of drilling in June 1991. Shallow and subsurface soil samples were obtained during the drilling of two monitoring wells, EMW-22L and EMW-23L. The second phase of drilling and sampling included EMW-21U, EMW-21L, EMW-24U, EMW-24L, and EMW-22U. Soil sampling depths of the monitoring well boreholes ranged from ground surface to approximately 210 feet bgs. Sampling locations are shown in Figure 28.

A drum removal was initiated in July 1991 as a time-critical (or emergency) action because buried drums containing hazardous material were discovered at the site during the first sampling round and posed a possible threat of release to the environment (URS 1993a). The soils that were excavated during the removal action were placed in a containment cell, as were the drums and containers that were removed. Soil samples from the containment cell and from the excavated pits were collected and analyzed for inorganics, VOCs, SVOCs, chlorinated herbicides, pesticides, and ordnance compounds.

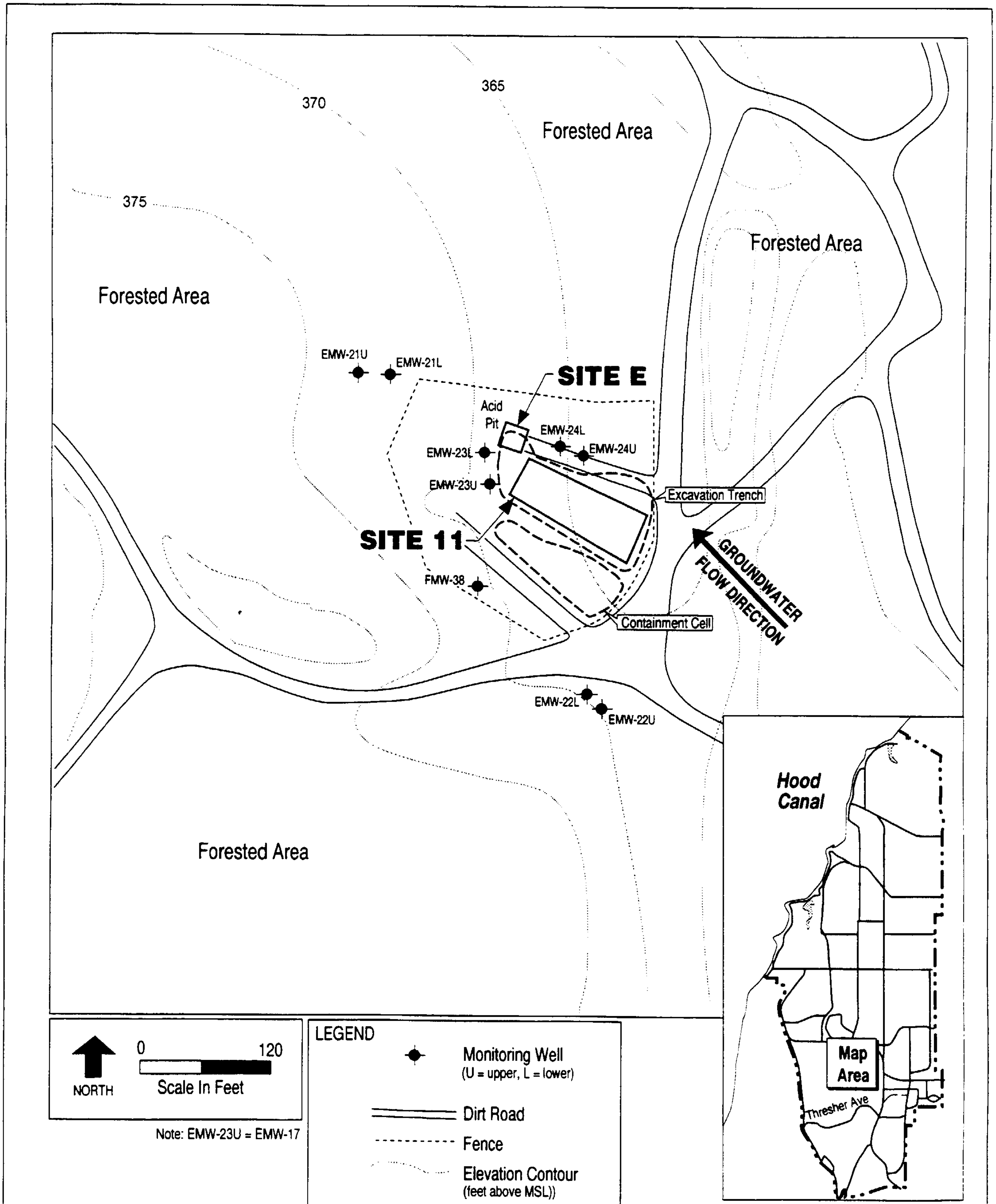
Groundwater samples were collected from seven monitoring wells and analyzed for total and dissolved inorganics, VOCs, SVOCs, pesticides, PCBs, chlorinated herbicides, and ordnance compounds.

7.9.1 Geophysical Investigations

A magnetic and GPR survey to locate subsurface debris at Site 11 indicated two strong anomalous areas, one minor anomaly (potentially buried pipe or scrap metal), and a lesser magnetic anomaly (attributed to metal scrap on or near the ground surface, or steel well casings). The survey results were used to establish two excavation areas.

7.9.2 Containment Cell Soil Sampling and Analysis

On July 16 and 17, 1991, trenches were excavated in the locations of the geophysical anomalies and soil samples were collected from each trench. The samples were analyzed for pesticides, chlorinated herbicides, and ordnance compounds. During this exploratory excavation, a drum with the label "Estron 99 (concentrated) Weedkiller" was encountered at an approximate depth of 5.5 feet. This drum was punctured



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 28** **Site E and Site 11** **Sampling and Monitoring Well Locations**	CTO 0058 SUBASE, Bangor Washington ROD

by the backhoe and liquid was observed in the drum. The quantity of liquid was determined to be a *de minimus* amount. A sample of the fluid was collected and analytical results indicated a low concentration of 2,4,6-TNT (339 μg/L). This fluid was also analyzed for chlorinated herbicides, but none were detected (URS 1992). Trenching logs are provided in the RI report (URS 1994a).

Subsequently, a more extensive drum and soil removal activity was conducted during the period June to September 1992. Thirteen 55-gallon drums, 72 small containers, debris, and contaminated soil were removed from the excavation trench and two interior excavation pits. A separate area (the Site E acid pit) was also excavated.

Excavated soils, drums, and containers were staged in the containment cell that occupied an area of approximately 100 by 50 feet. Approximately 400 cubic yards were removed from the Site 11 excavation trench, and approximately 250 cubic yards were removed from the Site E acid pit. Confirmation soil samples were collected from the excavation trench and acid pit trench. No organic compounds were detected in these samples, and no inorganics exceeded MTCA levels. The trenches were subsequently filled to grade with uncontaminated excavated material and clean backfill.

Samples of excavated soil were collected from eight subsections of the containment cell. No metals, VOCs, or SVOCs were detected above MTCA levels. One pesticide, DDT (at concentrations of up to 80,000 μg/kg), exceeded ARARs. All drums and drum contents were removed from the site and disposed of properly. The excavated soils remain in the containment cell. Analytical sample results for organic and inorganic chemicals from the excavation samples, confirmation samples, containment cell samples, and drum samples are described in the removal action report for Site 11 (URS 1993a).

Table 10 shows the chemicals that were detected above background levels and ARARs at Sites E and 11.

7.9.3 Shallow Soil Sampling and Analysis

No chemicals detected in shallow soil (0 to 5 feet bgs) exceeded ARARs, and therefore none were retained as COIs.

7.9.4 Subsurface Soil Sampling and Analysis

Arsenic and beryllium were detected in subsurface soil (more than 3 feet bgs) at concentrations above ARARs. However, the detections were in less than 10 percent of the samples, the maximum detected concentration was less than 2 times the lower of the background or MTCA Method B value, and the 95 percent UCL was less than the MTCA value. Therefore no chemicals were retained as COIs.

7.9.5 Groundwater Sampling and Analysis

Three inorganics—antimony, arsenic, and beryllium—were reported at concentrations above ARARs and background in the dissolved groundwater samples and were retained as COIs. The detected inorganics were within 2 to 3 times the background concentration and likely represent normal variations in background concentrations. The higher concentrations were found in the lower aquifer. Two VOCs (benzene and tetrachloroethene), one SVOC (bis[2-ethylhexyl]phthalate), and the ordnance compound RDX were detected

Table 10
Chemicals of Interest Detected at Site E and Site 11

COI	Number of Samples	Number of Detections	Minimum Detected Conc.	Maximum Detected Conc.	Calculated Background Conc.	Potential ARARs	
						Value	Reference
EXCAVATED SOIL IN CONTAINMENT CELL							
Pesticides (μg/kg)							
4,4′-DDT	8	7	3,000	80,000 J	N/A	2,940	MTCA
GROUNDWATER							
Dissolved Metals (μg/L)							
Antimony	14	2	59.5 J	62.4	20	6	MCL
Arsenic	14	4	1.3 J	6.5	2.3	0.05	MTCA
Beryllium	14	4	2.2	2.2	1.15	0.0203	MTCA
Volatile Organic Compounds (μg/L)							
Benzene	20	3	1	4 J	N/A	1.51	MTCA
Tetrachloroethene	20	1	2 J	2 J	N/A	0.858	MTCA
Semivolatile Organic Compounds (μg/L)							
Bis(2-ethylhexyl)phthalate	21	6	1 J	59	N/A	6	MCL
Ordnance (μg/L)							
RDX	19	1	5.4 J	5.4 J	N/A	0.795	MTCA

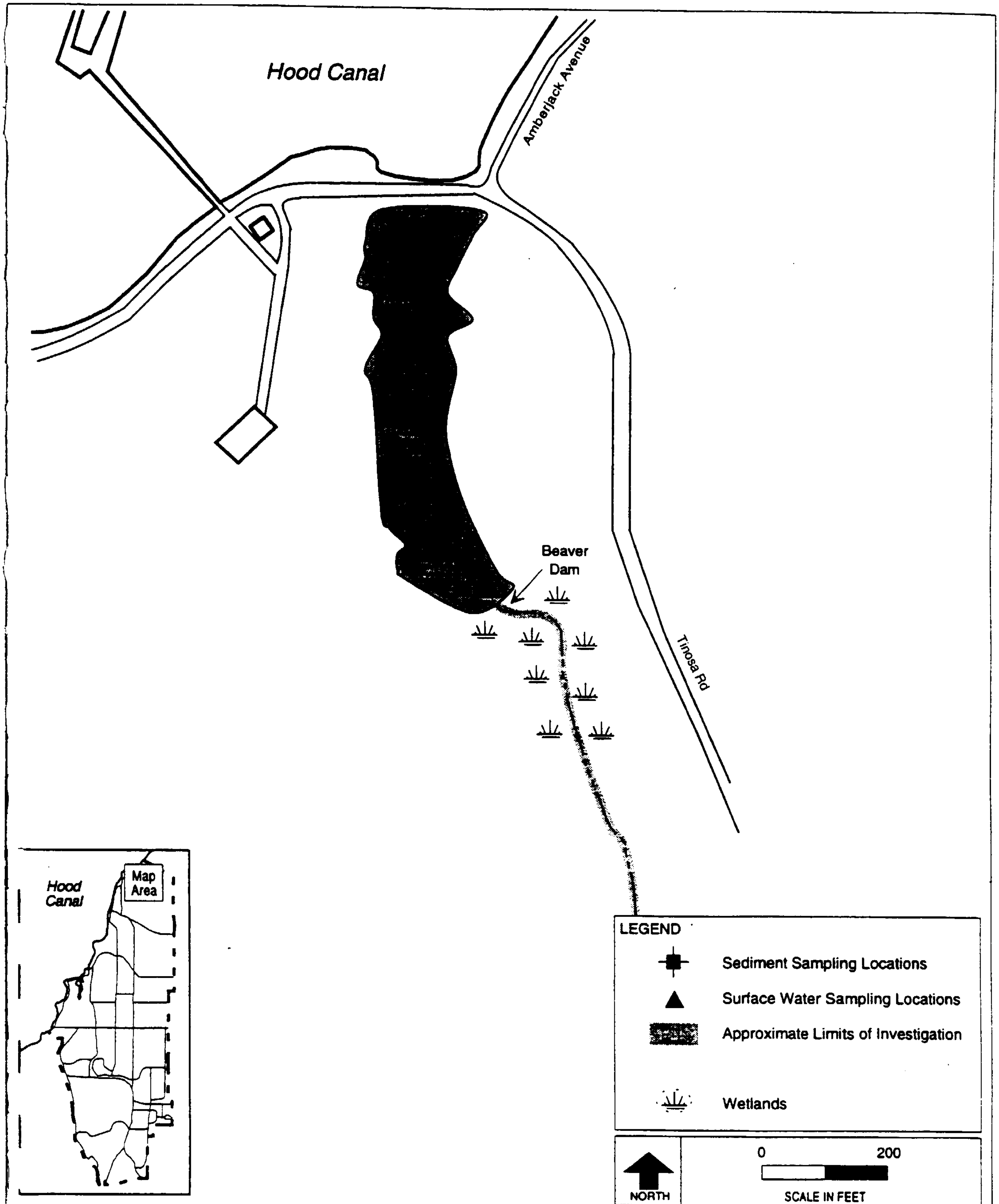
Notes:
ARAR Applicable or relevant and appropriate requirement
COI Chemical of interest
J Estimated value
MCL Maximum contaminant level
MTCA Model Toxics and Control Act Method B
N/A Not applicable—background concentrations assumed to be zero
RDX Royal Demolition Explosive

Source: URS 1994a

at concentrations above ARARs. The VOCs were detected in EMW-22L, bis(2-ethylhexyl)phthalate in several wells, and RDX in EMW-23L. RDX was not disposed of at Sites E and 11 and was detected only in the lower aquifer. It is suspected to be from the former wastewater lagoon upgradient at Site F, in OU 2. Other than bis(2-ethylhexyl)phthalate the organic COIs were detected in the lower aquifer in EMW-22L.

7.10 CATTAIL LAKE ECOLOGICAL AREA

Cattail Lake is located downstream of Site 7 and its discharge flows into Hood Canal. Sediment and surface water were sampled to determine potential chemical impacts on Cattail Lake. Lake sediment and surface water samples were collected along the major axis of Cattail Lake (Figure 29). Sediment samples were



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 29** **Cattail Lake Sampling Locations**	CTO 0058 SUBASE, Bangor Washington ROD

CTO58\SEC01\FIG2-33.DRW 4/7/93

collected from three depths at each of five locations. Surface water samples were collected from the farthest upstream and farthest downstream sediment sampling stations. All samples were analyzed for inorganics, VOCs, SVOCs, pesticides, PCBs, and ordnance compounds. In the surface water samples, the inorganics analyses included both total and dissolved inorganics.

7.10.1 Sediment Sampling and Analysis

Because no ARARs exist for chemicals in freshwater sediment, MTCA Method B soil cleanup levels were used as a TBC concentration for comparison. Arsenic exceeded both background and the TBC concentration in 4 samples out of 10. Detected concentrations of arsenic ranged from 1.02 to 1.59 times the background values. Beryllium exceeded both background and the TBC concentration in all samples collected. Detected concentrations of beryllium ranged from 1.7 to 5.2 times the background values. The pesticide aldrin was detected above the TBC concentration in 1 sediment sample out of 10, at Sampling Station CT01.

7.10.2 Surface Water Sampling and Analysis

As shown in Table 11, dissolved arsenic was the only COI identified in surface water. However, no background concentrations were determined for comparison with dissolved inorganics results.

Table 11
Chemicals of Interest Detected at Cattail Lake Ecological Area

COI	Number of Samples	Number of Detections	Minimum Detected Conc.	Maximum Detected Conc.	Calculated Background Conc.	Potential ARARs	
						Value	Reference
SURFACE WATER							
Dissolved Metals (µg/L)							
Arsenic	2	2	1.43	1.60	N/C	0.0842	MTCA

Notes:
ARAR Applicable or relevant and appropriate requirement
COI Chemical of interest
MTCA Model Toxics Control Act Method B
N/C No background concentrations evaluated

Source: URS 1994a

7.11 HUNTER'S MARSH ECOLOGICAL AREA

Eleven lake sediment and two surface water samples were collected from seven stations in Hunter's Marsh (Figure 30). Lake sediment samples were collected from one depth at three sampling stations and from four depths at two stations. All samples were analyzed for total metals, cyanide, VOCs, SVOCs, pesticides, PCBs, ordnance compounds, TOC, ammonia, and grain size.

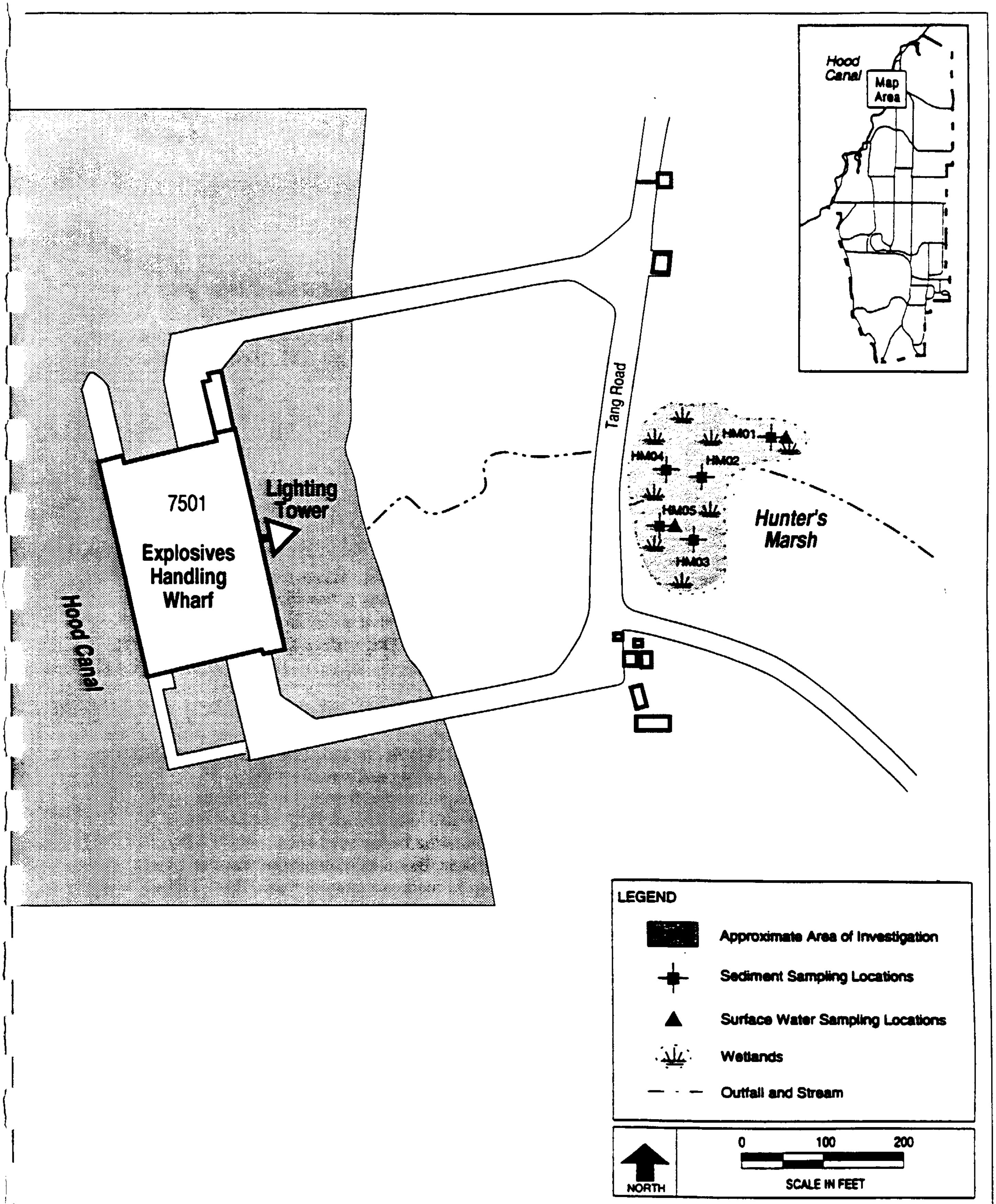


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Figure 30
Hunter's Marsh Sampling Locations

CTO 0058
SUBASE, Bangor
Washington
ROD

7.11.1 Sediment Sampling and Analysis

Because no ARARs exist for chemicals in freshwater sediment, MTCA Method B soil cleanup levels were used as a TBC concentration for comparison. Beryllium exceeded both background and the TBC concentration in all samples collected. Detected concentrations of beryllium ranged from 1.4 to 2.9 times the background values. Silver and the PAH benzo(a)pyrene were both detected above the TBC concentration in one sediment sample of nine, at Sampling Station HM01.

