EPA/ROD/R10-94/098
1994

EPA Superfund
Record of Decision:

BANGOR NAVAL SUBMARINE BASE
EPA ID: WA5170027291
OU 06
SILVERDALE, WA
08/08/1994

Text:

DECLARATION OF THE RECORD OF DECISION

SITE NAME AND LOCATION

Naval Submarine Base, Bangor
Operable Unit 6
Silverdale, Washington

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected action for Operable Unit 6 (OU 6) a Base (SUBASE), Bangor in Silverdale, Washington, chosen in accordance with the C Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amen Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practicable Hazardous Substances Pollution Contingency Plan (NCP). OU 6 consists of Site D, disposal area. This decision is based on the administrative record for this sit

The lead agency for this decision is the United States Navy. The United States Agency (EPA) and the Washington State Department of Ecology (Ecology) have parti site investigations and in evaluating alternatives for remedial action. Tbe EPA selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from Site D, if not addres response action selected in this Record of Decision, may present an imminent and to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

The selected remedy at Site D will address the threat posed by treatment of ordn Soil containing ordnance compounds at concentrations greater than established cl excavated and treated by on-base composting, an innovative technology. Confirma to ensure that cleanup levels have been attained. Once cleanup levels are achie be returned to the excavation, and the area will be regraded and revegetated.

DECLARATION

The selected remedy is protective of human health and the environment, is in com state requirements that are legally applicable or relevant and appropriate to th effective. This remedy uses permanent on-site solutions and alternative treatme technologies to the maximum extent practicable, and satisfies the statutory pref employ treatment that reduces toxicity, mobility, or volume as a principal eleme

Signature sheet for the foregoing SUBASE, Bangor Operable Unit 6, Remedial Actio
between the United States Navy and the United States Environmental Protection Ag
by the Washington State Department of Ecology.

_____ _____

Captain Ernest R. Lockwood Date
SUBASE, Bangor Commanding officer
United States Navy

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Signature sheet for the foregoing SUBASE, Bangor Operable Unit 6, Remedial Actio
between the United States Navy and the United States Environmental Protection Ag
by the Washington State Department of Ecology.

_____ _____

Chuck Clarke Date
Regional Administrator, Region 10
United States Environmental Protection Agency

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Signature sheet for the foregoing SUBASE, Bangor Operable Unit 6, Remedial Actio
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by the Washington State Department of Ecology.

_____ _____

Carol Kraege, Acting Program Manager Date
Toxics Cleanup Program
Washington State Department of Ecology

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FIGURES

TABLES

ABBREVIATIONS AND ACRONYMS

ARAR	applicable or relevant and appropriate requirement
AWQC	Ambient Water Quality Criteria
CERCLA	Comprehensive Environmental Response, Compensation, and Liability A of 1980
COPC	chemical of potential concern
CSF	carcinogenic slope factor
DSW	surface water/sediment sampling locations
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
FFA	Federal Facility Agreement
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
MAIV	mechanically agitated in-vessel
MCL	maximum contaminant level
MCLG	maximum contaminant level goals
mg/kg	milligrams per kilogram
MTCA	Model Toxics Control Act (Washington State)
MW	monitoring well
N/A	not available
NAD	Naval Ammunition Depot

Navy	United States Navy
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NTS	Naval Torpedo Station
NWP	Nationwide Permit
OSHA	Occupational Health and Safety Administration
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
Qk	Kitsap Formation
Qva	Vashon Advance Outwash
Qvr	Vashon Recessional Outwash
Qvt	Vashon Till

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RAO	remedial action objective
RBSC	risk-based screening concentration
RCRA	Resource Conservation and Recovery Act
RDX	Royal Demolition Explosive (cyclonite or hexahydro-1,3,5-trinitro-1 triazine)
RfD	reference dose
RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act of 1986
SUBASE	submarine base
TBC	to be considered
TCLP	Toxicity Characteristics Leachate Procedure
TNT	2,4,6-trinitrotoluene
UCL	upper confidence limit
VOC	volatile organic compound
WISHA	Washington Industrial Safety and Health Administration
æg/kg	micrograms per kilogram
æg/kL	micrograms per liter

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DECISION SUMMARY

1.0 INTRODUCTION

It is the policy of the United States Navy (Navy) to address contamination at it installations, under the Defense Enironmental 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).

2.0 SITE NAME, LOCATION, AND DESCRIPTION

Naval Submarine Base (SUBASE), Bangor is situated on Hood Canal, in Kitsap Count Washington, approximately 10 miles north of Bremerton (Figure 1). Land surround SUBASE, Bangor is generally undeveloped, supporting limited residential uses. N activities began at Bangor on June 4, 1944, when the United States Naval Magazin Bangor was officially established as a Pacific shipment point for ordnance. Whe War lI ended, the Bangor Naval Complex became available for the storage of ordna

On July 22, 1987, Site A was listed on the United States Environmental Protectio Agency's (EPA) National Priorities List (NPL) of hazardous waste sites. On Augu 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) signed by the Navy, EPA, and the Washington State Department of Ecology (Ecology for study and cleanup of possible contamination on the SUBASE, Bangor property. Operable Unit 6 (OU 6) consists of Site D, 1 of the 19 sites that are included i SUBASE, Bangor FFA.

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3.0 SITE HISTORY

Site D is a former ordnance disposal area (Figure 2). The primary disposal prac consisted of burning and detonating ordnance on the site. Some material was als buried. Site D served as the principal area for burning and detonating ordnance SUBASE, Bangor from 1946 until 1963, when these activities were transferred to S The area was used sporadically for ordnance disposal until approximately 1965. disposal areas at Site D included a small arms incinerator, a burn trench, and s burn areas or mounds.

Based on historical aerial photos, the dimensions of the suspected burn trench a estimated to be 15 to 20 feet by 200 feet. The depth of the trench, although un suspected to be less than 10 feet because of the presence of groundwater in a pe aquifer. The trench was located during the remedial investigation (RI) using ge techniques.

Between 1944 and 1957, explosive D (ammonium picrate) sludge from the steam cleaning of projectiles at other areas was transferred to Site D for disposal (U 1983). This practice reportedly was most active for a 6-year period in the late early 1950s. Records fail to clarify whether this material was burned or buried

Previous site investigations, including personal interviews, indicated that phot bombs and ammonium nitrate blocks were detonated at Site D (Hart Crowser 1989). Other items that were burned or detonated may have included smokeless powder, bl powder, rocket propellant, white phosphorous shells, compound B (2,4,6-trinitrot [TNT] and Royal Demolition Explosive [RDX]), amatol (ammonia nitrate and 2,4,6-trinitrotoluene), and ordnance wastes containing 2,4,6-trinitrotoluene and RDX. Propulsion missile grains from approximately 600 obsolete rocket motors were rep destroyed in trenches on the site. The missile grains were ignited with smokele and, upon completion of burning, the trenches were soaked with water. In conjun with these activities, a small arms incinerator was in operation prior to 1964 (1983). The quantities of wastes deposited at Site D could not be determined fro available data (Hart Crowser 1989).

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4.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

The SUBASE, Bangor Community Relations Plan for the remedial activity on the bas available for review at the information repositories. Community relations activ established communication among citizens living near the site, the Navy, EPA, an Ecology. The actions taken to satisfy the requirements of the federal law (cite have also provided a forum for citizen involvement and input to the remedial act decision.

The specific requirements for public participation pursuant to CERCLA Section 113(k)(2)(b) and Section 117(a) as in 42 USC 9617(2), as amended by SARA, includ releasing the proposed plan for remedial action to the public. The proposed pla remedial action was placed in the administrative record and information reposito

The administrative record is on file in the following location:

Engineering Field Activity, Northwest
Naval Facility Command
1040 NE Hostmark Street
Olympic Place II
Poulsbo, Washington
(206) 396-5984

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
Bangor, Washington
(206) 779-9274
(Base access is required.)

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A fact sheet was issued in May 1992 that discussed the historical activities at the proposed investigation. The proposed plan for remedial action was issued in sheet format recommended by EPA guidance and was mailed to all known interested parties in January 1994. Notice of the availability of the proposed plan and no

public meeting on the proposed plan and public comment period were published in Sun (Bremerton) on January 9, 1994, and The Trident Tides on January 14, 1994. public comment period was held from January 9, 1994, to February 8, 1994. A pub meeting was held on January 27, 1994, at the Olympic View Community Club in Silverdale, Washington. A total of 27 people attended.

Two public comments were received by the Navy concerning the proposed plan for remedial action at OU 6. The comments, which were submitted at the public meeti are summarized in the Responsiveness Summmy (Attachment 1).

5.0 SCOPE AND ROLE OF OPERABLE UNITS

This Record of Decision (ROD) addresses all of OU 6. OU 6 consists of Site D, 1 the 19 sites that are listed in the SUBASE, Bangor FFA. The sites were organize seven operable units based on geographic location, suspected contamination, or o factors. A separate study is being conducted for each operable unit to determin appropriate cleanup actions. The baseline risk assessment in the remedial investigation/feasibility study (RI/FS) (URS 1993) indicated that the chemicals at Site D posed potential risks to human health and the environment.

Composting, the selected remedy at Site D, is a measure to minimize human health ecological risks associated with soil contamination. This action includes soil destroy soil contaminants. Surface water and groundwater will be monitored to e that conditions at the site after soil treatment are protective of human health environment.

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6.0 SUMMARY OF SITE CHARACTERISTICS

6.1 SURFACE WATER HYDROLOGY

Much of Site D is seasonally wet; the lower portion of the site contains standin during the wet season. Surface water becomes impounded in the topographically l area between the general slope of the site and the railroad grade and flows off ephemeral drainage. Groundwater seepage also occurs in this area along a broad seepage front where the perched aquifer, contained within the recessional outwas truncated. Surface water enters the site from two ephemeral drainages and one perennial stream and flows into the poorly drained, seasonally wet western porti site. Runoff ultimately drains into Devil's Hole Lake to the northwest.

6.2 SITE HYDROGEOLOGY

Four geologic units were identified during drilling at Site D. These units are Recessional Outwash, Vashon Till, Vashon Advance Outwash, and Kitsap Formation. The designation "Vashon" is used to distinguish those units deposited during the recent glacial advance. The Kitsap Formation was deposited during an interglaci period and is distinguished by its massive thickness of silt with high organic c

The aquifers identified in the study area of Site D during RI/FS activities are perched and the shallow aquifers. The aquitards identified in the study area ar Vashon Till, between the perched and shallow aquifers, and the Kitsap Formation, underlies the shallow aquifer.

The surficial geology and well locations at Site D are shown in Figure 3. Figur present geologic cross-sections of Site D.

6.2.1 Vashon Recessional Outwash

The Vashon Recessional Outwash (Qvr), the uppermost geologic unit at Site D, con a perched aquifer. This unit ranges in thickness from 0 feet to approximately 3 Site D and is deposited over the surface of the Vashon Till. The Vashon Recessi Outwash is typically a reddish-brown sandy gravel with varying amount of silt, c sand.

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Water levels measured within the perched aquifer were often at or near the groun surface. The aquifer flows in a west to northwesterly direction. Potentiometri for August 1992 (shown in Figure 6) are a typical representation of the perched groundwater characteristics. Groundwater gradients in the perched aquifer range about 0.04 ft/ft to 0.20 ft/ft. Seasonal variations of the perched aquifer wate individual wells ranged from less than 1 foot to almost 9 feet.

The perched aquifer at Site D is unconfined. The unit thins to the west portion site, creating a marshy area in the western portion of Site D. The measured hyd conductivity in the perched aquifer ranges from 1.4 x 10-4 cm/sec to 6.2 x 10-3 Grain size analysis indicated that the soil from the perched aquifer consists predominantly of a silty sand.

Using an average gradient and hydraulic conductivity within the perched aquifer Site D, an average groundwater velocity of about 1.46 feet per day was estimated yields in excess of 0.5 gallons per minute could be sustained for a short period However, because of the perched nature of the aquifer and proximity to the disch area, this aquifer could not be depended on to provide a reliable water supply a should not be considered a potential drinking water source. Long-term pumping c induce infiltration of surface water from the wetland into the aquifer.

6.2.2 Vashon Till

The Vashon Till (Qvt) is approximately 10 feet thick at Site D and extends to ne feet thick near the western portion of the area of study. The Qvt encountered a consists of a blue-gray, very dense, poorly sorted mixture of sand, gravel, silt Sand lenses are present within the Qvt but are thin and discontinuous. This uni to an orange-brown color near the surface.

The hydrologic characteristics of the Qvt vary considerably throughout SUBASE, B Permeabilities range from a low of 0.003 feet per day (1 x 10-6 cm/sec) to a hig 0.08 feet per day (3.0 x 10-5 cm/sec). The Qvt is designated as an aquitard. A the Qvt occurs primarily as a low-permeability unit impeding downward flow of wa

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6.2.3 Vashon Advance Outwash

The Vashon Advance Outwash (Qva) at Site D is a light gray, fine silty sand with This formation ranges in thickness from 10 to 60 feet at Site D. The Qva contai shallow aquifer at Site D.

Horizontal gradients ranged from 0.05 ft/ft to 0.18 ft/ft for the shallow aquife range in groundwater gradients is the result of both topographic changes across and seasonal variations during the observation period of October 1991 through Au 1992. Potentiometric contours for August 1992 are illustrated in Figure 7. Gro flows in a west to northwesterly direction.

Water levels in individual monitoring wells (MW) in the shallow aquifer varied f than 1 foot up to 7 feet from October 1991 to August 1992.

Vertical gradients calculated from seasonal water level measurements ranging fro 0.023 to 0.067 were calculated between MW-21 and MW-22, screened in the upper an lower portions of the shallow aquifer, respectively. Water level measurements i that there is a net upward now within this unit at this location. Vertical grad between the perched and shallow aquifers are generally downward across the site, indicating a potential for downward movement. However, at the upgradient locati (MW-20, -21, and -22) an upward gradient exists between the confined shallow aqu and the perched zone indicating possible upward leakage at this location.

The estimated hydraulic conductivity of the shallow aquifer at Site D ranges fro 10-3 to 2.8 x 10-6 cm/sec. Values in the range of 10-6 obtained from MW-28 are questionable and may not be an accurate representation of the aquifer conductivi Based on an average hydraulic conductivity and groundwater gradient, the estimat average groundwater velocity in the shallow aquifer is approximately 2.03 feet p

6.2.4 Kitsap Formation

A dense, lacustrine, clayey silt unit of the Kitsap Formation (Qk) is below the Outwash. Regionally the thickness of the Qk is approximately 200 feet. The thi of the Kitsap Formation was not determined at Site D.

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6.3 NATURE AND EXTENT OF CONTAMINATlON

The remedial investigation of Site D included sampling of the site surface water

sediments, surface and subsurface soils, and groundwater. Analytical results fr background sampling were used to establish naturally occurring levels of inorgan chemicals (metals) to distinguish them from increased levels resulting from acii the site. Samples were analyzed for concentrations of all compounds on the EPA compound list (semivolatile organics, volatile organics, and pesticides/polychlo biphenyls [PCBs]), for all analyses on the EPA target analyte list (metals and c ordnance compounds, and for water quality parameters.

6.3.1 Surface Water

Surface water samples were collected from Site D and vicinity during three separ sampling efforts in October and November 1991 and in February 1992. Samples wer collected from three ephemeral streams in the Site D vicinity and one perennial on the site (Figure 8). Samples were collected on the site, upgradient of the s downgradient of the site during each sampling effort. Surface water quality par measured included temperature, specific conductance, pH, turbidity, chloride, di oxygen, ammonia as nitrogen, nitrate, nitrite, total hardness, phosphorus, total solids, total organic carbon, sulfate, and alkalinity. Laboratory samples were for volatile and semivolatile organic compounds, ordnance compounds, pesticides PCBs, and total (unfiltered) and dissolved (filtered) metals.

