FINAL REPORT

BRAC HTRW SITE CLOSURE REPORT

for Landfills 1, 2, and 3; Former Burn Area; Buildings 1962 and 1963; Grease Pits at the Camp Bonneville and Camp Killpack Cantonments; Former Sewage Pond; and Hazardous Materials Accumulation Point

Camp Bonneville
Washington

Prepared for

Seattle District
U.S. Army Corps of Engineers
4735 East Marginal Way South
Seattle, Washington 98124

September 2000

1501 Fourth Avenue, Suite 1500
Seattle, Washington 98101
(206) 343-7933

Contract No. DACA67-98-D-1005
Delivery Order Number 43
53F0072250.00

CONSENSUS STATEMENT

The enclosed report is entitled "BRAC HTRW Site Closure Report for Landfills 1, 2, and 3; Former Burn Area; Building 1962 and 1963; Grease Pits at the Camp Bonneville and Camp Killpack Cantonments; Former Sewage Pond; and Hazardous Materials Accumulation Point," and is dated September 2000. Based on the results of the enclosed report, no further action for the HTRW component is required at the sites discussed in the report. Further UXO work may; however, be required at these sites.

Richard L. Conte
Colonel, EN
Director of Public Works

1/9/01
Date

Eric Waehling
BRAC Environmental Coordinator

1/8/01
Date

Christopher Maurer
Washington State Department of Ecology

11/8/00
Date

Harry Craig
U.S. EPA Region 10

11/7/00
Date

TABLE OF CONTENTS

TABLE OF CONTENTS

Tables

Figures

Appendices

ARAR	applicable or relevant and appropriate requirement
AST	aboveground storage tank
BCT	BRAC Cleanup Team
bgs	below ground surface
BRAC	Base Realignment and Closure
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CCC	Civilian Conservation Corps
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERFA	Community Environmental Response Facilities Act
CFR	Code of Federal Regulations
CLARC	cleanup regulations and risk calculations
CSM	Conceptual Site Model
DoD	Department of Defense
EBS	Environmental Baseline Survey
Ecology	Washington State Department of Ecology (Ecology)
EM	electromagnetic
EO	explosive ordnance
EOD	explosive ordnance demolition
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbons
FBI	Federal Bureau of Investigation
FOSL	Finding of Suitability to Lease
FOST	Finding of Suitability to Transfer
GPR	ground-penetrating radar
LAW	light anti-tank weapon
MCL	Maximum Contaminant Level
MDL	method detection limit
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
MTCA	Model Toxics Control Act

MW	monitoring well
NFA	No Further Action
ng	nanograms
OE	Ordnance and Explosives
PA	picric acid
PCBs	polychlorinated biphenyls
PETN	pentaerythritol tetranitrate
PID	photoionization detector
PL	Public Law
ppm	parts per million
RA	remedial action
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RL	Reporting Limit
SCR	Site Closure Report
SI	Site Investigation
SOW	Scope of Work
SVOC	semi-volatile organic compound
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TPH-DX	total petroleum hydrocarbons – diesel extended
TPH-Gx	total petroleum hydrocarbons – gasoline extended
UCL	upper confidence limit
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
URSGWC	URS Greiner Woodward Clyde
USACE	U. S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
UXO	unexploded ordnance
VOC	volatile organic compound
VPH	volatile petroleum hydrocarbons
WAC	Washington Administrative Code

The Camp Bonneville Military Reservation (Camp Bonneville) in Clark County, Washington, is a United States government military facility that was selected for closure under the Base Realignment and Closure (BRAC) 95 process. Camp Bonneville was established in 1909 as a drill field and rifle range, and has been used since then as a training camp for Department of Defense (DoD) and other government personnel. As a result of past waste and resource management practices in support of these activities, some areas may have been contaminated by hazardous substances or wastes.

In accordance with the BRAC program, an Environmental Baseline Survey (EBS) was conducted in 1997 to classify areas of real property associated with Camp Bonneville that are subject to lease or transfer into one of seven standard environmental condition of property area types. These types are defined by Community Environmental Response Facilitation Act (CERFA) guidance and the DoD BRAC Cleanup Plan Guidebook (DoD 1995).

Based on review of installation-related documents, government records, aerial photographs, a visual property inspection, and interviews, CERFA categories were identified at the 3,840-acre property. Of the 3,840 acres, approximately 3,826 acres were designated as Category 1 and Category 2. The remaining 14 acres were designated as Category 5 and Category 7. The eight base sites covered by this report all were classified as Category 7 sites. Of the 3,840 acres, 1.3 acres were designated as qualified for asbestos-containing materials and lead-based paint. The entire installation was qualified for unexploded ordnance and/or ordnance fragments.

Based on areas of potential concern identified primarily by the EBS, as well as earlier reports, a multi-site investigation was performed at Camp Bonneville in 1998 and 1999 (Shannon and Wilson 1999). The overall objective of this investigation, which has been conducted as part of the BRAC process, has been to identify contaminated areas and determine the next appropriate step toward restoration of those sites. The sites that were investigated included three inactive landfills, a former burn area, two burned buildings, two grease pit locations, a former sewage pond, and one hazardous material accumulation building. Activities included unexploded ordnance (UXO) avoidance in areas outside of the cantonments; geophysical surveys where the contaminant sources were suspected to be underground; soil sampling at all of the sites that could be located (i.e., excluding Landfill 1); and well installation and groundwater sampling at the landfills and former sewage pond.

The analytical results obtained from soil and groundwater samples collected at the various sites were compared with project screening levels to determine if each site potentially poses an unacceptable environmental risk. These screening levels include state and federal regulatory and risk-based cleanup criteria for residential exposure. The analytical results for metals in soil were also compared with site background levels established for the facility, and with background concentrations established by the Washington State Department of Ecology (Ecology).

No further action is recommended at the eight sites discussed in this report because little or no contamination was detected at the seven locations and no evidence of the existence of Landfill 1 (the eighth site) was found. Based on these findings, future land use restrictions may apply only to use of the areas underlain by landfill debris. These findings only pertain to the hazardous, toxic, and radioactive waste components of the sites. The findings do not pertain to the unexploded ordnance components of the sites.

The Seattle District of the U.S. Army Corps of Engineers (USACE) is preparing final project closeout documentation to meet Comprehensive Environmental Response Compensation and Liability Act (CERCLA) requirements in support of finding of suitability to lease (FOSL) or suitability of transfer (FOST) for eight separate sites within Camp Bonneville (Figure 1-1). As part of this documentation, a BRAC Site Closure Report (SCR) has been prepared by URS Greiner Woodward Clyde (URSGWC) in accordance with the USACE scope of work (SOW) entitled *Scope of Work for BRAC Site Closure Reports, Camp Bonneville, Washington* (Contract No. DACA67-98-D-1005, Delivery Order No. 0043) (USACE November 10, 1999).

1.1 PROJECT OBJECTIVES AND SCOPE OF SERVICES

As specified in the SOW, the objectives of this SCR are to document that the past work at the eight sites meets cleanup requirements of the Camp Bonneville BRAC Cleanup Team (BCT) and to prepare closeout documentation for eight separate sites within Camp Bonneville that require no further action (NFA) to meet CERCLA requirements for FOSL or FOST. This closure report pertains only to the hazardous, toxic, and radioactive waste (HTRW) components of the sites discussed. It does not include the unexploded ordnance (UXO) component of the sites. Shown on Figure 1-2, the eight sites discussed in this SCR include:

- Landfill 1
- Landfill 2
- Landfill 3
- Former Burn Area
- Buildings 1962 and 1983
- Grease Pits at the Camp Bonneville and Camp Killpack cantonments
- Former Sewage Pond
- Hazardous Materials Accumulation Point

To achieve these project objectives, the following tasks were performed:

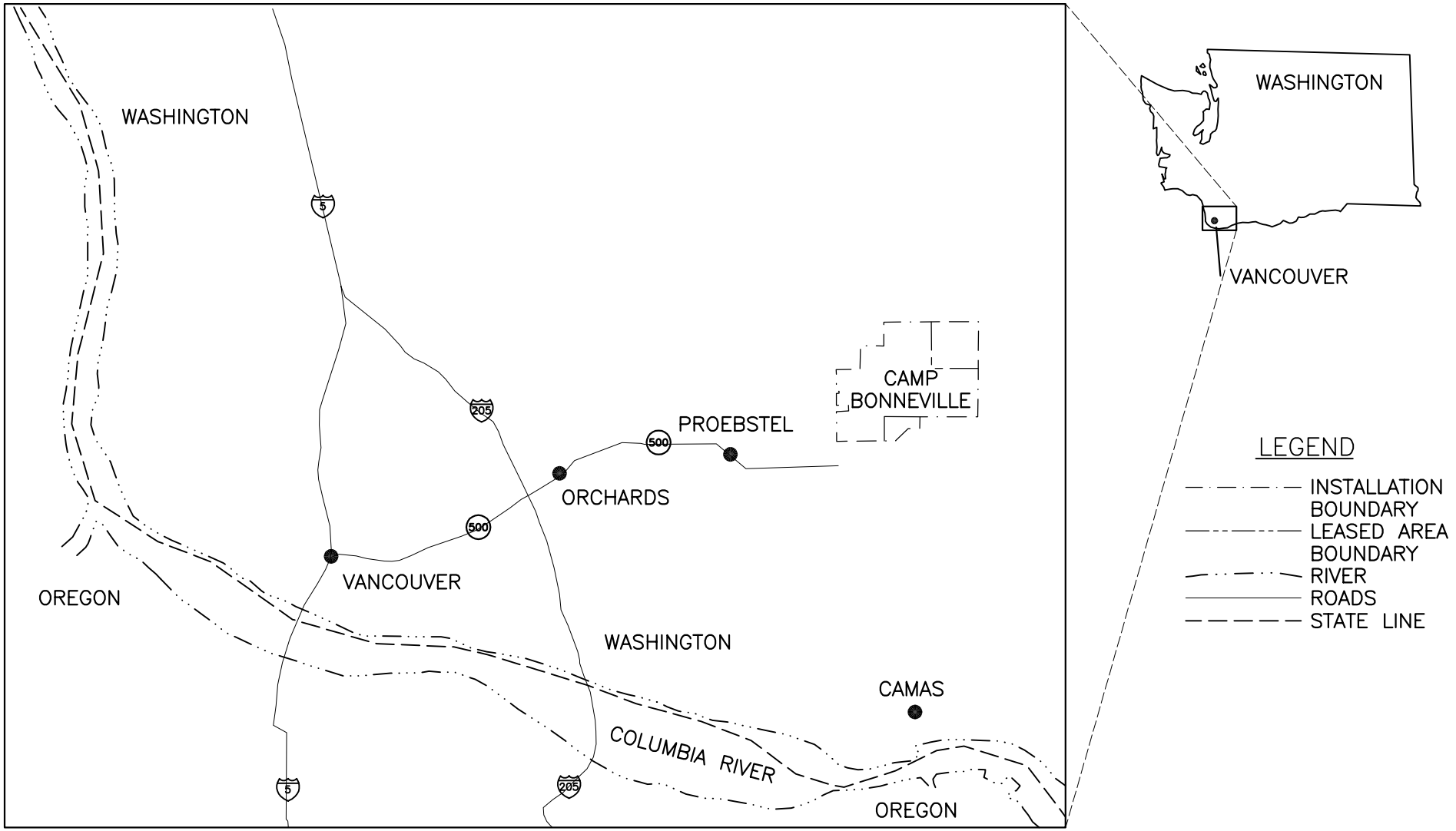
- **Document and Report Gathering** – Background information and files documenting investigation and remediation activities at the eight sites listed above were gathered and reviewed. These files are presented in Section 7.0 – References. These reports were reviewed to create a synopsis of investigation activities to date at the eight sites and to evaluate the data with regard to CERCLA requirements for FOSL or FOST.
- **Compare Existing Data to Cleanup Levels and Evaluate Potential Exposure Pathways and Receptors in the Conceptual Site Model (CSM)** – Data presented in the reports reviewed for the eight sites were compared to existing cleanup levels to evaluate the potential for site closeout. These data were also used to assess the CSM for each site and whether adequate data exist on potential sources of contamination, exposure pathways, and receptors to support site closure. This evaluation included a risk-based analysis to assess if the sites can be closed in accordance with CERCLA requirements.