7.11.2 Surface Water Sampling and Analysis

No COIs were identified in Hunter's Marsh surface water samples.

7.12 DEVIL'S HOLE ECOLOGICAL AREA

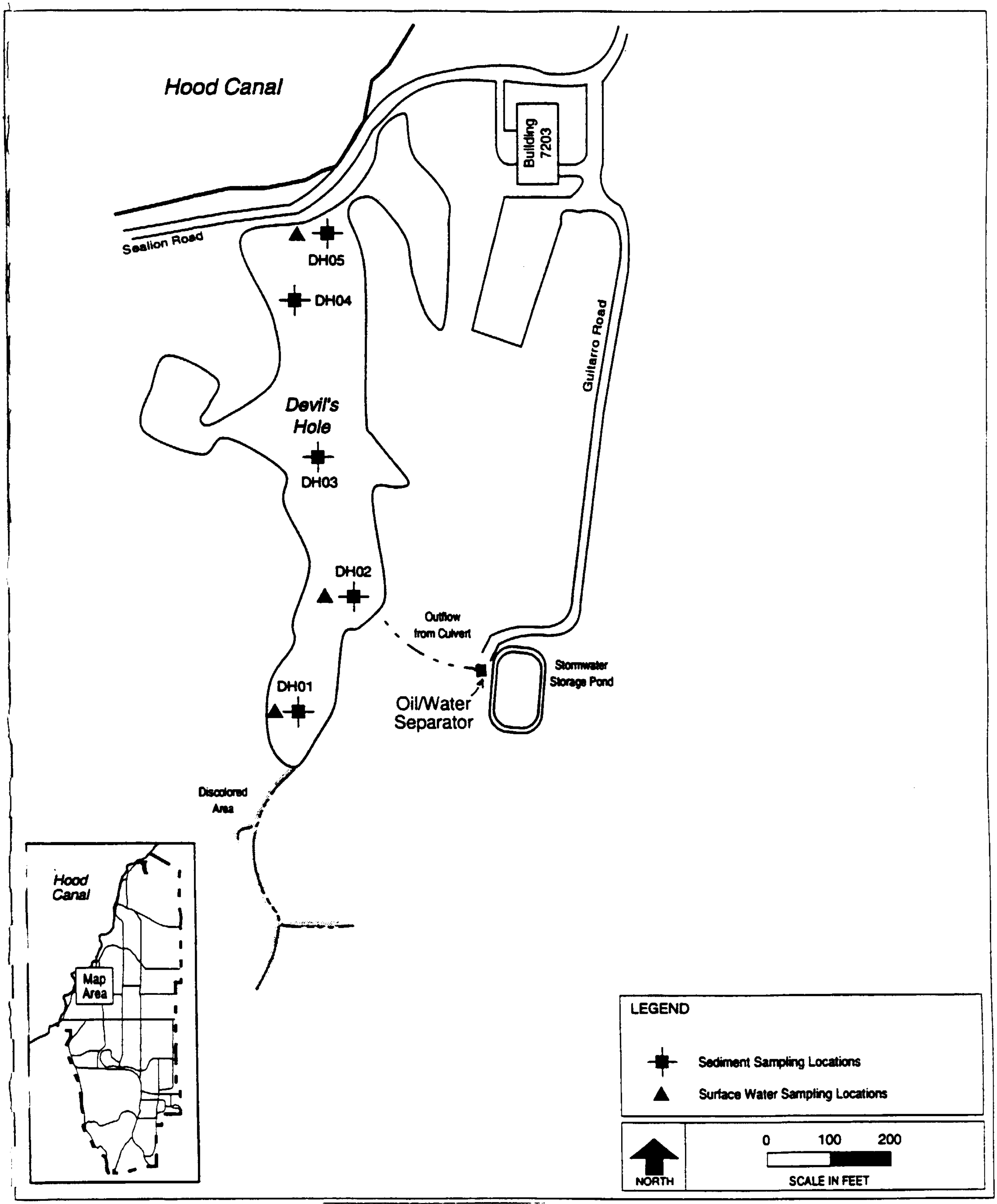
Fourteen lake sediment samples were collected from five sampling stations (DH01 through DH05) at the Devil's Hole ecological area (Figure 31). One surface sediment sample each was collected from Stations DH01 through DH05. Nine subsurface sediment samples were collected at depths of 0.2 to 0.5 foot, 0.5 to 1.5 feet, and 1.5 to 2.5 feet bgs at Stations DH01, DH02, and DH05. One surface water sample each was collected from Stations DH01, DH02, and DH05.

7.12.1 Sediment Sampling and Analysis

Because no ARARs exist for chemicals in freshwater sediment, MTCA Method B soil cleanup levels were used as a TBC concentration for comparison. Arsenic exceeded both background and the TBC concentration in 7 samples out of 14. Detected concentrations of arsenic ranged from 1.3 to 3.1 times background values. Beryllium exceeded both background and the TBC concentration in 12 samples out of 14. Detected concentrations of beryllium ranged from 1.1 to 4.4 times the background value. The PAH compounds benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene were detected above the TBC concentration in sediment samples from DH02, DH03, and DH05, with the highest concentrations at DH02.

7.12.2 Surface Water Sampling and Analysis

Three COIs were identified in Devil's Hole surface water: arsenic, mercury, and selenium (Table 12). Dissolved arsenic and total selenium each exceeded ARARs in the surface water sample collected at DH02. Total mercury exceeded ARARs in the surface water sample collected at DH01.



CLEAN COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY	**Figure 31** **Devil's Hole Sampling Locations**	CTO 0058 SUBASE, Bangor Washington ROD

CTO58\FIG2-32.DRW 4/7/93

Table 12
Chemicals of Interest Detected at Devil's Hole Ecological Area

COI	Number of Samples	Number of Detections	Minimum Detected Conc.	Maximum Detected Conc.	Calculated Background Conc.	Potential ARARs	
						Value	Reference
SURFACE WATER							
Metals (μg/L)							
Mercury	3	1	0.80	0.80	0.2	0.012	WWQC
Selenium	3	2	3.80	5.20	3	5	WWQC
Dissolved Metals (μg/L)							
Arsenic	3	1	1.10	1.10	N/C	0.0842	MTCA

Notes:
ARAR Applicable or relevant and appropriate requirement
COI Chemical of interest
MTCA Model Toxics Control Act Method B
N/C No background concentrations evaluated
WWQC Washington State Water Quality Criteria

Source: URS 1994a

8.0 SUMMARY OF SITE RISKS

As part of the RI for OU 7, a baseline human health risk assessment and an ecological risk assessment were conducted. These risk assessments are summarized in Sections 8.1 and 8.2, respectively. The human health and ecological risk values calculated for each site and ecological area are summarized in Table 13. An uncertainty analysis is presented in Section 8.3.

8.1 HUMAN HEALTH RISK ASSESSMENT

The purpose of the baseline human health risk assessment is to estimate the probabilities of adverse health effects resulting from current and future hypothetical exposures to on-site chemicals in the absence of remediation. The risk assessment is a multi-step process consisting of data evaluation, chemical toxicity assessments, and exposure assessments. By means of the information gathered in each of these steps, cancer and noncancer risks are quantified in a final step termed risk characterization.

Cancer risk is expressed as an excess probability that an individual will develop cancer if exposed to a chemical over a lifetime. The risk value represents the size of the group of people in which one person would develop cancer from exposure to a chemical. For example, a risk value of 1.0×10^{-7} represents a risk of 1 person in 10,000,000. The EPA requires that cleanup action be considered if cancer-causing chemicals pose a risk greater than 1 in 10,000 (1.0×10^{-4}). No action is required for risks less than 1 in 1,000,000 (1.0×10^{-6}). Risks in between these values represent marginal risks that may require action, depending on the situation.

Table 13
Risk Assessment Summary for OU 7 Sites and Ecological Areas

Site	Medium	Human Health Scenario	Maximum Human Health RME HI	Summary Human Health RME Cancer Risk	Maximum Ecological Risk HI (Chemical of Concern)	Major Chemicals of Concern for Human Health Risk
Site B	Soil	Residential	<1.0	1.6 x 10^{-4}	3.6 (lead and vanadium)	Arsenic, Aroclor 1248, Aroclor 1254, PAHs
		Industrial	<1.0	1.4 x 10^{-5}		Arsenic, benzo(a)pyrene
		Recreational	<1.0	1.0 x 10^{-6}		None
	Groundwater	Residential	5.0	2.7 x 10^{-5}	N/A	Aroclor 1016, arsenic, TPH
Site 2	Stockpiled soil	Residential	<1.0	1.4 x 10^{-5}	<1.0	Aroclor 1260
		Industrial	<1.0	1.4 x 10^{-6}		Aroclor 1260
		Recreational	<1.0	<1.0 x 10^{-6}		None
	Site soil	Residential	<1.0	<1.0 x 10^{-6}	<1.0	None
	Groundwater	Residential	<1.0	<1.0 x 10^{-6}	<1.0	None
Site 4	All media	Residential	<1.0	<1.0 x 10^{-6}	<1.0	None
Site 7	Groundwater	Residential	<1.0	<1.0 x 10^{-6}	1.4 (lead)	None
Site 10	Soil	Residential	<1.0	<1 x 10^{-6}	N/A	None
	Groundwater	Residential	11 (TPH)	1.0 x 10^{-6}	N/A	TPH
Site 18	All media	Industrial	<1.0	<1 x 10^{-6}	N/A	None
Site 26	Sediments	Recreational	<1.0	<1.0 x 10^{-6}	N/A	None
	Marine clam tissue	Recreational	<1.0	<1.0 x 10^{-6}	N/A	None
Site 30	Soil	Industrial/recreational	<1.0	<1.0 x 10^{-6}	N/A	None
Site E and Site 11	Stockpiled soil	Residential	<1.0	1.8 x 10^{-5}	6.3 (DDT)	DDT
		Industrial	<1.0	1.8 x 10^{-6}		DDT
	Site soil	Residential	<1.0	<1.0 x 10^{-6}	N/A	None
	Groundwater	Residential	2.7 (Otto fuel)	1.1 x 10^{-5}	N/A	Arsenic, Otto fuel, RDX

Table 13 (Continued)
Risk Assessment Summary for OU 7 Sites and Ecological Areas

Site	Medium	Human Health Scenario	Maximum Human Health RME HI	Summary Human Health RME Cancer Risk	Maximum Ecological Risk HI (Chemical of Concern)	Major Chemicals of Concern for Human Health Risk
Cattail Lake	All media	Recreational	<1.0	<1.0 x 10^{-6}	2.0 (aldrin)	None
Devil's Hole	All media	Recreational	<1.0	<1.0 x 10^{-6}	35.8 (mercury)	None
Hunter's Marsh	All media	Recreational	<1.0	<1.0 x 10^{-6}	17.8 (aluminum)	None

Notes:

HI Hazard index
N/A Not applicable
PAH Polycyclic aromatic hydrocarbon
RDX Royal Demolition Explosive
RME Reasonable maximum exposure
TPH Total petroleum hydrocarbons

Source: URS 1994a

Noncancer risk, or the risk of adverse health effects other than cancer, is expressed as a hazard quotient (HQ). The HQ represents a ratio of the estimated intake dose of the chemical to the acceptable daily intake level established by the EPA. Generally, an HQ greater than 1.0 is considered an unacceptable risk. The sum of the HQs is called the hazard index (HI). An HI greater than 1.0 is unacceptable and may require cleanup action; an HI less than 1.0 is considered acceptable.

To select the chemicals to be evaluated in the human health risk assessment, chemicals detected in the various media at OU 7 were screened by comparing their concentrations to EPA risk-based screening concentrations (RBSCs). The RBSCs for soil are based on a cancer risk of 1.0×10^{-7} and a noncancer risk, or HQ, of 0.1. The RBSCs for groundwater are based on a cancer risk of 1.0×10^{-6} and a noncancer HQ of 1.0.

This screening process included all detected organic chemicals and only the inorganic chemicals that were detected at a concentration above the OU 7 background value at least once. Inorganic chemicals with maximum detected concentrations below the background value were eliminated from further assessment. Essential nutrients were also eliminated. Chemicals with concentrations exceeding the RBSCs were considered chemicals of potential concern (COPCs) and evaluated further to assess their risk to human health.

Once the COPCs were identified, the risk assessment continued with an evaluation of potential current and future human exposures and chemical toxicity to potential receptors. Default exposure assumptions are defined in current EPA risk assessment guidance (U.S. EPA 1989b). Site-specific exposure assumptions are explained in the RI/FS (URS 1994a, 1994b). Toxicity information obtained from EPA's Integrated Risk Information System (IRIS) database was applied to each COPC.

The human exposure assessment evaluates concentrations of COPCs at locations where human contact may occur (the exposure point) and evaluates potential exposures via various exposure routes. The exposure assessment evaluates both average case exposures and reasonable maximum exposures (RMEs). Average case exposures are based on average concentrations (arithmetic means) and standard exposure parameters. RME estimates are based on the highest of two values: either the maximum concentration or the upper-bound exposure (95 percent UCL). Important factors considered in the human exposure assessment include exposure pathways through environmental media, points of contact for human receptors (land use), exposure routes, estimates of intake, and the range defined by the average estimates and the RME.

Human health risks for sites in OU 7 were evaluated for current recreational and occupational (industrial) land uses, as well as future residential land uses. Risks associated with future residential scenarios are typically greater than those for recreational and industrial scenarios. Future residential exposures assume long durations of exposure, contain inherent degrees of uncertainty, and should be carefully interpreted; nevertheless, they provide a conservative estimate of risk. The risk due to chemicals in groundwater was evaluated based on the future residential scenario.

The toxicity assessment characterizes the toxicological properties and effects of each COPC, including all aspects of its absorption, metabolism, elimination, and mode of action. Special emphasis is placed on the establishment of dose-response characteristics, which are used to define the cancer and noncancer risk values used in the risk assessment.

The risk characterization integrates the results of the exposure and toxicity assessments, comparing the dose estimates with the appropriate toxicological endpoints to determine the likelihood of adverse effects on human receptors.

In the risk characterization for the sites in OU 7, any chemical with a risk greater than 1.0×10^{-6} or an HQ greater than 1.0 was considered a chemical of concern (COC). Table 14 shows the COCs resulting from the human health risk assessment. The chemicals are grouped by site and by receptor (i.e., industrial, residential, or recreational) for both noncancer (hazard quotient) and cancer risks. The noncancer and cancer risk estimates are further grouped by average exposure estimate and RME. The human health risk assessment in the RI/FS indicates that the risk is not significant at Sites 4, 7, 18, 26, and 30, and the ecological areas, Cattail Lake, Hunter's Marsh, and Devil's Lake. Therefore these sites and ecological areas are not listed in Table 14 and are not discussed further in this section.

During the RI, analyses of groundwater revealed large differences in concentrations of inorganics between total and dissolved organics in most of the well samples. These differences reflect the amount of suspended particulate matter present in the groundwater samples. High turbidity was noted in many samples, reducing the probability that such samples are representative of groundwater characteristics that would be associated with a drinking water well. Because of the high turbidity of the groundwater samples, the human health risks presented in the following subsections are based on the results of the dissolved inorganics analyses.

Upon initial inspection of the results, the inorganic arsenic found in clams at Floral Point Beach appeared to pose an unacceptable cancer risk via the ingestion of clams contaminated with arsenic. However, arsenic is not considered a COC because 95 percent of the arsenic found in shellfish is in a nontoxic form. There is evidence that arsenic in shellfish tissue exists in a complex methylated organic form (PSEP 1988). Complex organic forms of arsenic are generally less readily absorbed and are less toxic than elemental arsenic (URS 1993b).

8.1.1 Site B, Floral Point

The risk assessment for Site B, Floral Point, indicates a marginal cancer risk for the ingestion of soil by an industrial receptor because of the PAHs found at the site. Using a future residential drinking water scenario, an unacceptable cancer risk was identified for groundwater. However, the nonpotable nature of the groundwater makes exposure via this pathway unlikely.

8.1.2 Site 2, Classification Yard/Fleet Deployment Parking

Primarily due to the presence of Aroclor 1260 (a PCB), an unacceptable cancer risk was identified for the ingestion of stockpiled soil by a future resident or an industrial worker. No unacceptable risks were identified for site soil and groundwater.

8.1.3 Site 10, Pesticide Storage Quonset Huts

Due to the presence of TPH found in one sample of groundwater, an unacceptable noncancer risk was identified for the ingestion of groundwater by a future resident. No other chemicals in groundwater were identified as risk drivers.