Findings: Table 1 1ists minimum, maximum, and average concentrations of all che detected in surface water at the site. Five ordnance compounds (2,4-dinitrotolu dinitrotoluene, 2,4,6-trinitrotoluene, 1,3,5-trinitrobenzene, and RDX) were dete surface water samples, although no exceedances of regulatory criteria occurred. Ordnance compounds were detected in 10 out of 32 samples collected from two surf water/sediment sampling locations (DSWs) on site (DSW-03 and DSW-10) and two locations downgradient of Site D (DSW-07 and DSW-04). The majority of ordnance detections were from samples collected near the burn trench. Regulatory criteri metals in surface water may be based on either the total or dissolved fraction, for a particular analyte. The following metals exceeded regulatory criteria in water samples collected from Site D: arsenic, copper, mercury, thallium, and zi

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Table 1
Chemicals Detected in Surface Water

Potential

Chemical	No. of Samples	No. of Detections	Minimum Detection (æg/L)	Maximum Detection (æg/L)	Average Detection (æg/L)	AR Va (æ
Metals-Dissolved						
Aluminum	32	29	78.7	339	172	N
Antimony	32	2	16.2	16.3	16.3	1
Arsenic	32	2	2.5	2.6	2.55	0
Barium	32	28	5.3	209	68.1	N
Chromium	32	14	2	8.2	3.56	N
Copper	32	2	14.6	32.5	23.6	6
Iron	32	27	64.3	299	152	N
Lead	32	1	2.1	2.1	2.1	1
Manganese	32	29	2.3	69.6	13.5	N
Selenium	32	1	2.3	2.3	2.3	N
Thallium	32	1	2.4	2.4	2.4	1
Vanadium	32	9	2.1	4.2	2.7	N
Zinc	32	14	2.7	123	24.6	5
Metals-Total						
Aluminum	32	32	107	9,690	892	N
Arsenic	32	2	2.2	6.7	4.45	0
Barium	32	29	5.3	848	104	
Cadmium	32	2	1.9	4.3	3.1	N
Chromium	32	21	2.2	23.2	5.6	1
Cobalt	32	2	7.9	9.7	8.8	N
Copper	32	6	6.2	266	66.6	N
Iron	32	31	70.7	7,420	874	N
Lead	32	7	2	53.8	11.6	N
Manganese	32	32	3.1	865	80	N
Mercury	32	2	.24	.32	.28	.
Nickel	32	2	23.8	38.3	31.1	N
Selenium	32	1	2.4	2.4	2.4	5
Vanadium	32	10	2.7	46	12.3	N
Zinc	32	13	2.6	1,000	120	N

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Table 1 (Continued)
Chemicals Detected in Surface Water

Chemical	No. of Samples	No. of Detections	Minimum Detection (æg/L)	Potential Maximum Detection (æg/L)	Average Detection (æg/L)	AR Va (æ

Ordnance Compounds						
1,3,5-Trinitrobenzene	32	1	0.066	0.066	0.066	N
2,4,6-Trinitrotoluene	25	4	0.003	2.3	0.587	N
2,4-Dinitrotoluene	32	2	0.057	0.12	0.089	1
2,6-Dinitrotoluene	32	2	0.006	0.083	0.04	N
RDX	28	1	3	3	3	N
Semivolatile Organic Compounds						
Bis(2-ethylhexyl) phthalate	32	8	0.7	51	8.3	3
Volatile Organic Compounds						
1,1,1-Trichloroethane	32	1	0.9	0.9	0.9	4
Acetone	32	6	10	20	12.2	N
Benzene	32	7	1	12	4	4
Chlorobenzene	32	2	1	2	1.5	5
Methylene chloride	32	5	5	38	28	960
Styrene	32	1	4	4	4	N
Toluene	32	1	2	2	2	4

aARAR is based on total metal analysis
bBased on an average hardness of 55 mg/kg as CaCO3

Notes:
The metals calcium, magnesium, potassium, and sodium are not shown due to lack o toxicity
æg/L - micrograms per liter
ARAR - applicable or relevant and appropriate requirement
N/A - not available/not applicable
RDX - Royal Demolition Explosive (cyclonite or hexahydro-1,3,5-trinitro-1,3,5-tr

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Arsenic exceeded the Model Toxics Control Act (MTCA) Method B cleanup level in 2 out of 32 samples at DSW-01 (upgradient) and DSW (on site)

Copper exceeded the Washington State Water Quality Standard in 2 ou 32 samples at DSW-03 (on site)

Mercury exceeded the Washington State Water Quality Standard in 2 o of 32 samples at DSW-03 and DSW-10 (on site)

Thallium exceeded the MTCA Method B cleanup level in 1 out of 32 samples at DSW-05 (on site)

Zinc exceeded the Washington State Water Quality Standard in 2 out samples at DSW-03 (on site)

The following chemicals exceeded regulatory criteria in surface water samples co downgradient or cross-gradient from Site D: lead and bis(2-ethylhexyl) phthalat

Lead exceeded the Washington State Water Quality Standard in 1 out 32 samples at DSW-09 (downgradient)

Bis(2-ethylhexyl) phthalate exceeded the MTCA Method B cleanup leve 2 out of 32 samples at DSW-06 (cross-gradient) and DSW-08 (downgradient)

6.3.2 Freshwater Sediments

Freshwater sediment samples were collected from Site D and the vicinity during t separate sampling efforts in October and November 1991 and in February 1992. Samples were collected from three ephemeral streams in the Site D vicinity and o perennial stream on site (Figure 8). Samples were collected on site, upgradient site, and downgradient of the site during each sampling effort. Samples were an for volatile and semivolatile organic compounds, ordnance compounds, pesticides PCBs, and metals.

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There are no regulatory requirements associated with freshwater sediments in Washington State. However, guidance concentrations have been developed for sele parameters by EPA Region 5 and the Wisconsin Department of Natural Resources.

Findings: Table 2 lists minimum, maximum, and average concentrations of all che detected in freshwater sediments. The concentrations of eight metals exceeded g concentrations, specifically arsenic, cadmium, chromium, copper, lead, manganese mercury, and nickel.

6.3.3 Surface Soils

Sampling grids were established to collect surface soil samples from the burn/de areas of Site D for chemical analysis (Figure 9). Each grid was divided into 25 25-foot cells. Random and biased soil grab samples were collected within the gr screened for 2,4,6-trinitrotoluene and RDX as specified in the sampling and anal plan.

Field screening for ordnance involved collection of samples from 80 percent of t cells randomly across the site. Additionally, 24 biased samples were collected

screened to further define the extent of contamination in areas exhibiting chara of historical burn/detonation activities and in areas having anomalous geophysic readings. Biased sample locations included four near the small arms incinerator sample at each corner of the foundation), six samples from the burn trench area, remaining 14 based on the geophysical results.

To confirm the screening results, 60 field samples and 6 duplicates were collect splits with field screening samples and sent to an off-site laboratory for ordna analysis. Figure 9 depicts the locations of all laboratory confirmation samples Additional surface soil samples were collected in the locations shown in Figure analyzed for metals to determine compliance with regulatory criteria and to eval potential treatment technologies.

Findings: Table 3 lists minimum, maximum, and average concentrations of all che detected in surface soils. Ordnance compounds detected at concentrations that e regulatory requirements were 2,4-dinitrotoluene (in 25 of 107 samples collected) 2,6-dinitrotoluene (in 4 of 107 collected), and 2,4,6-trinitrotoluene (in 11 of collected). The concentration of the metal arsenic exceeded regulatory requirem 3 of 74 samples collected.

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Table 2
Chemicals Detected in Freshwater Sediments

Chemical	No. of Samples	No. of Detections	Minimum Detection (mg/kg)	Maximum Detection (mg/kg)	Average Detection (mg/kg)
Metals					
Aluminum	35	35	4,930	17,000	9,774
Antimony	35	14	5.9	21.1	9.13
Arsenic	35	31	0.89	6.2	2.35
Barium	35	35	16.7	198	53.6
Beryllium	35	3	0.25	0.3	0.273
Cadmium	35	9	0.46	1.5	0.939
Chromium	35	35	11	48.7	24.3
Cobalt	35	35	3.3	12.6	6.93
Copper	35	35	3.6	63	15.5
Lead	35	32	0.87	46.2	7.53
Manganese	35	35	120	430	220
Mercury	35	11	0.12	0.86	0.257
Nickel	35	35	14.1	47.8	30.7
Selenium	35	2	0.47	1.3	0.885
Silver	35	3	0.93	2.3	1.51
Vanadium	35	35	14.3	81.5	32.4

Zinc	35	35	13	157	45
Ordnance Compounds					
2,4,6-Trinitrotoluene	35	3	0.065	0.89	0.408
2,4-Dinitrotoluene	35	2	1.1	5.1	3.1
2,6-Dinitrotoluene	35	2	0.1	0.39	0.245
Semivolatile Organic Compounds					
2,4-Dinitrotoluene	35	3	0.5	4.9	2.57
Benzo(a)anthracene	35	1	0.12	0.12	0.12
Benzo(a)pyrene	35	1	0.085	0.085	0.085
Benzo(b)fluoranthene	35	1	0.19	0.19	0.19
Benzo(k)fluoranthene	35	2	0.096	0.14	0.118
Chrysene	35	2	0.09	0.14	0.115
Di-n-octylphthalate	34	1	0.12	0.12	0.12
Fluoranthene	35	2	0.11	0.25	0.18

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Table 2 (Continuted)
Chemicals Detected in Freshwater Sediments

Chemical	No. of Samples	No. of Detections	Minimum Detection (mg/kg)	Maximum Detection (mg/kg)	Average Detection (mg/kg)
N-Nitrosodiphenylamine	35	3	0.25	0.63	0.48
Phenanthrene	35	2	0.17	0.45	0.31
Pyrene	35	2	0.18	0.44	0.31
Bis(2-ethylhexyl) phthalate	35	6	0.075	0.11	0.091
Volatile Organic Compounds					
1,1,1-Trichloroethane	35	3	0.006	0.037	0.019
2-Butanone	35	1	0.005	0.005	0.005
Acetone	35	13	0.002	0.038	0.017
Benzene	35	2	0.002	0.002	0.002
Chlorobenzene	35	2	0.001	0.003	0.002
Methylene chloride	35	14	0.003	0.097	0.029
Tetrachloroethene	35	4	0.001	0.045	0.016
Toluene	35	3	0.002	0.016	0.0073
Xylenes	35	1	0.004	0.004	0.004

Notes:
The metals calcium, iron, magnesium, potassium, and sodium are not shown due to toxicity.
mg/kg - milligrams per kilogram

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Table 3
Chemicals Detected in Surface Soils

Chemical	No. of Samples	No. of Detections	Minimum Detection (mg/kg)	Maximum Detection (mg/kg)	Average Detection (mg/kg)	Pot (
Metals						
Aluminum	74	74	7,760	21,000	13,835	
Antimony	45	7	7.4	27.1	13.6	
Arsenic	74	71	1.1	68.2	8.48	
Barium	74	74	23.2	1,810	202	
Beryllium	74	39	0.22	0.48	0.333	
Cadmium	74	31	0.59	15	3.77	
Chromium	74	74	18.3	77.7	34.1	8
Cobalt	74	64	4.7	17.5	8.08	
Copper	74	74	4.9	2,230	110	
Cyanide	18	7	0.81	3.5	1.69	
Lead	74	74	0.9	1,570	51.7	
Manganese	74	74	136	1,010	393	
Mercury	74	8	0.12	3.2	0.594	
Nickel	74	74	23.5	76.6	39.1	
Selenium	74	5	0.49	0.95	0.804	
Silver	74	16	0.7	27.5	3.83	
Vanadium	74	74	26.2	115	46	
Zinc	74	74	16.5	2,880	188	2
Ordnance Compounds						
1,3,5-Trinitrobenzene	107	21	0.04	3.4	0.397	
1,3-Dinitrobenzene	107	5	0.1	2.8	0.828	
2,4,6-Trinitrotoluene	107	53	0.025	14,000	638	
2,4-Dinitrotoluene	107	49	0.045	78	5.68	
2,6-Dinitrotoluene	107	38	0.018	5.6	0.643	
Nitrobenzene	66	2	0.073	0.075	0.074	
RDX	39	8	0.02	1.7	0.358	
Picramic acid	41	2	0.27	0.38	0.325	
Picric acid	39	4	1.5	6	3.55	

Table 3 (Continued)
Chemicals Detected in Surface Soils

Chemical	No. of Samples	No. of Detections	Minimum Detection (mg/kg)	Maximum Detection (mg/kg)	Average Detection (mg/kg)	P
Semivolatile Organic Compounds						
Di-n-butylphthalate	41	6	0.11	5.3	1.091	
Di-n-octylphthalate	41	10	0.079	0.25	0.154	
N-Nitrosodiphenylamine	41	4	0.19	7	2.85	
Bis(2-ethylhexyl) phthalate	41	10	0.059	2.4	0.390	
Volatile Organic Compounds						
1,1,1-Trichloroethane	41	1	0.027	0.027	0.027	
Acetone	42	18	0.002	2	0.126	
Chloroform	41	3	0.005	0.011	0.008	
Ethylbenzene	41	1	0.003	0.003	0.003	
Methylene chloride	42	20	0.002	0.15	0.014	
Tetrachloroethene	41	14	0.001	0.02	0.0054	
Trichloroethene	41	1	0.001	0.001	0.001	
Xylenes	41	4	0.002	0.015	0.008	16

aMTCA Method B value for 2,4-dinitrotoluene and 2,6-dinitrotoluene mixture

Notes:
The metals calcium, iron, magnesium, potassium, and sodium are not shown due to toxicity.
mg/kg - milligrams per kilogram
ARAR - applicable or relevant and appropriate requirement
N/A - not available
RDX - Royal Demolition Explosive (cyclonite or hexahydro-1,3,5-trinitro-1,3,5-tr

6.3.4 Subsurface Soils

The soil boring program was conducted during February and March 1992. Boring locations (Figure 10) were selected in compliance with the final work plan. Thi soil borings were attempted; 36 were completed to the required depth of 15 feet. Sixteen of the 36 borings were drilled at biased locations: 1 near the incinera foundation, 2 in the burn trench, 2 at each of the 6 previously identified mound at an area with surface soil staining. Twenty additional borings were completed confirm contamination found during field screening.

Subsurface soil samples were also collected during monitoring well installation. final work plan specified the installation of three new well clusters (three wel cluster) and three single wells at Site D (Figure 11). The final work plan requ were modified based on the geologic conditions encountered, resulting in the dri installation of only two of the three wells in two of the three monitoring well

Four distinct glacial stratigraphical units were identified during this RI/FS. their depth from the ground surface, shallowest to deepest, these units are the Recessional Outwash, the Vashon Till the Vashon Advance Outwash, and the Kitsap Formation.

Subsurface soil samples were analyzed for metals, ordnance compounds, volatile a semivolatile organic compounds, and pesticides and PCBs. The findings for each unit are discussed separately in the following sections.

Vashon Recessional Outwas

Table 4 lists minimum, maximum, and average concentrations of chemicals detected the Vashon Recessional Outwash. Arsenic was the only metal detected at a level exceeded regulatory requirements in 1 sample out of 132 samples. One ordnance compound, 2,4-dinitrotoluene, exceeded regulatory requirements in 1 sample out o samples.