- **Prepare SCR** – This Draft SCR is submitted as a deliverable for this project. The report includes a review and presentation of information from earlier investigation activities at the eight sites, and an evaluation of soil and groundwater data with regard to established cleanup levels and the CSMs postulated for the sites. A final SCR will be submitted after receipt of comments on the Draft SCR and submittal of a response to the comments.
- **Attend Meetings** – Two meetings will be attended regarding the SCR. The initial meeting will be attended after submittal of the Draft SCR to discuss review comments received from the USACE and potentially other reviewers. After submittal of the Final SCR, the findings will be presented to the BCT at Camp Bonneville. The BCT is comprised of representatives from Fort Lewis, U.S. Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology). The date of this presentation will be specified by the USACE after receipt of the Final SCR.

1.2 REPORT ORGANIZATION

This report encompasses seven sections, each of which is briefly described below:

- **Section 1 – Introduction**: Section 1 includes an introduction to the project, the project objectives and scope of services, and the organization of the report.
- **Section 2 – Site History**: A general history of Camp Bonneville is presented in Section 2 as well as specific descriptions of the eight sites covered by this report.
- **Section 3 – Chronology of Events**: Section 3 includes a graphic representation and discussion of a chronology of events that have occurred at Camp Bonneville since 1909. A discussion of previous investigation and remediation activities and their results, at the eight sites, are also presented in Section 3. The regulatory and risk-based screening criteria used to evaluate the investigation data and CSMs is presented in Section 3. The use of background data as a means to evaluate the data is also discussed in Section 3.
- **Section 4 – Evaluation of Conceptual Site Models**: The potential sources of contamination, exposure pathways, and human and ecological receptors of the CSMs for each site are evaluated and discussed in Section 4. A discussion of whether the exposure pathways are complete, incomplete, or negligible is also presented in this Section.
- **Section 5 – Conclusions**: A summary of the results of the information review, as well as a discussion of whether site closure is supported for each of the eight sites, is presented in Section 5.
- **Section 6 – References**: A list of the documents reviewed as part of preparation of this report is presented in Section 6.



FILENAME: Q:\COE\Camp Bonneville\Management Plan 9_00\CB-MP-9-00-01.dwg
EDIT DATE: 09/19/00 AT: 13:50

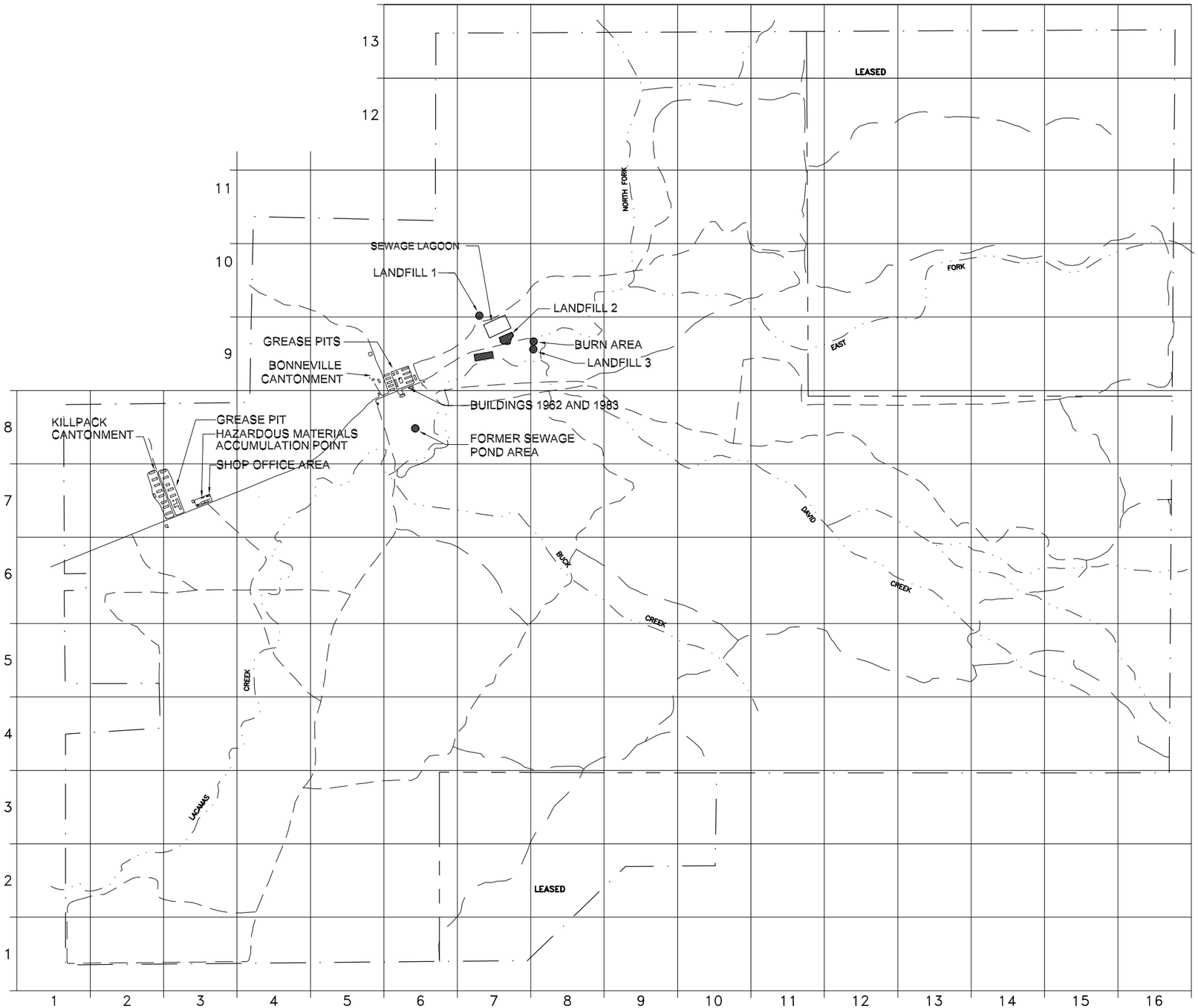
URS

U.S. ARMY
CORPS OF ENGINEERS
SEATTLE DISTRICT
SEATTLE,WASHINGTON

LOCATION OF CAMP BONNEVILLE MILITARY INSTALLATION

CAMP BONNEVILLE PN 53F0072323.00 WASHINGTON

FIGURE 1-1



LEGEND

- INSTALLATION PROPERTY BOUNDARY
- LEASED AREAS BOUNDARY
- ALL WEATHER, HARD SURFACE, ASPHALT ROAD
- ALL WEATHER, LOOSE SURFACE, GRAVEL ROAD
- FAIR WEATHER, LOOSE SURFACE, EARTHEN ROAD
- CREEKS

NOTE

REFERENCE: SHANNON AND WILSON

N

0 400 800 1600 3200

SCALE IN FEET

FILENAME: Q:\COE\Camp Bonneville\Bonn-119.dwg
EDIT DATE: 09/20/00 AT: 15:55

Camp Bonneville Location, WA	Project No. 53F0072250.00	Location of the Eight Base Sites	Figure 1-2
URS			

A general history of Camp Bonneville is presented below and is followed by specific descriptive information related to each of the eight sites included in this report.

Camp Bonneville, located in Clark County, Washington, is a U.S. Government property that was selected for transfer and reuse by the Base Realignment and Closure (BRAC) 95 Commission. Camp Bonneville is a sub-installation of Vancouver Barracks, which is a sub-installation of Fort Lewis, Washington. Camp Bonneville encompasses approximately 3,840 acres, which have been identified as BRAC property subject to lease or transfer. Two areas within Camp Bonneville, totaling 820 acres, are currently leased by the Army from the Washington State Department of Natural Resources.

The installation is bounded by residential developments, densely forested lands, and small farms on all sides. Future use of the property by Clark County is intended to provide the community with educational, environmental, and recreational benefits. Clark County's draft land reuse plan for Camp Bonneville proposes that approximately 1,000 acres along the western portion be used as a regional park. More remote portions of Camp Bonneville are planned for trail use by the public, including hiking, equestrian, and mountain biking activities. In addition, timber management and wildlife habitat areas are planned.

2.1 GENERAL SITE HISTORY

Camp Bonneville was established in 1909 as a drill field and rifle range. Troops from Vancouver Barracks began to use part of the facility for a target range in 1910. Installation use grew to include a range for assault weapons, artillery, and field and air defense artillery between 1910 and 1995. The original reservation, consisting of approximately 3,020 acres, was acquired by the federal government in 1918. It was officially named Camp Bonneville in 1926. The Camp Bonneville cantonment area was built in the late 1920s. The Camp Killpack cantonment area was built and occupied by the Civilian Conservation Corps (CCC) in 1935. The facilities were used for several military training programs, in addition to being used by Vancouver Barracks. During World War II, the facility was also used to house Italian prisoners of war.

In 1950, many of the buildings and systems at the facility were rehabilitated to use for training Army Reserve units. In the early 1950s, an additional 840 acres of land were leased from the State of Washington. Vancouver Barracks, including Camp Bonneville, became a sub-installation of Fort Lewis, Washington, in 1959.

Since World War II, Camp Bonneville has been used as a training camp for active Army, Army Reserve, National Guard, Marine Corps Reserve, Navy Reserve, and Coast Guard Reserve units, as well as other DoD and government personnel. In the 1980s, the facility was used by a number of civilian organizations for camping, picnics, and environmental studies. Camp Bonneville is currently used by federal, state, and local law enforcement agencies for firearms training and practice, and general training purposes. The Federal Bureau of Investigation (FBI) makes frequent use of one of the firing ranges.

In 1996, following the selection of Camp Bonneville for closure by the BRAC commission, all active military training units ceased operations at the camp. All out-grants for use of the facilities were cancelled, with the exception of the FBI range. The FBI currently plans to maintain a firing range on Camp Bonneville property after the base has been officially released by the DoD.

Ordnance and explosives (OE) items, including ordnance scrap and unexploded ordnance (UXO), have been found in areas of Camp Bonneville. A surface and subsurface OE characterization project was conducted at Camp Bonneville to determine the presence and density of OE left from the years of training conducted at Camp Bonneville. The OE characterization was performed by dividing Camp Bonneville into sectors and performing random OE sampling within these sectors. The areas indicating the highest density of ordnance at the site included the former rifle-fired grenade ranges, the former demolition area, and the fenced impact area.