Table 14
Summary of Human Health Risk From Chemicals of Concern at OU 7

Parameter	Concentrations (ppm)*		Hazard Quotient		Cancer Risk	
	Avg	RME	Avg	RME	Avg	RME
SITE B						
RESIDENTIAL						
Soil						
Aroclor 1248	0.16	0.42			1.7×10^{-7}	5.2×10^{-6}
Aroclor 1254	0.13	0.28			1.4×10^{-7}	3.5×10^{-6}
Arsenic	4.2	5.5	0.016	0.068	1.0×10^{-6}	1.6×10^{-5}
Benzo(a)anthracene	0.81	2.1			8.3×10^{-7}	2.4×10^{-5}
Benzo(a)pyrene	0.64	1.6			6.6×10^{-7}	1.9×10^{-5}
Benzo(b)fluoranthene	0.66	1.7			6.8×10^{-7}	2.0×10^{-5}
Benzo(g,h,i)perylene	0.27	0.45			2.7×10^{-7}	5.3×10^{-6}
Benzo(k)fluoranthene	0.66	1.6				1.9×10^{-5}
Chrysene	1.1	2.9			1.1×10^{-6}	3.4×10^{-5}
Dibenz(a,h)anthracene	0.29	0.50			3.0×10^{-7}	5.9×10^{-6}
Summary Risk (Soil)			0.016	0.068	5.0×10^{-6}	1.6×10^{-4}
Groundwater						
Aroclor 1016	0.00013	0.00016			1.9×10^{-6}	1.4×10^{-5}
Arsenic	0.0060	0.0073	0.30	0.65	1.9×10^{-6}	1.4×10^{-5}
TPH			N/A	4		
Summary Risk (Groundwater)	0.00613	0.00746	0.30	4.65	3.8×10^{-5}	2.7×10^{-5}
Summary Cancer Risk					4.3×10^{-5}	1.9×10^{-4}
INDUSTRIAL						
Soil						
Arsenic	4.2	5.5		0.0089		1.6×10^{-6}
Benzo(a)anthracene	0.81	2.1		<0.001		2.5×10^{-6}
Benzo(a)pyrene	0.64	1.6		<0.001		2.0×10^{-6}
Benzo(b)fluoranthene	0.66	1.7		<0.001		2.1×10^{-6}
Benzo(k)fluoranthene	0.66	1.7		<0.001		2.0×10^{-6}
Chrysene	1.1	2.9		<0.001		3.5×10^{-6}
Summary Risk				0.0089		1.4×10^{-5}
SITE 2						
RESIDENTIAL						
Stockpiled Soil						
Aroclor 1260	0.65	1.1	0.0094	0.058	6.5×10^{-7}	1.4×10^{-5}
INDUSTRIAL						
Stockpiled Soil						
Aroclor 1260	0.65	1.1	0.0094	0.058	6.5×10^{-7}	1.4×10^{-6}

Table 14 (Continued)
Summary of Human Health Risk From Chemicals of Concern at OU 7

Parameter	Concentrations (ppm)[a]		Hazard Quotient		Cancer Risk	
	Avg	RME	Avg	RME	Avg	RME
SITE 10						
RESIDENTIAL						
Groundwater						
TPH	3,100	3,100	11	11	$<1.0 \times 10^{-6}$	$<1.0 \times 10^{-6}$
Summary Risk			11	11	$<1.0 \times 10^{-6}$	$<1.0 \times 10^{-6}$
SITE E AND SITE 11						
RESIDENTIAL						
Stockpiled Soil						
DDT	17.0	32.0	0.037	0.24	8.1×10^{-7}	1.8×10^{-5}
Groundwater						
Otto fuel	0.00040	0.00040	1.5	2.7	$<1.0 \times 10^{-6}$	$<1.0 \times 10^{-6}$
RDX	0.00050	0.0014	0.0025	0.013	1.1×10^{-7}	1.9×10^{-6}
Arsenic	0.0023	0.00275	0.12	0.25	7.8×10^{-6}	9.4×10^{-6}
Summary Risk (Groundwater)			1.62	2.9	7.9×10^{-6}	1.13×10^{-5}
INDUSTRIAL						
Stockpiled Soil						
DDT	17.0	32.0	N/A	0.031	N/A	1.8×10^{-6}

[a]Risk and concentration of inorganics in groundwater are based on dissolved fraction.

Notes:
N/A Not available
ppm Parts per million
RDX Royal Demolition Explosive
RME Reasonable maximum exposure
TPH Total petroleum hydrocarbons

Source: URS 1994a

8.1.4 Site E, Acid Disposal Pit; Site 11, Pesticide/Herbicide Drum Disposal Area

Due to the presence of DDT, an unacceptable cancer risk was identified for the ingestion of stockpiled soil by a resident or an industrial worker. Using a residential drinking water exposure scenario, a minor cancer risk was identified for groundwater due to the presence of arsenic and the explosives RDX and Otto fuel. Otto fuel in groundwater poses a noncancer risk.

8.2 ECOLOGICAL RISK ASSESSMENT

The ecological risk assessment was separated into terrestrial, marine, and freshwater evaluations. Sites B, 7, E, and 11 were evaluated for terrestrial ecological risk; Site 26 was evaluated for marine ecological risk; and Site 2 and the three ecological areas (Cattail Lake, Devil's Hole, and Hunter's Marsh) were evaluated for freshwater ecological risk.

Sites 4, 10, 18, and 30 were not included in the ecological risk assessment. The exclusion of these sites from the ecological risk assessment was based on marginal detections (Site 4), paved sites (10 and 18), and a site nonconducive to plant and animal habitat (Site 30).

The approach to the ecological risk assessment followed both federal (U.S. EPA 1986a, 1989a, 1989b, 1990, 1992a, 1992b) and Washington State (Ecology 1991) guidance. Exposure modeling was used to evaluate potential risks. Exposure models use results of chemical analysis, chemical biotransfer factors, and exposure factors to provide conservative dose estimates for ecological receptors. Estimated doses are compared with conservative toxicity reference values to evaluate potential risks. There is considerable uncertainty associated with exposure modeling because the biotransfer and exposure factors are not unique to the site.

The ecological risk assessment described in the RI used a variety of techniques to assess risk. In the terrestrial environment (described in Section 6.2 of the RI report), three media were evaluated individually: soil, surface water, and freshwater sediments. Soil was evaluated for adverse effects to plants and soil invertebrates based on literature values. Surface water and freshwater sediments were evaluated by comparison to environmental criteria, guidelines, or literature values. In addition to the evaluation of risk from individual media, risk arising from exposure to a variety of media was evaluated by food chain modeling.

In the ecological risk assessment for the marine environment described in Section 6 of the RI report, three empirical techniques (sediment chemistry, bioassays, and benthic infauna) and one modeling approach were used to assess risk. The chemical concentrations measured in marine sediments were compared to criteria, guidelines, and literature values (including equilibrium partitioning of nonpolar organic compounds). Sediment bioassays with two test organisms were performed on samples collected from 29 stations at Site 26. Benthic infauna were evaluated at Cattail Lake Beach, Explosives Handling Wharf, Service Pier, Marginal Wharf, and Keyport/Bangor Dock. Food chain exposures were modeled with six species exhibiting different kinds of feeding behavior: the littleneck clam *(Prototheca staminea)*, the bent-nose clam *(Macoma nasuta)*, a generic infaunal polychaete, the English sole (*Paraphrys vetulus*), the surf scoter (*Melanitta perspicillata*), and the marbled murrelet (*Brachyramphus marmoratus*). The species were selected because they adequately represent the main trophic groups of all SUBASE marine habitats. The marbled murrelet was also selected because it is a fish-eating bird of the area and is a federally listed threatened species.

In addition, the marine sediment chemicals were compared with the SQS of the State of Washington SMS. The detected chemicals were carbon normalized, as required, and compared to the SQS. Those that exceeded these standards were grouped into a cluster (a cluster being a dock or area), and the average of the three highest chemicals exceeding the SQS was compared to the Cleanup Screening Levels (CSLs). Areas with no exceedances of CSLs were classified as clusters of low concern. Bioassays were conducted at Site 26 areas; clusters with CSL exceedances were compared with bioassay results for that area.

Ecological COCs were identified as chemicals with an HQ greater than 1.0. Table 15 provides the receptor-specific HQ values for small mammals, which were modeled using the Townsend's vole. No chemicals were determined to have an HQ greater than 1.0 for mallard ducks, which were used to model risks to omnivorous birds. Table 16 lists the HQs for freshwater sediment and surface water based on food chain modeling. The following subsections discuss the risk to ecological receptors.

Table 15
Small Mammal HQ Values for Soil

Chemical of Concern	Hazard Quotient		
	Site B	Site 7	Sites E and 11
4,4'-DDT	<0.01	CNE	**6.3**
Arsenic	0.28	CNE	CNE
Barium	0.21	CNE	CNE
Copper	0.16	CNE	CNE
Lead	**1.6**	**1.4**	CNE
Vanadium	**1.3**	CNE	CNE
Total	**3.6**	**1.4**	**6.3**

Notes:
3 Shaded, bold face indicates HQ greater than or equal to 1.0.
CNE Chemical not evaluated (not a chemical of potential concern for this medium at this site)
HQ Hazard quotient

Source: URS 1994a

8.2.1 Terrestrial Ecological Risk

Site B, Floral Point

Lead and vanadium are ecological COCs at Site B. Potential adverse effects to soil organisms may occur at highly localized point sources. The concentration of barium in the soil may affect certain plant species. Ground-dwelling small mammals may experience some localized risk from multiple chemicals in the soil.

Table 16
Ecological HQ Values for Freshwater Sediment and Surface Water

Chemical of Concern	Aquatic HQ	Sediment HQ
Cattail Lake Ecological Area		
Aldrin	CNE	**1.95**
Nickel	CNE	**1.02**
Total	<0.1	**2.97**
Devil's Hole Ecological Area		
Di-n-octylphthalate	**1.0**	<0.01
delta-BHC	CNE	**2.0**
Mercury	**35.8**	CNE
Selenium	**1.0**	CNE
Chromium	CNE	**1.02**
Total	**37.8**	**3.02**
Hunter's Marsh Ecological Area		
Aluminum	**17.8**	CNE
Iron	**2.1**	CNE
Total	**19.9**	<1

Notes:
3 Shaded, bold face indicates HQ greater than or equal to 1.0.
CNE Chemical not evaluated (not a chemical of potential concern for this medium at this site)
HQ Hazard quotient

Source: URS 1994a

Although the individual HQs of arsenic, barium, and copper are not above 1.0, these inorganics are retained in Table 15 because they contribute to the overall risk of soil at Site B (the cumulative soil HQ for Site B equals 3.6).

Site 7, Old Paint Can Disposal Site

The only ecological COC at Site 7 is lead. With the possible exception of lead, the levels of chemicals in the soil, sediments, and stream water at Site 7 do not indicate adverse risks to receptor organisms. The protective nature of exposure modeling, the conservative endpoint used, and magnitude of the HQs suggest low risk.

Site E, Acid Disposal Pit; Site 11, Pesticide/Herbicide Drum Disposal Area

Localized risk to ground-dwelling small mammals from DDT may occur within the pesticide disposal area. Other detected chemicals are not anticipated to pose risks to the vole (Table 15). Possible food chain transfer of DDT may occur from the vole population, and DDT was considered to be a COC; however, due to the conservative exposure parameters, risk is likely to be minimal.

8.2.2 Marine Ecological Risk

Site 26, Hood Canal Sediments

In the Hood Canal sediments, a "weight-of-evidence" approach was used to reach an overall conclusion regarding the level of risk posed to marine organisms by COPCs in each area. COPCs with an HQ greater than 0.1 were termed "risk drivers."

Cattail Lake Beach/Magnetic Silencing Facility. Risk at Cattail Lake Beach and the Magnetic Silencing Facility is negligible, based on low concentrations of chemicals and a low cumulative HQ for intertidal clam tissue (0.15), low concentrations of chemicals in sediments, and acceptable sediment bioassay results. No risk drivers were identified.

Floral Point Beach. Ecological risk to selected receptors at Floral Point Beach is low. This conclusion is based on infrequent detections of xenobiotic compounds in the sediments and tissues, and low HQ for identified COPCs. No risk drivers were identified.

Explosives Handling Wharf. Risk at Explosives Handling Wharf is negligible. This conclusion is based on low HQs calculated for both intertidal and subtidal sediment and interstitial water COPCs. There were no indications of bioaccumulating chemicals in intertidal clam tissues, and the modeling shows low potential for biomagnification to chronically toxic levels in the aquatic food chain. Laboratory biological tests of intertidal sediments showed no apparent toxic effects, and the presence of a healthy and diverse subtidal benthic infaunal population was noted. No risk drivers were identified.

Marginal Wharf. Sediments tested for toxicity were collected from stations showing the highest concentrations of COPCs in both intertidal and subtidal zones. Even though these chemicals show no acute or chronic affects to the benthic infaunal community, bioaccumulation is a possible concern. Risk to the subtidal ecosystem at Marginal Wharf arises from body burden results for polychaetes, *M. nasuta*, and English sole. The subtidal area of highest risk is located along the Marginal Wharf face. The area offshore of the wharf may be at less risk, as evidenced by the number of chemicals exceeding environmental effects data and the lack of toxic responses in biological indicators.

Risk drivers for Marginal Wharf (subtidal zone) are the following:

PAH	Pesticides	Other
Phenanthrene	Endrin	Bis(2-ethylhexyl)phthalate
Benzo(a)anthracene	Endrin aldehyde	
	Endrin ketone	

Delta Pier. Risk at Delta Pier is negligible, based on low concentrations of COPCs in sediments, and low predicted body burdens in infauna species and English sole. No risk drivers were identified.

Devil's Hole Beach. Some risk to marine biota at Devil's Hole Beach was identified, although the effect is localized to a single station. Risk drivers for Devil's Hole Beach subtidal zone are the pesticides endrin and endrin aldehyde.

Keyport/Bangor Dock. The subtidal zone of Keyport/Bangor Dock poses a risk to marine biota. Sediments tested for toxicity were collected from all stations in the subtidal zone. Based on the results of these tests, COPCs show no acute effects to the benthic infaunal community; however, chronic adverse effects and bioaccumulation of chemicals are potential concerns. There is risk to the subtidal ecosystem from phenanthrene, fluoranthene, and benzo(a)anthracene based on sediment chemistry, predicted interstitial water measurements, and body burden results for polychaetes, *M. nasuta,* and English sole. There is also risk from mercury based on sediment chemistry and body burden modeling results (*M. nasuta* only). The area of highest risk is located along the pier face (Stations MS40, MS41, MS42, and MS70). Stations offshore of the pier may be at less risk, as evidenced by the number of chemicals exceeding environmental effects data and the lack of toxic responses in biological indicators.

Risk drivers for Keyport/Bangor Dock (subtidal zone) are as follows:

Inorganics	PAH
Mercury	Phenanthrene
	Fluoranthene
	Benzo(a)anthracene

Service Pier/Carlson Spit. Risk to marine biota in the immediate vicinity of Service Pier and Carlson Spit is caused by high levels of PAHs and chlorinated pesticides at concentrations that exceed environmental effects data using either whole sediment indices or the equilibrium partitioning approach. Furthermore, the potential for bioaccumulation and biomagnification through the aquatic food chain to toxic levels is predicted. Confirmatory toxicity tests demonstrated significant responses at stations inshore of the pier, and benthic infaunal community analysis, the most sensitive of the biological indices, suggests a depression in total numbers of an otherwise common species of arthropod.

Stations offshore of the pier may be at less risk; no environmental effects data were exceeded and no toxic responses were observed in the bioassays.

The following chemicals are identified as risk drivers at Service Pier/Carlson Spit:

PAH	Pesticides	Other
Phenanthrene	Endrin	Dibenzofuran
Fluoranthene	Endrin aldehyde	
Benzo(a)anthracene		
Fluorene		
Acenaphthene		
Chrysene		
Benzofluoranthenes		

Sediment Management Standards Comparison

In addition to the Site 26 ecological risk assessment (Hood Canal Sediments) described above, the risk from the chemicals in the sediments was evaluated under the Sediment Management Standards (SMS). Bioassay tests were conducted at five of the eight areas investigated within Site 26. However, data are available only for two of the three required bioassay tests under the SMS. using the evaluation techniques in the SMS, only one area—Marginal Wharf—was found to be a "cluster of potential concern." All other areas were "clusters of low concern." The clustering analysis and the results of the bioassays are summarized below.

- **Cattail Lake Beach/Magnetic Screening Facility.** The average of the three highest concentrations for SMS chemicals was below the corresponding cleanup screening level (CSL) of minor adverse effects. Bioassay test results were below the sediment quality standards (SQS) of no adverse effects.

- **Floral Point Beach.** The average of the three highest concentrations for SMS chemicals was below the corresponding CSL. Bioassay tests were not analyzed at Floral Point Beach.

- **Explosives Handling Wharf.** The average of the three highest concentrations for SMS chemicals was below the corresponding CSL. Bioassay test results were below the SQS.

- **Marginal Wharf.** One chemical, bis(2-ethylhexyl)phthalate, was shown to have an average concentration (average of three highest stations) that exceeded the CSL. Bioassay tests were analyzed at seven stations at Marginal Wharf, but not at the same three stations with the highest chemistry. Bioassay test results were below the SQS.

- **Delta Pier.** The average of the three highest concentrations for SMS chemicals was below the corresponding CSL. Bioassay tests were not analyzed at Delta Pier.

- **Devil's Hole Beach.** The average of the three highest concentrations for SMS chemicals was below the corresponding CSL. Bioassay tests were not analyzed at Devil's Hole Beach.

- **Keyport/Bangor Dock.** The average of the three highest concentrations for SMS chemicals was below the corresponding CSL. Bioassay test results were below the SQS.

- **Service Pier/Carlson Spit.** The average of the three highest concentrations for SMS chemicals was below the corresponding CSL. Two bioassay test results (one *Rhepoxynius abronius,* one *Neanthes*) exceeded the CSL, and the benthic infaunal data for arthorpods exceeded the SQS.

8.2.3 Freshwater Ecological Risk

Site 2, Classification Yard/Fleet Deployment Parking (Trident Lakes)

Based on water quality comparisons, some aquatic organisms in Trident Lakes may experience adverse effects from aluminum and iron, although these chemicals appear unrelated to Site 2 and reflect uncertainties in the toxicity reference values (e.g., particulate aluminum in samples). The organic chemical concentrations found in lake sediments were below toxicological reference values.

Cattail Lake Ecological Area

Based on the single round of surface water sampling, the maximum COPC concentrations in lake water are below chronic toxicity reference values. Risk from COPCs in sediments is considered low based on the HQs. Aldrin may provide some localized risk to benthic organisms. A fishery resource exists in Cattail Lake; however, given the low frequency of aldrin in the sediments, the potential for food chain transfer of this chemical appears to be low. From the data available, there is no indication that chemicals from Site 7 have adversely affected Cattail Lake (Table 16). Although trace levels of ordnance compounds from a composite fish tissue sample were found during an earlier investigation, ordnance compounds were not detected in lake surface water or sediments during the RI/FS sampling.

Devil's Hole Ecological Area

With the possible exception of mercury at one sample location in Devil's Hole that exceeded the chronic toxicity reference value, the surface water data do not suggest significant adverse impacts to aquatic organisms. The concentrations of mercury in sediments were less than background, and mercury was not detected in two other surface water samples. The potential for risk to receptor organisms from COPCs in the sediments is low (Table 16).

Hunter's Marsh Ecological Area

Seasonal variation of COPCs in this marsh affects predictions of risk. Aluminum and iron exceeded water quality criteria in one of three sampling rounds. Concentrations in the sediments are not elevated with respect to background. It is suspected that the exceedances are related to suspended particulate matter in the samples. Risk from COPCs in sediments is considered low to negligible based on the HQs.

8.3 UNCERTAINTY ANALYSIS

Sources of uncertainty identified in the risk assessments are summarized in Table 17. For each source of uncertainty, the possible effect on the risk estimate (i.e., underestimation or overestimation), the degree of such effect, and the steps taken to mitigate the uncertainty are noted. A more detailed summary of the uncertainty associated with the risk analyses is provided in the RI report (URS 1994a).

Risk assessment is based upon a combination of scientific methods applied with varying levels of certainty. The quality, accuracy, and reliability of the final risk assessment are directly proportional to the least certain variable used in the analysis. It is important to emphasize that the baseline risk assessment is primarily a decisionmaking tool for assessing the need for remedial action. The results of risk assessment are presented in terms of the potential for adverse effects based upon a number of very conservative assumptions. This conservatism is an effort to err on the side of the protection of public health and ecosystems.