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Table 4
Chemicals Detected in Subsurface Soils From the Vashon Recessional Outwash

Chemical	No. of Samples	No. of Detection	Minimum Detection (mg/kg)	Maximum Detection (mg/kg)	Average Detection (mg/kg)	Pot A V (m
Metals						
Aluminum	132	132	4,630	21,000	10,000	
Antimony	132	6	7.7	9.3	8.2	
Asenic	132	125	0.63	34.5	2.93	
Barium	132	132	16	116	37	5
Beryllium	132	56	0.22	0.47	0.275	
Cadmium	132	1	0.44	0.44	0.44	
Chromium	132	132	14.7	61.9	28.1	80
Cobalt	132	132	2.9	17.7	8.05	4
Copper	132	132	3.8	34.9	15.8	2
Lead	132	127	0.79	21.4	2.55	
Manganese	132	132	117	1,240	259	8
Mercury	132	4	0.2	0.73	0.348	
Nickel	132	132	23.1	238	45	1
Selenium	132	2	0.44	0.55	0.495	
Silver	132	8	0.47	106	22.8	
Vanadium	132	132	15.5	125	36	
Zinc	132	132	13.5	91.6	26.4	22
Ordinance Compounds						
1,3,5-Trinitrobenzene	132	19	0.032	0.18	0.086	
2,4,6-Trinitrotoluene	132	36	0.021	11	0.45	
2,4-Dinitrotoluene	132	2	0.03	1.8	0.915	
2,6-Dinitrotoluene	132	1	0.13	0.13	0.13	
Picramic acid	131	1	0.16	0.16	0.16	
Picric acid	127	1	0.12	0.12	0.12	
Pesticides						
Heptachlor	132	1	0.052	0.052	0.052	
Semivolatile Organic Compounds						
Di-n-butylphthalate	123	11	0.009	0.98	0.193	8
Di-n-octylphthalate	123	40	0.01	0.76	0.218	1
Phenol	123	1	0.052	0.052	0.052	48
Phyrene	123	1	0.36	0.36	0.36	2
Bis(2-ethylhexyl) phthalate	123	21	0.034	0.63	0.143	

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Table 4 (Continued)
Chemicals Detected in Subsurface Soils From the Vashon Recessional Outwash

Chemical	No. of Samples	No. of Detections	Minimum Detection (mg/kg)	Maximum Detection (mg/kg)	Average Detection (mg/kg)	Pot A V (m
Volatile Organic Compounds						
1,1,1-Trichloroethane	132	5	0.001	0.002	0.0016	7
4-Methyl-2-pentanone	132	2	0.004	0.009	0.0065	N
Acetone	132	66	0.003	0.057	0.021	8
Chloroform	132	9	0.001	0.006	0.0036	
Methylene chloride	132	58	0.0004	0.032	0.0074	
Tetachloroethene	132	14	0.0005	0.014	0.0043	
Toluene	132	1	0.001	0.001	0.001	16,0
Trichloroethene	132	1	0.003	0.003	0.003	
Xylenes	132	3	0.0004	0.002	0.0011	165

aMTCA Method B value for 2,4-dinitrotoluee and 2,5-dinitrotoluene mixture

Notes:
The metals calcium, iron, magnesium, potassium, and sodium are not shown due to toxicity.
mg/kg - milligrams per kilogram
ARAR - applicable or relevant and appropriate requirement
N/A - not available
RDX - Royal Demolition Explosive (cyclonite or hexahydro-1,3,5-triazine)

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Vashon Til

Table 5 lists minimum, maximum, and average concentrations of chemicals detected the Vashon Till. Beryllium was the only chemical detected at a level that excee regulatory requirements. This occurred in 1 sample out of 23 samples.

Vashon Advance Outwas

Table 6 lists minimum, maximum, and average concentrations of chemicals defected the Vashon Advance Outwash. Beryllium was the only chemical detected at a level

exceeded regulatory requirements. This occurred in 2 samples out of 9 samples.

Kitsap Formatio

Table 7 lists minimum, maximum, and average concentrations of chemicals detected the Kitsap Formation.

No chemicals were detected at levels that exceeded regulatory requirements.

6.3.5 Groundwater

Groundwater samples were collected from 21 monitoring wells at Site D and vicini during three separate sampling events: in the dry season in 1991, in the wet se 1991, and in 1992. These sampling events corresponded to the seasons when groundwater is either scarce or abundant. Samples were collected from two separ water-bearing units: the perched aquifer and the shallow aquifer. During each event, samples were collected at upgradient, on-site, and downgradient locations to the site.

Groundwater samples were analyzed for volatile and wemivolatile organic compound ordnance compounds, pesticides and PCBs, and total (unfiltered) and dissolved (f metals. The findings for groundwater samples from the perched aquifer and the s aquifer are discussed separately in the following sections.

Perched Aquife

Table 8 lists minimum, maximum, and average concentrations of all chemicals dete in the groundwater from the perched aquifer. Two volatile organic compounds,

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Table 5
Chemicals Detected in Subsurface Soils From the Vashon Till

Chemical	No. of Samples	No. of Detections	Minimum Detection (mg/kg)	Maximum Detection (mg/kg)	Average Detection (mg/kg)	Pot A V (m
Metals						
Aluminum	23	23	6,050	35,600	10,993	N
Antimony	23	2	5.5	10.3	7.9	
Arsenic	23	19	0.86	6.7	2.15	
Barium	23	23	22.9	228	47.2	5
Beryllium	23	11	0.22	0.83	0.325	

Chromium	23	23	14.6	86.4	29.9	80
Cobalt	23	23	5.4	32.4	9.21	
Copper	23	23	8.6	71.9	19.5	
Lead	23	22	1.2	12	2.48	
Manganese	23	23	158	1,020	282	8
Nickel	23	23	24.7	117	42.4	1
Vanadium	23	23	20.9	101	37.3	
Zinc	23	23	17.2	123	31.5	22
Ordnance Compounds						
1,3,5-Trinitrobenzene	23	3	0.082	0.14	0.121	
2,4,6-Trinitrotoluene	23	5	0.021	0.053	0.037	
Pesticides						
Methoxychlor	23	1	0.17	0.17	0.17	
Semivolatile Organic Compounds						
Di-n-octylphthalate	22	7	0.08	0.25	0.128	1
Bis(2-ethylhexyl) phthalate	22	4	0.034	0.13	0.101	
Volatile Organic Compounds						
Acetone	23	8	0.007	0.041	0.018	8
Chloroform	23	1	0.006	0.006	0.006	
Methylene chloride	23	8	0.002	0.006	0.004	
Tetrachloroethene	23	1	0.003	0.003	0.003	

Notes:
The metals calcium, iron, magnesium, potassium, and sodium are not shown due to toxicity.
mg/kg - milligrams per kilogram
ARAR - applicable or relevant and appropriate requirement
N/A - not available

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Table 6
Chemicals Detected in Subsurface Soils From the Vashon Advance Outwash

Chemical	No. of Samples	No. of Detections	Minimum Detection (mg/kg)	Maximum Detection (mg/kg)	Average Detection (mg/kg)	Pot A V (m
Metals						
Aluminum	9	9	7,000	32,000	15,304	
Antimony	9	2	9.3	10.5	9.9	
Arsenic	9	5	0.97	5.5	2.97	
Barium	9	9	28.9	185	79.5	5

Beryllium	9	6	0.24	0.72	0.46	
Chromium	9	9	18.7	70.8	37.3	
Cobalt	9	9	6.3	23.7	12.6	
Copper	9	9	8.7	54.2	24.8	
Lead	9	7	1.5	14.2	5.8	
Manganese	9	9	204	835	398	
Mercury	9	2	0.12	0.39	0.255	
Nickel	9	9	32.4	84.2	51.7	
Selenium	9	1	0.69	0.69	0.69	
Vanadium	9	9	22	88.6	46.9	
Zinc	9	9	23.4	102	51.2	
Semivolatile Organic Compounds						
1,2,4-Trichlorobenzene	9	1	0.27	0.27	0.27	
1,4-Dichlorobenzene	9	1	0.26	0.26	0.26	
4-Chloro-3-methyiphenol	9	1	0.6	0.6	0.6	
Acenaphthene	9	1	0.39	0.39	0.39	
Di-n-octylphthalate	9	1	0.47	0.47	0.47	
Phenol	9	1	0.57	0.57	0.57	
Pyrene	9	1	0.43	0.43	0.43	
Bis(2-ethylbexyl) phthalate	9	1	0.042	0.042	0.042	
Volatile Organic Compounds						
1,1,1-Trichloroethane	9	1	0.004	0.004	0.004	
1,2-Dichioroethene	9	1	0.0007	0.0007	0.0007	
Acetone	9	5	0.019	0.044	0.029	
Chloroform	9	1	0.006	0.006	0.006	
Ethylbenzene	9	1	0.001	0.001	0.001	
Methylene chloride	9	4	0.006	0.022	0.0133	
Tetrachloroethene	9	5	0.001	0.037	0.0106	
Trichloroethene	9	1	0.007	0.007	0.007	
Xylenes	9	2	0.001	0.001	0.001	1

Notes:
The metals calcium, iorn, magnesium, potassium, and sodium are not shown due to toxicity.
mg/kg - milligrams per kilogram
ARAR - applicable or relevant and appropriate requirement
N/A - not available

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Table 7
Cbemicals Detected in Subsurface Soils From the Kitsap Formation

Chemical	No. of Samples	No. of Detections	Minimum Detection (mg/kg)	Maximum Detection (mg/kg)	Average Detection (mg/kg)	Pot
Metals						
Aluminum	4	4	14,500	35,200	21,425	
Antimony	4	2	8.2	12.6	10.4	
Arsenic	4	4	3.7	6.8	4.83	
Barium	4	4	83	216	123	
Beryllium	4	4	0.34	0.8	0.528	
Chromium	4	4	40.4	83.3	54.5	
Cobalt	4	4	13.2	28.4	18.5	
Copper	4	4	24.8	65.9	38.5	
Lead	4	4	3.9	10.4	6.23	
Manganese	4	4	402	958	594	
Nickel	4	4	56.7	103	70	
Selenium	4	1	0.59	0.59	0.59	
Vanadium	4	4	49.7	98.4	68.8	
Zinc	4	4	52.4	119	74.6	
Semivolatile Organic Compounds						
Benzo(a)pyrene	4	1	0.067	0.067	0.067	
Volatile Organic Compounds						
Acetone	4	3	0.16	0.19	0.177	
Chloroform	4	1	0.007	0.007	0.007	
Methylene chloride	4	1	0.001	0.001	0.001	
Xylenes	4	1	0.005	0.005	0.005	

Notes:
The metals calcium, iron, magnesium, potassium, and sodium are not shown due to toxicity.
mg/kg - milligrams per kilogram
ARAR - applicable or relevant and appropriate requirement
N/A - not available

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Table 8
Chemicals Detected in Groundwater From the Perched Aquifer

No. of	No. of	Minimum Detection	Maximum Detection	Average Detection	Pot A V

Chemical	Samples	Detections	(æg/L)	(æg/L)	(æg/L)	(
Metals						
Aluminum	25	16	71.1	230	134	
Arsenic	25	2	7.2	33.9	20.6	
Barium	25	15	4.3	161	69.8	1,0
Chromium	25	6	2.5	7.4	4.93	
Cobalt	25	1	6.4	6.4	6.4	9
Copper	25	12	5.3	29.9	12.2	5
Iron	25	18	9.1	531	99.7	N
Lead	25	12	1.1	3.8	1.98	
Manganese	25	24	1.4	3.370	312	1,6
Mercury	25	5	0.24	0.29	0.264	
Nickel	25	8	8.1	30.9	13.4	1
Selenium	25	3	2.2	3.3	2.73	
Vanadium	25	4	2	4	2.85	1
Zinc	25	18	4.4	58.6	14.2	4,8
Ordnance Compounds						
1,3,5-Trinitrobenzene	22	4	0.24	24	14.3	
2,4,6-Trinitrotoluene	16	2	1.6	33	17.3	
2,4-Dinitrotoluene	25	6	0.097	0.19	0.139	
2,6-Dinitrotoluene	24	6	0.015	0.45	0.281	
RDX	23	4	0.061	4	1.46	
Semivolatile Organic Compounds						
Benzoic acid	25	1	1	1	1	64,0
Butylbenzylphthalate	25	1	0.6	0.6	0.6	1
Di-n-butylphthalate	25	2	1	4	2.5	1,6
Di-n-octylphthalate	25	8	3	13	6.38	3
Diethyiphthalate	25	1	0.9	0.9	0.9	12,8
Naphthalene	25	2	1	4	2.5	
Pentachlorophenol	25	1	1	1	1	
Phenol	25	1	2	2	2	9,6
Pyrene	25	1	1	1	1	4
Bis(2-ethylhexyl phthalate	25	6	1	7	3.5	
Volatile Organic Compounds						
Acetone	25	4	11	26	16	8

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Table 8 (Continued)
Chemicals Detected in Groundwater From the Perched Aqulfer

Pote

Chemical	No. of Samples	No. of Detections	Minimum Detection (æg/L)	Maximum Detection (æg/L)	Average Detection (æg/L)	AR Va (æ
Chlorobenzene	25	1	3	3	3	
Dibromochloromethane	25	1	2	2	2	
Methylene chloride	25	3	3	26	11	
Tetrachloroethene	25	1	2	2	2	
Toluene	25	2	3	5	4	1,
Xylenes	25	1	6	6	6	10,

aDissolved metals
bMTCA Method B value for 2,4-dinitrotoluene and 2,6-dinitrotoluene mixture

Notes:
The metals calcium, magnesium, potassium, and sodium are not shown due to not sh ecological toxicity.
æg/L - micrograms per liter
ARAR - applicable or relevant and appropriate requirement
N/A - not available
RDX - Royal Demolition Explosive (cyclonite or hexahydro-1,3,5-trinitro-1,3,5-tr

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methylene chloride and tetrachloroethene, were detected in 1 sample out of 25 sa each at concentrations exceeding regulatory criteria. Methylene chloride is a c laboratory contaminant. Two semivolatile organic compounds, pentachlorophenol a bis(2-ethylhexyl) phthalate, were each detected at concentrations greater than r criteria in 1 out of 25 samples. Five ordnance compounds were detected at level regulatory criteria. The concentration of 2,4-dinitrotoluene exceeded regulator requirements in 4 of 25 samples, 2,6-dinitrotoluene in 5 of 24 samples, RDX in 2 samples, 1,3,5-trinitrobenzene in 3 of 22 samples, and 2,4,6-trinitrotoluene in samples. Concentrations of the metals arsenic and manganese exceeded regulatory requirements in 2 of 25 samples.

Shallow Aquife

Table 9 lists minimum, maximum, and average concentrations of all chemicals dete in groundwater from the shallow aquifer. The volatile organic compounds benzene tetrachloroethene were detected at concentrations greater than regulatory requir benzene in 1 sample out of 26 (at DMW-22) and tetrachloroethene in 2 samples out 26 (at DMW-21 and DMW-32). Concentrations of methylene chloride exceeded regulatory requirements in 5 out of 26 samples; however, methylene chloride is a common laboratory contaminant. The pesticide heptachlor was detected in one sam at a concentration greater than regulatory requirements. The semivolatile organ

compound bis(2-ethylhexyl) phthalate was detected at a level greater than regula requirements in 3 out of 26 samples and was detected in a laboratory blank. Concentrations of two metals, arsenic and beryllium, exceeded regulatory require in 9 out of 26 samples and 6 out of 26 samples, respectively.