2.2 CHARACTERISTICS OF BASE SITES

The descriptions of the eight sites discussed below are from Shannon & Wilson (1999). Parcel Number classifications are from Woodward-Clyde (1997).

2.2.1 Landfill 1

This disposal area is located east of the Camp Bonneville cantonment area and just north of the existing sewage lagoon. It was identified as having potential historic significance, based on a 1980 cultural resources survey (Larson 1980), which stated that bottle fragments dating from the early 1900s were found in the area. There is no record of when the site was used or what other types of materials it may contain. In the 1980 archaeological survey, the site was described as a small (approximately 12-foot by 15-foot), shallow depression. This site was assigned BRAC parcel number 2(7)HR(P), meaning that the second BRAC parcel is categorized as Category 7 because it requires additional evaluation and because it is qualified (as is all of Camp Bonneville) due to the possible presence of unexploded ordnance.

2.2.2 Landfill 2

This former landfill was discovered about 1978, during excavation for construction of the current sewage lagoon. According to an interview performed during the EBS, landfill material was unearthed at the eastern and northern borders of the sewage lagoon. No description of the materials encountered during construction of the sewage lagoon was found. No additional records of the type or quantity of material that was placed in this landfill, and the exact dates of use are unknown. Although the EBS suggests that the landfill may have been operated from 1940 to 1950, its use apparently preceded the mid-1970s, based on the fact that base personnel working at Camp Bonneville at that time and interviewed for the report were unaware of its existence. This site was assigned BRAC parcel number 3(7)HR(P).

The general landfill area is bounded by the existing sewage lagoon to the west and north, and wooded areas to the south and east (Figure 2-1). The landfill area slopes gently southward toward Lacamas Creek. Although most of the site area is fairly flat, portions of the area are bumpy and uneven. The area between the sewage lagoon and the gravel road to the south is covered with native grasses.

2.2.3 Landfill 3

This former landfill is located southeast of the existing sewage lagoon, near Lacamas Creek, and approximately 300 feet southeast of Landfill 2 (Figure 2-1). According to the EBS, the site was described by the previous Camp Bonneville Facility Manager as having been dugout as a trench and then used as a trash burial area from the mid- to late 1970s to the early to mid-1980s. The landfill trench reportedly was approximately 40 feet long by 12 feet wide by 8 feet deep, and ran north-south. Objects such as a refrigerator, a locker, wallboard, and paint cans were reportedly buried here. Soil was scraped from nearby and pushed onto the landfill, creating a broad mound that currently marks the location of the landfill. This site was assigned BRAC parcel number 5(7)HR(P).

The location of Landfill 3 is evident by the mound of soil in an otherwise fairly flat area on the Lacamas Creek floodplain. Lacamas Creek flows along the eastern and southern sides of the site. At its closest point, Lacamas Creek is approximately 20 feet east of the landfill area. The creek banks are nearly vertical with the top of the bank about four feet above stream level.

2.2.4 Former Burn Area

The former Burn Area is located immediately north of Landfill 3, to the southeast of the existing sewage lagoon (Figure 2-1). A pile of wooden debris approximately 20 feet long by 15 feet wide marking the site was removed in June 1997. The area reportedly was used infrequently to burn wood and debris, although there is no record of the length of use or list of materials burned (Woodward-Clyde 1997). This area has apparently not been used for burning material since the mid-1980s. According to the Camp Bonneville Facility Manager, debris had been piled on the site for three or four years, before its removal in June 1997. This site was assigned BRAC parcel number 4(7)HR(P).

2.2.5 Buildings 1962 and 1983

Buildings 1962 and 1983 were located near the southeastern corner of the Camp Bonneville cantonment area (Figure 2-2). They were burned in place, and the burned debris was removed to an unknown location, leaving no visible trace of the footprints of the buildings. Building 1962 was a 9-foot-wide by 12-foot-long storage shed used to store fire hoses, and Building 1983 was a 10-foot-wide by 40-foot-long structure used as a stage and outdoor theater. Both buildings were constructed in the 1930s with wooden frame walls, wooden floors, wooden post/concrete pillar foundations, and rolled composition roofs. Based on their age and type of construction, it is reasonable to suspect that lead-based paint may have been used in the buildings. Lead from the paint could have been released to the soils over the life of the buildings and when they were burned. Asbestos and semivolatiles may also have been present in the composition roofing materials and other building materials. This site was assigned BRAC parcel number 8(7)HR(P).

2.2.6 Grease Pits

Three grease pits have been identified at Camp Bonneville: two are located in the Camp Bonneville cantonment north of Building 1828 (Figure 2-2), and one is located in the Camp Killpack cantonment east of Building 4389 (Figure 2-3). The grease pits in the Camp Killpack and Camp Bonneville cantonments have been assigned BRAC parcel numbers 11(7)HR(P) and

6(7)HR(P), respectively. Each of the grease pits consists of a gravel-filled excavation with a corrugated metal pipe extending vertically down into the gravel. The grease pits were used for disposal of waste cooking greases and oils from nearby mess halls. Use of the pits reportedly began around 1935 and continued until recently. During an interview performed as part of the EBS, the potential for the disposal of unauthorized materials in the pits was suggested.

The two grease pits in the Camp Bonneville cantonment (Figure 2-2) are located north of the mess hall and associated structures. They occupy a flat, elevated area north of the gravel road. The ground surface is covered with grass and slopes steeply down to a ditch and the gravel road, approximately 10 feet south of the grease pits. Several rows of concrete tent pads remain immediately north of the pits. Each of these grease pits consists of a single corrugated metal pipe approximately 18 inches in diameter. The pipes are approximately 1.5 feet apart. There are no lids on these grease pits, and trash has been observed in both.

The grease pit at the Camp Killpack cantonment (Figure 2-3) is located approximately 10 feet east of the gravel road that runs north-south, on the east side of the former mess hall building (Building 4389). Small ditches run along both sides of the gravel road. The grease pit is located just inside a heavily wooded area; access is somewhat limited by the trees. The visible portion of the grease pit consists of two corrugated metal pipes, one inside the other. The outer pipe is approximately 16 inches in diameter, and the inner pipe is approximately 10 inches in diameter. The pipes are covered with a metal lid.

2.2.7 Former Sewage Pond

The Former Sewage Pond site, BRAC parcel number 17(7)HR(P), is located south of the Camp Bonneville cantonment area (Figure 2-4). The exact location and dimensions of the pond were not documented in the records URSGWC reviewed. According to the former Facility Manager, the pond was an unlined lagoon that was pumped out and filled with clean soil derived from a local source when it was abandoned. It reportedly was used for sewage disposal until 1978, when the existing sewage lagoon was constructed. The years of pond usage are not known; however, according to the current Facility Manager, it may have been used for only a short period of time.

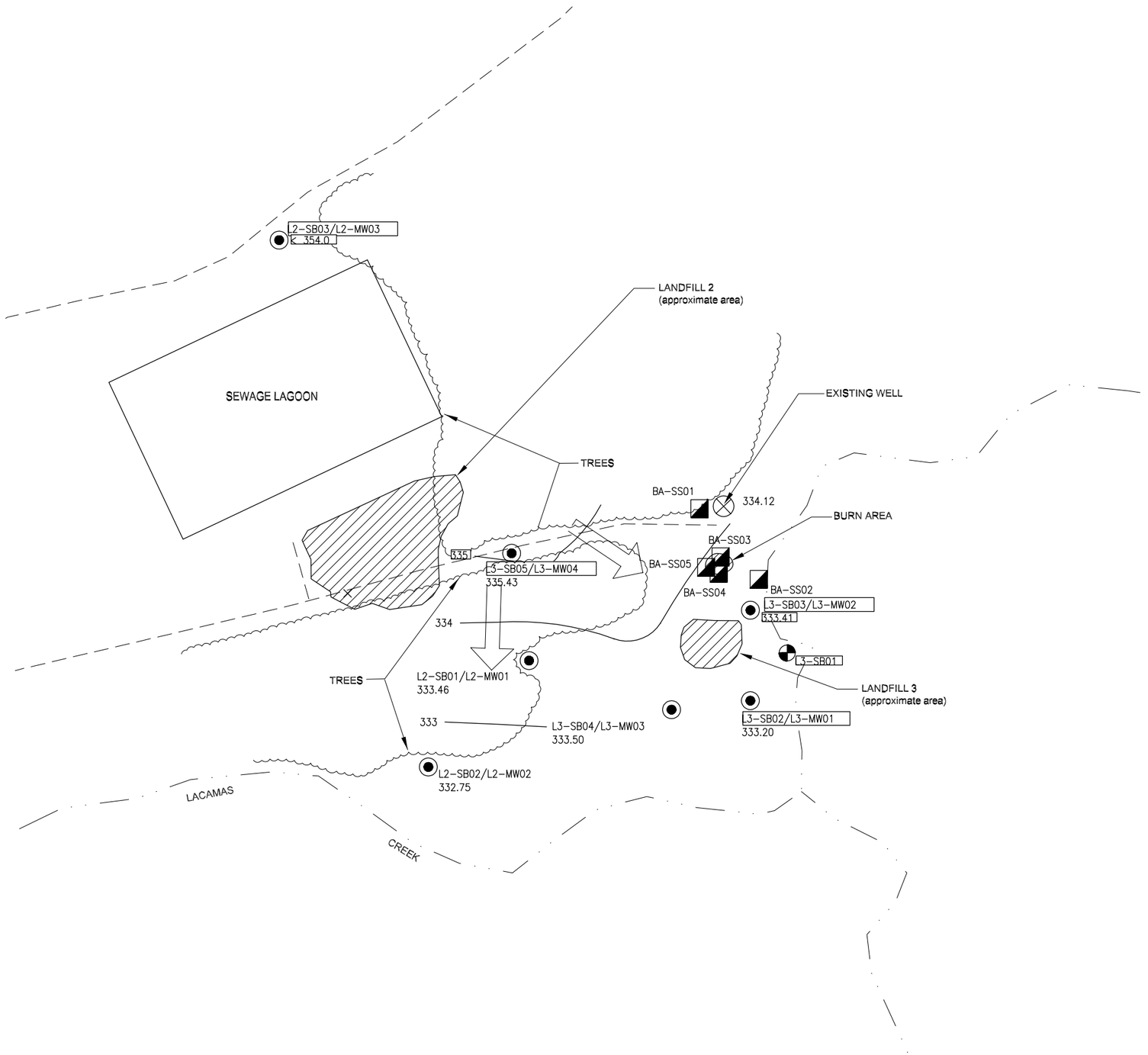
Although there are no records of hazardous materials disposal in the sewage pond and no evidence of contamination has been observed in the area, the potential for contamination could not be discounted given the nature and purpose of the facility. There was also a potential for UXO at the site because of munitions misfires impacting outside of established range fans, unauthorized munitions disposal, or other activities. The general site area is on the floodplain of Lacamas Creek, and the terrain is low-lying and flat. Water tends to pond in much of this area during the wet season. Lacamas Creek is approximately 200 feet southeast of the site at the closest point.