The sources of uncertainty may be related to the sampling and subsequent analysis of data. If limited data or data of questionable validity are used, samples with extreme concentrations (high or low) may bias the exposure estimates. With small data sets, it is very difficult to identify anomalous results and to perform

Table 17
Summary of Uncertainties in the Risk Assessment

Source of Uncertainty	Direction[a]	Magnitude[b]	Action or Result
HUMAN HEALTH RISK ASSESSMENT			
Sampling			
Small sample sets	+/-	2	Statistical distribution used with caution
Limited background data	+/-	2	Used quality-assured data
Filtered monitoring well samples	+	1	Used filtered water to better represent drinking water
Exposure Parameters			
Exposure assumptions	+	2	Used conservative values
No attenuation of chemical concentrations	+	1	Conservatively assumed that no attenuation would occur
Scenario assumptions	+	2	Used conservative assumptions
Toxicity Values			
Lack of dermal toxicity values	-	2	Used oral toxicity values
Extrapolation from animal studies to human toxicity	+	3	Used conservative approach incorporating safety factors and upper-bound estimates
Toxicological values based on specific pathologies from experimental/epidemiological studies	+	2	Used conservative approach to estimating risk
Lack of toxicological data for some chemicals	-	2	Used surrogate values where possible
Risk Characterizations			
Assumption of additive interactions	+/-	2	Assumed additive risks
Evaluating risk for individual sites and separate OUs within SUBASE, Bangor	-	2	Multiple exposures not included in individual assessments
ECOLOGICAL RISK ASSESSMENT			
Availability of toxicity information	-	2	Used surrogate values
Greater availability of data for aquatic and mammal receptors	+	2	Greater emphasis on these species
Extrapolation of toxicity values for other species	+	2	Used conservative assumptions
Literature toxicity values are based on oral exposure to pure chemicals	+	3	Overestimate of exposure
Synergistic or antagonistic effects on toxicity not evaluated	+	2	Overestimate of exposure

[a]Direction of effect:
- \+ potentially overestimate risk
- \- potentially underestimate risk

[b]Magnitude of effect:
- 1 small effect on risk estimates
- 2 medium effect on risk estimates
- 3 large effect on risk estimates

Source: URS 1994a

sufficient statistical analysis. In addition, assumptions and analytical methodologies used during the risk assessment may be sources of uncertainty.

8.3.1 Human Health Risk Assessment

Some of the major issues of uncertainty related to the assessment of human health risk are discussed below.

Sampling

The most prevalent source of uncertainty is related to the small sample sets used for some analyses of soil and water, especially groundwater analyses. In addition, background values for each medium were based on a limited amount of data.

It should be noted that results of groundwater analyses for Site 10, where risk was discovered, were based on only a single sample; therefore, the risk given for this site and appropriate media are heavily skewed and possibly overestimated or underestimated.

Statistical Distribution Uncertainty

The exposure concentrations were based on assumptions of a normal sample distribution and used the existing untransformed data sets. These assumptions could introduce uncertainty, although estimates based on t-distributions should not be seriously affected by slight deviations from normality.

Small data sets influenced the use of some statistical evaluations. Care was taken during analysis to avoid using the UCL of arithmetic mean concentrations if they exceeded maximum detected values. In those cases, the maximum detected value was used to calculate risk. The final set was analyzed in detail and compared nondetection values with detected concentrations.

Uncertainty in Exposure Parameters

Many of the exposure parameters used in the risk assessment were default values recommended by the EPA. These default parameters, which are used nationwide, do not necessarily reflect actual behavior at OU 7 and were used in the absence of site-specific information.

In addition, some assumptions regarding the land uses at OU 7 were highly speculative. It was assumed that any site not physically secured could be used for recreation. Anecdotal information from Navy personnel provided justification for the majority of these scenarios. Future residential scenarios were also highly speculative due to the improbability of future land use changes at SUBASE, Bangor, although this approach was considered most conservative. Overall, it is difficult to predict future land use for any military base due to the inherent uncertainties of such an undertaking.

The Floral Point human health risk was calculated by including groundwater data that pertain to the future residential scenario. The probability of the groundwater being used is extremely low due to its elevated salinity (related to its proximity to Hood Canal).

In general, an assumption was made for all sites that a receptor population could possibly be exposed to several contaminated areas within a general proximity. This sort of assumption is generally thought to be a conservative approach; however, an underestimation of risk might occur if certain hotspots had been overlooked during sampling.

Toxicity Value Uncertainty

Because dermal toxicity values are unavailable, oral toxicity values have been used for evaluating dermal exposures. This approach is recommended by the EPA in the dermal assessment manual (U.S. EPA 1992a). It does not seem appropriate to use fractional absorption factors in these analyses. The approach taken is the most conservative and may overestimate risks from this exposure pathway.

Although an attempt has been made to account for the uncertainties in calculation of reference doses and slope factors, considerable uncertainty does exist relative to the use of these values for human health risk assessment. The main reasons for this uncertainty are the following: (1) the applicability of extrapolating from animal data to assess human health effects and (2) the accuracy of analyses of sensitive populations, including differences in responses to toxic exposures between children and adults.

For some specific chemicals, toxicological values are based on specific pathologies identified by experimental studies and epidemiological research. However, actual exposure from specific media, and possible deleterious effects, may not coincide with the specific pathology on which the toxicological values were based. This anomaly may overestimate levels calculated for noncancer and cancer risk. For example, beryllium, manganese, nickel, and vanadium toxicological values are largely based on studies that use an inhalation exposure route. The air pathway was not considered an appropriate exposure pathway for the scenarios in this risk assessment; however, it was deemed conservative to proceed with analysis using these values for evaluating exposure from ingestion. It should be noted that all reference doses and slope factors are based on oral exposures only and not on inhalation (reference concentrations) factors.

Toxicity values for carcinogenic PAHs were based on that of benzo(a)pyrene. This approach has been recommended by EPA guidance (U.S. EPA 1989b). The main chemicals affected by this protocol would be benzo(a)anthracene and chrysene.

In addition, toxicological data are not available for some chemicals. Because none of these chemicals were found at significant levels (>1 ppm), no risk analysis was performed. Chemicals without appropriate toxicological data, but with ARARs such as drinking water standards, were evaluated separately (e.g., lead).

Risk Quantification of TPH Using Provisional Toxicological Values

Risk evaluation of TPH is difficult, given that no promulgated toxicity values are available; however, provisional values are available for various specific TPH compounds (Dollarhide 1992). The original assessment assumed detected TPH to be marine diesel fuel; therefore, the provisional reference dose (RfD) for TPH-diesel (0.008 mg/kg/day) was used. Current EPA guidance suggests applying these values in the absence of other information.

The studies on which the TPH numbers are based were *in vivo* animal studies, which used inhalation doses of the various specific fuels. In addition, the detected TPH concentrations may represent weathered fuels, from which many of the toxic volatile components (e.g., benzene) have evaporated. Extrapolation across exposure pathways, and across species, indicates high uncertainty of these toxicological values and, thus, the risks calculated using these values are highly uncertain. The following HQs, relative to ingestion of TPH via groundwater, were calculated based on the given exposure point concentrations: Site 10's exposure point concentration of 3.1 ppm resulted in an HQ of 11, and Floral Point's exposure point concentration of 0.89 ppm resulted in an HQ of 5.3.

Operable Unit Uncertainty

OU 7 is one of many operable units at SUBASE, Bangor that have been analyzed for human (and ecological) risk. It is difficult to perform a complete and accurate risk assessment of separate units within a larger source of exposure. It is possible that risk found at an adjacent operable unit may be contributing to total risk within OU 7. Multiple exposures between operable units would result in a cumulative risk greater than the risk evaluated for this assessment of OU 7. In addition, COCs found at OU 7 sites might have their source within other operable units upwind or upgradient from OU 7. Potential upstream contamination sources have been evaluated for Devil's Hole (which is downstream of OU 6) and Hunter's Marsh (downstream of OU 4).

Summary Risk Uncertainty

Risks were summarized for each medium and chemical at each OU 7 site and ecological area. The assumptions that allow this protocol are extremely conservative. Uncertainties lie in assuming that the routes of absorption and target organs are congruent for each specific COC. This, in reality, is not necessarily accurate. In addition, potential synergistic interactions between chemicals could result in a cumulative risk much greater than that calculated for individual chemicals. This would most likely be true for hepatotoxins, with exposures to multiple chemicals resulting in a large cumulative risk for hepatic pathologies.

8.3.2 Ecological Risk Assessment

Some of the major uncertainty issues are summarized below for the ecological assessment.

Selection of COPCs

The initial selection of COPCs for the terrestrial habitat was considered conservative. Only those inorganic COPCs with RME concentrations below background levels were deleted as COPCs; all remaining detected chemicals were retained as COPCs and evaluated further.

Chemical-Specific Toxicity

Chemical-specific toxicity information varies widely depending on the kinds of organisms and exposure media that may be of concern. For many of the COPCs, toxicity information that could be used to assess potential ecological risks was not available. The lowest toxicity values within the structural compound class were used as surrogate values. For some compound classes, the use of such surrogate values may be highly conservative and result in an overestimation of risk. For some chemicals, sufficient information was not available to determine surrogate toxicity values. Although these substances were carried through the exposure analysis, the missing toxicity information precluded interpretation of that exposure and resulted in an underestimation of potential risk.

Receptor-Specific Toxicity

In general, chemical-specific or surrogate toxicity values are more widely available for aquatic receptors and mammals than for birds. These limitations result in greater emphasis on assessment of risks to aquatic and mammalian receptors and an underestimation of risks to avian receptors.

For mammals and birds, toxicity values were often available for only one kind of a receptor within a phylogenetic class. This toxicity value has been extrapolated directly to other wildlife species. Because the lowest literature toxicity reference value was generally selected, this may result in an overestimation of risk.

Significant Endpoints

Preferably, toxicity values representing ecologically significant endpoints at the chronic no observed effects levels or lowest observed effects levels were selected. However, in some cases is was necessary to apply safety factors to extrapolate from another endpoint (e.g., median lethal dose to a no observed effects level). The extrapolation of toxicity values from one endpoint to another was based on published equations that may not be directly applicable to the specific organisms or chemicals in this evaluation.

Exposure Levels

Toxicity values obtained from the literature to develop toxicity reference values are based on oral doses of pure chemicals. Exposure to chemicals in natural environments is modified because chemicals are often associated with other media, such as soil, or are incorporated into different organisms, such as plants and small mammals. It is generally assumed that chemicals in soil, plants, and prey will not be absorbed as readily through the digestive tract as will pure chemicals. The exposure models used in this screening level assessment assume that the chemical is in the most readily available form and there is 100 percent absorption into the body; therefore, the model probably overestimates actual exposure.

Certain chemicals can toxicologically interact, having either synergistic or antagonistic effects on the toxicity of the individual chemical. However, neither the magnitude nor the direction of COPC interactions is understood, so potential toxicological interactions were not evaluated in the assessment.

The exposure modeling approach used in the risk assessment contains many assumptions that could affect the estimated levels of exposure used to evaluate potential risks. For example, the amount of chemical accumulating in plants was estimated at 5 percent of the RME soil concentration. In addition, modeled receptors were conservatively assumed to obtain 100 percent of their diets from the study areas.

Risk from chemical exposure to terrestrial receptors was based on RME estimates. RME point concentrations were calculated using the 95 percent UCL on the arithmetic mean. These estimates of exposure do not account for spatial variability in chemical concentrations in soil. For example, the exposure point concentration may be high but may result in a single elevated hit from a sample population. For animals with localized home ranges, such as the vole, a discontinuous distribution of chemicals in soil would mean that only certain members of the population would be potentially exposed. Consequently, population-level effects may be considerably overestimated when using average chemical concentrations.

9.0 DESCRIPTION OF THE NO-ACTION SITES

The baseline risk assessment concluded that conditions at the sites and ecological areas discussed in Sections 9.1 and 9.2 pose no unacceptable risks to human health and the environment. No remedial action is necessary at these sites to ensure protection of human health and the environment. The results of risk assessment for the no-action sites are summarized in Table 18.

Table 18
Risk Summary at No-Action Sites

Site or Ecological Area	Medium	Chemical of Concern	Human Health Risk	
			Carcinogenic	Noncarcinogenic HQ
4	Soil	None	$<10^{-6}$ (acceptable)	< 1 (acceptable)
7	Soil	None	$<10^{-6}$ (acceptable)	< 1 (acceptable)
	Sediment	None	$<10^{-6}$ (acceptable)	< 1 (acceptable)
	Surface water	None	$<10^{-6}$ (acceptable)	< 1 (acceptable)
	Groundwater	None	$<10^{-6}$ (acceptable)	< 1 (acceptable)
18	Soil	None	$<10^{-6}$ (acceptable)	< 1 (acceptable)
30	Soil	None	$<10^{-6}$ (acceptable)	< 1 (acceptable)
Cattail Lake	Surface water	None	$<10^{-6}$ (acceptable)	< 1 (acceptable)
	Sediment	None	$<10^{-6}$ (acceptable)	< 1 (acceptable)
Hunter's Marsh	Surface water	None	$<10^{-6}$ (acceptable)	< 1 (acceptable)
	Sediment	None	$<10^{-6}$ (acceptable)	< 1 (acceptable)
Devil's Hole	Surface water	None	$<10^{-6}$ (acceptable)	< 1 (acceptable)
	Sediment	None	$<10^{-6}$ (acceptable)	< 1 (acceptable)

Note:
HQ Hazard quotient

9.1 OU 7 SITES

9.1.1 Site 4, Carlson Spit

No ordnance compounds were detected at Carlson Spit, the detected inorganic analytes present no significant risk, and no remedial action is necessary. Risks from both cancer-causing and noncancer-causing chemicals were found to be acceptable for any type of exposure (see Table 13). No ARARs were exceeded.

9.1.2 Site 7, Old Paint Can Disposal Site

Site 7 showed no significant risk and no remedial action is necessary. Several inorganics were detected in site soil, sediment, and groundwater with concentrations exceeding ARARs, but the highest concentration was less than 2 times the background value. Risks from both cancer-causing and noncancer-causing chemicals were found to be acceptable for any type of exposure (see Table 13).

9.1.3 Site 18, PCB Spill Site

Site 18 showed no significant risk from exposure to the detected organic and inorganic chemicals, and no remedial action is necessary. Risks from both cancer-causing and noncancer-causing chemicals were found to be acceptable for any type of exposure (see Table 13). No chemicals exceeded ARARs.

9.1.4 Site 30, Railroad Tracks

Site 30 demonstrated no significant risk and no remedial action is necessary. Risks from both cancer-causing and noncancer-causing chemicals were found to be acceptable for any type of exposure (see Table 13). No chemicals exceeded ARARs.

9.2 ECOLOGICAL AREAS

9.2.1 Cattail Lake

Cattail Lake showed no significant risk and no remedial action is necessary. Risks from both cancer-causing and noncancer-causing chemicals were found to be acceptable for any type of exposure (see Table 13). No chemicals exceeded ARARs.

9.2.2 Hunter's Marsh

Hunter's Marsh showed no significant risk and no remedial action is necessary. Risks from both cancer-causing and noncancer-causing chemicals were found to be acceptable for any type of exposure (see Table 13). No chemicals exceeded ARARs.

9.2.3 Devil's Hole

Devil's Hole showed no significant risk and no remedial action is necessary. Arsenic, mercury, and selenium were detected at concentrations above ARARs in site surface water (Table 12). The inorganic ARAR exceedances are believed to be due to the brackish nature of Devil's Hole surface water. Risks from both cancer-causing and noncancer-causing chemicals were found to be acceptable for any type of exposure (see Table 13).

10.0 REMEDIAL ACTION OBJECTIVES

Actual or threatened releases of hazardous substances from Sites B, 2, 10, 26, E, 11, if not addressed by implementing the response actions selected in this ROD, may present a hazard to public health, welfare, or the environment. Sampling results and the risk assessment indicate some human health risk to hypothetical future residents from stockpiled, surface, and subsurface soils, and groundwater. Consistent with EPA's National Oil and Hazardous Substances Contingency Plan (NCP) and under the guidance of CERCLA as well as State of Washington MTCA regulations, remedial action is warranted to address these potential risks to human health and the environment and to address those areas where chemicals exceed federal or state standards.

The human health risk assessment and ecological risk assessment (Sections 6.1 through 6.3 of the RI report [URS 1994a]) identified COCs that contribute an excess lifetime cancer risk greater than 10^{-4} (1 in 10,000) or a noncancer cumulative HQ greater than 1.0. Table 19 presents those chemicals identified as COCs in the risk assessments. MTCA provides cleanup standards for most of the chemicals and pathways of concern at OU 7.

The remedial action goals shown in Table 19 are based on attaining acceptable risk levels and achieving ARARs. The COCs shown include mixtures of chemicals of a given type of compound (such as carcinogenic PAHs) that have exceeded standards in a particular medium at the site. The cumulative excess cancer risk associated with each site will be reduced to, at most, 1×10^{-5}, consistent with MTCA.

The following sections present the remedial action objectives for soil and groundwater at OU 7.

10.1 SITE B, FLORAL POINT

The human health risk assessment for Site B showed that soil poses an unacceptable risk due to cancer-causing chemicals (refer to Table 13). Although the cancer and noncancer risk for chemicals in groundwater was determined to be unacceptable, the groundwater at this site naturally contains salt water from Hood Canal, precluding its use as a future source of drinking water. However, chemicals detected in groundwater may have impacts on the marine environment.

Table 19
Remedial Action Goals for Chemicals of Concern

Site	Medium	Chemical	Remedial Action Goal	
			Concentration (ppm)	Source
B	Shallow and subsurface soil	Arsenic	20	MTCA Method A
		Total PAHs (carcinogenic)[a]	1	MTCA Method A
		Total PCBs[b]	1	MTCA Method A
2	Stockpiled soil	PCBs	1	MTCA Method A
10	Groundwater	Total petroleum hydrocarbons	1	MTCA Method A
E and 11	Stockpiled soil	DDT	2.94	MTCA Method B
	Groundwater	Otto fuel[c]	0.0002	Method detection limit

[a]Total carcinogenic PAHs include benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene.
[b]PCB mixtures include Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260.
[c]The indicator chemical for Otto fuel is propylene glycol dinitrate.

Notes:
PAHs Polycyclic aromatic hydrocarbons
PCBs Polychlorinated biphenyls

The following remedial action objectives are identified for Site B:

- Prevent direct contact and ingestion of shallow and subsurface soil containing PAH and PCB concentrations above the state cleanup level of 1 ppm for soil to 15 feet bgs and arsenic concentrations above 20 ppm.
- Confirm through monitoring of the Hood Canal sediments and clam tissue that groundwater discharge from Floral Point into Hood Canal is not negatively affecting the sediments or clam tissues.

10.2 SITE 2, CLASSIFICATION YARD/FLEET DEPLOYMENT PARKING

The human health risk assessment of Site 2 showed that a marginal cancer risk is posed by the stockpiled soils due to the presence of PCBs. The chemical concentrations in surface water, sediment, site soils, and groundwater do not pose a health risk.

The following remedial action objective is identified for Site 2:

- Prevent direct contact with and ingestion of stockpiled soil and underlying soil (down to 15 feet bgs) that contain PCB concentrations above the state cleanup level of 1 ppm.

10.3 SITE 10, PESTICIDE STORAGE QUONSET HUTS

The human health risk assessment showed that the soil at Site 10 presents no risk. Although dieldrin was detected in the shallow subsurface soil at concentrations above ARARs, the soil is covered by asphalt, and there is no risk posed to human or ecological receptors. The cancer risk from the groundwater at the site is within the acceptable range. However, the noncancer risk to potential future residents from groundwater is unacceptable due to the presence of gasoline.

The following remedial action objective is identified for Site 10:

- Prevent ingestion of groundwater containing TPH concentrations above the state cleanup level of 1 ppm throughout the aquifer.

10.4 SITE 26, HOOD CANAL SEDIMENTS

The risk to human health at Site 26 has been determined to be within the acceptable range for ingestion of shellfish and sediments in all areas. Minor risk to the environment was found in marine sediments at Marginal Wharf, Keyport/Bangor Dock, and Service Pier. Comparison to the SMS showed the marine sediments at Marginal Wharf were a "cluster of potential concern." All other areas were "clusters of low concern" (see Section 8.2.2). Consistent with the requirements of the SMS, continued monitoring of the sediments is appropriate.

The following remedial action objective is identified for Site 26:

- Confirm that chemical concentrations in the sediment's biologically active zone are not increasing.

10.5 SITE E, ACID DISPOSAL PIT; SITE 11, PESTICIDE/HERBICIDE DRUM DISPOSAL AREA

The human health risk assessment for Site E and Site 11 indicates marginal cancer risk from DDT in the soil stockpiled in the containment cell. Site soil that remains in place presents no risk. The groundwater presents marginal risk for both cancer-causing and noncancer-causing chemicals (inorganics and ordnance compounds). Arsenic was the only inorganic that showed a risk and it may be due to background variations.