6.4 PHYSICAL AND CHEMICAL BEHAVIOR OF ORDNANCE COMPOUNDS

The two most important transformation processes controlling the fate and distrib ordnance compounds in the environment are, in general microbiological and photochemical transformation. Oxidation and reduction, and hydrolysis are not considered significant mechanisms for the transformation of 2,4,6-trinitrotoluen 2,4-dinitrotoluene, 2,6-dinitrotoluene, 1,3,5-trinitrobenzene, and 1,3-dinitrobe

The compounds 2,4,6-trinitrotoluene and 1,3,5-trinitrobenzene are microbially transformed, but are not completely mineralized to inorganic products and are kn persist in soil and sediment for years. The compounds 2,4-dinitrotoluene,

Table 9
Chemicals Detected in Groundwater From the Sballow Aquifer

Chemical	No. of Samples	No. of Detections	Minimum Detection (æg/L)	Maximum Detection (æg/L)	Average Detection (æg/L)	Po
Metalsa						
Arsenic	26	9	2.6	22.4	8.51	
Barium	26	23	7.3	133	29.1	1,
Beryllium	26	6	1	1.3	1.15	
Cadmium	26	3	2	6.1	3.6	
Chromium	26	8	2.6	4.1	3.74	
Cobalt	26	1	4	4	4	
Copper	26	12	6	16.1	9.92	
Lead	26	14	1.3	5	3.09	
Manganese	26	25	17.4	276	114	1
Mercury	26	4	0.2	0.32	0.27	
Nickel	26	1	9.2	9.2	9.2	
Selenium	26	1	3	3	3	
Silver	26	1	2	2	2	
Vanadium	26	1	7.8	7.8	7.8	
Zinc	24	18	2.2	426	43.4	4
Pesticides						

4,4-DDT	26	1	0.0072	0.0072	0.0072	
Heptachlor	26	1	0.064	0.064	0.064	
Semivolatile Organic Compounds						
Benzoic acid	26	1	1	1	1	64
Butylbenzylphthalate	26	1	2	2	2	
Di-n-butylphthalate	26	1	2	2	2	1
Di-n-octylphthalate	26	1	0.03	0.03	0.03	
Naphthalene	26	1	2	2	2	
Bis(2-ethylhexyl phthalate	26	7	1	130	27.1	
Volatile Organic Compounds						
1,1,1-Trichloroethane	26	1	6	6	6	
Acetone	26	2	15	55	35	
Benzene	26	2	1	7	4	
Chloroform	26	1	2	2	2	
Methylene chloride	26	6	5	17	11.3	
Tetrachloroethene	26	2	1	2	1.5	

aDissolved metals

Notes:
The metals aluminum, calcium, iron, magnesium, potassium, and sodium are not sho
æg/L - micrograms per liter
ARAR - applicable or relevant and appropriate requirement
N/A - not available
4,4-DDT - 4,4-dichlorodiphenyltrichloroethane

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2,6-dinitrotoluene, and 1,3-dinitrobenzene, unlike 2,4,6-trinitrotoluene, have b
to be biodegradable to inorganic products such as nitrate and carbon dioxide. T
transformation processes of 2,4,6-trinitrotoluene, 2,4-dinitrotoluene, and 2,6-
dinitrotoluene involve the successive reduction of nitro groups to amino groups
amino derivatives of 2,4-dinitrotoluene and 2,6-dinitrotoluene. The metabolic
transformation products of 2,4,6-trinitrotoluene are adsorbed strongly to organi
materials and have significantly lower toxicity than 2,4,6-trinitrotoluene, 2,4-
dinitrotoluene, and 2,6-dinitrotoluene. High organic carbon concentrations, aer
conditions, and the presence of readily biodegradable co-substrate have been fou
enhance the biotransformation of 2,4,6-trinitrotoluene. High concentrations of
2,4,6-trinitrotoluene can inhibit the development of an acclimated microbiota.
Biotransformation is expected to be an important process in sediment and surface

Photochemical transformation of 2,4,6-trinitrotoluene occurs at a higher rate th
biotransformation. Ordnance compounds typically undergo reduction of nitryl gro
followed by oxidation methyl groups. The primary photochemical transformation b

product of 2,4,6-trinitrotoluene in natural surface water appears to be 1,3,5-trinitrobenzene, which is relatively stable to further photodegradation. phototransformation rate for 2,4,6-trinitrotoluene is inversely proportional to pH. Phototransformation of ordnance compounds is expected to be an important process in surface waters.

Although the quantity of 2,4,6-trinitrotoluene released to the environment at Si unknown, the compound appears to be transforming, as indicated by the number of detections and the concentrations of the 2,4,6-trinitrotoluene transformation pr 1,3,5-trinitrobenzene and 1,3-dinitrobenzene. As indicated by their high octano partition coefficients, the compounds 2,4,6-trinitrotoluene, 2,4-dinitrotoluene, dinitrotoluene, 1,3,5-trinitrobenzene, and 1,3-dinitrobenzene are all strongly a humus and clays. Ordnance concentrations in the area downgradient from the burn trench are possibly the result of surface water runoff and erosion of soil and o particles containing ordnance compounds. Erosion is probably the primary transp pathway causing the spread of ordnance compounds. This explanation is supported surface water sampling that showed that all detections of ordnance compounds in water occurred during storm event sampling. The wider area of the surface detec for both field screening and laboratory results corresponds to a decrease in slo the burn trench. Over time, erosion is expected to transport soil particles con ordnance compounds further downgradient at Site D, and ultimately into the peren streams that drain into Devil's Hole.

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Most of the ordnance compounds occur in the top 3 feet of the soil column. This is consistent with the fact that ordnance compounds are strongly adsorbed by soi organic material. The compound 1,3,5-trinitrobenzene is considerably more mobil 2,4,6-trinitrotoluene and would be expected to migrate both vertically and horiz away from the original source.

7.0 SUMMARY OF SITE RISKS

7.1 HUMAN HEALTH RISK ASSESSMENT AND CHARACTERIZATION

The baseline risk assessment in Section 6.0 of the RI/FS (URS 1993) estimated th probabilities of adverse health effects from current and future hypothetical exp chemicals of concern in the absence of remediation. The risk assessment is a mu process consisting of data evaluation, chemical toxicity assessments, and exposu assessments. By combining the information gathered during each of these three s noncancer and cancer risks can be quantified in a final step termed risk charact

All chemicals detected at Site D were screened in accordance with EPA gridelines select chemicals of potential concern (COPCs) for evaluation in the risk assessm Inorganic cbemicals whose maximum detected concentrations were less than the calculated background concentration for OU 6 were screened from the risk assessm A detailed exposure assessment followed, which consisted of evaluating the speci exposure setting and exposure pathways. Default exposure assumptions are define current EPA risk assessment guidance. (Site-specific exposure assumptions for S are explained in Section 6.0 of the RI/FS.) Toxicity information obtained from Integrated Risk Information System (IRIS) database was then applied to each COPC

Noncancer risks were quantified by comparing the estimated intake dose resulting site exposure to a reference dose (RfD), an EPA estimate of the acceptable daily of a chemical. Hazard indexes (HIs) greater than 1.0 were considered a concern.

Cancer risks were expressed as an excess probability that an individual will dev cancer if exposed to a chemical over a lifetime. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) states that acceptable risks lie bet 10-4 and 10-6. For example, a risk expressed as 1.0 x 10-6 means that 1 person

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1,000,000 exposed people may develop cancer over a lifetime of exposure to the s chemicals at the site.

Three exposure scenarios were evaluated: the current worker, the future worker, the future resident. These scenarios were evaluated on the basis of cancer and noncancer risks for all significant pathways of exposure.

The COPCs for Site D are presented in Table 10. The total HI and cancer risk fo pathway for the future residential scenario are shown in Table 11. The primary chemicals of concern contributing to the total risk at Site D are 2,4,6-trinitro 2,4-dinitrotoluene in surface soils, and arsenic in groundwater in the shallow a These risks represent all chemicals detected at the site and include risks for i chemicals that were not eliminated in the background screening step. Although i not possible to screen out all inorganic chemicals in the background screening s on-site concentrations of inorganics were generally consistent with the concentr measured in the area background. HIs and cancer risks associated with naturally occurring area-wide levels of inorganics in soil and groundwater are shown in Ta

The excess noncancer HI (summed across all chemicals and exposure pathways) and excess cancer risk for each scenario for Site D are shown in Table 13. These ri estimates, called incremental risks, do not include risks from metals in the soi groundwater, which were attributed to naturally occurring conditions and are not to previous activities at the site. The total groundwater risks for Site D were predominantly due to naturally occurring levels of background inorganics. Groun

risks in the 10-6 range were associated with bis(2-ethylhexyl) phthalate, a comm laboratory contaminant, and heptachlor, which was detected in 1 sample out of 26 samples.

The incremental HI for noncancer risk at Site D for the hypothetical future resi most conservative) is 5.0, which exceeds the threshold value of 1.0. This incre noncancer risk is due almost entirely to 2,4,6-trinitrotoluene in surface soil. incrementa1 cancer risk for the future resident is approximately 5.0 x 10-5. Ap 70 percent of the incremental cancer risk is due to 2,4,6-trinitrotoluene and 2, dinitrotoluene in soil. The remainder of the incremental cancer risk is attribu infrequent detections of heptachlor and bis(2-ethylhexyl) phthalate in groundwat PAH compounds in sediments.

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Table 10
Reasonable Maximum Exposure Concentrations
for Chemicals of Potential Concern-Human Health Evaluation

Chemical	Surface Water (mg/L)	Soil/Sediment 0 to 3 feet (mg/L)	Soil/Sediment 0 to 12 feet (mg/L)	Shallow Unfiltered Groundwater (mg/L)
Ordnance Compounds				
2,4-Dinitrotoluene	0.00006	3.7	2.0	ND
2,6-Dinitrotoluene	0.00045	0.35	0.19	ND
Nitrobenzene	ND	0.075	0.075	ND
Pricramic acid	ND	0.064	0.051	ND
Picric acid	ND	0.29	0.17	ND
RDX	0.004	0.43	0.24	ND
1,3,5-Trinitrobenzene	0.0043	0.21	0.14	ND
2,4,6-Trinitrotoluene	0.0045	530	280	ND
Volatile Organic Compounds				
Acetone	0.0084	0.11	0.047	0.009
Benzene	0.0026	0.002	0.002	ND
2-Butanone	ND	0.005	0.005	ND
Chlorobenzene	0.0025	0.003	0.003	ND
Chloroform	ND	0.0054	0.0038	ND
Dibromochloromethane	0.002	ND	ND	ND
Ethylbenzene	ND	0.003	0.003	ND
4-Methyl-2-pentanone	ND	ND	0.0074	ND
Methylene chloride	0.0048	0.015	0.0086	0.0088
Styrene	0.0026	ND	ND	ND
Tetrachloroethene	0.002	0.0059	0.004	ND

Toluene	0.0027	0.0054	0.0037	ND
1,1,1-Trichloroethane	0.0009	0.0068	0.0042	ND
Trichloroethene	ND	0.001	0.003	ND
Xylenes	0.0028	0.0055	0.0037	ND
Semivolatile Organic Compounds/Pesticides				
Benzo(a)anthracene	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	0.19	0.19	ND
Benzo(k)fluoranthene	ND	0.096	0.096	ND
Benzo(a)pyrene	ND	ND	ND	ND

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Table 10 (Continued)
Reasonable Maximum Exposure Concentrations
for Chemicals of Potential Concern-Human Health Evaluation

Chemical	Surface Water (mg/L/)	Soil/Sediment 0 to 3 feet (mg/L)	Soil/Sediment 0 to 12 feet (mg/L)	Shallow Unfiltered Groundwater (mg/L)
Benzoic acid	0.001	ND	ND	ND
Butylbenzylphthalate	0.0006	ND	ND	0.002
Chrysene	ND	0.09	0.09	ND
4,4'-DDT	ND	ND	ND	ND
Di-n-butylphthalate	0.001	0.68	0.47	0.002
Diethylphthalate	0.0009	ND	ND	ND
1,3-Dinitrobenzene	ND	0.19	0.14	ND
Di-n-octylphthalate	0.006	0.25	0.42	0.00003
Bis(2-ethylhexyl) phthalate	0.0063	0.63	0.44	0.041
Fluoranthene	ND	ND	ND	ND
Heptachlor	ND	ND	0.01	0.000036
Naphthalene	0.004	ND	ND	ND
N-Nitrosodiphenylamine	ND	0.87	0.55	ND
Pentachlorophenol	0.001	ND	ND	ND
Phenanthrene	ND	ND	ND	ND
Phenol	0.002	ND	ND	ND
Pyrene	0.001	ND	0.36	ND
Metals				
Antimony	ND	6.5	4.5	ND
Arsenic	0.0047	8.9	5.8	0.0093
Barium	0.19	230	130	0.14
Beryllium	0.0011	0.24	0.21	<Background
Cadmium	0.0012	2.2	1.1	ND

Chromium	0.03	33	31	<Background
Cobalt	0.011	7.5	7.7	<Background
Copper	0.051	150	76	0.049
Cyanide	ND	1.2	1.2	ND
Lead	0.013	78	36	<Background
Manganese	0.46	400	330	0.5
Mercury	0.00019	0.19	0.12	0.00018
Nickel	0.063	38	44	0.1

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Table 10 (Continued)
Reasonable Maximum Exposure Concentrations
for Chemicals of Potential Concern-Human Health Evaluation

Chemical	Surface Water (mg/L)	Soil/Sediment 0 to 3 feet (mg/kg)	Soil/Sediment 0 to 12 feet (mg/kg)	Shallow Unfiltered Groundwater (mg/L)
Selenium	0.0058	0.43	0.37	0.01
Silver	0.0011	2.0	1.3	<Background
Thallium	ND	ND	ND	0.006
Vanadium	0.036	46	41	<Background
Zinc	0.13	230	120	<Background

Notes:
mg/L - milligrams per liter
mg/kg - milligrams per kilogram
ND - not detected
< Background - concentration less than background concentration

Table 11
Total Hazard Index and Cancer Risk for Site D for Future Resident

Exposure Pathway	Hazard Index	Cancer Risk
Incidental soil ingestion	2.3	1 in 27,000 (3.7 x 10-5)
Dermal contact with soil	2.7	1 in 50,000 (2.0 x 10-5)
Ingestion of groundwater	6.0	1 in 5,000 (2.0 x 10-4)
Inhalation of groundwater	<0.1	1 in 5,900,000 (1.7 a 10-7
Dermal contact with surface water	<0.1	1 in 2,000,000 (5.1 x 10-7
Total risk	11.0	1 in 4,000 (2.6 x 10-4)

Table 12
Total Hazard Index and Cancer Risk for Naturally Occurring Inorganic Compounds Detected in Area Background Samples

Scenario	Hazard Index	Cancer Risk
Current worker	<0.1	1 in 3,800,000 (2.6 x 10-7
Future worker	3.0	1 in 10,000 (9.7 x 10-5)
Future resident	8.6	1 in 5,000 (2.1 x 10-4)

Table 13
Total Incremental Hazard Index and Cancer Risk for Site D

	Hazard Index			Cancer Risk	
Scenario	Total	Primary Contributorsa		Total	Pri Contr
Current worker	0.5	2,4,6-trinitrotoluene	0.4	3.6x 10-4	2,4,6-trinitroto
Future worker	1.3	2,4,6-trinitrotoluene	1.2	1.1 x 10-5	2,4,6-trinitroto
					2,4-dinitrotolue
					bis(2-ethylhexyl)phthal
Future resident	5.0	2,4,6-trinitrotoluene	4.7	5.0 x 10-5	2,4,6-trinitroto
					2,4-dinitrotolue
					benzo(b)fluorant
					benzo(k)fluorant
		beryllium		1.4 x 10-6	
					bis(2-ethylhexyl
		chrysene		1.0 x 10-6	
					heptachlor

aIncludes those chemicals contributing a Hazard Index of 0.1 or greater
bIncludes those chemicals contributing a cancer risk of 1.0 x 10-6 or greater

Note: The incremental risks in this table represent only site-related chemicals by naturally occurring inorganic chemicals are not included.

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7.2 ECOLOGICAL RISK ASSESSMENT

The purpose of the ecological risk assessment was to determine potential toxicol threats that chemicals released into the environment at Site D may pose to sensi ecological receptors. For purposes of the ecological risk assessment, Site D wa separated into two areas: the burn trench and the main area. This ecological assessment encompassed both areas.

The approach to the ecological risk assessment followed both federal (U.S. EPA 1 1989a, 1989b, l990, 1992a) and Washington State (Ecology 1991) guidance. Exposu modeling was used to evaluate potential risks. Exposure models use results of c analysis, chemical biotransfer factors, and exposure factors to provide conserva estimates for receptors. Estimated doses are compared with conservative toxicit reference values (TRVs) to evaluate potential risks. There is considerable unce associated with exposure modeling, because the biotransfer and exposure factors unique to the site.

The ecological assessment evaluated potential risks from two matrices: surface surface water. Most of Site D is characterized as seasonal wetlands with satura nearly saturated soil during periods of high precipitation. Because of the mini aquatic habitat associated with this site, aquatic populations are limited to am This ecological assessment focused exposure modeling on terrestrial species.

Table 14 lists the ecological COPCs for soils and surface water and their associ RME concentrations. Because the ecological risk assessment uses exposure assump different from the human health risk assessment, the ecological RME concentratio somewhat different from the human health RME concentrations. These chemicals we used for the exposure modeling for the Townsend's vole, the black-tailed deer, t tailed weasel, and the northern pygmy owl.