2.2.8 Hazardous Material Accumulation Point

The Hazardous Material Accumulation Point, Building 4476, is located in the northeast corner of the Camp Bonneville shop area, in the Camp Killpack cantonment (Figure 2-3). The building is a three-walled structure, built in 1990, with concrete masonry block walls and a concrete slab floor. The open front of the structure is secured with locking metal gates. The structure, also

referred to as the Covered Vehicle Maintenance Storage, has been used for the storage of drums of liquids such as antifreeze and waste oil. It may have been used for temporary accumulation of drums of other hazardous materials. The structure currently is used for empty drum storage. The concrete floor of the building is sloped toward a sump in the middle of the floor. The sump measures approximately 2 feet square and is approximately 2 feet deep. No drains are present in the sump. No evidence or reports of spills at this site were found.

The Hazardous Material Accumulation Point is bounded by a gravel driving surface to the south and east, small storage buildings and equipment to the west, and woods to the north. A vehicle fuel AST, covered and within a concrete containment structure, is located immediately west of the building. The chain-link fence that surrounds the shop office area runs along the north and east sides of the building. The site area is fairly flat. Drainage from the area likely flows to the ditch running parallel to the main access road, south of the fenced shop area. This site was assigned BRAC parcel number 13(7)/PR(P).



N

LEGEND

- GRAVEL ROAD
- CREEK
- L3-SB01 — SOIL BORING LOCATION AND DESIGNATION
- L3-SB02/L3-MW01 333.20 — BORING AND MONITORING WELL LOCATION, DESIGNATION AND GROUNDWATER ELEVATION (MEASURED 8-3-98)
- BA-SS1 — SURFACE SOIL SAMPLE LOCATION AND DESIGNATION
- 333 — GROUNDWATER ELEVATION CONTOUR AND APPROXIMATE DIRECTION OF GROUNDWATER FLOW

NOTE

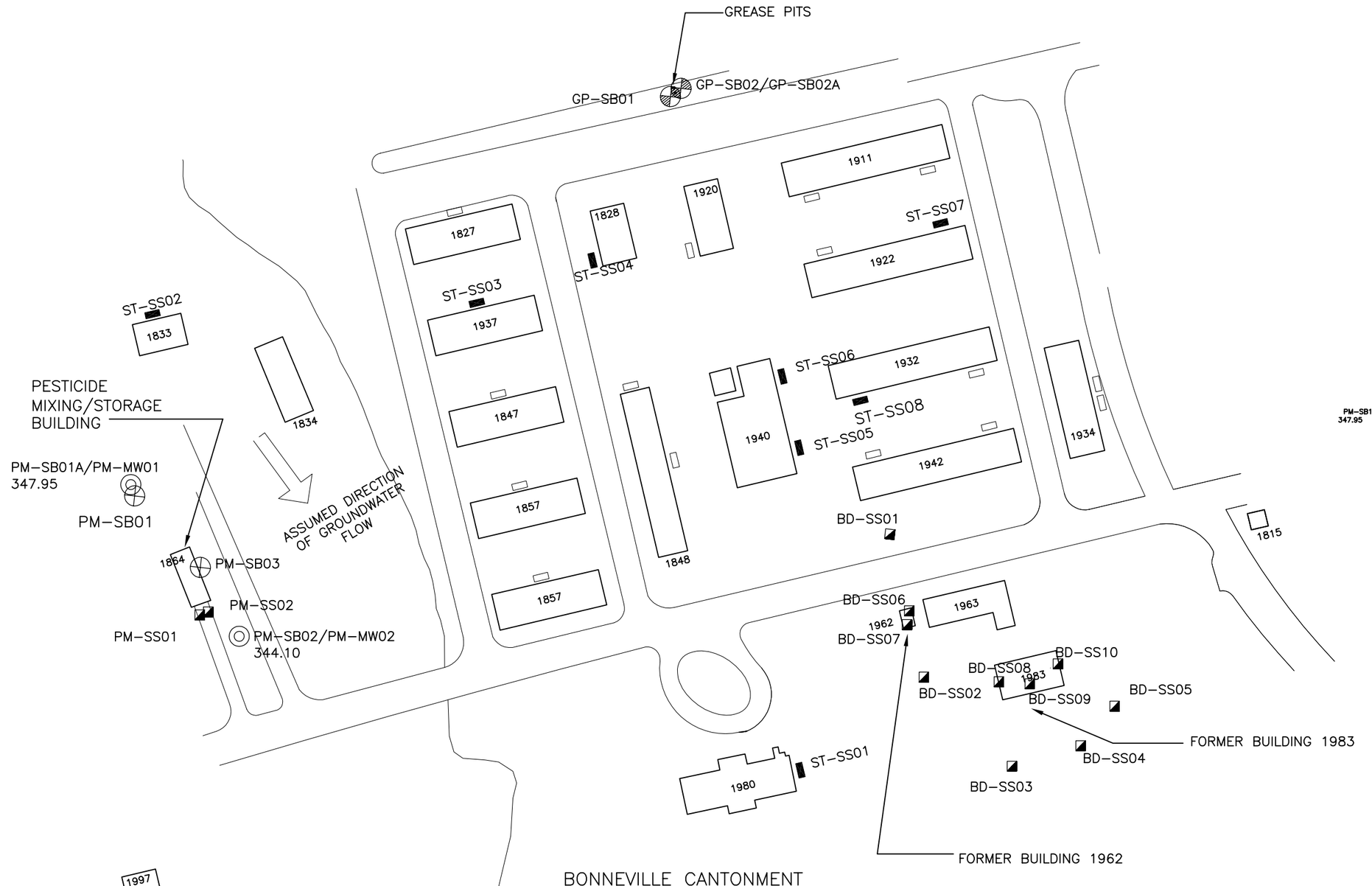
THE GROUNDWATER LEVEL IN THE EXISTING WELL WAS MEASURED ON 8-6-98.

REFERENCE: SHANNON AND WILSON 1999

0 300 600
Scale in Feet

FILENAME: Q:\COE\Camp Bonneville\Bonn-112.dwg
EDIT DATE: 09/21/00 AT: 11:30

Camp Bonneville Location, WA	Project No. 53F0072250.00	LANDFILLS 2 AND 3 AND BURN AREA EXPLORATION PLAN	Figure 2-1
URS			



N

LEGEND

- GP-SB01 — SOIL BORING LOCATION AND DESIGNATION
- ABOVEGROUND STORAGE TANK
- ST-SS01 — ABOVEGROUND STORAGE TANK SAMPLE LOCATION AND DESIGNATION
- CREEK
- BD-SS01 — SURFACE SAMPLE LOCATION AND DESIGNATION
- PM-SB01 — SOIL BORING LOCATION AND DESIGNATION
- PM-SB1A/PM-MW01 347.95 — BORING AND MONITORING WELL LOCATION, DESIGNATION, AND GROUNDWATER ELEVATION (8-3-98)

NOTE

SAMPLE PREFIXES ARE AS FOLLOWS:

BD-XX00 = FORMER BUILDING 1962 AND 1983 SAMPLE

GP-XX00 = GREASE PIT SAMPLE

PM-XX00 = PESTICIDE MIXING/STORAGE BUILDING SAMPLE

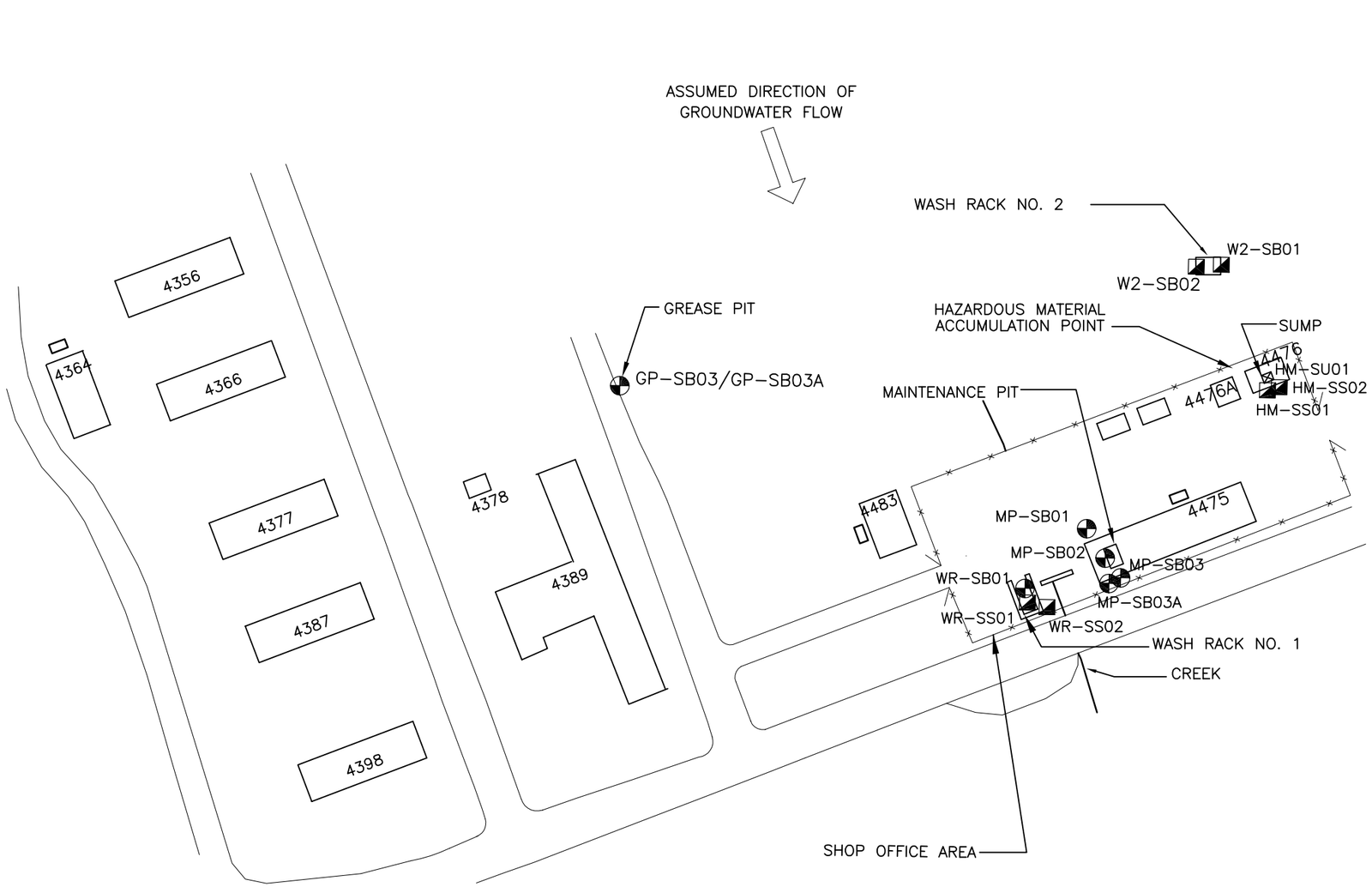
ST-XX00 = ABOVEGROUND STORAGE TANK SAMPLE

REFERENCE: SHANNON AND WILSON 1999

0 400 800
Scale in Feet

FILENAME: Q:\COE\Camp Bonneville\Bonn-113.dwg
EDIT DATE: 09/21/00 AT: 11:27

Camp Bonneville Location, WA	Project No. 53F0072250.00	BONNEVILLE CANTONMENT AREA EXPLORATION PLAN	Figure 2-2
URS			