The following remedial action objectives are identified for Site E and Site 11:

- Prevent direct contact with and ingestion of stockpiled soil and underlying soil down to 15 bgs that contains DDT in concentrations above the state cleanup level of 2.94 ppm.

- Prevent ingestion of groundwater containing Otto fuel concentrations above 0.0002 ppm. Propylene glycol dinitrate is one of several chemical compounds in Otto fuel and is used as the indicator chemical. There is no cleanup value for Otto fuel. The calculated preliminary remediation cleanup goal is 0.000038 ppm (calculated from U.S. EPA 1989b, Vol. 1, Part B:

Development of Risk-Based Preliminary Remediation Goals). However, the method detection limit for Otto fuel is 0.0002 ppm and in accordance with state regulations is used as the cleanup goal.

11.0 DESCRIPTION OF ALTERNATIVES

11.1 SITE B, FLORAL POINT

11.1.1 Soil

The top 2 feet of soil at Floral Point is contaminated primarily with PAHs, PCBs, and arsenic. Lead presents some ecological risk. The most conservative value for cancer risk to human health, based on a residential scenario, suggests a cancer risk of 1.6×10^{-4}.

Alternatives considered for the remediation of Floral Point are discussed in the following paragraphs.

Alternative 1—No Action

This alternative would mandate that no remediation measures take place at the site, although groundwater monitoring would be performed. Retention of the no-action alternative is required by the NCP and is the baseline used to evaluate other alternatives.

Alternative 2—Monitoring/Institutional Controls

This alternative would include groundwater monitoring and implementation of institutional controls in the master plan by the Navy, such as fencing, site use limitations, and restricted site access. Institutional controls do not affect contamination fate and transport but instead reduce the exposure of humans to chemicals by restricting access. The proposed fence is a 6-foot-high chainlink fence with double-strand barbed wire topping. Approximately 2,500 linear feet of fencing would be needed.

Alternative 3—Vegetative Soil Cover

This alternative would include the construction of a soil cover of approximately 375,000 square feet and the Navy's maintenance of the cover. The proposed cover would be designed in conjunction with a development plan to provide a natural recreational area at the site. The test pit area would be covered with a vegetative and graded soil cover.

Alternative 4A—Excavation, Off-Site Transport, and Disposal Without Stabilization

This alternative would involve excavation of the top 2 feet of soil equaling 750,000 cubic feet or 28,000 cubic yards of soil, followed by transport and disposal. Disposal of excavated soils is regulated by Resource Conservation and Recovery Act (RCRA) land disposal restrictions. This alternative would be used instead of Alternative 4B if chemical analysis of the transported soil shows that stabilization is not required.

Alternative 4B—Excavation, Off-Site Transport, and Disposal With Stabilization

This alternative would be the same as Alternative 4A but would include stabilization of the soil prior to disposal. This alternative would be used in lieu of Alternative 4A if stabilization is required.

11.1.2 Groundwater

Concentrations of arsenic and some organics, including low-level pesticides and PCBs, in groundwater exceeded levels allowed by the strictest environmental regulations. The cancer risk from groundwater was found to be unacceptable; the noncancer risk was acceptable. The risk scenario included hypothetical future residents drinking water from the site over a 30-year period. The groundwater at this site contains salt water from Hood Canal, making it undrinkable. Monitoring of potential effects from discharges of the groundwater from this site into Hood Canal will be accomplished under remedial activities for Site 26, Hood Canal Sediments. A minimum of two rounds of sediment and clam tissue samples from Floral Point Beach will be collected to verify that chemicals in the groundwater have not affected the marine environment (see Section 11.4).

11.2 SITE 2, CLASSIFICATION YARD/FLEET DEPLOYMENT PARKING

The soil in Containment Cell No. 2 contains levels of PCBs above cleanup levels and lead and steel in the form of small-caliber ordnance and scrap metal mixed in the soil. There is no human health risk from the groundwater. Three alternatives were considered for remediation of the stockpiled soil.

Alternative 1—No Action

No further action would be taken at this site, and no groundwater monitoring would be conducted. Retention of the no-action alternative is required by the NCP and is the baseline used to evaluate other alternatives.

Alternative 2—No Action With Monitoring

This alternative would involve long-term groundwater monitoring to determine whether the contaminants in the stockpiled and deep soil of the site constitute a problem for groundwater quality. A public health evaluation of the stockpiled soil would be conducted every 5 years. The Navy would include provisions in the base master plan to restrict site access and maintain site fencing.

Alternative 3—Size Screening and Removal of Metallic Debris

This alternative would involve size screening of the remaining 5,000 cubic yards of soil and debris currently stored in Containment Cell Nos. 1 and 2. Although the lead bullets showed toxicity characteristics leaching procedure (TCLP) concentrations in excess of hazardous waste thresholds, it is proposed that the screened metallic debris be transported to a local metal reclamation facility to beneficially reuse these waste materials or that it be sent to an off-site landfill for disposal. If testing of the soil after it has been screened indicates no lead or PCB concentrations above cleanup levels, the soil would be used for backfill at the site. If testing indicates that the screened residuals contain chemicals above ARARs, then the material would be disposed of at an off-site facility.

11.3 SITE 10, PESTICIDE STORAGE QUONSET HUTS

Although pesticides were found in the soil, they present no human health risk because direct contact is prevented by the existing asphalt paving. No action was the only alternative considered for soil, with the provision that the existing asphalt be maintained.

The groundwater at this site is contaminated with TPH. The most conservative cancer risk to human health, associated with the residential scenario, is an HQ of approximately 11. The cancer risk is less than 1 in 1,000,000. Groundwater is not currently used for drinking. Alternatives considered for groundwater include no action and extraction combined with reinjection.

Alternative 1—No Action With Monitoring

This alternative would mandate no remedial measures, but it would include confirmational sampling using the existing monitoring well (10-MW-1) to confirm the presence of TPH. If the presence of TPH in 10-MW-1 is confirmed, the site would be investigated further, and a use restriction placed by the Navy on the groundwater in the base master plan. Maintenance of the existing pavement to prevent direct contact with site soil would be part of this alternative.

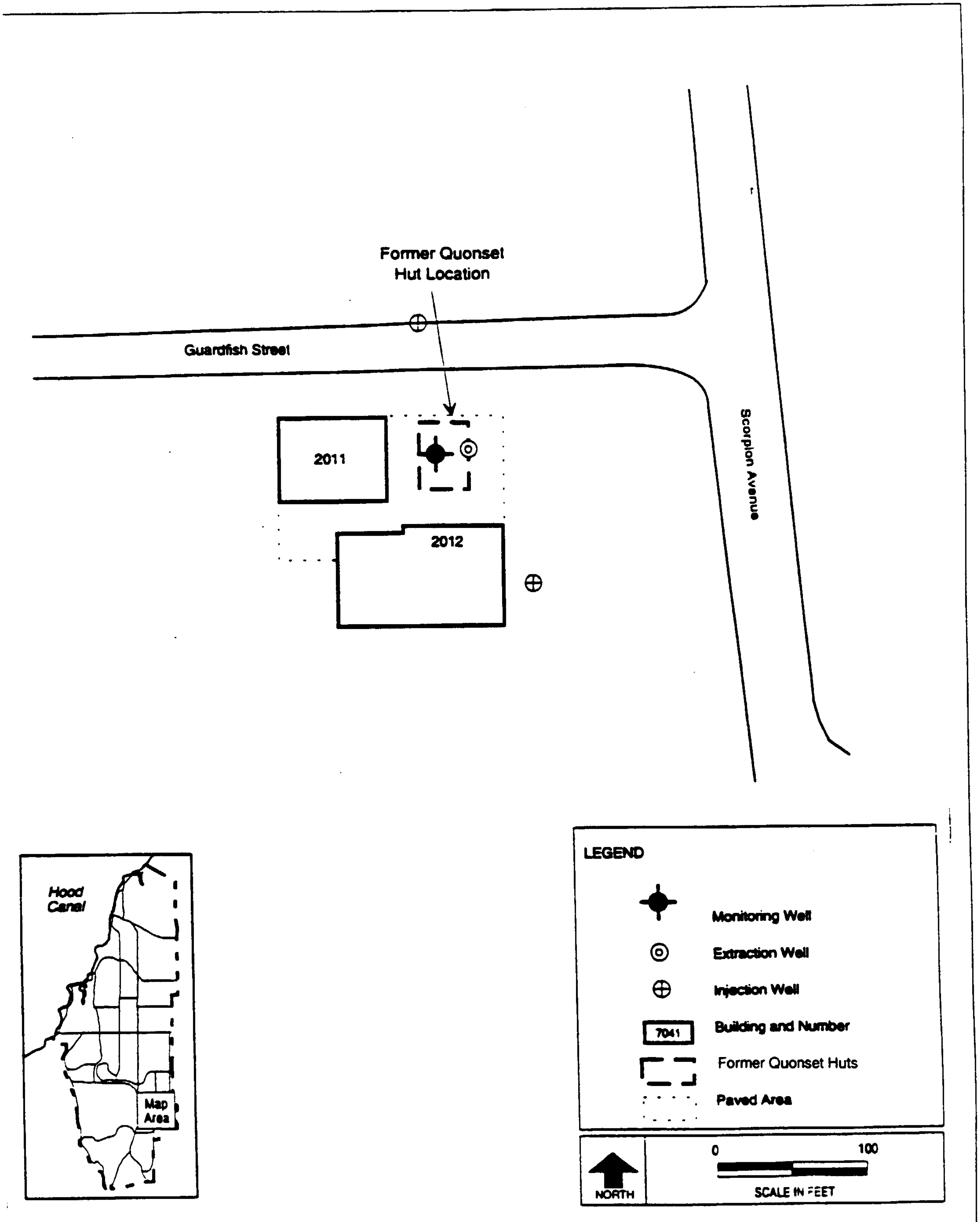
Alternative 2—Extraction and Reinjection

This alternative would include removal of contaminated groundwater using an array of extraction wells, as well as maintenance of the existing pavement to prevent direct contact with site soil. Wells in the extraction system would be located to mitigate further migration of the groundwater contamination. Groundwater would be extracted through one well and treated for TPH using granular activated carbon. The treated water would then be reinjected into the aquifer (Figure 32). With an assumed design flow of 13 gallons per minute (gpm), it is estimated that less than 2 years would be needed to remediate the TPH. This estimate does not take into account such factors as natural biodegradation or additional source contaminants entering the groundwater.

11.4 SITE 26, HOOD CANAL SEDIMENTS

The only alternative considered for detailed analysis is no action. No action includes monitoring sediments and clam tissue to determine whether concentrations of chemicals are increasing, decreasing, or not changing and ensure continued protection of the environment.

Under this alternative, Site 26 sediments would be left in place and a monitoring program would be instituted that would include periodic sampling of sediments with a minimum of two rounds (maybe three) in 5 years. Sampling would take place at Marginal Wharf, Keyport/Bangor Dock, and Service Pier. In addition, sediment and clam tissue samples would be collected from the vicinity of Floral Point Beach to confirm that chemicals in the groundwater from Floral Point (Site B) are not affecting the marine



CLEAN
COMPREHENSIVE
LONG-TERM
ENVIRONMENTAL
ACTION NAVY

Figure 32
Site 10 - Proposed Locations of Extraction and Injection Wells

CTO 0058
SUBASE, Bangor
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ROD

environment. The monitoring program would identify trends in contaminant levels. If contamination is increasing in concentration and/or areal extent, the need for additional source control activities, additional sediment sampling, and implementation of engineered sediment controls would be assessed.

11.5 SITE E, ACID DISPOSAL PIT; SITE 11, PESTICIDE/HERBICIDE DRUM DISPOSAL AREA

11.5.1 Stockpiled Soil

The stockpiled soil at Sites E and 11 contained DDT. The risk for the residential scenario is 1.8×10^{-5}. Alternatives considered for the remediation of the stockpiled soil are discussed in the following paragraphs.

Alternative 1—No Action

This alternative would mandate no remediation measures. Retention of the no-action alternative is required by the NCP and is the baseline used to evaluate other alternatives.

Alternative 2—Off-Site Transport and Disposal

This alternative would involve loading approximately 400 cubic yards of containment cell soil onto hazardous waste transport trucks and transporting the soil for off-site disposal at a RCRA subtitle C or D facility depending on the sampling results of the stockpiled soil.

Alternative 3—On-Site Incineration

This alternative would involve bringing a small transportable incineration unit to SUBASE, Bangor and incinerating the containment cell soil on site. Mobilization, site preparation, setup, and testing of the incineration unit would take approximately 2 months, and incineration of the soil would take approximately 2 weeks, operating 24 hours a day, 7 days a week. An estimated 400 cubic yards, weighing 520 tons, would be incinerated to reduce DDT concentrations below MTCA cleanup levels. Because the stockpiled soil has been determined not to be a RCRA-listed waste, it is anticipated that the treated soil may be disposed of on site as backfill. However, the treated soil would first be characterized to ensure that it is not a RCRA hazardous waste or a state dangerous waste.

Alternative 4—Off-Site Incineration

This alternative would involve loading the contaminated soil onto hazardous waste transport trucks and transporting it to a RCRA-approved incineration facility. The ash from the incinerator would be disposed of at a landfill near the incinerator facility.

11.5.2 Groundwater

The source of groundwater contamination at this site is due at least in part to upgradient sources for organics and to natural conditions for inorganics. The upgradient source for the ordnance compounds is Site F, a former ordnance wastewater lagoon in OU 2. The inorganics at Sites E and 11 within 2 to 3 times the background value and are found mostly in the lower aquifer, suggesting that they are the result of natural background. The remedial action being undertaken at Site F is pumping and treating the groundwater and continued monitoring. Sites E and 11 are within the zone of capture of the Site F groundwater extraction system and will be treated by the Site F remedial action. The Site F treatment unit, granular activated carbon, is effective in removing organic chemicals present at Sites E and 11.

Alternatives 2 through 4 were developed prior to final selection of the OU 2 action at Site F and are presented here to be consistent with the feasibility study (URS 1994b).

Alternative 1—No Action With Monitoring

The alternative would mandate no remediation measures, but would include groundwater monitoring and a review of the OU 2 pump-and-treat remediation to confirm that groundwater at Sites E and 11 is being cleaned up. This alternative assumes that the pump-and-treat option selected at Site F in OU 2 will also treat the groundwater at Sites E and 11. The groundwater monitoring will be conducted with the Site F ongoing monitoring program. If it is determined that hazardous substances remain on the site, a review will be conducted within 5 years. The Navy would place a groundwater use restriction in the master plan to prevent groundwater use while chemical levels in groundwater exceeded cleanup levels.

Alternative 2—Limited Action /Institutional Controls

This alternative would include fencing the site, monitoring (including annual reports) existing monitoring wells at the site for 30 years, and placing a groundwater use restriction in the master plan for the base to prevent future use of groundwater at the site.

Alternative 3—Extraction, Treatment, and Reinjection

This alternative would include monitoring and reporting similar to Alternative 1 and placing a groundwater use restriction in the SUBASE Bangor master plan similar to the one in Alternative 2. This alternative also would include removal of contaminated groundwater using an array of extraction wells. The extent of the groundwater contamination at the site is not well defined, but the volume of the contaminated plume is estimated at 350 feet by 450 feet by 80 feet. Wells in the extraction system would be located to mitigate further migration of the groundwater contamination. One well capable of extracting 5 gpm is suggested and two wells (one upstream and one downstream) would be used as injection wells (see Figure 33).

Treatment for Otto fuel would use granular activated carbon. The groundwater treatment standards would be based on Safe Drinking Water Act standards.

Alternative 4—Extraction, Treatment, and Disposal

This alternative would be similar to Alternative 3, except that the treated water would be discharged to a basin to replenish groundwater. The basin would be large enough to adequately contain the water that is discharged and allow it to infiltrate the groundwater system. Groundwater would be pumped using the extraction well shown in Figure 33. A groundwater use restriction would be placed in the base's master plan.

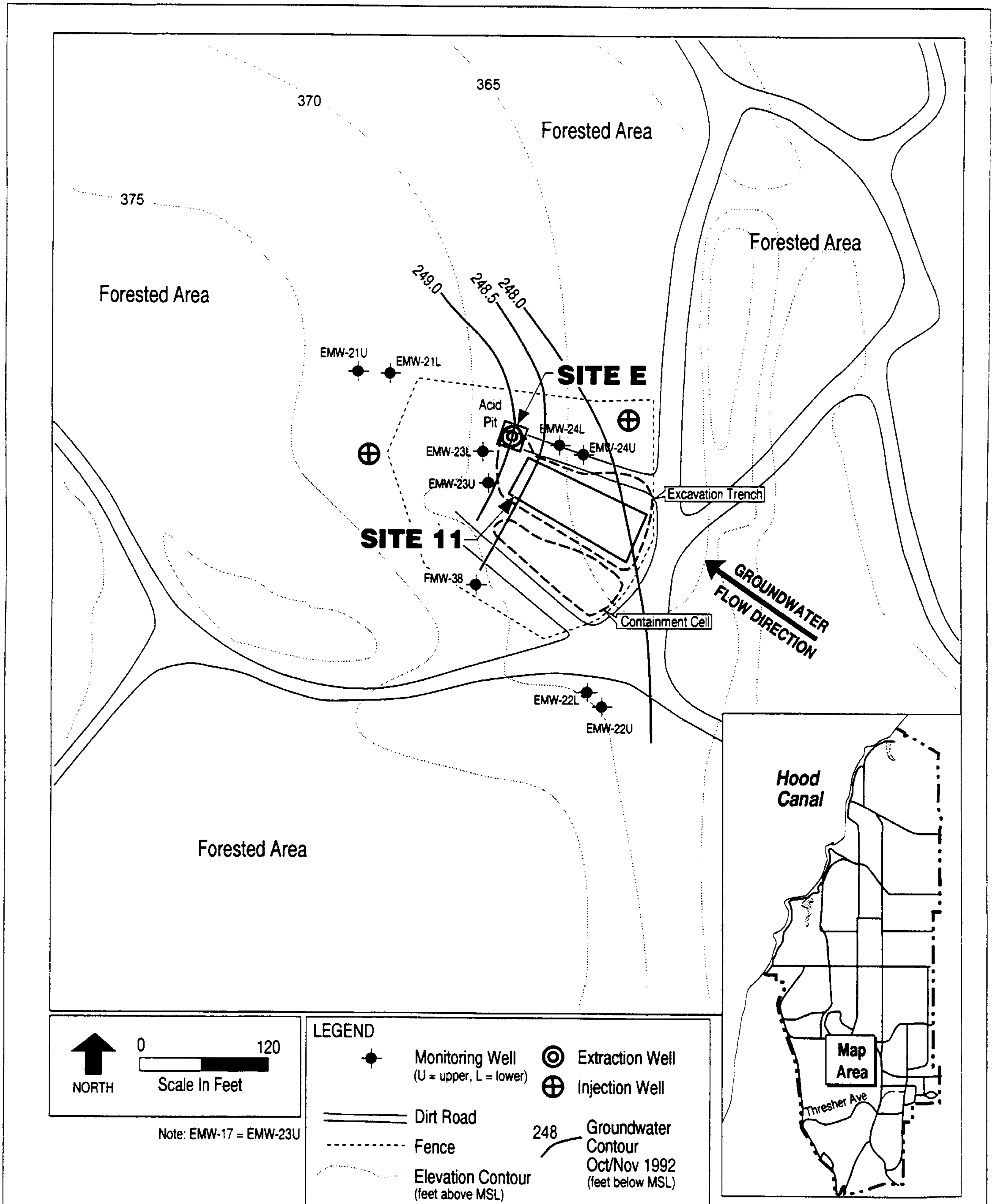

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Figure 33
Site E and Site 11
Proposed Locations of Extraction and Injection Wells

CTO 0058
SUBASE, Bangor
Washington
ROD

12.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

CERCLA, as amended by SARA, requires that the specific statutory requirements listed below be addressed in the ROD and be supported by the feasibility study. Under CERCLA, remedial actions must meet the following requirements:

- Protect human health and the environment
- Attain ARARs unless justifications are provided for invoking a waiver
- Be cost-effective
- Use permanent solutions and alternative technologies or resource recovery technologies to the maximum extent practicable
- Satisfy the preference for treatment that reduces toxicity, mobility, or volume

In addition, CERCLA emphasizes long-term effectiveness and encourages the evaluation of innovative technologies.