Table 15 shows the results of the exposure modeling for hazard quotients (HQs) g than 1.0. The Townsend's vole had HQs greater than 1.0 for aluminum, cadmium, copper, lead, zinc, 1,3,5-trinitrobenzene, 2,4,6-trinitrotoluene, and 2,4-dinitr TRVs for aluminum, copper, lead, and zinc were based on the most toxic form of t metals known. Because the chemical forms of metals were not determined, it was difficult to ascertain the potential risks these metals pose. With the possible cadmium, the metals are not likely to be on site in their most toxic form; thus, not pose significant risks.

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Table 14
Chemicals of Potential Concern-Ecological Evaluation

Chemical	Soil RME Concentration (mg/kg)	Surface Water RME Concentration (mg/L)
Metals		
Aluminum	15,900	10.1
Antimony	6.96	N/A
Arsenic	9.35	N/A
Barium	536	0.94
Cadmium	6.22	0.0012
Chromium	34.5	0.03
Cobalt	8.91	0.011
Copper	301	0.051
Mercury	0.21	0.00019
Nickel	45.1	N/A
Selenium	N/A	0.0058
Silver	N/A	0.0011
Vanadium	53.3	0.036
Zinc	447	0.132
Ordnance Compounds		
2,4-Dinitrotoluene	8.44	N/A
2,6-Dinitrotoluene	1.16	N/A
1,3,5-Trinitrobenzene	0.742	N/A
2,4,6-Trinitrotoluene	2,830	N/A
Volatile Organic Compounds		
Tetrachloroethene	0.0048	N/A

Notes:
RME - reasonable maximum exposure
mg/kg - milligrams per kilogram
N/A - not considered a chemical of potential concern in this medium

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Table 15
Hazard Quotients Greater Than 1.0 for Ecological Receptors

Chemical	Townsend's Vole	Black-Tailed Deer	Long-Tailed Weasel	Northern Pygmy Owl
Metals				
Aluminum	1.46		2.27	2.24

Cadmium	5.06		
Copper	3.49		
Lead	1.55		3.03
Vanadium			1.39
Zinc	1.42		
Ordnance Compounds			
1,3,5-Trinitrobenzene	3.35		
2,4,6-Trinitrotoluene	1,830	21.8	1.87
2,4-Dinitrotoluene	5.69		

The three ordnance compounds (1,3,5-trinitrobenzene, 2,4,6-trinitrotoluene, and dinitrotoluene) were found to pose risk to the vole. Methods for determining bioconcentration factors (BCFs) were not developed using ordnance compounds and, thus, may not apply. However, ordnance compounds were found at concentrations t would require substantial changes in the BCFs to reduce the HQ to less than 1.0.

Thus, the ordnance compounds may pose threats to small mammalian herbivores and carnivores. The compound 2,4,6-trinitrotoluene was found at such an elevated concentration around the burn trench that deer using the area less than 1 percen time still would receive doses that substantially exceed HQs of 1.0.

7.3 UNCERTAINTY ANALYS1S

Sources of uncertainty identified in this risk assessment are summanzed in Table For each source of uncertainty, the following are noted: the possible effect on

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Table 16
Summary of Uncertainties in the Risk Assessment Approach
and Site-Specific Characteristics

Source of Uncertainty	Directiona	Magnitudeb	
Data Evaluation			
Identification of COPCs present at the sites	-	1	Used site-sampling work plan and focus samp efforts
Quality of analytical data	+/-	1	Used qua
Esposure Assessment			
No attenuation of chemical concentration	+	1	Conserva would ta
Exposure assumptions	+/-	2	Used sta evaluate
Experimental dermal absorption rates	+/-	2	Preferen

Theoretical dermal absorption rate	+/-	3	Evaluate for comp
Toxicity Assessment			
Failure to include all chemicals because of lack of toxicity values	-	2	Used sur
Extrapolation from animal studies to human toxicity	+	3	Used con factors
Lack of chemical-specific dermal toxicity values	-	2	Used una surrogat
Risk Characterization			
Assumption of additive interactions	+/-	2	Assumed
Site-Specific Uncertainties			
Future development of the site for industrial or residential purposes	+	3	Assumed site's d classifi site dev
Future site (e.g., residential use the shallow aquifer as a drinking water source)	+	2	Assumed would oc
Delineation of hot spot	+/-	1	Used sta hot spot
Grouping of samples for sitewide evaluation	+	2	Evaluate sets for
Use of biokinetic model (i.e., calculating total risk rather than incremental risk)	+	1	Used mod

aDirection of effect: + = potentially overestimate risk
- = potentially underestimate risk

bMagnitude of
3 = large effect

Notes:
COPC - chemical of potential concern
RME - reasonable maximum exposure

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estimate (i.e., underestimation or overestimation), the degree of such effect, a steps taken to mitigate the uncertainty.

7.3.1 Data Evaluation

COPCs were identified by using the analytical data from the RI. Confidence in t results presented in the risk characterization depend on the quality of the anal obtained during the RI. All analytical data used in the risk assessment were va ensure accuracy. Quality assurance aspects of the environmental sampling data w discussed in Section 4.0 of the RI/FS (URS 1993). In general, most analytical m

produce results with an accuracy range of 10 to 20 percent.

Risk estimates presented for the sitewide evaluation may be biased high, because higher density of samples was obtained from the hot spot than from the main area overweights the samples from the hot spot and results in exposure-point concentr that are biased high.

Sample station distribution and coverage indicate that Site D is well characteri the nature and extent of chemical distribution. However, there is a lack of dat intermediate and sea-level aquifers.

7.3.2 Exposure Assessment

Several uncertainties associated with the exposure assessment affect the risk es the most important of which are summarized as follows:

For the purposes of statistical calculations, quantitation limits f undetected values were divided by two (in cases where the chemical detected at least once in that medium). This practice may underest or overestimate the true average value.

Although current exposure levels are based on measured concentratio the media of concern, these values are uncertain because of limited sampling and analytical variation. To account for this, the 95 per upper confidence limit (UCL) of the mean concentration values and t average values were used in dose calculations. Using the 95 percen in risk assessments is likely to result in an overestimate of the a average dose.

Chemical concentrations that could occur under the future land-use scenario are highly uncertain. Chemical concentrations in soil to of 12 feet below ground surface were included in the data set for f land use. The 95 percent UCL of the mean of the soil concentration the depth of 0 to 12 feet below ground surface may result in an underestimate or overestimate of actual dose.

Chemical concentrations in all media for future use were assumed to the same as current concentrations, with no adjustment due to dilut biodegradation, or volatilization. This assumption is reasonable f inorganic COPCs (metals); however, for organic COPCs it may result overestimate of site risks.

Dermal uptake of chemicals from soil is difficult to estimate becau

value depends on both chemical-specific characteristics of contamin and the soil at the site, which affects the extent of elemental fix desorption, and adsorption to soil particles. The absorption value estimate dermal uptake, particularly when no chemical-specific valu available, are highly uncertain, leading to an overestimate or unde of the dose.

The risk estimates presented in the risk characterization section o RI/FS were calculated using 6 percent dermal absorption for all che The risks were recalculated using 50 percent dermal absorption for trinitrotoluene, 2,4-dinitrotoluene, 2,6-dinitrotoluene, 1,3,5-trin and RDX, whereas all other parameters remained the same.

The 6 percent dermal absorption value was based on experimental dat available for dermal absorption evaluations. This was the highest absorption value reported under conditions similar to actual human exposure. The 50 percent value is based on a theoretical value ass for compounds with low Kàs and low dimensionless Henry's Law consta All risk estimates calculated using dermal exposure values should b considered highly uncertain because of the paucity of data availabl chemical-specific dermal absorption rates. Both approaches to eval dermal exposure (i.e., the experimental and theoretical approaches determining dermal absorption values) result in dermal absorption v

that have not been scientifically validated and may result in an overestimation or underestimation of actual exposure.

The permeability constants used in the derivation of dermal uptake water are not available for all chemicals identified as COPCs and m calculated. This may lead to an overestimate or underestimate of t for these chemicals. According to EPA's Dermal Exposure Assessment Principles and Applications, preliminary testing showed the dermal resulting from a 10-minute shower exceeds the dose associated with drinking 2 L/day for a number of pollutants: "For the fastest pene chemicals the dermal dose was predicted to exceed the ingested dose about two orders of magnitude . . . This seems counterintuitive an concerns that the model may be overly conservative. Lack of data m validation of the model very difficult." (U.S. EPA 1992).

Most of the assumptions in the exposure assessment involved use of default value standardized risk assessment recommended for EPA Region 10 (U.S. EPA 1991a). Uncertainties regarding exposure assumptions stem from the natural variabilities parameters such as body weight or soil ingestion rate, as well as from insuffici

the distribution of these parameters.

7.3.3 Toxicity Assessment

EPA policy states, ". . . as a matter of science policy, the study of the most s species (the species showing a toxic effect at the lowest administered dose) is the critical study for the basis of the RfD" (U.S. EPA 1989). This may overesti underestimate the actual risks to humans of the lack of empirical human toxicity data.

The prediction of potential human health effects likely to occur following expos given dose of a chemical is imprecise because of the many uncertainties in toxic information on dose-response relationships. The quantity of toxicity informatio chemicals evaluated is typically limited, with correspondingly varying degrees o uncertainty associated with the calculated toxicity values.

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Sources of uncertainty associated with toxicity values include the following:

- Using dose-response information from effects observed at high doses predict the potential adverse health effects from exposure to the l expected from human contact with the agent in the environment

- Using dose-response information from short-term exposure studies to predict the effects of long-term exposures and vice versa

- Using dose-response information from animal studies to predict effe humans

- Using dose-response information from homogeneous animal populations predict the effects likely to be observed in a general population c of individuals with a wide range of sensitivities

Uncertainty factors for most of the RfD values are in the range of 100 or 1,000, indicating considerable uncertainty regarding the actual value of the RfD. For the uncertainty factor for oral RfDs for 2,4,6-trinitrotoluene is 1,000. This h uncertainty factor allows for uncertainties in laboratory animal to human dose extrapolation, interindividual sensitivity, subchronic to chronic extrapolation, observed adverse effects level to no observed adverse effects level extrapolatio other hand, the uncertainty factors for the oral RfDs for arsenic, barium, manga silver are less than 10, indicating little uncertainty regarding the actual valu RfDs.

Two of the carcinogens (cancer-causing chemicals) evaluated in the human health

assessment (arsenic and chromium VI) are classified as Group A, known human carcinogens. There is little uncertainty regarding the carcinogenicity of these in humans.

Most of the remainder of the carcinogens are classified as Group B2, probable hu carcinogens. Whereas there is no evidence of carcinogenicity in humans, there i sufficient evidence in animals. There are a number of uncertainties regarding e of carcinogenicity based on animal tests. One is the use of maximum tolerated d that cause cellular damage, which increases the rate of cell growth during repai processes. High rates of cell growth tend to increase the potential for carcino effects as a result of the exposure. Another source of uncertainty is the assum

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all chemicals that are carcinogenic in animals are also carcinogenic in humans. chemicals classified as Group B2, lack of evidence of carcinogenicity in humans considerable uncertainty in the cancer risk estimates.

The assumption that response is linear with respect to dose and that there is no threshold for induction of cancer are important sources of uncertainty. Current suggest that carcinogens may act by several different mechanisms, which could re more than one type of dose-response curve. Currently, however, data are inadequ support more detailed assumptions regarding dose-response. The uncertainties associated with carcinogenic slope factors (CSFs) make the greatest contribution total uncertainty of a cancer risk estimate.

The CSF for benzo(a)pyrene was used as a surrogate for all polycyclic aromatic hydrocarbon (PAH) compounds that are considered carcinogenic. Because benzo(a)pyrene may be the most potent carcinogenic PAH, aggregating carcinogenic PAHs in this fashion may serve to overestimate risks. However, until more toxic are available on these contaminants, it is not possible to conduct more chemical evaluations.

Risks associated with dermal contact with soils were evaluated for only a limite of contaminants. Because metals are not easily absorbed through the skin, the d route was not evaluated for metals. In addition, the uncertainty concerning der and CSFs is high because of the lack of chemical-specific dermal toxicity inform

No RfD or CSF is currently available for lead. Therefore, the LEAD5 model was u to evaluate potential exposure to lead. This model provides a conservative esti risk because it evaluates exposure to the most sensitive subpopulation.

7.3.4 Risk Characterization

The factors that contribute uncertainty to the estimates of exposure concentrati

intakes, and toxicity information also contribute uncertainty to the estimates o
and noncancer risks. These factors include the following:

- Chemicals not included
- Exposure pathways not considered

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- Derivation of exposure-point concentrations
- Intake uncertainty
- Toxicological dose-response and toxicity values

When values for cancer and noncancer risk are summed across chemicals, it is ass
that the chemical-specific carcinogenic and noncarcinogenic effects are independ
additive. Actually, these effects may interact to produce a less-than-additive
(antagonistic) or a more-than-additive effect (synergistic). Unfortunately, dat
chemical interactions are lacking for most chemical mixtures. In the absence of
specific toxicity data, the assumption of additivity is a standard approach. Th
result in an overestimate or underestimate of the cancer and noncancer risks.

The standard approach for evaluating potential health risks at a site is to calc
incremental risks (i.e., the risks attributable to site-related contamination an
risks attributable to background sources). The results of the LEAD5 model take
account other sources of lead (e.g., lead present in food). The model provides
estimate of the blood lead concentration resulting from background and site expo
lead. This may lead to an overestimation of risk.

Elevated human health risks were predicted for metals in groundwater. These ris
considered representative of background, and exposure is not likely for the foll
reasons:

- The history of the site indicates that the COPCs expected to contri
most of the risk are ordnance compounds and semivolatile organic
compounds. No information exists to indicate that the metals in
groundwater are attributable to site activities.

- The sea-level aquifer is used in the region for drinking water. An
drinking water at the site will most likely be obtained from this a

- Concentrations of metals in groundwater at Site D are comparable to
background and regional background (i.e., Kitsap County) concentrat

8.0 REMEDIAL ACTION OBJECTIVES

Actual or threatened releases of hazardous substances from this site, if not add implementing the response action selected in this ROD, may present a hazard to h health or the environment.

The results of the baseline risk assessment indicate some human health risk to c industrial workers, hypothetical future industrial workers, and hypothetical fut residents. Potential ecological effects on small burrowing mammals and deer are predicted if soil contamination is unabated. Based on the risk assessment resul contamination at Site D exceeds established health-based thresholds. Consistent EPA's NCP and EPA policy, remedial action is warranted to address these potentia to human health and the environment and to address those areas where chemicals exceed state standards. The following sections present the remedial action obje (RAOs) for soil, surface water, and groundwater at Site D.

8.1 SOILS

The human health risk assessment identified excess carcinogenic risks exceeding and excess non-carcinogenic hazard indexes exceeding 1.0 associated with COPCs i The compounds 2,4,6-trinitrotoluene and 2,4-dinitrotoluene are the COPCs present highest concentrations and quantities in soil and contribute more than 70 percen total excess cancer risk at Site D, based on the future residential scenario. E 2,4,6-trinitrotoluene in soil accounts for greater than 95 percent of the total noncarcinogenic risks. The exposure routes of concern are ingestion and dermal with soil. The ecological risk assessment concluded that the compounds 1,3,5-trinitrobenzene, 2,4,6-trinitrotoluene, and 2,4-dinitrotoluene may pose risks to mammals and the black-tailed deer.

The ordnance compounds of concern were detected in surface and subsurface soils burn trench area in the top 3 feet of the soil column and in surface soil at gri G-1 and M-12 at concentrations that pose a significant risk to human health and environment and exceed state cleanup criteria (Figure 12).

The RAO identified for soils at Site D is to prevent unacceptable current and po future risks to human health and the environment that are posed by ingestion and

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dermal contact with 2,4,6-trinitrotoluene and 2,4-dinitrotoluene. Response acti achieve the RAO for soils include treatment of the soils to remove these ordnanc compounds.