N

LEGEND

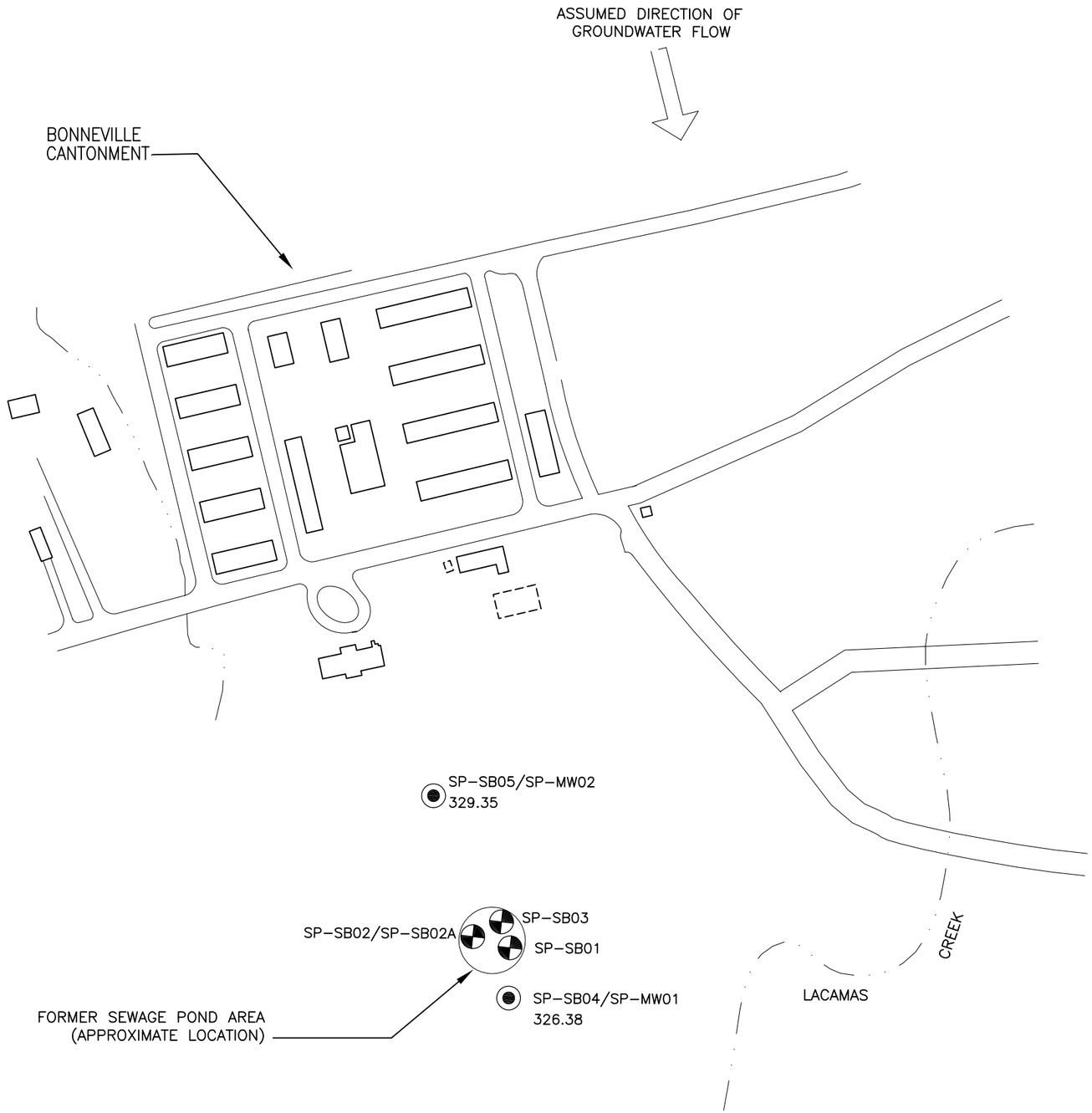
- FENCE
- CREEK
- ABOVE GROUND STORAGE TANK
- MP-SB01 — SOIL BORING LOCATION AND DESIGNATION
- HM-SS01 — SURFACE/NEAR SURFACE SAMPLE LOCATION AND DESIGNATION
- HM-SU01 — SUMP SAMPLE LOCATION AND DESIGNATION

0 100 200
Scale in Feet

REFERNCE: SHANNON & WILSON 1999

FILENAME: Q:\COE\Camp Bonneville\Bonn-116.dwg
EDIT DATE: 09/21/00 AT: 10:28

Camp Bonneville Location, WA	Project No. 53F0072250.00	KILLPACK CANTONMENT AREA EXPLORATION PLAN	Figure 2-3
URS			



N

LEGEND

ROAD

CREEK

SP-SB01 SOIL BORING LOCATION AND DESIGNATION

SP-SB05/SP-MW02 329.35 BORING AND MONITORING WELL LOCATION, DESIGNATION, AND GROUNDWATER ELEVATION (8-3-98)

REFERENCE: SHANNON AND WILSON 1999

0 100 200
Scale in Feet

FILENAME: Q:\COE\Camp Bonneville\Bonn-114.dwg
EDIT DATE: 09/21/00 AT: 08:49

Camp Bonneville Location, WA	Project No. 53F0072250.00	FORMER SEWAGE POND EXPLORATION PLAN	Figure 2-4
URS			

3.1 HISTORICAL CHRONOLOGY

A general description history of Camp Bonneville since 1909 is presented in Section 2.1 of this report and a chronology identifying historical events of the site is presented on Figure 3-1. This section focuses on the history of Camp Bonneville during the 1980s and 1990s, a time during which several environmental surveys, investigations, and cleanup activities occurred at the site. The dates of these environmental activities and resultant are presented on Figure 3-1.

Prior to the late 1980s, base closure was a time-consuming and inconsistent process. The Secretary of Defense, in cooperation with Congress, proposed a base closure law to create a process to close military bases and bring base infrastructure in line with military force status. Public Law (PL) 100-526, enacted in 1988, created the Commission on Base Realignment and Closure (BRAC). The law charged the Commission with recommending installations for closure or realignment based on independent study of the domestic military base structure.

The closure process was refined in PL 101-510, in which Congress created the Defense Base Closure and Realignment Commission. The closure process identified installations based on military value criteria, including savings and return-on-investment, and the economic and environmental impacts of closure. The Commission met in 1991, 1993, and 1995. As seen on Figure 3-1, Camp Bonneville was selected for closure in 1995.

The Final EBS was submitted to the USACE in 1997 (Woodward-Clyde 1997). The EBS included a characterization of the environmental condition of the Camp Bonneville property, which was completed through record searches, historical document review, interviews, aerial photograph review, visual inspections, and historical map review. Evaluation of this information enabled the preparation of an overview of past and current (at the time) operations at Camp Bonneville and a discussion of potential environmental concerns associated with those operations, including past waste management practices.

The potential environmental concerns identified in the EBS included those discussed in prior reports and those not addressed by previous investigations. Among the areas identified were the eight base sites discussed in this report that are proposed for closure and NFA. As a result of the EBS and prior site investigations, several environmental studies were undertaken as part of the restoration effort for the site in support of the BRAC 95 program. Beginning in 1996, several Management Plans were developed to perform environmental investigations at those areas identified by the EBS as having potential environmental concerns. These plans included the Management Plans for the three phases of the Multi-Sites Investigation (Shannon & Wilson 1997, 1998a, and 1998b), which addressed the eight base sites presented for closure in this report.

3.2 CLEANUP STANDARDS AND ARARS

Comparison criteria, or screening levels, for Camp Bonneville consist of regulatory and risk-based limits for soil and groundwater, as well as background levels established for metals in soils. In Section 3.3.2, the sample results are compared with these criteria to evaluate which constituents may present a concern at each site.

3.2.1 Cleanup Levels and Risk-Based Concentrations

The following regulations and guidance provide cleanup-level and risk-based concentrations for chemicals in soil and groundwater.

Maximum Contaminant Levels. Maximum contaminant levels (MCLs) and non-zero MCL goals for groundwater were obtained from EPA Primary Drinking Water regulations and health advisories. In addition, the EPA-recognized action level of 15 micrograms per liter (µg/L) for lead in drinking water at the tap has been used (40 Code of Federal Regulations [CFR] 141.80).

Use of MCLs as MTCA cleanup levels is supported by the determination of the Ecology Toxics Cleanup Program that most MCLs (with the exception of arsenic, hexavalent chromium, and silver) are sufficiently protective of human health (Ecology 1993).

EPA Region 3 Tap Water. Risk-based concentrations (RBCs) for tap water were obtained from EPA Region 3 (and adopted by EPA Region 10). These concentrations are based on a default residential groundwater use scenario and a 10^{-6} cancer risk or a hazard quotient of 1 (Region 3 1996).

EPA Region 3 Risk-Based Concentrations for Residential Exposure to Soil. Residential soil ingestion RBCs were obtained from the table prepared by EPA Region 3 (and adopted by EPA Region 10) (EPA Region 3 1996).

The Model Toxics Control Act (MTCA) regulations (Chapter 173-340 WAC) set forth cleanup levels for environmental media for sites within Washington state. Substantially revised regulations have been developed and will be issued in the summer of 2000. The proposed Method A values have been included in the tables here.

MTCA Method A. MTCA Method A cleanup level values for soil and groundwater are applicable to sites undergoing routine cleanup actions as defined in MTCA and are not site specific. Establishment of actual MTCA Method A cleanup levels requires meeting requirements for use of Method A and consideration of applicable laws, achievable quantitation limits, background concentrations, and other factors in addition to the values listed in the Method A tables.

MTCA Method B for Protection from Direct Contact. Method B is the standard method of determining cleanup levels under MTCA and is applicable to all sites. It is based on protection of humans via direct contact exposure. MTCA Method B risk-based concentrations for soil and groundwater were obtained from the MTCA Cleanup Levels and Risk Calculations (CLARC) II database (based on a 10^{-6} cancer risk or a hazard quotient of 1) (Ecology 1996). These are formula values obtained from the February 1996 CLARC II Update (Ecology 1996). Establishment of actual MTCA Method B cleanup levels requires considering applicable laws, site-specific information, cross-media impacts, and other factors in addition to formula risk-based calculations. Method B RBCs were not derived for chemicals that are not listed in the CLARC II database.

MTCA Method B for Groundwater Protection. Soil concentrations (in milligrams per kilogram [mg/kg]) for the protection of groundwater are based on MCLs or the MTCA Method B groundwater concentration (in milligrams per liter [mg/L]) multiplied by the MTCA attenuation factor of 100 (Ecology 1996a; and Ecology 1996b).

3.2.2 Background Concentrations for Soils

Natural background concentrations of metals in soil were obtained from two sources. Ecology (1994) has reported on background metals concentrations for soil within the state of Washington including several regions within the state. Not all of the metals analyzed during this study are covered by the Ecology report. In addition, copper was typically detected at the investigation sites at concentrations exceeding the Ecology background concentrations. Background soil samples were collected at Camp Bonneville and were statistically evaluated to establish concentrations representative of area background.

Statewide Background

Ecology conducted a study to measure the natural background concentrations of metals in soil throughout Washington State. The report, titled *Natural Background Soil Metals Concentrations in Washington State*, provides background data for selected regions, as well as statewide (Ecology 1994). One of the regions investigated was the Clark County area. Soil samples used in the study were collected from the ground surface to a depth of 3 feet below ground surface (bgs).