To address these requirements, EPA has developed nine evaluation criteria that serve as the basis for conducting the detailed feasibility study evaluation and, subsequently, for selecting an appropriate remedial action. EPA groups the nine criteria into the following three categories, based on each criterion's role during remedy selection.

- Threshold criteria
  - Overall protection of human health and the environment
  - Compliance with ARARs
- Primary balancing criteria
  - Long-term effectiveness and permanence
  - Reduction in toxicity, mobility, or volume
  - Short-term effectiveness
  - Implementability
  - Cost
- Modifying criteria
  - State acceptance
  - Community acceptance

A description of each criterion is presented below.

- Overall protection of human health and the environment addresses whether adequate protection of health and the environment is provided during and after remedial activities.

- Compliance with ARARs addresses whether the alternative meets all applicable or relevant and appropriate requirements of federal and state laws and regulations.

- Long-term effectiveness and permanence refers to the ability of the remedy to maintain reliable protection of human health and the environment over time once cleanup levels have been met.

- Reduction of toxicity, mobility, or volume through treatment is the anticipated performance of the treatment technologies.

- Short-term effectiveness refers to the speed with which the remedy achieves protection, as well as the potential of the remedy to cause adverse impacts on human health and the environment during construction and implementation.

- Implementability is the technical and administrative feasibility of a remedy, including the availability of materials and services needed.

- Cost includes capital costs, operation and maintenance costs, and present-worth cost estimates including inflation.

- State acceptance refers to whether the alternative addresses the technical and administrative concerns of the state.

- Community acceptance pertains to whether the alternative adequately addresses concerns of the local community.

12.1 SITE B, FLORAL POINT

Contamination at the site consists of PCBs, PAHs, and arsenic, although the inorganic probably reflects naturally occurring concentrations. Currently, chemicals may be released from this site to surface water and there is a possibility of direct contact or dust inhalation. Remedial action alternatives for soils at Site B include the following:

Alternative 1	No action
Alternative 2	Monitoring/institutional controls (monitoring, installation of a fence, and/or site access restrictions)
Alternative 3	Vegetative soil cover
Alternative 4A	Excavation, off-site transport, and disposal without stabilization
Alternative 4B	Excavation, off-site transport, and disposal with stabilization

12.1.1 Overall Protection of Human Health and the Environment

Alternative 1 would do nothing physically over time to protect human health and the environment. Human health risk at the site is on the order of 1.6×10^{-4} for the residential scenario. Consequently, Alternative 1 does not meet this threshold criterion.

Alternative 2 would prevent the recreational visitor from being exposed to and accidentally ingesting soil affected by COCs. Direct contact risks would still be present for the industrial worker, but would be significantly diminished.

Alternative 3 would protect human health. The vegetative soil cap would prevent direct contact with soil, prevent contamination of surface water runoff, prevent airborne transport of soil particles, and may reduce surface water percolation through the contaminated soil. Long-term maintenance of the cap would be necessary for the alternative to remain protective.

Alternatives 4A and 4B, excavation and off-site disposal, are designed to be protective of human health and the environment. Soils of concern would be removed from the site, preventing further risk from direct contact and potential contamination of surface water. Toxicity would not be reduced; the greatest risk would occur during implementation of this remedy. Truck transport of large volumes of soil to a landfill would create the remote possibility for accidental releases to the environment along the transportation route.

12.1.2 Compliance With ARARs

Alternative 1 would not comply with ARARs. Washington State standards for direct contact are currently exceeded for PAHs and PCBs under the MTCA Method B calculations.

Alternative 2 would not meet chemical-specific ARARs because it does not include any action to treat or contain soil contamination.

Alternative 3 would comply with ARARs through containment of contaminated soil.

Alternatives 4A and 4B could be designed to address all ARARs. Important ARARs associated with these alternatives are RCRA hazardous waste and state dangerous waste regulations. The excavated soil would be evaluated to determine whether it is hazardous or dangerous waste. If the soil is designated as either, specific handling, transportation, treatment, and disposal requirements would apply. Alternative 4B would be selected if stabilization is needed.

12.1.3 Long-Term Effectiveness and Permanence

Alternative 1 would do nothing to reduce existing residual risk to human health, safety, public welfare, and the environment. However, the magnitude of that risk is low and may be acceptable.

Alternative 2 could reduce the residual risk to human health and the environment in the long term if the institutional controls are effectively maintained. As long as these controls remained effective, the risk of direct contact with chemicals left in place would be greatly diminished. Release of some chemicals from the soil would continue as at present; however, the magnitude of the residual risk is low.

Alternative 3 would leave the contaminated soil in place. Proper construction and maintenance to ensure the integrity of the soil cover would reduce the residual risk to human health and the environment in the long term. Regular maintenance of the soil cover and repair of erosion would minimize the future risks.

Alternatives 4A and 4B would provide permanent long-term effectiveness through the removal of the soil of concern. The long-term effectiveness and permanence of the off-site RCRA-approved landfill would depend on the integrity of the landfill. The shipment and landfilling of contaminated soil would create a potential future liability for the Navy.

12.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

None of the alternatives include treatment to reduce the toxicity, mobility, or volume of existing contaminated material. Alternative 4B would include stabilization of the COCs, which would reduce the mobility of these specific chemicals at the disposal facility.

12.1.5 Short-Term Effectiveness

Alternative 1 would not involve remedial action; therefore this criterion is not applicable.

Alternative 2 would include actions that would be effective in the short term.

The Alternative 3 soil cover would take about 6 months to complete. Potential health risks to the community and workers during implementation are considered low. The construction site would be fenced, and the public would experience additional truck traffic and heavy equipment noise. Dust control measures would be implemented during construction.

Alternatives 4A and 4B would involve considerations similar to those of Alternative 3 with respect to protection of the community and workers. Protective measures would include the use of appropriate personal protective equipment, dust control, surface water runoff control, decontamination of all equipment, and adherence to transportation guidelines. Excavation, transport, and disposal are estimated to take up to 6 months.

12.1.6 Implementability

Alternative 1 would not involve remedial action; therefore this criterion is not applicable.

Alternative 2 would be easily implementable since the property is under Navy control. Restrictive covenants would require coordination with Ecology and other agencies during any future property transfers from the Navy to other parties to ensure that financial and technical provisions are made for the continued operation and maintenance of the necessary institutional controls.

Alternative 3 would use a standard and accepted technology that would meet anticipated performance criteria. Integrity of the cap would be monitored by routine visual inspection. No difficulties are anticipated in obtaining the permits and approvals required to implement this alternative. The technical components in this alternative are standard to the construction industry and should not pose significant material or contractor availability problems.

Alternatives 4A and 4B would be easily implementable. The off-site disposal locations have stabilization operations at the facilities receiving the waste. There are no known difficulties associated with obtaining permits or approvals related to these alternatives. The equipment and practices necessary to implement these alternatives are standard in the industry.

12.1.7 Cost

Alternative 1 would not include capital costs; however, annual operation and maintenance costs for environmental sampling and analysis and reports to regulatory agencies are estimated at $39,000. The present-worth cost (5 percent discount rate, 30-year life) would be $600,000.

Alternative 2 estimated costs for implementing the monitoring/institutional controls would be $46,000, most of which would be for 2,500 linear feet of 6-foot-high chainlink fence topped with barbed wire. Annual operation and maintenance costs are estimated to be $40,000, the majority of which would be for sampling and monitoring. The present-worth cost would be approximately $661,000.

Alternative 3 estimated capital costs would be $568,000, and the estimated annual operation and maintenance costs would be $17,000. The present-worth cost would be approximately $829,000.

Alternative 4A estimated capital cost would be $11,788,000 to excavate and dispose of a total 28,000 cubic yards of soil off site without treatment. The estimated annual operation and maintenance cost is zero because the soil would be removed from the site. The present-worth cost would be approximately $11,788,000.

Alternative 4B estimated capital cost would be $17,453,000 to excavate and dispose of a total 28,000 cubic yards of soil off site following chemical stabilization pretreatment. The estimated annual operation and maintenance cost would be zero because the soil would be removed from the site. The present-worth cost would be approximately $17,453,000.

12.1.8 State Acceptance

Ecology concurs with the selected remedial action at Site B and has been involved in the development and review of the RI, feasibility study, Proposed Plan, and ROD. Comments from Ecology have resulted in substantive changes in these documents, and the agency has been integrally involved in determining which cleanup standards apply to environmental media.

12.1.9 Community Acceptance

Comments received during the public comment period indicate that the public accepted the Proposed Plan.

12.2 SITE 2, CLASSIFICATION YARD/FLEET DEPLOYMENT PARKING

Contamination at Site 2 consists of approximately 5,000 cubic yards of soil excavated and stockpiled during the two drum removals. The soil contains PCB concentrations that exceed the most stringent cleanup level and lead and steel from small-caliber shells and projectiles and steel-banding debris. Currently, chemicals may be released from this site to surface water and there is a possibility of direct contact or dust inhalation. Remedial action alternatives for stockpiled soil at Site 2 include the following:

Alternative 1	No action
Alternative 2	No action with monitoring
Alternative 3	Size screening and removal of metallic debris from stockpiled soil

12.2.1 Overall Protection of Human Health and the Environment

Alternative 1 would not protect human health and the environment and therefore does not meet this threshold criterion. Human and environmental exposures to chemicals in the stockpiled soil could occur over time.

Alternative 2 would include groundwater monitoring to determine whether chemicals are migrating from the stockpile to groundwater. This alternative would protect most of the people on the base, but would provide only limited protection to the occasional industrial worker and would not protect the environment.

Alternative 3 would result in long-term reduction of risk associated with lead and metal debris. Short-term risk to workers would be mitigated through adequate health and safety measures during screening and removal activities. After the stockpile has been screened and classified, the site would be returned to a more natural setting by backfilling the disturbed area with the screened soil, if the soil meets MTCA Method A cleanup standards for PCBs.

12.2.2 Compliance With ARARs

Alternatives 1 and 2 would not comply with ARARs. Chemicals would remain in the stockpiled soil at concentrations above state cleanup levels.

Alternative 3 would comply with ARARs.

12.2.3 Long-Term Effectiveness and Permanence

Alternatives 1 and 2 would do nothing to reduce existing residual risk to human health, safety, public welfare, and the environment. However, the magnitude of that risk is low.

Alternative 3 would permanently reduce the risk to human health and the environment. The metallic debris would be removed from the site, along with any PCB-contaminated soil that exceeds the state cleanup level.

12.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternatives 1 and 2 would not reduce the toxicity, mobility, or volume of the existing chemicals through treatment.

Alternative 3 would reduce the mobility of lead in the metallic debris by screening the debris for reclamation and beneficial reuse. If off-site disposal of PCB-contaminated soil is necessary, no treatment would occur to reduce the toxicity or mobility of the PCBs.

12.2.5 Short-Term Effectiveness

Alternatives 1 and 2 would not involve remedial action; therefore this criterion is not applicable.

Alternative 3 would reduce the risk due to lead debris and PCBs in the stockpiled site soil within several months. Dust control and stormwater control measures would be implemented during the remedial action to reduce risks to workers and the environment.

12.2.6 Implementability

Alternative 1 would not involve remedial action; therefore, this criterion is not applicable.

Alternative 2, groundwater monitoring using existing wells, is readily implementable. Monitoring would have to be coordinated with ongoing remedial efforts.

Alternative 3, size screening, has already been completed for the soil previously staged in Containment Cell No. 2. A local vendor has been identified to accept the metallic debris containing high concentrations of lead. Off-site transport and disposal of soil containing PCBs, if necessary, is readily implementable.

12.2.7 Cost

Alternative 1 would incur no capital or operating and maintenance costs.

Alternative 2 would not incur capital costs. Operating and maintenance costs would be $66,000. The present-worth cost would be approximately $1,014,000.

Alternative 3 would incur a one-time capital cost of approximately $399,000 and no operating and maintenance costs. Thus, the present-worth cost would be approximately $399,000.

12.2.8 State Acceptance

Ecology concurs with the selected remedial action at Site 2 and has been involved in the development and review of the RI, feasibility study, Proposed Plan, and ROD. Comments from Ecology have resulted in substantive changes in these documents, and the agency has been integrally involved in determining which cleanup standards apply to contaminated soil.

12.2.9 Community Acceptance

Comments received during the public comment period indicate that the public accepted the Proposed Plan.

12.3 SITE 10, PESTICIDE STORAGE QUONSET HUTS

Dieldrin was reported in soil samples from this site at levels slightly above ARARs. TPH was detected in groundwater at concentrations that exceeded ARARs. Both soil and groundwater were evaluated for remedial action alternatives.

Only the no-action alternative was evaluated for the soil because although contaminants were detected in subsurface soil, the area is covered with asphalt. Furthermore, no unacceptable cancer or noncancer risks were found in the soil.

The groundwater alternatives include the following:

Alternative 1	No action with monitoring (which includes sampling and groundwater use restrictions)
Alternative 2	Extraction, treatment, and reinjection into the aquifer

12.3.1 Overall Protection of Human Health and the Environment

Soil Alternative 1 would protect human health and the environment through long-term maintenance of the existing asphalt. There would be no other limitations on site usage.

Groundwater Alternative 1 would involve sampling the groundwater twice to confirm the presence of TPH and, if necessary, placing groundwater use restrictions in the base master plan to prevent use of site groundwater. This would prevent exposure to COCs on site.

Groundwater Alternative 2 would protect human health and the environment through extraction, treatment, and reinjection of the groundwater into the aquifer. Ingestion of the affected groundwater would be prevented by institutional controls in the short term and by shallow aquifer cleanup in the long term. The groundwater extraction system would be designed to lessen further migration of the groundwater contamination. Existing and future groundwater wells would be routinely monitored.

12.3.2 Compliance With ARARs

Soil Alternative 1 would comply with chemical-specific ARARs through maintenance of the existing asphalt pavement. Furthermore, it is expected that dieldrin would degrade to lower levels as a result of natural degradation.

Groundwater Alternative 1 would not provide any direct action to reduce the COC concentrations to chemical-specific ARARs. It would restrict the use of groundwater to nondrinking water uses and prevent exposure to groundwater contamination.

Groundwater Alternative 2 would require at least a few years of continuous operation to attain groundwater ARAR levels. In the interim, institutional controls would be used to prevent domestic use of site groundwater. The drinking water ARARs would continue to be exceeded during construction and part of the implementation of the remedy. However, ARAR compliance would eventually be achieved.

12.3.3 Long-Term Effectiveness and Permanence

Soil Alternative 1 would reduce the existing risk to human health, safety, public welfare, and the environment.

Groundwater Alternative 1 would effectively protect human health and the environment in the long term through groundwater use restrictions. TPH in the groundwater would slowly abate through natural degradation.

Groundwater Alternative 2 would be effective in the long term. The groundwater pump-and-treat system would permanently clean up the petroleum contamination and reduce risks to acceptable levels. The principal elements of this remedial alternative would be extraction wells, reinjection wells, and water treatment, storage, and transport facilities. All of these elements are reliable, proven technologies.

12.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Soil Alternative 1 would continue to restrict the mobility of existing contaminants through the maintenance of the existing asphalt.

Groundwater Alternative 1 would not reduce the toxicity, mobility, or volume of the existing contaminated material.

Groundwater Alternative 2 would reduce the toxicity, mobility, and volume of COCs in groundwater by treatment. The extraction system would prevent migration of contamination, thus reducing contaminant mobility until treatment to performance criteria is complete.

12.3.5 Short-Term Effectiveness

Soil Alternative 1 would be effective in the short term through maintenance of the asphalt cover.

Groundwater Alternative 1 would be effective in the short term through base groundwater use restriction.

Groundwater Alternative 2 would require the design of an extraction, treatment, and reinjection system. Several years of system operation would be required to achieve the cleanup goals. Groundwater use restrictions would be implemented immediately to prevent human exposure to petroleum in groundwater. Proper use of personal protective equipment for site workers, as defined in the site health and safety plan, would provide sufficient protection from exposure.

12.3.6 Implementability

Soil Alternative 1, which would involve maintenance of the asphalt, is readily implementable.

Groundwater Alternative 1 is easily implementable.

Groundwater Alternative 2 would use standard and accepted technologies that are easily implemented.

12.3.7 Cost

Soil Alternative 1 would include no capital costs. Annual operating and maintenance costs are estimated at $7,000. The present-worth cost would be approximately $108,000.

Groundwater Alternative 1 would involve no capital costs. Annual operating and maintenance costs of $8,600 would include monitoring, annual reports to federal and state agencies, and the 5-year public health evaluation. The two rounds of confirmational sampling would confirm whether TPH is present. The present-worth cost would be approximately $132,000.

Groundwater Alternative 2 would require an estimated capital cost of $560,000, and the estimated annual operating and maintenance cost would be $313,000. The present-worth cost for this alternative would be $5,371,000 for a 10-year project life. These costs are highly uncertain given the lack of information concerning the source and extent of the TPH in groundwater. The TPH may originate off site.

12.3.8 State Acceptance

Ecology concurs with the selected remedial action at Site 10 and has been involved in the development and review of the RI, feasibility study, Proposed Plan, and ROD. Comments from Ecology have resulted in substantive changes in these documents, and the agency has been integrally involved in determining which cleanup standards apply to environmental media.

12.3.9 Community Acceptance

Comments received during the public comment period indicate that the public accepted the Proposed Plan.

12.4 SITE 26, HOOD CANAL SEDIMENTS

No human health COCs in the Hood Canal sediments or clam tissues were found at any of the eight areas in Site 26. Arsenic was not considered a COC because 95 percent is in a nontoxic form. Some ecological COCs (PAHs, pesticides, mercury, bis(2-ethylhexyl)phthalate, and dibenzofuran) were found at Marginal Wharf, Keyport/Bangor Dock, and Service Pier. Comparison to the ecological SMS showed the marine sediments at Marginal Wharf were a "cluster of potential concern." All other areas were "clusters of low concern."

Only the no-action alternative was evaluated for Site 26. This alternative includes sediment and clam tissue monitoring and reporting. As discussed in Section 11.4, clam tissue would be monitored at Floral Point Beach.

12.4.1 Overall Protection of Human Health and the Environment

Alternative 1 should protect human health and the environment sufficiently in the long term. No human health risk was identified for sediments or clam tissues.

Minor risk to the environment was found in marine sediments at Marginal Wharf, Keyport/Bangor Dock, and Service Pier. Sediment monitoring would identify trends in contaminant levels. If contamination is increasing in concentration and/or areal extent, the need for additional source control activities, additional sediment sampling, and implementation of engineered sediment controls would be assessed.

12.4.2 Compliance With ARARs

Alternative 1 complies with Ecology's SMS. All marine sediment areas, except Marginal Wharf, are considered "clusters of low concern." The Marginal Wharf area is considered a "cluster of potential concern." Active cleanup is not recommended.

12.4.3 Long-Term Effectiveness and Permanence

The continued use of a source control program for all pier activities at Marginal Wharf, Keyport/Bangor Dock, and Service Pier would prevent sediment concentrations to rise above risk-based levels in the future.