In developing the remedial goals for soils, consideration was given to the poten impacts of the remediation on the environment at Site D. Washington State Model Toxics Control Act (MTCA) Method B cleanup levels for 2,4,6-trinitrotoluene were applied for the entire site because the concentration of 2,4,6-trinitrotoluene e MTCA Method B cleanup levels in two distinct areas of contamination. However, 2 dinitrotoluene is widely distributed across the site at concentrations exceeding Method B cleanup levels. Approximately 1.4 acres are potentially affected withi wetlands boundary. Therefore, a remedial action to attain MTCA Method B cleanup levels for 2,4-dinitrotoluene within the wetlands would result in significant da existing wetlands ecosystem. In keeping with MTCA requirements (WAC 173-340-706 MTCA Method C cleanup levels will be applied to the cleanup of 2,4-dinitrotoluen within the wetlands boundary to minimize ecological damage to the wetlands.

The following remedial goals have been defined for soils at Site D.

> Remediate all soils at Site D that contain 2,4,6-trinitrotoluene at concentrations exceeding the MTCA Method B cleanup level (33.3 mg/k
>
> Outside the wetlands boundary, remediate soils that contain 2,4-dinitrotoluene at concentrations exceeding the MTCA Method B cleanu level (1.47 mg/kg). Within the wetlands boundary, apply the MTCA Method C cleanup level (58.8 mg/kg) to 2,4-dinitrotoluene.
>
> For all soils that are remediated, attain MTCA Method B cleanup lev for 2,4,6-trinitrotoluene and related ordnance compounds, induding dinitrotoluene and 2,6-dinitrotoluene. The soil treatment levels a presented in Table 17.

Attaining the remedial goals for ordnance compounds in soils will reduce the sit reasonable maximum exposure concentrations such that excess carcinogenic risks t human health will be in the 10-6 range, and excess noncancer hazard indexes will than 1.0. Residual human health risks in soils will be primarily attributable t ordnance concentrations in soils and concentrations of PAH compounds detected in sediments on site and upgradient of Site D.

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Table 17
Soil Treatment Levels for 2,4,6-Trinitrotoluene and
Related Ordnance Compounds

Compound	MTCA Method B Cleanup Level (Corresponds to 1.0 x 10-6 Cancer Riska,b) (mg/kg)
2,4,6-Trinitrotoluene	33.3
2,4-Dinitrotoluene	1.5
2,6-Dinitrotoluene	1.5
Nitrotoluenec	800
1,2-Dinitrobenzene	32
1,3-Dinitrobenzene	8
1,4-Dinitrobenzene	32
Trinitrobenzened	4
Nitrobenzene	40

aCumulative risk from all ordnance compounds remaining in treated soil shall no
1.0 x 10-5.
bRisk calculated from MTCA Method B equations
cIncludes all isomers
dNoncarcinogen, i.e., cleanup level based on hazard index of 1.0

Hazard quotients for ordnance compounds will be reduced to less than 1.0 for all ecological receipts except the Townsend's vole. The hazard quotient for the Tow vole will be reduced approximately by a factor of 100, with the residual risk be attributed mainly to 2,4,6-trinitrotoluene. Applying the MTCA Method C cleanup to 2,4-dinitrotoluene in the wetlands boundary will also contribute to the resid the Townsend's vole.

Figure 12 shows the areas at Site D in which the concentrations of ordnance comp in surface soil exceed the remedial goals. Based on these objectives, 880 cubic (1,200 tons) of soil will require remediatiom. The area near the burn trench is approximately 60 by 125 feet and will be excavated to a depth of 2 to 3 feet. T areas at grid locations G-1 and M-12 are assumed to be approximately 25 by 25 fe will be excavated to a depth of 1 foot. The excavation depth estimates are base

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results of subsurface borings. Actual excavation umits at any given location wi
on confirmation sampling during excavation.

8.2 SURFACE WATER

The human health and ecological risk assessments did not identify significant ri
associated with COPCs in surface water. However, arsenic, copper, mercury, thal
and zinc exceeded regulatory criteria in surface water samples collected from Si
discussed in Section 6.0, each of these chemicals exceeded in one or two samples
32 samples collected. Arsenic also exceeded regulatory criteria in surface wate
collected upgradient of Site D.

Under MTCA, Method B cleanup levels are established to be at least as stringent
concentrations established under state and federal laws. Thus, exceedances of t
Washington State Water Quality Standards (WAC 173-201A) and Clean Water Act
Ambient Water Quality Criteria (33CFR330) are considered to be exceedances of
MTCA Method B surface water cleanup levels.

No source has been identified for the exceedances of MTCA Method B cleanup level
for metals in Site D surface water. Of these metals, only arsenic was detected
concentrations exceeding MTCA Method B soil cleanup levels, in three out of 74
samples. The locations of the arsenic exceedances in soil do not correspond to
locations of the arsenic exceedances in surface water. Stormwater runoff from E
Road may contribute to the detected concentrations of metals in surface water at
Arsenic, copper, lead, and zinc have been shown to be present at elevated levels
stormwater runoff (Metro 1982).

Wetlands are known to remove heavy metal pollutants in surface water (Chan 1982,
Greeson 1979). Removal mechanisms include sedimentation, adsorption, filtration,
vegetative uptake. These mechanisms likely occur at Site D, as evidenced by the
that none of the metals detected in Site D surface water exceeded MTCA Method B
cleanup levels in downgradient surface water.

Lead and bis(2-ethylhexyl) phthalate exceeded regulatory criteria in surface wat
samples collected downgradient or cross-gradient from Site D. As discussed in S
6.0, each of these chemicals exceeded regulatory criteria in one or two samples
samples collected. Lead and bis(2-ethylhexyl) phthalate do not appear to be rel

site activities. Dissolved lead was not detected in Site D surface water and bi
ethylhexyl) phthalate did not exceed MTCA Method B cleanup levels on site. Othe
sources may exist for the detected cross-gradient and downgradient exceedances,
bis(2-ethylhexyl) phthalate may have been introduced in the samples as a laborat

contaminant. Since the affected off-site sampling stations (DSW-06, DSW-08, and 09) receive runoff from areas outside of the study area, the single detection of the two exceedances of bis(2-ethylhexyl) phthalate in off-site surface water can attributed to Site D.

In summary, active remediation of surface water at Site D to address exceedances MTCA Method B cleanup levels is not practicable for the following reasons:

No COPCs in surface water were identified in the human health or ecological risk assessments as posing significant risks (URS 1993).

No source area has been identified for the metals found in Site D s water, although stormwater runoff from Escolar Road may contribute the metals concentrations.

No transport of metals is occurring from Site D to downgradient sur water. The wetlands area of Site D provides natural attenuation of concentrations.

Active remediation within the wetlands, where the majority of surfa water regulatory exceedances occurred, is likely to cause loss of h greater short-term and long-tenn environmental risk compared to cur risks.

The RAO identified for surface water at Site D is to prevent migration of metals Site D surface waters in quantities that may adversely affect ecological recepto downgradient surface waters. Because the Site D wetlands currently attenuate th metals concentrations, the response actions for surface water are limited to ins controls (specifically confirmation sampling). However, if the results of the c sampling indicate that regulatory criteria are exceeded in downgradient surface due to transport of contaminants from Site D, response actions including active remediation will be considered, if feasible.

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8.3 GROUNDWATER

8.3.1 Perched Aquifer

Groundwater in the perched aquifer is not a potential future source of drinking The human health and ecological risk assessments concluded that it does not pose unacceptable risks when it is manifested as surface water through seeps. Theref regulatory criteria are exceeded and no RAOs are identified for groundwater in t perched aquifer.

8.3.2 Shallow Aquifer

The human health risk assessment concluded that risks due to ingestion or inhala shallow aquifer groundwater are almost entirely due to naturally occurring conce of inorganics. For organic compounds, regulatory criteria were exceeded in the aquifer for benzene in one sample upgradient of Site D, for tetrachloroethene in sample upgradient and one sample downgradient of Site D, and for heptachlor in o sample within Site D. Methylene chloride and bis(2-ethylhexyl) phthalate, commo laboratory contaminants, exceeded regulatory criteria in 5 out of 26 samples and 26 samples, respectively. No sources for the exceedances have been identified. characterization of the shallow aquifer is warranted to address these exceedance regulatory cateria. Accordingly, the RAO established for the shallow aquifer is prevent potential future risks to human health that may be caused by ingestion o inhalation of COPCs in shallow aquifer groundwater. Response actions to meet th RAO include:

Short-term monitoring for volatile organic compounds (VOCs) in the shallow aquifer to verify exceedances of health-based criteria

Further characterization of the shallaw aquifer to determine the na extent of contamination, if confirmed by the short-term monitoring

If exceedances of health-based criteria are confirmed, active remed shallow groundwater will be considered.

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9.0 DESCRIPTION OF ALTERNATIVES

Three areas at Site D have concentrations of ordnance compounds in surface soil require remedial action. The principal applicable or relevant and appropriate requirement (ARAR) for these remedial actions is MTCA, which lists cleanup stand Three alternatives were evaluated as possible remedial actions.

9.1 ALTERNATIVE 1: NO ACTION

Alternative 1 is included for comparison purposes under CERCLA. This alternativ would not require any action. No treatment, storage, or containment of waste wo occur.

Monitoring would be conducted for the chemicals of concern in groundwater in the shallow aquifer and in surface water. The monitoring program would consist of t following components:

Confirmation sampling of on-site and downgradient surface water for metals would be conducted to assess any transport of surface water contaminants from Site D.

Short-term monitoring for VOCs in the shallow aquifer would be conducted, using existing monitoring wells, to confine previous exc of health-based criteria. If confirmed, long-term monitoring for V the shallow aquifer would be conducted.

CERCLA requires a review at least every 5 years if the selected remedial action in some untreated contamination. This review is also required under MTCA (WAC 1 340-420) because exceedances of Method B cleanup levels will remain on site. Th reviews are conducted to ensure that human health and the environment are protec (CERCLA, Section 121). The results of the review would be used to determine whe additional ongoing monitoring is required. A detailed monitoring program would developed in the remedial design.

Alternative 1 does not sufficiently protect human health or the environment, nor meet state and federal regulations for Site D. It does not remove or remediate

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contaminants detected in the surface soils at Site D and, therefore, results in human health and the environment.

9.2 ALTERNATIVE 2: INCINERATION

Incineration is a proven technology that would permanently destroy the highest concentrations of contaminants at Site D, thereby protecting human health and th environment. This alternative includes excavation of approximately 1,200 tons o contaminated soils with conventional excavation equipment, testing of the soils excavation to verify removal of contaminants to an acceptable level, on-site inc testing of incinerated soils to confirm effectiveness, and replacement of the in soils in the excavation. The disturbed area would then be covered with clean to graded, and revegetated. Monitoring of groundwater and surface water would be required. The components of Alternative 2 are described in detail in the follow sections.

9.2.1 Excavation

A detailed excavation plan would be developed before soil removal has started. plan would describe the configuration and quantity of contaminated material (inc soil, debris, vegetation, etc.), the methods to be used to excavate the soil, th be used for staging and stockpiling the soils, the methods for loading the haul

decontamination procedures, and the requirements for personnel protection and he and safety monitoring. The excavation plan would include an environmental prote plan.

Sampling would be performed during excavation to ensure that all contaminated so exceeding the RAOs are removed and remediated. The excavation plan would includ verification sampling and data analysis plan defining statistical methods to ver attainment of RAOs. Appropriate statistical methods would be used to determine required number of verification samples. The actual number of samples would var based on field conditions.

Proper erosion and drainage controls would be implemented during on-site remedia action work to protect any wetlands. Disturbed areas would be restored after th treatment is complete.

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9.2.2 Stockpiling

A staging area would be constructed on or near Site D for excavated soils. The location of the staging area would be verified in the remedial design. Soils aw treatment would be staged in bermed and lined stockpiles in the staging area.

9.2.3 Process Description

A mobile rotary kiln incinerator would be mobilized to the site. The incinerati process uses a controlled, enclosed environment to reduce the levels of contamin the soils by combusting the soils at high temperatures (approximalely 1,600 to 2 The process permanently destroys organic contaminants, converting them into stab inorganic compounds such as carbon dioxide and water.

Incineration involves the following basic steps:

- Contaminated soil is fed into the incinerator as a fuel source (typ an auxiliary fuel)
- Soils are burned, destroying organic compounds and yielding residua products in the form of dust and gases
- Treated soils are cooled and stockpiled for use as backfill
- Residual gases are cooled, cleaned, and released to the atmosphere

Incineration would provide nearly complete destruction of ordnance compounds. Possible treatment residuals from incinerator operations include dust and/or scr

water from the off-gas treatment system. Treatment residuals generated from the incinerator would be analyzed and disposed of in accordance with applicable regu

9.2.4 Operating Parameters

Site Requirement

Sufficient area is needed for the incineration system, the feed and auxiliary fu area, and the treated soil stockpile. In addition, space is required for decont spare parts storage, and other auxiliary equipment. Portions of the site may be

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and others covered with asphalt. A surface area of approximately 0.5 acre would required for the incineration site. Construction of access roads to the inciner may be necessary. Fencing and signs would be required around the treatment site limit access.

Utility requirements for a mobile incinerator include a continuous water supply electrical service.

Backfilling of Treated Soil

The treated soil would be tested for ordnance compounds to verify the effectiven the treatment in achieving RAOs and treatment standards, and then used to backfi excavated areas. Treated soil would be devoid of any organic content and would conducive to plant growth. Therefore, the disturbed area would be covered with minimum of 1 foot of clean soil. Additional clean fill may be required to retur to natural contours under the incineration alternative because of an approximate percent reduction in volume. The area would be revegetated with native plants.

The treatment system would be removed and the treatment area returned to natural contours and revegetated. Any access roads required for construction of the tre system, along with the existing access road constructed during the RI at Site D, removed and returned to natural contours and revegetated.

Implementation Tim

After completion of the remedial design and construction of necessary facilities incineration process is expected to take approximately 2 weeks.

9.2.5 Incineration ARARs

Incineration will require meeting the substantive permit requirements, including and performance criteria. Requirements are set forth in the Clean Air Act (40 C

and WAC 173-460, and in the Puget Sound Air Pollution Control Agency regulations

Excavation and backfilling would be performed in accordance with the health and requirements of the Occupational Safety and Health Administration (OSHA) (29 CFR 1910 and 1926) and the Washington Industrial Safety and Health Administration WISHA) (WAC 296-62 Part P). Under typical conditions, no respiratory protection

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would be required; however, the contractor would use appropriate dust control me and would monitor for airborne particulates. Fugitive dust emissions would be r by the Puget Sound Air Pollution Control Agency.

The chemical and historical information from the RI indicates that excavated soi debris would not be designated as a dangerous or hazardous waste. However, exca soil and debris and any treatment residuals would be evaluated by the Navy to de whether dangerous or hazardous waste is being generated. The evaluation criteri forth in the Washington State Dangerous Waste Regulations (WAC 173-303) and the Resource Conservation and Recovery Act (RCRA) regulations (40 CFR 261).

9.2.6 Monitoring and Review

Under Alternative 2, the monitoring program would consist of the following compo

Confirmation sampling of on-site and downgradient surface water wou conducted following soil remediation. Surface water samples would analyzed for metals to address previous metals exceedances and for ordnance compounds to verify that ordnance compounds were not mobilized during soil remediation activities. If the results of th confirmation sampling indicate that regulatory criteria are exceede downgradient surface waters due to transport of contaminants from S response actions including active remediation would be considered.

Short-term monitoring for VOCs in the shallow aquifer would be conducted, using existing monitoring wells, to confirm previous exc of health-based criteria. If confirmed, further investigations to the source and extent of VOCs in the shallow aquifer would be condu Once characterized, active remediation of the shallow aquifer would conducted, if necessary and feasible.

A review would be conducted within 5 years of implementation of the remedy to evaluate the effectiveness of the remedy and to ensure that human health and the environment are protected. The results of the review would be used to determine whether additional actions or ongoing monitoring is required. A detailed monito program would be developed in the remedial design.

9.2.7 Land-Use Restrictions

Alternative 2 does not include deed restrictions or other administrative limitat future land use. Existing wetlands laws would prevent future development of Sit wetlands.