Natural background soil metals concentrations can be used to establish a cleanup standard for a hazardous substance for which no applicable or relevant and appropriate requirement (ARAR) exists (Chapter 173-340-700 [4][d] WAC). Natural background concentrations can also be used to replace existing Method A or Method B cleanup standards that are below the natural background level (Chapter 173-340-700 [1][a] WAC). Numbers typically used for comparison are the 90^{th} percentile values for the data. Statewide and Clark County 90^{th} percentile natural background values are shown in Table 3-1. According to the Ecology report, use of the statewide 90^{th} percentile values is unrestricted (i.e., they can be compared with data from anywhere within the state). The regional (for example, Clark County) 90^{th} percentile numbers are to be compared only with data from that region.

The Ecology 90^{th} percentile numbers ideally are compared with the 95 percent upper confidence limit (UCL) of a given data set when comparing site data with background values. However, because of the limited number of data points collected from most of the investigation sites, such a statistical comparison is not practical. When comparing individual data points with the 90^{th} percentile values, there is a 10 percent chance that an individual data point from an unaffected site will exceed the 90^{th} percentile value. According to Ecology, if background values are used as cleanup levels, no single sample concentration can be greater than two times the 90^{th} percentile value, and less than 10 percent of the sample concentrations can exceed the 90^{th} percentile value (WAC Chapter 173-340-7407[e]).

Site Background

Surface and near-surface soil samples were collected to determine background concentrations of metals in soil at Camp Bonneville. Ten background locations (BK-SS01 through BK-SS10) were sampled. Two soil samples were collected from each location: one from 0 to 1 foot bgs and one from 1 to 2 feet bgs. The sample locations were distributed around the facility, generally near the perimeter on the west, northwest, and southwest sides (Figure 3-2). An attempt was made to locate relatively undisturbed areas for sampling. Two locations (BK-SS01 and BK-SS02) were selected near Lacamas Creek, close to the point were it exits the site to the west. These locations were selected in an attempt to look at the chemical composition of floodplain

soils. Table 3-2 provides a summary of the metals concentrations detected. Most of the samples were collected from densely wooded areas. Sample depths were influenced, in some cases, by the presence of roots, very dense clay, gravel, or cobbles.

The metals data were analyzed to establish concentrations representative of area background. Background values were calculated only for metals that tended to exceed both the risk-based or regulatory criteria and the Ecology background values in on-site soils. Background values could not be calculated for antimony or thallium because the majority of the concentrations detected were reported as estimated (detected at a concentration between the method detection limit [MDL] and the reporting limit [RL]). The maximum concentrations of these two metals have been listed in Table 3-1 for comparison purposes.

Summary statistics were calculated using concentrations for barium and copper. Before summary statistics were calculated, field duplicates were compared with field samples to determine which samples would be included in the data set, and statistical tests were applied to determine what types of distributions were present. Twenty field samples and two field duplicates were collected. A duplicate was compared with its corresponding field sample, and the lowest concentration was included in the data set. Distributions were tested for normality and lognormality using the Shapiro-Wilk test (SPSS 1997). No data set fits a normal distribution. One data set, for barium, fit a lognormal distribution. The distribution for copper was assumed to be nonparametric.

The summary statistic calculated for barium was the 90^{th} percentile of the lognormal distribution (Ecology 1992). This statistic was calculated using the following formula:

$$Y = \exp (X + Z_{90}\ SD)$$

where:

Y = 90^{th} percentile of the lognormal distribution

X = mean of the $\log_e$-transformed data

Z_{90} = value from the normal distribution corresponding to the 90^{th} percentile.

SD = standard deviation of the $\log_e$-transformed data.

The summary statistic used for copper was the 90^{th} percentile calculated using the nonparametric (distribution-free) method (Ecology 1992). This method ranks the data in ascending order and uses the value with the rank corresponding to the desired percentile and given by the following formula:

$$V = p/100\ (n+1)$$

where:

V = rank of the p^{th} percentile data.

p = percentile (i.e., 90).

n = number of samples (i.e., 20).

In cases where V was not an integer, linear extrapolation between two data points was used.

3.2.3 Background Concentrations Used for Screening Criteria

Many of the statewide natural background numbers are the same as or similar to the Clark County numbers; however, the statewide background numbers for chromium and mercury are more representative than the Clark County numbers for concentrations detected in background soil samples from Camp Bonneville. In an effort to use published numbers to the extent possible, the statewide background numbers were selected for comparison, rather than the Clark County numbers. Camp Bonneville-specific background numbers were calculated only for metals that exceeded the default Ecology background values, or for which no Ecology values were available.

Table 3-1 includes a summary of available background numbers (90^{th} percentile) for metals in soils for statewide, Clark County, and Camp Bonneville-specific samples. The shaded numbers are those selected for use as screening criteria.

3.3 PREVIOUS INVESTIGATIONS

3.3.1 Environmental Baseline Survey

Camp Bonneville Military Reservation was selected for closure in 1995 under the BRAC process. An Environmental Baseline Survey (EBS) was prepared in 1997 (Woodward-Clyde 1997) to classify discrete areas of real property associated with Camp Bonneville, subject to transfer or lease into one of seven standard environmental condition of property area types as defined by Community Environmental Response Facilitation Act (CERFA) guidance and the Department of Defense (DoD) BRAC Cleanup Plan (BCP) Guidebook (DoD 1995).

Classification was performed by identifying, characterizing, and documenting the presence or likely presence of a release of hazardous substances or petroleum products associated with the historical use of Camp Bonneville. Releases at properties adjacent to Camp Bonneville that could affect the environmental condition of property were also identified, characterized, and documented. Areas containing or suspected of containing non-Comprehensive Environmental Compensation and Liability Act (non-CERCLA) contamination substances (i.e., asbestos, lead-based paint) that might limit or preclude the transfer or lease of the property for unrestricted use were delineated separately as being qualified.

Areas that were designated as Category 1, 2, 3, or 4 are suitable for transfer or lease, subject to the consideration of qualifiers. Areas that were designated as Category 5, 6, or 7 are not suitable for transfer, but may be suitable for lease.

Based on review of installation-related documents, government records, aerial photographs, visual property inspection, and interview, CERFA categories were identified at the 3,840-acre property. Of the 3,840 acres, approximately 3,826 acres were designated as Categories 1 and 2. The remaining 14 acres were designated as Categories 5 and 7. Additionally, 1.3 acres of the 3,840 acres were designated qualified for asbestos-containing materials and lead-based paint. The entire installation was qualified for unexploded ordnance and/or ordnance fragments. The eight base sites and their respective CERFA categories discussed in this SCR are presented in Table 3-3.

3.3.2 Multi-Sites Investigation

The information presented in the following section summarizes the Multi-Sites Investigation Report prepared by Shannon & Wilson (1999). This report addresses the eight base sites discussed in this SCR as well as other Camp Bonneville sites. The objective of the Multi-Sites investigation was to identify contaminated areas and recommend future steps toward restoration, if necessary. For more detailed information regarding the sites, refer to the final Multi-Site Investigation Report.

3.3.2.1 Landfill 1

Site Investigations and Findings

UXO avoidance/screening surveys were performed on December 9, 1997, in the general area where the landfill was reportedly located, since its precise location was unknown. UXO specialists swept a large area generally north and northwest of the existing sewage lagoon. Representatives from Shannon & Wilson, the USACE, and the Camp Bonneville facility manager followed behind the UXO specialists. No evidence of the landfill area was found.

On December 12, 1997, the UXO specialists and a geophysicist, the USACE on-site representative, and the facility manager made another search of the area with three meters. The group spread out evenly spaced in a line and walked together across the area of the reported landfill. The meters used to search for buried landfill debris meters are Fisher and Garrett metal locators, both of which are EM devices and create a magnetic field in the detector to locate buried objects made of metal. In addition, a Schonstedt flux-gate gradiometer (the standard UXO detection device) was used. The area surveyed was covered with dense vegetation, including trees and thick underbrush. No evidence of a landfill was found using the magnetometers, nor was there visual evidence of the landfill, either in the way of a depression, or of debris at the ground surface.

As directed by the USACE on-site representative, attempts to locate Landfill 1 were ended after these efforts. Based on this survey work, it is likely that the term "landfill" may not be appropriate for this site. Rather, it may have been an area where some household debris (such as old bottle fragments) was disposed of from a former homestead.

No soil or groundwater sampling has been conducted at Landfill 1.

3.3.2.2 Landfill 2

Site Investigations

Tasks performed at this site included:

- UXO avoidance surveying
- Geophysical surveying
- Soil gas surveying
- Drilling and subsurface soil sampling
- Monitoring well installation
- Groundwater sampling

The initial site characterization work was performed during the Phase 1 investigation. The drilling, well installation, and sampling tasks were performed during the Phase 3 investigation.

A UXO avoidance/screening survey was performed in December 1997. Magnetic anomalies were flagged and avoided during subsequent activities at the site. A large area was initially surveyed, and additional areas were surveyed, as needed, as the fieldwork progressed.

An electromagnetic (EM) survey was then performed over the Landfill 2 area. Two ground penetrating radar (GPR) instruments were run across the site, but because of high natural ground conductivity, uneven terrain, and the presence of ponded water, GPR was not used as the primary geophysical method. Based on the results obtained in the field, the EM survey was extended into the trees on the east side of the suspected landfill area, and across to the south of the gravel road.

A soil gas survey was also performed during December 1997. Sixty-four soil gas samplers were planted in a grid pattern over the landfill and adjacent areas, as delineated by the geophysical survey (Figure 2-1).

Three soil borings were drilled outside of the estimated perimeter of Landfill 2 during July 1998 (Figure 2-1). Monitoring wells were installed in all three borings. The monitoring wells were installed in locations assumed to be upgradient (one well) and downgradient (two wells) of the landfill, based on area topography and surface drainage. Each soil boring was initially advanced by UXO specialists to a depth of approximately 5 to 7 feet bgs. The drilling rig was then moved over the borehole (or immediately adjacent to it), and drilling continued by the hollow-stem auger method. One soil sample was collected for chemical analysis at or immediately above the water table (i.e., capillary fringe) in each of the downgradient soil borings. Groundwater was not encountered in the upgradient boring. Because the UXO specialists had to advance the boreholes to depths below the water table for safety purposes, soil samples for chemical analysis were collected from the hand auger barrel in the two downgradient borings. A soil sample was collected from the anticipated wet-season water table zone at the upgradient boring (L2-SB03) using a split-spoon sampler from the drill rig.

Because suspect landfill material was found slightly into a dense stand of trees south of the gravel road, the two downgradient monitoring wells (L2-MW01 and L2-MW02) were installed to the south of the trees, as close to the landfill as possible (Figure 2-1). These two wells were installed to depths of 13.3 and 12.7 feet bgs, respectively. The upgradient well (L2-MW03) was

installed to a depth of 10.4 feet bgs, near the northeast corner of the sewage lagoon, to allow for potential seasonal changes in groundwater elevation. This depth corresponded with the top of the bedrock, above which shallow groundwater was expected to perch during the rainy season.

The two wells were sampled on August 4 and August 6, 1998. A rinsate blank also was collected using the sampling pump, following sampling of well L2-MW02.