12.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternative 1 would not reduce the toxicity, mobility, and volume of the existing contaminated sediments through treatment.

12.4.5 Short-Term Effectiveness

The sediment monitoring would be effective in the short term.

12.4.6 Implementability

Monitoring is easily implemented without interfering with current activities.

12.4.7 Cost

The estimated operation and maintenance costs for Alternative 1 would be $100,000 based on two 2-year monitoring cycles for Floral Point Beach, Marginal Wharf, Keyport/Bangor Dock, and Service Pier marine areas. This cost estimate would include time for field preparation, field sampling, interpretation, and reporting and all analytical costs (chemical and biological). The present-worth cost of this alternative would be $100,000 (based on a 5-year project life).

12.4.8 State Acceptance

Ecology concurs with the selected remedial alternative at Site 26 and has been involved in the development and review of the RI, feasibility study, Proposed Plan, and ROD. Comments from Ecology have resulted in substantive changes in these documents, and the agency has been integrally involved in determining which cleanup standards apply to environmental media.

12.4.9 Community Acceptance

Comments received during the public comment period indicate that the public accepted the Proposed Plan.

12.5 SITE E, ACID DISPOSAL PIT; SITE 11, PESTICIDE/HERBICIDE DRUM DISPOSAL AREA

Marginal and conditional human health risk from Sites E and 11 was identified based on the presence of the pesticide DDT in stockpiled soil, and arsenic and ordnance compounds in groundwater. No risks were shown to be present in the site soil. Since the development of the groundwater alternatives, the groundwater contamination at Sites E and 11 has been found to be within the zone of influence of the pump-and-treat remediation at OU 2 (Site F). Site F is hydrogeologically upgradient of Sites E and 11. The following alternatives were evaluated for both the stockpiled soil and groundwater:

Stockpiled Soil

Alternative 1	No action
Alternative 2	Off-site transport and disposal
Alternative 3	On-site incineration
Alternative 4	Off-site incineration

Groundwater

Alternative 1	No action with monitoring (monitoring in conjunction with ongoing OU 2 remediation)
Alternative 2	Monitoring/institutional controls (monitoring, groundwater use restrictions)
Alternative 3	Extraction, treatment, and reinjection into aquifer
Alternative 4	Extraction, treatment, and disposal into recharge basin

12.5.1 Overall Protection of Human Health and the Environment

Stockpiled Soil

Alternative 1 would not protect human health and the environment over time. The containment cell soil contains DDT, which poses a risk and would not be remediated under this alternative. Concentrations of DDT in the containment cell soil would decrease very slowly through natural attenuation. However, leaving excavated soil in a containment cell may not be protective of human health and the environment in the long term due to wind and wear of the plastic cover. Consequently, Alternative 1 does not meet this threshold criterion.

Alternative 2 would protect human health and the environment at the site by permanently removing the contaminated soil from the containment cell. Short-term risks to workers can be mitigated through the use of proper health and safety measures during removal activities.

Alternative 3 would use a mobile incinerator to SUBASE, Bangor. The on-site incinerator would be RCRA approved and equipped with air pollution control and monitoring equipment necessary to meet RCRA requirements. Because the organic contamination would be destroyed through incineration, Alternative 3 would offer significant long-term protection.

Alternative 4 would transport the contaminated soil to an off-site incinerator for destruction of the pesticides. This action would provide long-term protection of human health and the environment.

Groundwater

Alternative 1, no action, would protect human health and the environment if implemented in conjunction with the associated remedial action at OU 2.

Alternative 2, monitoring and groundwater use restrictions, would be protective of human health and the environment in the long term.

Alternative 3 would protect human health and the environment through extraction, treatment, and reinjection of the groundwater. Ingestion of the affected groundwater by the public would be prevented by institutional controls in the short term and by shallow aquifer cleanup in the long term.

Alternative 4 would protect human health and the environment through extraction, treatment, and disposal of groundwater into a recharge basin.

12.5.2 Compliance With ARARs

Stockpiled Soil

Alternative 1 would not comply with ARARs. Currently, MTCA Method B requirements are exceeded for DDT in the containment cell soil.

Alternative 2 would achieve compliance with ARARs by removing the stockpiled soil from the site. Transportation and disposal of the stockpiled soil would be conducted in compliance of all state and federal regulations.

Alternatives 3 and 4 would be designed and implemented to comply with all state and federal ARARs.

Groundwater

Alternative 1 in and of itself would not comply with ARARs but would if implemented in conjunction with the selected remedial action of OU 2.

Alternatives 2, 3, and 4 would comply with ARARs.

12.5.3 Long-Term Effectiveness and Permanence

Stockpiled Soil

Alternative 1 would not abate the existing risk to human health, safety, public welfare, and the environment from the COCs. Human or environmental exposures to the stockpiled soil are possible over the long term.

Alternative 2 would provide a permanent reduction in the site risks through transport of the soil in the containment cell to an off-site disposal facility.

Alternatives 3 and 4 would destroy the contaminants and would be highly effective in long-term protection against risk from pesticides and other organics. Following incineration, the residues would either be backfilled or landfilled.

Groundwater

By itself, Alternative 1 would not effectively provide long-term human health and environmental protection. However, implemented in conjunction with the selected action in OU 2, Alternative 1 would provide long-term protection.

Alternative 2 would protect human health and the environment in the long term. Groundwater use restrictions to prohibit the domestic use of shallow aquifer water would prevent risk to human health, and no environmental risks are associated with groundwater.

Alternatives 3 and 4 would be effective in the long term by permanently removing contamination from the groundwater.

12.5.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Stockpiled Soil

Alternative 1 would not reduce the toxicity, mobility, or volume of existing chemicals.

Alternative 2, off-site transportation and disposal of stockpiled soil, does not include treatment to reduce the toxicity, mobility, or volume of existing chemicals.

Alternatives 3 and 4 would reduce the toxicity and mobility of contaminants in the containment cell soil by treatment. The ash from the incinerator could be used as backfill or landfilled (after testing) in Alternative 3, or with Alternative 4, the soils could be landfilled directly following incineration.

Groundwater

Alternative 1 would not reduce the toxicity, mobility, or volume of hazardous substances present. However, the risk to human health would be eliminated by treatment under OU 2.

Alternative 2 would not reduce the toxicity, mobility, or volume of contamination in the groundwater.

Alternatives 3 and 4 would reduce toxicity, mobility, and volume of the chemicals of concern in groundwater by treatment.

12.5.5 Short-Term Effectiveness

Stockpiled Soil

Alternative 1 does not involve a remedial activity; therefore, this criterion is not applicable.

Alternative 2 would be effective in the short term. The alternative can be implemented quickly. Proper excavation techniques, compliance with transportation requirements, and use of personal protective equipment would prevent short-term adverse effects.

Alternatives 3 and 4 could be designed and constructed to protect human health and the environment in the short term. Personal protective equipment would be used to protect workers during implementation of these alternatives. Decontamination procedures would be employed to prevent the spread of contamination via vehicles, clothing, etc. Air pollution monitoring and control equipment would be used to prevent hazardous emissions resulting from the incineration process. Both alternatives could be implemented within 1 or 2 years.

Groundwater

Alternative 1 would not likely pose any additional health risks during implementation of the monitoring program with properly trained and protected personnel during sampling operations.

Alternative 2 would not likely pose additional health risks in implementing groundwater use restrictions or conducting the monitoring program.

Alternatives 3 and 4 would take several months for design and construction and 30 years of operation for the remedial action to be completed. Significant adverse health effects on site workers during construction would not be expected. Proper use of personal protective equipment for site workers would provide sufficient protection.

12.5.6 Implementability

Stockpiled Soil

Alternative 1, no action, would not involve the implementability criterion.

Alternative 2, off-site transport and disposal, could be easily implemented.

Alternatives 3 and 4, incineration, would be easily implemented. The incineration alternatives would meet anticipated performance criteria. Both types of incineration facilities are standard and well-proven technologies. Operation and maintenance functions would be performed under the incineration facility's regular operational activities. No difficulties are anticipated in obtaining the permits and approvals required to implement either incineration alternative. Implementability may be lower for on-site incineration than for off-site due to possible resistance by local residents to incineration technology. The equipment necessary to implement Alternatives 3 and 4 is readily available.

Groundwater

Alternative 1, groundwater monitoring using existing wells, would be easily implemented.

Alternative 2, monitoring/institutional controls, such as groundwater use restrictions, and continued groundwater monitoring, would be easily implemented.

Alternatives 3 and 4, extraction and treatment, use standard and accepted technologies. Adequate space exists to construct all of the anticipated facilities at Sites E and 11. Electric power and other utilities are also available.

12.5.7 Cost

Stockpiled Soil

Alternative 1 would have no costs associated with it.

Alternative 2 would have a one-time capital cost of $256,000. There would be no operation and maintenance costs associated with this alternative.

The estimated capital cost for Alternative 3 (on-site incineration) would be $1,200,000 and for Alternative 4 (off-site incineration), $1,169,000. No annual operation and maintenance costs would be expected for either alternative because the contamination would be completely destroyed and the clean residues would be either backfilled or landfilled.

Groundwater

Alternative 1 would have no capital costs. Operation and maintenance costs of approximately $93,000 per year would be expected for quarterly sampling and analysis, annual reports to the state, and for performing a public health evaluation every 5 years. Assuming a monitoring period of 5 years, the estimated present-worth cost would be $404,000.

For Alternative 2, capital costs of $28,000 would be primarily for installation of a fence. Operation and maintenance costs of approximately $94,000 per year would be for quarterly sampling and analysis, annual reports to the state, performing a public health evaluation every 5 years, and maintaining the fence. The public health evaluations would be performed every 5 years as long as hazardous substances remain on site. Assuming a monitoring period of 30 years, the estimated present-worth cost would be $1,434,000.

For Alternative 3, the estimated capital cost would be $606,000, and the estimated annual operation and maintenance costs would be $385,000. The present-worth cost would be $6,523,000, assuming a 30-year project life.

For Alternative 4, the estimated capital cost would be $494,000, and the estimated annual operation and maintenance costs would be $369,000. The present-worth cost would be $6,166,000, assuming a 30-year project life.

12.5.8 State Acceptance

Ecology concurs with the selected remedial action at Sites E and 11 and has been involved in the development and review of the RI, feasibility study, Proposed Plan, and ROD. Comments from Ecology have resulted in substantive changes in these documents, and the agency has been integrally involved in determining which cleanup standards apply to environmental media.

12.5.9 Community Acceptance

Comments received during the public comment period indicate that the public accepted the Proposed Plan.

13.0 THE SELECTED REMEDY

Based on consideration of CERCLA requirements, the detailed analysis of the alternatives using the nine EPA criteria, and the public comments received, the Navy, the EPA, and Ecology have selected the most appropriate remedies for the OU 7 action sites (Sites B, 2, and E and 11) and no-action-with-monitoring sites (Sites 10 and 26), at SUBASE, Bangor.

13.1 ACTION SITES

The Navy, the EPA, and Ecology have determined that the most appropriate remedies for Sites B, 2, and E and 11 are the following:

- Site B (Alternative 3—vegetative soil cover)
- Site 2 (Alternative 3—soil screening)

- Sites E and 11 soil (Alternative 2—off-site soil disposal)
- Sites E and 11 groundwater (Alternative 1—groundwater monitoring)

13.1.1 Site B, Floral Point

The vegetative soil cover, with incidental surface water control, best achieves the remedial action objectives established for Site B. The soil cover will prevent direct human or animal contact of contaminated soil and therefore is protective of human health and the environment. The proposed cover will be designed in conjunction with a site development plan to provide public access to the shoreline. The selected remedy includes the following components:

- Covering the site with a soil cover
- Vegetating the soil cover
- Constructing swales to control or reduce infiltration of rainwater
- Maintaining the soil cover to prevent future contact with the contaminated soil

The selected remedy for groundwater at Site B is a 5-year monitoring program of marine sediments and clam tissue, to be included under Site 26. The monitoring program will achieve the remedial action objective of determining whether the COCs detected in Site B groundwater are impacting the sediment and clam tissues on Floral Point Beach. The groundwater discharges into the marine environment off of Floral Point.

13.1.2 Site 2, Classification Yard/Fleet Deployment Parking

Screening metallic debris from the stockpiled soils and properly disposing of the screened soil best achieves the remedial action objective of preventing human contact with contaminated soil and is protective of human health and the environment. The selected remedy includes the following components:

- Screening of approximately 5,000 cubic yards of stockpiled soil for metallic debris (primarily steel banding, lead and steel bullets, and shell casings)

- Waste characterization of the collected metallic debris and screened soil

- Disposal of the metallic debris. Depending on the waste characterization results, the metallic debris will be disposed of at an approved landfill or transported to a metal reclamation facility.

- Disposal of the screened soil. Depending on the waste characterization results, the screened soil will be disposal of at an approved landfill or used as backfill material for the disturbed area at Site 2.

13.1.3 Site E, Acid Disposal Pit; Site 11, Pesticide/Herbicide Drum Disposal Area

The off-site disposal of the stockpiled soil at an approved landfill best achieves the remedial action objective of preventing direct human contact with contaminated soil and is protective of human health and the environment. The selected remedy involves transporting and disposing of approximately 400 cubic yards of contaminated stockpiled soil to a RCRA-approved landfill.

The groundwater at Sites E and 11 is currently being treated under OU 2. The selected remedy at Sites E and 11 will entail monitoring of groundwater for ordnance compounds and a 5-year evaluation of the effectiveness of OU 2 remediation in removing Otto fuel. A groundwater use restriction would be put in the base's master plan.

13.2 NO-ACTION-WITH-MONITORING SITES

The Navy, the EPA, and Ecology have determined that the most appropriate remedies for Sites 10 and 26 are the following:

- Site 10 soils (Alternative 1—no action)
- Site 10 groundwater (Alternative 1—no action)
- Site 26 sediments (Alternative 1—no action)

13.2.1 Site 10, Pesticide Storage Quonset Huts

Because the cancer and noncancer risks for future residents from chemicals in soil at Site 10 were found to be acceptable based on EPA criteria and the site is covered with an asphalt pavement, only the no-action alternative was considered. Included under this alternative is long-term maintenance of the existing asphalt pavement to protect human health and the environment.

The combination of long-term groundwater monitoring and implementation of institutional controls through groundwater use limitations best achieves the remedial action objective of preventing ingestion of groundwater containing TPH and is protective of human health and the environment. The selected groundwater remedy includes the following components:

- Conducting confirmatory groundwater sampling
- Establishing restrictions to prevent groundwater use

In the event that the presence of TPH in the groundwater is confirmed, the site would be investigated further.

13.2.2 Site 26, Hood Canal Sediments

Based on the information currently available, the marine sediments at Marginal Wharf, Keyport/Bangor Dock, and Service Pier pose a minor risk to the environment. The risks associated with human ingestion of the sediment and dermal contact with it were determined to be acceptable based on EPA criteria. Therefore, only one alternative (no action) is proposed for Site 26.

Under this alternative, a monitoring program conducted over a 5-year period will include at least two monitoring cycles for sampling of sediment and marine biota. Sampling will take place at Marginal Wharf, Keyport/Bangor Dock, and Service Pier. In addition, sediment and clam tissue samples will be collected from the vicinity of Floral Point Beach to confirm that chemicals in the groundwater from Floral Point (Site B) are not affecting the marine environment. The monitoring program will identify trends in contaminant levels. If contamination is increasing in concentration and/or areal extent, the need for additional source control activities, additional sediment sampling, and implementation of engineered sediment controls will be assessed.

14.0 STATUTORY DETERMINATION

Under CERCLA, Section 121, the selected remedies must be protective of human health and the environment, comply with ARARs, be cost-effective, and use 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 treatments that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes as their principal element. The following sections discuss how the selected remedies for Sites B, 2, 10, 26, and E and 11 meet these statutory requirements.

14.1 SITE B, FLORAL POINT

The selected remedial alternative for soil at Site B is Alternative 3. Alternative 3 will provide a vegetative (planted with grass) soil cover to prevent direct contact between contaminated soil and site visitors. The selected remedial alternative for groundwater at Site B is a 5-year monitoring program of marine sediment and clam tissue, as outlined for Site 26.

14.1.1 Protection of Human Health and the Environment

Alternative 3 for soil will protect human health and the environment by containing the contaminated soil with a cover. The cover will prevent direct contact with soil, contamination of surface water runoff, and airborne transport of soil particles and will reduce surface water percolation through the contaminated soil. Also, swales will be constructed to reduce infiltration of rainwater. Long-term maintenance of the cover and swales will be necessary for the alternative to remain protective.

The no-action alternative for groundwater, in conjunction with the Site 26 marine monitoring program, will confirm that the marine environment is not being impacted by groundwater from Floral Point. Other alternatives to protect human health were not considered because of the saltwater intrusion into groundwater of Floral Point.

14.1.2 Compliance With ARARs

The selected remedy of a vegetative cap and monitoring of marine sediments to assess any effects of residual chemicals in groundwater will comply with all state and federal ARARs. Action-specific, chemical-specific, and location-specific ARARs are presented below, along with TBC policies, guidance, and regulations that have been developed to implement ARARs.

Action-, Chemical-, and Location-Specific ARARs

- **Washington Clean Air Act** (Chapter 70.94 RCW, WAC 173-400, 403, 460; also 40 CFR 60). These requirements are applicable to sources of fugitive dust that are generated during the remediation efforts and that must be controlled to avoid nuisance conditions.

- **State Minimum Standards for the Construction and Maintenance of Wells** (WAC 173-160-415). These regulations are applicable to decommissioning of water and resource protection wells.

- **Puget Sound Air Pollution Control Agency (PSAPCA) Regulation 1, Section 9.15**. These regulations require the use of best available control technology to control fugitive dust emissions.

- **Endangered Species Act of 1973** (16 USC 1531 *et seq.;* 50 CFR 402); **Fish and Wildlife Coordination Act** (16 USC 661 *et seq.*). Although no known threatened or endangered species have been observed at this site, eagles have been observed at SUBASE, Bangor. The bald eagle (*Haliaeetus leucocephalus*) is protected by the Endangered Species Act of 1973 and the Fish and Wildlife Coordination Act. Any action that would affect the critical habitat of the bald eagle would be subject to these ARARs.

- **State of Washington Hazardous Waste Cleanup—Model Toxics Control Act** (MTCA; WAC 173-340). These regulations establish procedures for selection of cleanup actions, remediation, and monitoring of sites contaminated with hazardous waste, and are applicable to setting cleanup standards for soil.

- **Clean Water Act—Water Quality Standards** (CWA Section 303; also 40 CFR 131). State criteria for some pollutants are required to enforce federal water quality criteria. These water quality regulations are applicable to surface water, as well as groundwater discharge to surface water for the protection of public health, fish, shellfish, and wildlife.

- **State of Washington Water Quality Standards for Surface Waters** (WAC 173-201A). State water quality standards are applicable for the protection of aquatic life in fresh and marine surface waters. These state standards enforce the requirements of the Clean Water Act and are applicable to the groundwater discharged to surface water.

TBC Guidance

Two Ecology documents—*Statistical Guidance for Ecology Site Managers* and *Guidance on Sampling and Data Analysis Methods*—are identified as TBCs in implementing the requirements of MTCA. In addition, Section 304 of the Clean Water Act requires the EPA to publish and periodically update ambient water quality criteria. These criteria are not rules and do not have regulatory impact, but are considered TBC guidelines for marine water based on acute and chronic effects of chemicals on marine organisms. These criteria are presented in *Quality Criteria for Water* (U.S. EPA 1986b) and *Water Quality Criteria Summary* (U.S. EPA 1991).