9.3 ALTERNATIVE 3: COMPOSTING

Composting is an innovative technology that would permanently destroy the highes concentrations of contaminants at Site D, thereby protecting human health and th environment. This alternative includes excavating approximately 1,200 tons of contaminated soil with conventional excavation equipment, testing the soil below excavation to verify removal of contaminants to an acceptable level, on-site com testing the composted soils to confirm effectiveness, and replacing the composte the excavation. The disturbed area would then be covered with clean topsoil gra and revegetated. Monitoring of groundwater and surface water would be required. components of Alternative 3 are described in detail in the following subsections

9.3.1 Excavation

Excavation would be conducted as described under Alternative 2.

9.3.1 Stockpiling

Stockpiling would be conducted as described under Alternative 2.

9.3.3 Process Description

Composting is a biological treatment process by which toxic organics are biodegr less toxic organic and inorganic by-products and heat energy. The heat energy i trapped within the compost matrix, enhancing the microbiological growth rate and the biodegradation rate. Composting is a well-developed technology used commerc to treat garbage, yard and agricultural waste, and wastewater sludges.

Composting can be accomplished by three methods: static pile, mechanically agit vessel (MAIV), and windrow. Static composting was rejected during the screening process of the FS on the basis of effectiveness. Windrow and MAIV composting ar

methods that have been proven effective at treating ordnance-contaminated soils (Weston 1993). Windrow composting has been shown to be as effective as, or supe to, MAIV in biodegrading 2,4,6-trinitrotoluene. The primary difference between composting systems is the technology level required to maintain operating parame order to achieve the desired degradation efficiency. The MAIV method is a highl automated and multistep process with capital and operation and maintenance costs higher than that of the windrow composting process. For these reasons, the wind technology is the preferred process option for Site D soils.

Components of a windrow composting system include an excavated soil staging area material storage area, soil screening and mixing areas, a process water system a electrical service, a front-end loader and dump truck, a treatment pad, a canopy windrow-turning machine.

The first step in the windrow composting process is feed preparation. Before th amendments (additives to promote composting) are added, the excavated soil may n mechanical screening to remove unacceptable debris and large rocks in order to p damage to or interference with the composting process. Rocks and debris would b washed to remove any contaminated particulate. The rocks would be returned to t excavated area and other debris would be properly disposed of in an acceptable o or off-site location. Wastewater would be collected in a leachate collection sy reused in the composting system to maintain a proper moisture content. Vegetati from the remediation area would be chipped and/or shredded, if necessary, and incorporated into the compost piles.

The most effective and least expensive amendments used in previous treatability were manure/alfalfa-based amendments. The exact composition of amendments to be used in composting Site D soils will be determined in the pilot-scale treatabili The most effective soil loading volumes, as a percentage of total composting vol range from 10 to 30 percent. Greater soil volume loadings significantly reduce degradation potential of the ordnance compounds by reducing heat generation. Th pilot-scale treatability study for Site D soils being conducted at Site F will v heat generated within the windrows is sufficient to maintain optimum temperature technical concerns identified in the pilot-scale treatability study will be addr remedial design.

The compost mixture would be prepared by adding soil and amendments to a mixing Multiple bins allow the material to be prepared in stages. The mixture would th

transferred from the bin to a windrow. After a new batch of compost mixture is in a row, a windrow-turning machine would pass over the new compost to fluff, ae and shape the pile. Once established, the windrow would require periodic turnin windrow-turning machine.

No treatment residuals, other than the compost mixture itself, would be generate Treatabilly studies have indicated that a greater than 99 percent reduction in 2 trinitrotoluene concentrations can be readily achieved. Degradation products of trinitrotoluene in the compost mixture, which include monoaminodinitrotoluenes a diaminonitrotoluenes, have limited mobility and significantly lower toxicity tha parent compound.

9.3.4 Operating Parameters

Site Requirement

The composting facility would be sited at SUBASE, Bangor. The primary design parameter for windrow composting is the assumption that the desired degradation achieved for each batch after 7 weeks of treatment. This timeframe has been ver the bench-scale treatability study using soils from Site D. The remediation tim will be verified in the pilot-scale study and may affect the size of the treatme required for window composting. The total area required for windrow composting estimated at 41,000 square feet.

Utility requirements for the composting system include a coniunuous water supply electrical service. Fencing and warning signs would be constructed to limit acc treatment site.

Treatability Stud

In addition to the bench-scale treatability study that has verified the effectiv composting, a pilot-scale treatability study will determine the optimal soil-to- ratio, amendment composition, water requirements, and residence times. This information is required for developing design parameters for a final composting treatment facility.

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Backfilling of Treated Soil

The treated soils would be tested for ordnance compounds to verify the effective

the treatment in achieving RAOs, and then used to backfill the excavated areas. materials in the compost amendment, such as the manure, are expected to decompos within the specified treatment time. However, some of the components may not to decompose during the specified treatment time but are expected to continue to decompose after being placed in the excavated area. This phase of composting is referred to as curing and results in the production of stabilized compost. A st compost requires no additional nutrients to enhance degradation and has a low ox demand. Curing would continue at a slow rate after the materials have been plac the excavation, and the compost would not require continued management. To mini runoff of excess nutrients from curing compost, the backfilled areas would be co with 1 foot of clean soil and revegetated with native plants. The soil cover wo minimize public and environmental exposure to the compost material.

Upon completion, the treatment system would be removed and the treatment area returned to natural contours and revegetated. Any access roads required for construction of the treatment system, along with the existing access road constr during the RI at Site D, would be removed and returned to natural contours and revegetated.

Implementation Tim

After completion of the remedial design and construction of necessary facilities expected time to remediate the soils by composting is 8 months. The operation t may vary seasonally and would depend on the soil condition.

9.3.5 Composting ARARs

Excavation and backfilling would be performed in accordance with the health and requirements of the Occupational Safety and Health Administration (OSHA) (29 CFR 1910 and 1926) and the Washington Industrial Safety and Health Administration (WISHA) (WAC 296-62 Part P). Under typical conditions, no respiratory protectio would be required; however, the contractor would use appropriate dust control me and would monitor for airborne particulates. Fugitive dust emissions would be r by the Puget Sound Air Pollution Control Agency.

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The chemical and historical information from the RI indicates that excavated soi debris would not be designated as a dangerous or hazardous waste. However, exca soil and debris and any treatment residuals would be evaluated by the Navy to de whether dangerous or hazardous waste is being generated. The evaluation criteri forth in the Washington State Dangerous Waste Regulations (WAC 173-303) and the Resource Conservation and Recovery Act (RCRA) regulations (40 CFR 261).

9.3.6 Monitoring and Review

Under Alternative 3, the monitoring program would consist of the following compo

Confirmation sampling of on-site and downgradient surface water wou conducted following soil remediation. Surface water samples would analyzed for metals to address previous metals exceedances, and for ordnance compounds to verify that ordnance compounds were not mobilized during soil remediation activities. If the results of th confirmation sampling indicate that regulatory criteria are exceede downgradient surface waters due to transport of contaminants from S response actions including active remediation would be considered.

Short-term monitoring for VOCs in the shallow aquifer would be conducted, using existing monitoring wells, to confirm previous exc of health-based criteria. If confirmed, further investigations to the source and extent of VOCs in the shallow aquifer would be condu Once characterized, active remediation of the shallow aquifer would conducted if necessary and feasible.

A review would be conducted within 5 years of implementation of the remedy to evaluate the effectiveness of the remedy and to ensure that human health and the enviromnent are protected. The results of the review would be used to determine whether additional actions or ongoing monitoring is required. A detailed monito program would be developed in the remedial design.

9.3.7 Land-Use Restrictions

No deed restrictions or other administrative limitations on future land use are in Alternative 3. Existing wetlands laws would prevent future development of Si wetlands.

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10.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The EPA has established nine criteria for the evaluation of remedial alternative

Overall protection of human health and environment-whether a remedy provides adequate protection and how risks posed through each pathw are eliminated, reduced, or controlled through treatment engineerin controls or institutional controls

Compliance with ARARs-whether a remedy will meet all of the ARARs of other federal and state environmental statutes and/or provide gr for invoking a waiver

Long-term effectiveness and permanence-the magnitude of residual ri
and the ability of a remedy to maintain reliable protection of huma
and the environment over time once cleanup goals have been met

Reduction of toxicity, mobility, or volume through treatment-the
anticipated performance of the treatment technologies that may be
employed in a remedy

Short term effectiveness-the speed with which the remedy achieves
protection, as well as the remedy's potential to adversely affect h
health and the environment during the construction and implementati
period

Implementability-the technical and administrative feasibility of a
including the availability of materials and services needed to impl
chosen solution

Cost-indudes capital and operation and maintenance costs

State acceptance-whether, based on its review of the RI/FS and prop
plan, the State concurs with, opposes, or has no comment on the pre
remedy.

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Community acceptance-comments received during the public comment
period indicate whether the community concurs with the preferred re

The three remedial action alternatives for Site D were evaluated against these c
The following sections discuss each of the alternatives in terms of the evaluati

10.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

10.1.1 Alternative 1

Alternative 1 (no action) does not contribute any additional protection to prese
future workers or future residents at Site D, nor does it provide any additional
to the environment. The contaminant levels at the site, determined by the risk
assessment to be above acceptable limits, will remain essentially at current
concentrations for more than 10 years. The exposure pathways of concern at the
dermal contact and ingestion of ordnance-contaminated soils, and ingestion of
groundwater from the shallow aquifer. Alternative 1 does not eliminate, reduce,
control exposure to the contaminants and does not meet the RAOs.

10.1.2 Alternative 2

Alternative 2 (incineration) would be effective in protecting human health and t environment. All RAOs would be met by the alternative. Residual risks in treat are expected to be below the most stringent of the carcinogenic risk levels deem acceptable for human exposure. Final concentrations of ordnance compounds in th treated soil are expected to be near zero and below MTCA Method B cleanup values all ordnance compounds and their degradation products.

Treated soil (void of any organic content) deposited back in the original excava would not be conducive to plant growth. Therefore, 1 foot of clean topsoil woul placed over the treated soil and the site revegetated and returned to original g Adherence to the substantive permitting requirements would ensure that the incin system is operating safely and effectively. Gases emitted to the atmosphere wou monitored and the system shut down if the incinerator did not meet substantive p requirements. Occupational risks during construction would be addressed in the health and safety plan.

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Potential human health risks associated with groundwater in the shallow aquifer potential ecological risks associated with exceedances of regulatory criteria in water would be addressed in the monitoring program, and, if necessary and feasib through active remediation.

10.1.3 Alternative 3

Alternative 3 (composting) would provide for the overall protection of human hea the environment by reducing 2,4,6-trinitrotoluene concentrations in the finished to 33 mg/kg or less, and reducing 2,4-dinitrotoluene and 2,6-dinitrotoluene concentrations to 1.47 mg/kg or less. The results of the composting studies ind these levels can be achieved. Remediation to these concentrations or less would the RAOs. Consequently, human and environmental exposure to high concentrations ordnance compounds in soils would be reduced to acceptable levels. Following treatment, the compost mixture would be backfilled. One foot of clean top soil placed over the compost and revegetated to minimize runoff of excess nutrients f curing compost. Occupational risks during construction would be addressed in th project health and safety plan.

Potential human health risks associated with groundwater in the shallow aquifer potential ecological risks associated with exceedances of regulatory criteria in water would be addressed in the monitoring program, and, if necessary and feasib through active remediation.

10.2 COMPLIANCE WITH ARARS

10.2.1 Alternative 1

Alternative 1 (no action) does not comply with either federal or state ARARs reg soil remediation. The excess cancer risk posed by direct contact with contamina surface soils currently present at Site D based on the future residential use sc within the acceptable range of 10-4 to 10-6 stated in the NCP. However, the non hazard index exceeds 1.0. Concentrations of chemicals in soil exceed the cleanu standards established in MTCA.

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10.2.2 Alternative 2

Alternative 2 (incineration) will meet all ARARs as described:

Chemical-Specific ARARs

Incineration is expected to successfully reduce concentrations of o compounds in the excavated soil to below MTCA Method B cleanup leve Remediation to concentrations below the cleanup levels would meet MTCA's requirement of reducing access cancer risk to 1.0 x 10-6 or Chemical-specific ARARs for groundwater and surface water would be through monitoring, and, if necessary and feasible, active remediat

Location-Specific ARARs

Incineration would not affect protected species at SUBASE, Bangor. Remedial actions in potential wetlands areas would be conducted in accordance with the U.S. Army Corps of Engineers' conditions of the Nationwide Permit Program and will, therefore, meet the applicable ARARs.

Action-Specific ARARs

The mobile rotary kiln incineration process would be designed and operated to satisfy all action-specific ARARs.

10.2.3 Alternative 3

Alternative 3 (composting) would meet all ARARs, as described:

Chemical-Specific ARARs

Treatability studies of ordnance composting have shown that compost degrades greater than 99 percent of 2,4,6-trinitrotoluene in soil. Composting would reduce the concentrations of ordnance compounds in the excavated soil to below MTCA Method B cleanup levels. Remediat to concentrations below the cleanup levels would meet MTCA's requirement of reducing excess cancer risk to 1.0 x 10-6 or less.

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specific ARARs for groundwater and surface water would be met throu monitoring, and, if necessary and feasible, active remediation.

Location-Specific ARARs

Composting is not expected to affect protected species of SUBASE, Bangor. Remedial actions in or adjacent to the wetlands area that conducted in accordance with the U.S. Army Corps of Engineers' conditions of the Nationwide Permit Program will meet the applicabl ARARs.

Action-Specific ARARs

The composting system used for Site D would be designed and operate satisfy all action-specific ARARs.

10.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Under each alternative, surface water confirmation sampling would be conducted t ensure that downgradient surface water is not adversely affected by runoff from Short-term monitoring would be conducted for VOCs in the shallow aquifer to conf previous exceedances of health-based criteria. If confirmed, further investigat characterize the source and extent of VOCs in the shallow aquifer would be condu Once characterized, active remediation of the shallow aquifer would be conducted necessary and feasible (under Alternatives 2 and 3).

10.3.1 Alternative 1

The effectiveness and reliability of Alternative 1 (no action), which includes n control measures, is extremely low. The long-term magnitude of remaining risk w be altered under this alternative. Carcinogenic risks will remain above accepta and the potential for direct exposure for future site users remains.

10.3.2 Alternative 2

Alternative 2 (incineration) is an effective method of permanently destroying or such as the ordnance contaminants at Site D. Because the process destroys all t

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the contaminants in treated soils, the long-term effectiveness of the alternativ excellent.

10.3.3 Alternative 3

Alternative 3 (composting) is expected to reduce the concentration of ordnance compounds in excavated soil to levels that achieve the RAOs and satisfy MTCA Method B requirements. The residual concentrations in the treated compost are expected to be less than 33.3 mg/kg for 2,4,6-trinitrotoluene and 1.47 mg/kg for dinitrotoluene, requiring no additional remediation or long-term management.

10.4 REDUCTION OF TOXIClTY, MOBILITY, AND VOLUME THROUGH TREATMENT

10.4.1 Alternative 1

No treatment methods are employed under Alternative 1 (no action). Therefore, l any, reduction in toxicity, mobility, or volume of the on-site contaminants will achieved.

Natural processes will gradually reduce the toxicity of ordnance-contaminated so situ biodegradation is occurring, as evidenced by the presence of transformation of 2,4,6-trinitrotoluene; however, the natural degradation rate is slow. Unacce levels of contamination are still present at the site 25 years after ordnance in and disposal ceased. Ordnance compounds have a high affinity for soil, and surf contamination has spread downgradient of the burn trench because of natural eros and surface water runoff.

10.4.2 Alternative 2

Alternative 2 (incineration) will significantly reduce contaminant toxicity and organic contaminant mobility will not be an issue after the contaminants are tre The toxicity and volume of the ordnance contaminants will be reduced by nearly 1 percent through the incineration process. The soil volume will be reduced by approximately 25 percent. Incineration is the most effective alternative in red contaminant toxicity.

10.4.3 Alternative 3

Alternative 3 (composting) will permanently reduce the toxicity and mobility of compounds in the soil. Greater than 99 percent destruction of ordnance compound expected. However, the volume of finished compost product will be approximately percent greater than the volume of soils excavated for treatment.