Field Observations

A considerable amount of metallic debris (including pipes, vehicle parts, and wiring) was detected at and near the land surface during the UXO avoidance survey of Landfill 2. No UXO-related debris was observed during the field investigation; however, an undetonated 2.76-inch light anti-tank weapon (LAW) round was located during early scoping surveys of the Landfill 2 site. Fort Lewis Explosive Ordnance Demolition (EOD) personnel were brought to the base for in-situ detonation of the shell.

The geophysical survey results suggest that the landfill extends into the trees to the east and past the gravel road, and into the trees to the south. Three areas of low conductivity values were identified at Landfill 2. The conductivity lows at the junction of the access road and the sewage lagoon entrance road and along the entrance road are suspected to originate from a pipeline that runs to the sewage lagoon. The conductivity low observed to the east of the north-south road to the sewage lagoon is interpreted to reflect buried landfill debris. This conductivity low is centered at an area where metal debris was observed protruding from the ground surface. The third conductivity low lies south of the north-south road. The conductivity values in this area are typical of landfill debris; that is, the results do not show a trend but rather a random rising and falling along each traverse. These conductivity lows and highs were found in an area of low-relief mounds, south of the edge of the road. The approximate landfill boundary, as determined by the geophysical survey, is shown on Figure 2-1.

Soil

The downgradient soil borings at Landfill 2 generally encountered 3 to 5 feet of brown, silty clay/clayey silt with varying amounts of sand, which was underlain by 5 to 7 feet of brown, silty, gravelly sand to silty, sandy gravel. At L2-SB01, the gravel is underlain by about 15 feet of hard, reddish brown, gravelly clay. Beneath the clay at L2-SB01 and beneath the gravel at L2-SB02 (at depths of 25 and 10.5 feet bgs, respectively) is moderately hard, severely weathered andesite. The upgradient boring (L2-SB03) encountered 3 feet of fill (brown, slightly clayey, sandy, gravelly silt/silty gravel), underlain by 4 feet of dense, brown, slightly sandy, gravelly, clayey silt, with gravel content increasing with depth. Relatively unweathered andesite was encountered at a depth of about 7 feet in this boring.

No sheen or odor was observed and no volatiles were detected by the photoionization detector (PID) during field screening of soil samples from the borings, with the exception of PID readings for samples collected at and below the water table at L2-SB02. PID readings of the soil there ranged from 0.2 to 4.4 parts per million (ppm) at depths of 5 to 15 feet bgs. These PID readings are relatively low and may be related to the high moisture content of the soil samples.

Groundwater

The water table was encountered at depths of 2.6 to 2.9 feet bgs during drilling of the two downgradient soil borings. The lower part of the upper silty clay/clayey silt unit and the silty,

sand/gravel unit in borings L2-SB01 (well L2-MW01) and L2-SB02 (well L2-MW02) were saturated, whereas the underlying clay and bedrock were moist, indicating the presence of a perched aquifer in this area. No groundwater was encountered in the upgradient boring during or immediately after installation; however, evidence of a wet season water table (iron staining) was seen at about 3 feet bgs. Groundwater levels were measured in the Landfill 2 wells on August 3, 1998, and again during groundwater sampling (August 4 and 6, 1998). These groundwater levels were similar to those measured during drilling. Upgradient well L2-MW03 was dry.

The estimated groundwater gradient in the Landfill 2 vicinity is generally to the south, toward Lacamas Creek, and ranges from 0.005 to 0.02 foot/foot, based on groundwater levels measured in the Landfill 2 and Landfill 3 wells on August 3, 1998 (Figure 2-1). Based on a southerly groundwater flow direction, monitoring well L2-MW02 appears to be located directly downgradient of Landfill 2, while well L2-MW01 may be in a more crossgradient location.

Another round of water level measurements was obtained on December 16, 1998. The water level in well L2-MW01 was more than 1 foot higher than that measured during August, and the level in well L2-MW02 was more than 1/2-foot higher. Approximately 1/2 foot of water was present in the bottom of upgradient well L2-MW03 during December; however, there was insufficient volume to allow sampling. The new water level measurements corroborated the earlier conclusion that the direction of groundwater flow was to the south.

PID screening of the headspace of both well casings did not indicate the presence of VOCs, and no groundwater sheen or odor was noted during well development or groundwater sampling.

Analytical Results

Soil Gas Survey

Sixty-four soil gas samples were collected in the Landfill 2 area and analyzed for halogenated hydrocarbons and benzene, toluene, ethylene, and xylenes (BTEX) compounds by EPA Methods SW8010 and SW8020. These data were used as a screening tool to evaluate whether volatile constituents were present in and escaping from the landfill, rather than to provide a reliable quantitation of concentrations. Analytical results from this sampling were below the method detection limits for all soil gas samples, with the exception of chloroform. Trace concentrations of chloroform were detected in two samples: 4 nanograms (ng) in sample L2-SG-40 and 6 ng in sample L2-SG-58. These trace concentrations of chloroform may be due to contamination from sampling or analytical procedures and are not likely to be associated with VOCs emanating from the landfill.

Soil

One soil sample was collected from each of the three soil borings. The samples were analyzed for TPH, VOCs, semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs)/pesticides, nitroaromatic and nitramine explosives, pentaerythritol tetranitrate (PETN), picric acid (PA), cyanide, total organic carbon (TOC), and priority pollutant metals. Results of these analyses are summarized in Table 3-4.

Analytical results for TPH, VOCs, SVOCs, PCBs/pesticides, explosive compounds (including PETN and PA), and cyanide were below the detection limit for all samples, except for PETN in one sample. Sample L2-SB01-01 contained PETN at an estimated concentration of 0.22 mg/kg. No regulatory screening levels are available for PETN in soil.

Antimony, cadmium, lead, nickel, silver, and zinc were detected in all of the Landfill 2 soil samples, but at concentrations below the regulatory screening criteria. Arsenic, barium, beryllium, chromium, copper, and thallium were detected in all soil samples at concentrations exceeding one or more of the regulatory cleanup criteria for soils. However, only one of these metals exceeded the background levels. Copper was detected at a concentration of 134 mg/kg in sample L2-SB03-01 (from the upgradient soil boring); this slightly exceeds the background level of 114 mg/kg. Total organic carbon in all samples ranged from 0.36 mg/kg to 1.3 mg/kg.

Groundwater

Groundwater samples were collected from downgradient monitoring wells L2-MW01 and L2-MW02. The upgradient well was dry at the time of sampling in August 1998 and had too little water for sampling during a water level check in December 1998. A rinsate blank sample also was collected following sampling at well L2-MW02. All samples were analyzed for TPH, VOCs, SVOCs, explosive compounds (including PETN and PA), PCBs/pesticides, cyanide, and priority pollutant metals (total and dissolved). A summary of the analytical results is provided in Table 3-5.

TPH, SVOCs, explosive compounds, and PCBs/pesticides were not detected in any of the samples. One VOC was detected in groundwater sample L2-MW02-01; naphthalene was detected at an estimated concentration below the regulatory criteria.

Arsenic, barium, chromium, copper, lead, nickel, selenium, thallium, and zinc all were detected in one or both of the groundwater samples. However, arsenic was the only metal detected at a concentration above regulatory screening levels. Both total and dissolved arsenic were detected at concentrations above the EPA Region 3 risk-based criterion (0.000045 mg/L) and the MTCA Method B (0.00005 mg/L) screening level in both samples. However, neither of the samples exceeded the MCL of 0.005 mg/L for arsenic. Cyanide was detected at a concentration below regulatory levels in the rinsate blank sample. It was not detected in any of the monitoring well samples.

3.3.2.3 Landfill 3

Site Investigations

Tasks performed at this site included:

- UXO avoidance work
- Geophysical surveying
- Performance of a soil gas survey
- Drilling and subsurface soil sampling
- Monitoring well installation
- Groundwater sampling

The initial site characterization work was performed during the Phase 1 investigation. The drilling, well installation, and sampling tasks were performed during the Phase 3 investigation.

A UXO avoidance/screening survey was performed in December 1997. A two-person crew of UXO specialists flagged magnetic anomalies to be avoided during subsequent investigation activities. The landfill and a large area surrounding the landfill were initially surveyed, and additional areas were surveyed, as needed, as the fieldwork progressed. Numerous magnetic anomalies detected within the landfill area were likely due to the presence of buried metal debris at shallow depths.

An EM survey was then performed in the Landfill 3 area. GPR equipment was not used because of high natural ground conductivity and rough terrain.

A soil gas survey was also performed during December 1997. Eleven soil gas samplers were planted in and around the perimeter of the landfill area, as delineated by the geophysical survey. A grid pattern was used to select sample locations; however, many of the sample locations had to be adjusted (and in some cases eliminated entirely) because of the presence of magnetic anomalies (possible UXO). The samplers were planted on December 16, 1997, and retrieved on December 30, 1997.

Five soil borings were drilled outside of the estimated perimeter of Landfill 3 during July 1998 (Figure 2-1). The borings were drilled to characterize the shallow subsurface conditions and to evaluate potential pathways for contaminant migration from the landfill. Each soil boring was initially advanced by the UXO specialists to a depth of approximately 5 feet bgs. The drilling rig was then moved over the borehole, and drilling continued by the hollow-stem auger method.

One soil sample was collected (for chemical analysis) at or immediately above the water table (capillary fringe) in each soil boring to characterize the shallow groundwater pathway. Duplicate/split samples and MS/MSD samples were collected at location L3-SB02-01. Because the water table was shallow and safety provisions required the UXO specialists to advance the boreholes to depths of approximately 5 feet bgs using hand augers, soil samples for chemical analysis were collected from the hand auger rather than from split-spoon samplers advanced by the drilling rig.

The direction of groundwater flow was assumed to be to the east, southeast, and south, based on site topography and the proximity to Lacamas Creek. Of the four soil borings drilled in locations presumed to be downgradient of Landfill 3, two were originally planned to be used as wells. Following discussions with the on-site USACE representative, one additional downgradient boring was used for installation of a well, for a total of one upgradient (L3-MW04) and three downgradient monitoring wells.

The wells were developed on July 24 and 27, 1988, for approximately 4 hours each. During development, approximately 42, 39, 34, and 40 gallons of water were removed from wells L3-MW01, L3-MW02, L3-MW03, and L3-MW04, respectively. Groundwater samples were collected from the wells during August 3 through 6, 1998. A duplicate/split groundwater sample was collected from well L3-MW03. MS/MSD samples were collected from well L3-MW02.

Field Observations

A considerable amount of metallic debris (including corrugated metal sheets, pipes, drums, and wiring) was detected at and near the land surface; no UXO-related debris was observed. During the geophysical survey, the landfill area was found to generally coincide with the elevated mound of dirt at the site. The Landfill 3 area, as delineated by the geophysical survey, measured

about 50 feet wide by 70 feet long. The approximate outline of the landfill is shown in Figure 2-1.