14.1.3 Cost-Effectiveness

The estimated present-worth cost for the soils remedy (Alternative 3) is $829,000. Alternative 4A, which provides a somewhat higher degree of permanence, and Alternative 4B, which includes treatment, cost more than 10 times as much as the selected remedy. The selected remedy provides an overall effectiveness proportional to costs and represents a reasonable value for the money that will be spent.

The selected remedial alternative for groundwater is being conducted in conjunction with the Site 26 remedy and is cost-effective.

14.1.4 Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable

The selected remedies for soil and groundwater represent the best balance of tradeoffs among the alternatives evaluated. They provide a high degree of permanence, do not negatively affect human health or the environment during remediation, can be completed in a short time, and are cost-effective. Treatment was found to be not practicable at Site B because treatment of very large volumes of low-level contamination in soil and groundwater would involve costs and short-term risks that are disproportionate to the incremental degree of risk reduction. The selected remedies meet the statutory requirement to use permanent solutions and treatment technologies to the maximum extent practicable.

14.1.5 Preference for Treatment as Principal Element

The selected remedies do not satisfy the preference for treatment to address the potential risks posed by soil and groundwater. As explained above, treatment was found to be not practicable at Site B.

14.2 SITE 2, CLASSIFICATION YARD/FLEET DEPLOYMENT PARKING

The selected alternative for the stockpiled soil at Site 2 is Alternative 3. Alternative 3 will screen metallic debris—primarily metal banding, steel and lead bullets, and bullet shells—from the stockpiled soil. The metallic debris will be transported to a metal reclamation facility or disposed of off site at an approved landfill. The screened soil will be tested for PCBs. If total PCBs are detected below the remedial action goals listed in Table 17, the soil will be used as backfill. If the screened soil contains chemicals above the remedial action goals, the residuals will be characterized (including comparisons to dangerous waste thresholds under state law) and disposed of properly.

14.2.1 Protection of Human Health and the Environment

Alternative 3 will result in long-term reduction of risk associated with lead debris. Short-term risk to workers will be mitigated through adequate health and safety measures during screening and removal activities.

14.2.2 Compliance With ARARs

Alternative 3 will comply with all state and federal ARARs. If chemicals in the soil exceed ARARs, the soil will not be used as backfill, but will be disposed of in a manner consistent with state and federal regulations.

Action-, Chemical-, and Location-Specific ARARs

- **Washington State Dangerous Waste Regulations** (WAC 173-303); **Resource Conservation and Recovery Act** (RCRA) **Regulations** (40 CFR 261, 262, 263, 264, 265, 266, and 268). These regulations establish the procedures for the designation of waste as hazardous or dangerous. They are applicable to the stockpiled soil for characterizing solid wastes generated during cleanup activities and determining handling and disposal requirements for wastes that may contain hazardous substances.

- **Transportation of Hazardous Materials** (WAC 446-50). Protects persons and property from unreasonable risk of harm or damage due to incidents or accidents resulting from the transport of hazardous materials and hazardous wastes. This regulation is applicable if solid waste generated during cleanup is determined to be dangerous or hazardous and is transported off site.

- **State Minimum Standards for the Construction and Maintenance of Wells** (WAC 173-160-415). These regulations are applicable to the decommissioning of monitoring wells.

- **PSAPCA Regulation 1, Section 9.15.** Requires the use of best available control technology to control fugitive dust emissions.

- **Endangered Species Act of 1973** (16 USC 1531 *et seq.;* 50 CFR 402); **Fish and Wildlife Coordination Act** (16 USC 661 *et seq.*). Although no known threatened or endangered species have been observed at this site, eagles have been observed at SUBASE, Bangor. The bald eagle (*Haliaeetus leucocephalus*) is protected by the Endangered Species Act of 1973 and the Fish and Wildlife Coordination Act. Any action that would affect the critical habitat of the bald eagle would be subject to these ARARs.

- **Toxic Substance Control Act** (40 CFR 761). Requires that PCBs at concentrations exceeding 50 mg/kg be destroyed by incineration or be disposed in a hazardous waste disposal facility.

- **State of Washington Hazardous Waste Cleanup—Model Toxics Control Act** (MTCA; WAC 173-340). Establishes procedures for selection of cleanup actions, remediation, and monitoring of sites contaminated with hazardous waste. This regulation is applicable to setting cleanup standards for soil.

TBC Guidance

Two Ecology documents—*Statistical Guidance for Ecology Site Managers* and *Guidance on Sampling and Data Analysis Methods*—are identified as TBCs in implementing the requirements of MTCA.

14.2.3 Cost-Effectiveness

The estimated present-worth cost of Alternative 3 is $399,000. Alternative 2, which does not provide treatment or resource recovery technologies, would cost more than the selected remedy due to long-term maintenance of the untreated waste. The selected remedy provides an overall effectiveness proportioned to costs and represents a reasonable value for the money that will be spent.

14.2.4 Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable

The selected remedy represents the best balance of tradeoffs among the alternatives evaluated. It provides a high degree of permanence, uses treatment to the maximum extent practical, will not negatively affect human health or the environment during remediation, can be completed in a short time, and is cost-effective. The selected remedy meets the statutory requirement to use permanent solutions and treatment technologies to the maximum extent practicable.

14.2.5 Preference for Treatment as Principal Element

The selected remedy satisfies the preference for treatment by sending waste metallic debris that could be classified as hazardous waste to a reclamation facility for beneficial reuse.

14.3 SITE 10, PESTICIDE STORAGE QUONSET HUTS

The selected remedial alternative for groundwater at Site 10 is Alternative 1, no action, which includes long-term groundwater monitoring and limitations on groundwater use. The no-action alternative was also the selected alternative for Site 10 soil.

14.3.1 Protection of Human Health and the Environment

Soil Alternative 1 will protect human health and the environment through a long-term maintenance program for the existing asphalt, thereby preventing human or environmental exposure to chemicals in soil.

Groundwater Alternative 1 will protect human health and the environment through groundwater use restriction.

14.3.2 Compliance With ARARs

The selected remedy for soil will comply with state and federal ARARs through maintenance of the existing asphalt pavement.

The selected remedy for groundwater will not provide any direct action to reduce the concentrations of chemicals of concern to chemical-specific ARARs. It will restrict the use of groundwater to nondrinking water uses and prevent exposure to groundwater contamination.

Action-, Chemical, Location-Specific ARARs

- **State Minimum Standards for the Construction and Maintenance of Wells** (WAC 173-160). These regulations are applicable to the construction, testing, and decommissioning of resource protection wells.

- **Endangered Species Act of 1973** (16 USC 1531 *et seq.;* 50 CFR 402); **Fish and Wildlife Coordination Act** (16 USC 661 *et seq.*). Although no known threatened or endangered species have been observed at this site, eagles have been observed at SUBASE, Bangor. The bald eagle (*Haliaeetus leucocephalus*) is protected by the Endangered Species Act of 1973 and the Fish and Wildlife Coordination Act. Any action that would affect the critical habitat of the bald eagle would be subject to these ARARs.

- **Safe Drinking Water Act and National Primary Drinking Water Regulations** maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs) (40 CFR 141; 57 FR 31776); **National Secondary Drinking Water Regulations** secondary MCLs (40 CFR 143). The Safe Drinking Water Act establishes maximum contaminant levels and maximum contaminant level goals. The MCL is the maximum permissible level of a contaminant in water that is delivered to any user of a public water system, and is an enforceable regulation. The MCLG is the maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on human health would occur and that allows an adequate margin of safety. The MCLGs are nonenforceable health goals. The secondary MCLs are nonenforceable limits that are intended as guidelines.

- **State Board of Health Drinking Water Regulations** (WAC 246-290). Establishes maximum contaminant levels as standards for public drinking water systems, similar to federal MCLs.

- **State of Washington Hazardous Waste Cleanup—Model Toxics Control Act** (MTCA; WAC 173-340). MTCA establishes procedures for selection of cleanup actions, remediation, and monitoring of sites contaminated with hazardous waste. This regulation is applicable to setting cleanup standards for groundwater and soil.

TBC Guidance

Two Ecology documents—*Statistical Guidance for Ecology Site Managers* and *Guidance on Sampling and Data Analysis Methods*—are identified as TBCs in implementing the requirements of MTCA.

14.3.3 Cost-Effectiveness

The estimated present-worth costs for the selected remedies for soil and groundwater are $108,000 and $132,000, respectively. These costs are for long-term maintenance, monitoring, and reporting. Groundwater Alternative 2, which includes treatment, would cost approximately 40 times as much as the selected remedy. The selected remedy provides an overall effectiveness proportional to costs and represents a reasonable value for the money that will be spent.

14.3.4 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, will not negatively affect human health or the environment during remediation, can be completed in a short time, and are cost-effective. Treatment was found to be not practicable at Site 10 because basing the decision for treatment on a single sample was considered too costly for the incremental degree of risk reduction. The selected remedies meet the statutory requirement to use permanent solutions and treatment to the maximum extent practicable.

14.3.5 Preference for Treatment as Principal Element

The selected remedies do not satisfy the preference for treatment to address the potential risks posed by soil and groundwater. As explained above, treatment was found to be not practicable at Site 10.

14.4 SITE 26, HOOD CANAL SEDIMENTS

Alternative 1, the no-action alternative with sediment and clam tissue monitoring, was selected for Site 26.

14.4.1 Protection of Human Health and the Environment

Alternative 1 is protective of human health and the environment; the risks associated with the clams and sediments are within acceptable limits using EPA guidelines. The 5-year monitoring program will be used to confirm that source control activities are effective in reducing contamination on site. The monitoring program will also confirm that the groundwater from Floral Point is not affecting the Floral Point Beach sediments or clam tissue.

14.4.2 Compliance With ARARs

Alternative 1 will comply with Ecology's SMS for all chemicals. Currently there are exceedances of Ecology's SQS and CSL for several chemicals at Marginal Wharf, Keyport/Bangor Dock, and Service Pier. However, when the top three exceedances at these areas are averaged, only bis(2-ethylhexyl)phthalate exceeds the CSL at Marginal Wharf. Therefore, the Marginal Wharf area is considered a "cluster of potential concern." All other areas are considered "clusters of low concern."

Action-, Chemical-, Location-Specific ARARs

- **Endangered Species Act of 1973** (16 USC 1531 *et seq.*; 50 CFR 402); **Fish and Wildlife Coordination Act** (16 USC 661 *et seq.*). Although no known threatened or endangered species have been observed at this site, eagles have been observed at SUBASE, Bangor. The bald eagle (*Haliaeetus leucocephalus*) is protected by the Endangered Species Act of 1973 and the Fish and Wildlife Coordination Act. Any action that would affect the critical habitat of the bald eagle is subject to these ARARs.

- **Ambient Water Quality Criteria** (CWA Section 304; *Quality Criteria for Water,* U.S. EPA 1986b). Water quality criteria are enforceable standards for protection of human health and aquatic life for surface waters and sediments.

- **Water Quality Standards** (CWA Section 303; 40 CFR 131; WAC 173-201A). State criteria for some pollutants and required to enforce federal water quality criteria. Establishes use classification and water quality standards for surface waters for the protection of public health, fish, shellfish, and wildlife.

- **State of Washington Water Quality Standards for Surface Waters** (WAC 173-201A). State water quality standards are applicable for the protection of aquatic life in fresh and marine surface waters. These state standards enforce the requirements of the Clean Water Act.

- **Sediment Management Standards** (WAC 173-204). Establishes standards for the quality of surface sediments, addresses the application of these standards as the basis for the management and reduction of pollution discharges, and provides a management and decision process for the cleanup of contaminated sediments.

TBC Guidance

Two Ecology documents—*Statistical Guidance for Ecology Site Managers* and *Guidance on Sampling and Data Analysis Methods*—are identified as TBCs in implementing the requirements of MTCA. In addition, **Marine Water Quality Criteria** (CWA Section 304; *Water Quality Criteria Summary,* U.S. EPA 1991) are TBC guidelines for marine sediments and impacts on marine water based on acute and chronic effects of chemicals on marine organisms.

14.4.3 Cost-Effectiveness

The estimated present-worth cost for Alternative 1 is $100,000, based on two 2-year monitoring cycles for Floral Point Beach, Marginal Wharf, Keyport/Bangor Dock, and Service Pier marine areas. This cost estimate includes sampling, analysis, and reporting. The selected remedy provides an overall effectiveness proportional to costs and represents a reasonable value for the money that will be spent.

14.4.4 Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable

Treatment was not considered at Site 26 because existing risks are below cleanup levels and costs for treatment and potential short-term risks would be disproportionate to any risk reduction.

14.4.5 Preference for Treatment as Principal Element

Based on the information currently available, all marine sediment areas of Site 26 are considered to be "clusters of low concern." Therefore, as explained above, treatment was not considered.

14.5 SITE E, ACID DISPOSAL PIT; SITE 11, PESTICIDE/HERBICIDE DRUM DISPOSAL AREA

The selected remedial alternative for the stockpiled soil is Alternative 2. Alternative 2 will transport stockpiled soil off site and dispose of it at a RCRA Subtitle C landfill.

The selected remedial alternative for groundwater at Sites E and 11 is Alternative 1, no action with monitoring, which includes monitoring the existing groundwater wells and placing restrictions on groundwater use. The groundwater remediation being conducted at OU 2 addresses the chemicals found in Sites E and 11 groundwater.

14.5.1 Protection of Human Health and the Environment

Alternative 2 for the stockpiled soil will result in protection of human health and the environment by permanently removing the contaminated soil previously excavated from the site. Short-term risks to workers will be mitigated through the use of proper health and safety measures during removal activities.

Alternative 1 for the groundwater monitoring, in conjunction with the groundwater pump-and-treat alternative selected for OU 2, will protect human health and the environment through treatment of the groundwater.

14.5.2 Compliance With ARARs

Alternative 2 for the stockpiled soil and Alternative 1 for groundwater will comply with all state and federal ARARs.

Action-, Chemical-, Location-Specific ARARs

- **Washington State Dangerous Waste Regulations** (WAC 173-303); **Resource Conservation and Recovery Act (RCRA) Regulations** (40 CFR 261, 262, 263, 264, 265, and 268). These regulations establish the procedures for the designation of waste as hazardous or dangerous. They are applicable to the stockpiled soil for characterizing solid wastes generated during cleanup activities and determining handling and disposal requirements for wastes that may contain dangerous or hazardous substances.

- **Transportation of Hazardous Materials** (WAC 446-50). Protects persons and property from unreasonable risk of harm or damage due to incidents or accidents resulting from the transport of hazardous materials and hazardous wastes. This regulation is applicable if solid waste generated during cleanup is determined to be dangerous or hazardous and is transported off site.

- **State Minimum Standards for the Construction and Maintenance of Wells** (WAC 173-160). These regulations are applicable to the construction, testing, and decommissioning of resource protection wells and must be met during remediation and monitoring.

- **PSAPCA Regulation 1, Section 9.15**. Requires the use of best available control technology to control fugitive dust emissions.

- **Endangered Species Act of 1973** (16 USC 1531 *et seq.;* 50 CFR 402); **Fish and Wildlife Coordination Act** (16 USC 661 *et seq.*). Although no known threatened or endangered species have been observed at this site, eagles have been observed at SUBASE, Bangor. The bald eagle (*Haliaeetus leucocephalus*) is protected by the Endangered Species Act of 1973 and the Fish and Wildlife Coordination Act. Any action that would affect the critical habitat of the bald eagle is subject to these ARARs.

- **Safe Drinking Water Act** and **National Primary Drinking Water Regulations** maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs) (40 CFR 141; 57 FR 31776); **National Secondary Drinking Water Regulations** secondary MCLs (40 CFR 143). The Safe Drinking Water Act establishes maximum contaminant levels and maximum contaminant level goals. The MCL is the maximum permissible level of a contaminant in water that is delivered to any user of a public water system, and is an enforceable regulation. The MCLG is the maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on human health would occur and that allows an adequate margin of safety. The MCLGs are nonenforceable health goals. The secondary MCLs are nonenforceable limits that are intended as guidelines.

- **State Board of Health Drinking Water Regulations** (WAC 246-290). Establishes maximum contaminant levels as standards for public drinking water systems, similar to federal MCLs.

- **State of Washington Hazardous Waste Cleanup—Model Toxics Control Act** (MTCA; WAC 173-340). MTCA establishes procedures for selection of cleanup actions, remediation, and monitoring of sites contaminated with hazardous waste. This regulation is applicable to setting cleanup standards for soil and groundwater.

TBC Guidance

Two Washington State Department of Ecology documents—*Statistical Guidance for Ecology Site Managers* and *Guidance on Sampling and Data Analysis Methods*—are identified as TBCs in implementing the requirements of MTCA.

The EPA Off-Site Policy (50 FR 45933, Nov. 5, 1995, Procedure for Planning and Implementing Off-Site Response Actions) is a TBC for off-site disposal of wastes. It prohibits use of a RCRA facility for off-site management of Superfund hazardous substances if that facility has significant RCRA violations.

14.5.3 Cost-Effectiveness

Alternative 2 for the stockpiled soil has a one-time capital cost of $256,000. There are no operation and maintenance costs associated with this alternative.

Alternative 1 for groundwater, no action, has an estimated present-worth of $404,000 for monitoring and reporting, assuming a 5-year monitoring program. The present-worth cost will rise if longer term monitoring is required. The duration of monitoring is dependent on the progress of groundwater remediation at OU 2.

14.5.4 Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable

The selected remedies for the stockpiled soil and groundwater represent the best balance of tradeoffs among the alternatives evaluated. They will provide a high degree of permanence, will not negatively impact human health or the environment during remediation, can be completed in a short time, and are cost-effective. The selected remedies meet the statutory requirement to use permanent solutions and treatment technologies to the maximum extent practicable. Treatment of contaminated groundwater is being provided as part of the remedial action at OU 2.

14.5.5 Preference for Treatment as Principal Element

The selected remedy for the stockpiled soil does not satisfy the preference for treatment to address the risks posed by the soil. Treatment is not practicable for small volumes of stockpiled soil.

The selected remedy for groundwater satisfies the preference for treatment to address the risks posed by chemicals in groundwater. Treatment is being provided as part of the groundwater extraction-and-treatment system at OU 2.

15.0 EXPLANATION/DOCUMENTATION OF SIGNIFICANT CHANGES

No significant changes from the Proposed Plan (URS 1995) have occurred in preparing the ROD.

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APPENDIX A

RESPONSIVENESS SUMMARY

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RESPONSIVENESS SUMMARY

OVERVIEW

The responsiveness summary addresses public comments on the Proposed Plan for remedial action at Operable Unit (OU 7), Naval Submarine Base (SUBASE), Bangor. The public comment period on the Proposed Plan was held from April 13 to May 14, 1995. A public meeting was held on April 25, 1995, to present and explain the Proposed Plan and solicit public comments. The meeting was held at Breidablik Hall in Poulsbo, Washington, and all questions and comments received during the meeting were recorded for the record by a court reporter. Questions raised and answers given during the public meeting are summarized below.

RESPONSE TO COMMENTS ON THE PROPOSED PLAN FOR OU 7, SUBASE, BANGOR

Comment 1. Was there any medical waste found at Floral Point, Site B?

Response 1. *No medical waste was found during the site investigation activities at Floral Point.*

Comment 2. What will the monitoring frequency be at Sites 10 and 26 as the recommended alternatives for these sites?

Response 2. *Groundwater will be sampled for total petroleum hydrocarbons (TPH) at least once at Site 10 to confirm if there is an ongoing petroleum hydrocarbon problem. If the analyses indicate detections above regulatory concern, additional samples will be collected quarterly. If no detections above regulatory levels are found, no additional sampling will be conducted.*

Marine sediments will be sampled twice in a 5-year period to assess trends of sediment chemistry.