10.5 SHORT-TERM EFFECTIVENESS

10.5.1 Alternative 1

Because no new treatment or construction activities will occur with Alternative action), no additional risks would be posed to the environment or to workers or public.

10.5.2 Alternative 2

After completion of the remedial design and construction of the necessary facili incineration process is expected to take approximately 2 weeks.

No adverse effects on humans or the environment are expected during the incinera remediation process. The incinerator operator may conduct a "trial burn" (or su performance data that can serve as a substitute for trial burn results) to test the incinerator to meet all applicable performance standards. The risk to the environment and the public during a trial burn is minimal because of the small q of incinerated materials and the short duration of the test.

During excavation, dust would be monitored to protect on-site workers from airbo particulates. Monitoring and corrective actions required to maintain safe level discussed in the health and safety plan. Exposure to dust at the site is not ex be a significant problem.

Operation of the incinerator would alter the natural conditions of the site beca tree clearing, grading, and construction of an access road. Wetlands may be aff during the excavation/backfilling phases. Disturbed land areas would be reclaim following project completion.

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The incinerator, if operating properly, would be virtually smokeless and odorles white vapor, composed mostly of water vapor, would discharge from the stack. No from the incineration process is not expected to be significant. Monitoring of gases would be required to verify compliance with appropriate standards. A decontamination area would be constructed for workers and equipment to eliminate potential for off-site transport of contaminants. Fencing and signs would limit the treatment area. No protected species are expected to be affected during the remediation.

10.5.3 Alternative 3

After completion of the remedial design and construciion of the necessary facili time required to implement Alternative 3 is approximately 8 months. This altern poses minimum risks to workers or the commnunity during remediation. The site i currently a restricted area and there are no base-related activities in the area traffic on Escolar Road. The base is a secured facility. Fencing and signs wou access to the treatment area.

With a properly designed treatment facility, including leachate collection and containment features, emissions of ordnance compounds from the treatment site ar expected. Care would be taken to ensure that the operation of the windrow turner not release soil particles from the treatment area. Adequate ventilation would provided in the treatment area to prevent the buildup of ammonia from the compos process.

Implementing this alternative would alter the natural conditions of the site bec tree clearing, grading, and construction of an access road. Wetlands might be a during the excavation/backfilling phases. Disturbed land areas would be reclaim following project completion.

Workers would be required to wear protective gear, follow special handling proce and perform monitoring to minimize risk involved with the remediation process. backfilled compost would pose little or no ecological risk. No protected specie expected to be affected during the remediation.

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10.6 IMPLEMENTABILITY

10.6.1 Alternative 1

Technically, Alternative 1 (no action) is implementable. The administrative fea however, is relatively low. Regulatory agencies will probably find Alternative unacceptable.

10.6.2 Alternative 2

The technical and administrative implementability of Alternative 2 (incineration Incineration use has been demonstrated at other military installations. Fulfill substantive permit requirements will require that the owner or operator of the incinerator perform regular inspections and maintenance according to specified schedules. Mobile rotary kiln incinerators are widely available. Several vendo capable of providing the required incineration services.

10.6.3 Alternative 3

The technical implementability of Alternative 3 (composting) has been proven for ordnance-contaminated soils in pilot studies and with bench-scale studies of Sit Composting is a well-developed technology and is used commercially for treatment garbage, waste sludge, and yard waste. Additionally, sufficient information and experience is available as a resource for design and operating purposes. A pilo treatability study for windrow composting of Site D soils will verify design par Construction of a windrow composting facility poses no unusual design or constru problems. Composting is readily implemented administratively.

10.7 COST

The estimated capital and operation and maintenance (O&M) costs for each alterna are summarized in Table 18. Net present worth costs are also summarized and are based on 5 years of operations and an assumed annual discount rate of 5 percent. cost estmates provide an accuracy of +50 percent to -30 percent, in accordance w EPA guidelines.

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Table 18
Cost Comparison of Remedial Action Allernatives

Alternative	Capital Cost	Annual O&M Cost	Net Present Worth
No action	$0	$16,500	$75,000
Incineration	$1,424,000	$16,500	$1,499,000
Composting	$841,000	$16,500	$916,000

10.8 STATE ACCEPTANCE

Ecology concurs with the selected remedial action at Site D and has been involve development and review of the RI, FS, proposed plan, and ROD. Comments from Ecology have resulted in substantive changes in these documents, and the agency been integrally involved in determining which cleanup standards apply to contami soil under MTCA.

10.9 COMMUNITY ACCEPTANCE

Comments received during the public comment period (January 9 through February 8 1994) indicate that the public accepted the proposed plan.

11.0 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, both EPA and the State of Washington have determined that Alternative 3 (composting) the most appropriate remedy for OU 6, Site D, at SUBASE, Bangor.

The selected remedy includes the following components:

Excavating and stockpiling soils containing the highest concentrati ordnance compounds. All soils at Site D that contain 2,4,6-trinitr

in concentrations exceeding the MTCA Method B cleanup levels (33.3 mg/kg) will be excavated. Outside the wetlands boundary, soils tha contain 2,4-dinitrotoluene in concentrations exceeding the MTCA Method B cleanup levels (1.47 mg/kg) will be excavated. Within the wetlands boundary, the MTCA Method C cleanup level (58.8 mg/kg) wil be applied to 2,4-dinitrotoluene.

Remediating the excavated soils by composting at SUBASE, Bangor. Composting will attain MTCA Method B cleanup levels for 2,4,6-trinitrotoluene and its degradation products, including 2,4-dinitro and 2,6-dinitrotoluene.

Backfilling the treated soils in the excavations, covering them wit clean soil, and revegetating the affected areas with native vegetat

Returning the treatment area and any access roads (including the ex access road at Site D) to natural contours and revegetating them wi native vegetation.

Conducting confirmation sampling of on-site and downgradient surfac water. One round of surface water sampling will occur following so remediation. Surface water samples will be analyzed for metals to previous metals exceedances and for ordnance compounds to verify th ordnance compounds were not mobilized during soil remediation activ If the results of the confirmation sampling indicate that regulator are exceeded in downgradient surface waters due to transport of contaminants from Site D, response actions including active remedia will be considered.

Conducting short-term monitoring of the shallow aquifer to confirm previous exceedances of health-based criteria. The short-term moni in the shallow aquifer will consist of one round of sampling for VO existing monitoring wells. The results of this sampling will be co the most restrictive criteria established under the following ARARs federal MCLs (40 CFR 141); state MCLs (WAC 246-290-310); and MTCA Method B cleanup level (WAC 173-340-720). If exceedances are confirmed, further investigations to characterize the source and ex

VOCs in the shallow aquifer will be conducted. Once characterized, response actions including active remediation will be considered.

Conducting a review of the soil remediation data and the short-term monitoring data to evaluate the effectiveness of the remedy and to that human health and the environment are protected. The review wi conducted within 5 years of commencement of the remedial action. T results of the review will be used to determine whether additional monitoring is required.

The selected remedy will protect human health and the environment by achieving t RAOs and soil treatment levels presented in Section 8.0.

12.0 STATUTORY DETERMINATION

Under CERCLA, Section 121, the selected remedies must be protective of human hea

and the environment, comply with ARARs, be cost effective, and use permanent solutions and alternative treatment technologies or resource recovery technologi maximum extent practicable. In addition, CERCLA indudes a preference for remedi that employ treatment that permanently and significantly reduces the volume, tox mobility of hazardous wastes as their principal element. The following sections how the selected remedy meets these statutory requirements.

12.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy will protect human health and the environment by removing an treating the Site D soils that contain ordnance compounds in concentrations abov established MTCA Method B and Method C cleanup levels. The excavated soils will treated by composting to permanently reduce concentrations of ordnance compounds below MTCA Method B concentrations. The selected remedy will minimize risks to ecological receptors by removing the highest concentrations of ordnance compound from Site D, while minimizing the short-term environmental impacts of the remedi on wetlands.

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Confirmation sampling of surface water and characterization of shallow groundwat address potential human health and ecological risks associated with surface wate groundwater. A review will be conducted within 5 years of the commencement of t remedial action to ensure that the remedy continues to provide adequate protecti human health and the environment.

12.2 COMPLIANCE WITH ARARS

The selected remedy of soil treatment by composting, along with monitoring of su water and perched groundwater and monitoring and characterization of the shallow aquifer, will comply with all state and federal ARARs. Action-specific, chemica and location-specific ARARs are presented below, along with to-be considered (TB guidance that has been developed to implement ARARS.

12.2.1 Action-Specific ARARs

Hazardous Waste Management Act (42 USC 6901 et seg.); Resource Conservat and Recovery Act (RCRA), Regulations (40 CFR 260 to 268); Washington Stat Dangerous Waste Regulations (WAC 173-303)

These regulations establish the procedures for the designation of waste as hazar dangerous. They are applicable for determining handling and disposal requiremen solid wastes generated during cleanup activities.

The Clean Air Act, Section 101 (42 USC 7405, 7601); Washington Genera Regulations for Air Pollution Sources (WAC 173-400)

These requirements are applicable to sources of fugitive dust that are generated the remediation efforts and must be controlled to avoid nuisance conditions.

The Puget Sound Air Pollution Control Agency Regulation

These requirements are applicable to sources of fugitive dust that are generated the remediation efforts and must be controlled to avoid nuisance conditions.

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The Occupational Safety and Health Administration (OSHA) standards (29 C 1910.1000)

These standards regulate employee exposure to airborne hazardous substances list Tables 2-1-A through 2-3 of the rules. Table 2-1-A of the standards list 2,4,6-trinitrotoluene, 2,4-dinitrotoluene, and 2,6-dinitrotoluene. Table 2-3 provides for inert or nuisance dust that could be the result of airborne soil. These sta apply to worker conditions during the excavation and handling of contaminated so

Federal Occupational Safety and Health Regulations (29 CFR 1926

These requirements establish applicable health and safety standards for workers in hazardous waste investigations.

State of Washington Occupational Safety and Health Regulations (WAC 296-Part P)

These requirements establish applicable health and safety standards for workers in hazardous waste investigations.

Hazardous Materials Transportation Act (49 CFR 171 to 172

These regulations are applicable to the transportation of potentially hazardous including samples and wastes.

12.2.2 Chemical-Specific ARARs

The State of Washington Hazardous Waste Cleanup-Model Toxics Control Ac (MTCA; Chapter 70.105D RCW)

Establishes requirements for the identification, investigation, and cleanup of f

where hazardous substances have come to be located as codified in Chapter 173-34 WAC. Soil, surface water, and groundwater cleanup standards established under t MTCA are applicable for determining remediation areas and volumes and compliance monitoring requirements, and are relevant and appropriate for determining treatm standards.

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Washington Dangerous Waste Regulations (WAC 173-303

These regulations are applicable in determining whether excavated soil is consid dangerous waste for purposes of waste handling and treatment system design and operation.

Safe Drinking Water Act MCLs and MCLGs (40 CFR 141

The Safe Drinking Water Act establishes maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs). The MCL is the maximum permissible level of a contaminant in water that is delivered to any user of a public water The MCLG is the maximum level of a contaminant in drinking water at which no kno or anticipated adverse effect on human health would occur and that allows an ade margin of safety. MCLGs are nonenforceable. Although the groundwater at Site D not currently used as a source of drinking water, MCLs should be considered an A for the shallow aquifer.

State Board of Health Drinking Water Regulations (WAC 246-290-310

The Washington State Board of Health has established MCLs similar to federal MCL Because the groundwater in the shallow aquifer at Site D is a potential source o drinking water based on the future residential scenario, state MCLs should be co an ARAR for the shallow aquifer.

Safe Drinking Water Act Health Advisorie

The Safe Drinking Water Act health advisories are classified a "to be considered guideline for evaluating shallow aquifer groundwater quality at Site D.

State of Washington Water Quality Standards for Surface Waters (WA 173-201A)

These requirements establish water quality standards for surface waters at Site

Clean Water Act Ambient Water Quality Criteria for Surface Water (33 CFR

Chemical-specific numeric criteria have been promulgated for priority pollutants

ambient surface waters. These criteria are applicable to surface waters at Site

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12.2.3 Location-Specific ARARs

Several ARARs apply to wetlands and the critical habitat at Site D.

Executive Order ll990 (40 CFR 6); Clean Water Act, Section 404 (33 CFR 3

Executive Order 11990 requires federal agencies to avoid, to the extent possible adverse impacts associated with the destruction or loss of wetlands. The respon party is required to avoid adverse impacts or minimize these impacts if no pract alternative to the action exists (U.S. EPA 1991b). Under Section 404 of the fed Clean Water Act, the Secretary of the Army, acting through the United States Arm Corps of Engineers, provides the guidelines for actions that occur in wetlands. United States Army Corps of Engineers' Nationwide Permit (NWP) program (33 CFR 330) provides the regulations that apply to wetlands. The regulations provide s allowances for activities occurring in wetlands one of which specifically addres remedial actions in wetlands.

The allowance 33 CFR 330 (Appendix A[B][38]) is for specific activities required contain, stabilize, or remove hazardous waste that are performed, ordered, or sp by a government agency with established legal or regulatory authority. Court-or remedial action plans or related settlements are also authorized by the nationwi permit. Although this allowance provides for remedial actions in wetlands, such still must comply with the "Notification" general condition of the NWP (33 CFR 3 Appendix A[C][13]).

Endangered Species Act of 1973 (16 USC 1531 et seq.; 50 CFR 402); Fish a Wildlife Coordination Act (16 USC 661 et seq.)

Although no known threatened or endangered species have been observed on Site D, eagles have been observed at SUBASE. Bangor. The bald eagle (Haliaeetus leucocephalus) is protected by the Endangered Species Act of 1973 and the Fish a Wildlife Coordination Act. Any action that would affect the critical habitat of eagle would be subject to these ARARs.

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12.2.4 TBC Guidance

The Washington State Department of Ecology document "Statistical Guidance for Ecology Site Managers" is identified as a TBC in implementing the requirements o MTCA.

12.3 COST EFFECTIVENESS

Composting and incineration were the two alternatives capable of achieving the R The present worth cost of composting ($916,000) is nearly 40 percent less than t incineration ($1,499,000). The selected remedy provides an overall effectivenes proportional to costs and represents a reasonable value for the money that will

12.4 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 alternati evaluated. It provides a high degree of permanence, uses innovative treatment technologies to the maximum extent practicable, does not negatively affect human or the environment during remediation, can be completed in a reasonable length o and is cost effective.

The selected remedy was chosen primarily because it complies with MTCA, an applicable regulation, and is the most cost-effective means of achieving the RAO

The selected remedy meets the statutory requirement to use permanent solutions t maximum extent practicable. Composting of soil from Site D will permanently des ordnance compounds.

12.5 PREFERENCE FOR TREATMENT AS PRINCIPAL ELEMENT

The preference for treatment as a principal element of the remedial action is sa Site D by using composting, an innovative treatment technology, to permanently d the highest concentrations of ordnance compounds in soils.

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13.0 DOCUMENTATION OF SIGNIFICANT CHANGES

No significant changes from the final feasibility study or proposed plan have oc preparing the ROD.

14.0 REFERENCES

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Attachment 1

RESPONSIVENESS SUMMARY

Attachment 1

RESPONSIVENESS SUMMARY

This Responsiveness Summary addresses the public comments received on the propos plan for remedial action at OU 6 (Site D) at SUBASE, Bangor. Two comments were received during the public comment period of January 9, 1994, through February 8 The comments were received at a public meeting held by the Navy on January 27, 1 at the Olympic View Community Club in Silverdale, Washington.

1.0 SUMMARY OF PUBLIC COMMENT

Two comments were received by the Navy concerning the proposed plan. These were oral comments raised at and responded to during the public meeting. A transcrip public meeting is available at the information repositories.

Summary of Comments: Two members of a community organization stated that the organization had reviewed technical documents regarding the proposed plan. The organization agreed with the proposed plan and believed the Navy had done a good during the investigations. The members thanked the Navy for the opportunity to participate in the process and expressed interest in remaining involved in the development of the monitoring program and its results.

2.0 RESPONSE TO COMMENT

Response: The Navy appreciates the comment regarding the quality of the documen and investigations. The Navy encourages and values public participation in this