Soil

The soil profile in the Landfill 3 borings consists of a thin layer of alluvial and lacustrine soil over volcanic rock. The upper 5 feet of soil generally consists of brown, slightly sandy, slightly clayey to clayey silt. This fine-grained soil is underlain by about 5 to 7 feet of brown to gray, slightly silty to silty, sandy gravel to a depth of about 9 to 11 feet. At L3-SB05 (the upgradient boring), the gravel was underlain by about 18 feet of hard, gray to reddish brown, silty clay. Beneath the clay at L3-SB05 (at 29 feet bgs) and beneath the gravel at the other Landfill 3 borings (at 9 to 12 feet bgs) hard, gray, highly weathered andesite was encountered. The lower portion of the upper silt unit and the silty, sandy gravel units were saturated, whereas the underlying clay and the weathered bedrock were moist, indicating the presence of perched groundwater.

No sheen, odor, or detectable PID measurements were detected during field screening of soil samples from the Landfill 3 borings, with the exception of PID readings for two samples from below the water table at L3-SB04. PID readings of 3.3 and 0.5 ppm were measured in the 7.5- and 10-foot soil samples from this boring, respectively. These PID readings are relatively low and may be related to the high moisture content of the soil samples.

Groundwater

The water table was encountered between about 3 and 5 feet bgs during drilling, and at similar levels after the wells had been installed and developed. This shallow groundwater is perched above rock or clay within the relatively thin alluvial sandy gravel. Groundwater levels were measured in the Landfill 3 wells on August 3, 1998, and again during groundwater sampling (August 3 through 6). The estimated groundwater gradient in the Landfill 3 vicinity is generally to the southeast, toward Lacamas Creek, and ranges between about 0.007 and 0.01 foot/foot, based on groundwater levels measured on August 3, 1998, in the Landfill 2 and Landfill 3 wells (Figure 2-1).

Another round of water level measurements was obtained on December 16, 1998, to represent seasonal variation. Increases in water levels in the four monitoring wells ranged from 0.86 to 1.26 feet. The increase in the December water levels does not appear to significantly affect the direction of groundwater flow in the site area.

Based on a groundwater flow direction to the southeast, well L3-MW01 appears to be directly downgradient of Landfill 3. However, based on the topographic mound created by Landfill 3, and the fact that Lacamas Creek wraps around the site to the east and south, infiltration and precipitation at the site likely migrates somewhat radially toward the creek. Wells L3-MW02 and L3-MW03 may therefore be either downgradient or somewhat crossgradient of the landfill.

PID screening of the headspace of each well casing did not indicate the presence of VOCs. No groundwater sheen or odor was noted during well development or groundwater sampling.

Analytical Results

Soil Gas Survey

Eleven soil gas samples were collected in the Landfill 3 area to screen for halogenated hydrocarbons and BTEX compounds. The analyses were performed by EPA Methods SW8010 and SW8020. Analytical results for the soil gas samples were below the detection limits for all analytes in every sample.

Soil

Five soil samples and one duplicate/split sample were collected from the water table interface (capillary fringe) in the soil borings at Landfill 3. The samples were analyzed for TPH, VOCs, SVOCs, PCBs/pesticides, nitroaromatic and nitramine explosives, PETN, PA, cyanide, TOC, and priority pollutant metals. Results of these analyses are summarized in Table 3-4 and discussed below.

Analytical results for TPH, VOCs, SVOCs, PCBs/pesticides, explosive compounds (including PETN and PA), and cyanide were below the detection limits for all samples. Antimony, cadmium, lead, nickel, selenium, silver, and zinc were detected in some of the samples, but at concentrations below regulatory screening criteria. Arsenic, barium, beryllium, chromium, copper, and thallium were detected at concentrations exceeding one or more of the regulatory screening criteria; however, none of these metals exceeded the background levels. TOC in all samples ranged from 0.62 mg/kg to 1.3 mg/kg.

Groundwater

Four groundwater samples and one duplicate sample were collected from the monitoring wells at Landfill 3. All samples were analyzed for TPH, VOCs, SVOCs, nitroaromatic and nitramine explosives, PETN, PA, PCBs/pesticides, cyanide, and priority pollutant metals (total and dissolved). A summary of the analytical results is provided in Table 3-5.

TPH, SVOCs, explosive compounds (including PETN and PA), cyanide, and PCBs/pesticides were not detected in any of the samples. Methylene chloride was detected in samples L3-MW01-01 and L3-MW02-01 at concentrations below the regulatory screening criteria. Methylene chloride is a common laboratory contaminant and was also detected in the method blank for this analysis. Naphthalene was detected in one sample (L3-MW02-01) at an estimated concentration below the regulatory screening criteria.

Arsenic, barium, chromium, copper, lead, nickel, selenium, thallium, and zinc were detected in some or all of the groundwater samples. Of these, only arsenic was detected at concentrations above regulatory screening criteria. Arsenic was detected in both total and dissolved samples at concentrations above the EPA Region 3 level (0.000045 mg/L) and the MTCA Method B (0.00005 mg/L) level in all three of the downgradient well samples (L3-MW-01-01, L3-MW02-01, and L3-MW-03-01) and the duplicate. The arsenic concentrations detected ranged from 0.00086 mg/L (estimated) to 0.0035 mg/L. However, none of the samples exceeded the MCL of 0.05 mg/L for arsenic. Arsenic was not detected in the upgradient groundwater sample.

3.3.2.4 Former Burn Area

Site Investigations

A UXO avoidance/screening survey was performed across the former Burn Area during the debris removal. Soil sampling locations were rechecked by UXO specialists before sampling.

Surface and near-surface soil samples were collected from five locations in and adjacent to the former Burn Area in December 1997 (Figure 2-1). The samples were collected to evaluate the potential for contamination resulting from past disposal and burning activities. Three sampling locations (BA-SS-03, BA-SS-04, and BA-SS-05) were located within the former Burn Area. The other two locations (BA-SS-01 and BA-SS-02) were upslope and downslope of the Burn Area, respectively. Two samples were collected from each location to assess the vertical extent of contamination: one from the 0 to 1-foot bgs interval, and one from the 1- to 2-foot bgs interval. Duplicate/split samples were collected with sample BA-SS-03-01. MS/MSD samples were collected with sample BA-SS-05-01. Quality assurance samples for duplicates, splits, and MS/MSDs were co-located but homogenized, with the exception of those samples collected for volatile compound analyses.

Field Observations

Surface debris had to be removed at the site prior to initiation of the field investigation, leaving the area accessible for soil sampling. Soils encountered generally consisted of stiff, reddish, silty clay with occasional debris, including wood, charcoal, and glass. The upslope sample location (BA-SS-01) filled with water at a depth of about 1.2 feet bgs, and the deeper of the two samples from this location was saturated. PID readings were less than 1 ppm for all samples.

Analytical Results

Ten soil samples and one duplicate/split sample were collected from five locations (two depths each) in the former Burn Area. Each sample was analyzed for TPH, VOCs, SVOCs, PCBs/pesticides, nitroaromatic and nitramine explosives, PETN, PA, and priority pollutant metals. A summary of the analytical results is provided in Table 3-6.

TPH, SVOCs, PCBs/pesticides, and explosive compounds (including PETN and PA) were not detected in any of the samples. VOCs were detected (all at estimated concentrations) in three of the samples at levels below regulatory screening criteria. The VOCs detected in sample BA-SS-05-02 include xylenes, toluene, and acetone. Toluene and xylenes also were detected in sample BA-SS-02-02 (downslope), and xylenes were detected in sample BA-SS-01-01 (upslope).

Antimony, cadmium, lead, nickel, selenium, silver, zinc, and mercury were detected at concentrations below regulatory screening criteria in the samples. Arsenic, beryllium, chromium, and copper were detected in all samples at concentrations exceeding one or more of the regulatory screening criteria. However, these concentrations did not exceed the background levels. Thallium was detected in four samples; concentrations in two of these samples exceeded the MTCA B groundwater protection criterion. Thallium in one sample (0.29 mg/kg in sample BA-SS05-01) also slightly exceeded the background level of 0.27 mg/kg.

3.3.2.5 Buildings 1962 and 1983

Site Investigations

A magnetometer was used in an attempt to locate the footprints of former buildings 1962 and 1983. On February 25 and 26, 1998, surface soil samples were collected from five locations within the suspected footprints of the former buildings, and from five additional locations within 50 feet of the suspected footprint of the former buildings (Figure 2-2). The soil samples were collected to determine if soil contamination resulted from the building use or destruction.

Samples BD-SS-01 through BD-SS-05 were located outside of the building footprints from 0 to 1 foot bgs. Sample locations BD-SS-06 and BD-SS-07 were within the Building 1962 footprint, and sample locations BD-SS-08 through BD-SS-10 were within the Building 1983 footprint. Two samples were collected from each of the sample locations within the former building areas: one from the 0 to 1-foot depth interval, and one from 1 to 2 feet bgs. Duplicate/split samples and MS/MSD samples were collected from location BD-SS-06-01.

Field Observations

The area where Buildings 1962 and 1983 were located is a grassy field with no obvious evidence of the former buildings. Using available maps, the UXO specialists conducted a magnetometer survey of the area and were able to identify evidence of what may be the former building areas. This evidence included nails and pieces of wood in areas that corresponded to the mapped locations of the former buildings.

Soils encountered at the site consisted of stiff, reddish-brown, silty clay with some fine sand. The soil exhibited low to medium plasticity and commonly contained roots. The root mat was thick in many locations; therefore, sampling began at a depth of 1 to 3 inches bgs in most surface soil sample areas.

PID measurements for all surface samples were less than 1 ppm. At sample locations BD-SS-08 and BD-SS-09, soil samples were collected in resealable plastic bags for PID headspace readings. Results of these readings were below 1 ppm. However, when the PID tip was placed down each sample hole, the readings were 7.2 and 12.3 ppm, respectively. No visible evidence of contamination was observed in the samples collected at these locations. A natural organic odor was noted in the soil, and the PID readings likely are due to natural organics and/or moisture.

Analytical Results

Fifteen soil samples and one duplicate/split sample were collected from 10 locations at the Former Buildings 1962 and 1983 site. Each sample was analyzed for SVOCs, asbestos, and lead. A summary of the sample results is provided in Table 3-7. No SVOCs or asbestos were detected in any of the samples. Lead was detected in all fifteen samples and the duplicate sample; however, none of the concentrations detected exceed the regulatory or risk-based screening criteria for lead.

3.3.2.6 Grease Pits

Site Investigations

Camp Bonneville Grease Pits

The hollow-stem auger drill rig was used to pull out one of the corrugated metal pipes in the Camp Bonneville grease pit area (Figure 2-2). Based on the length of corrugated pipe, it was determined that the grease pit was approximately 3.5 to 4 feet deep. Two soil borings were drilled (using a hollow-stem auger) and logged adjacent to the rock-filled drain area surrounding the corrugated metal pipes. Bedrock was encountered at approximately 10 feet bgs in boring GP-SB01 and at 9 feet bgs in boring GP-SB02. Therefore, the available sampling interval was only between about 3.5 feet bgs (the approximate bottom of the grease pit) and 9.5 feet bgs (bedrock). Samples originally collected from borings GP-SB01 and GP-SB02 were improperly

handled by the shipping company and had to be discarded. On August 4, 1998, soil boring GP-SB02A was advanced immediately adjacent to boring GP-SB02, using a GeoProbe™ drive sampler and a solid-stem auger. Two soil samples were collected for chemical analysis from boring GP-SB02A from the 3.5- to 5.5-foot and 6- to 8-foot intervals.

Camp Killpack Grease Pits

On August 3, 1998, a GeoProbe™ was used to drill and sample a soil boring (GP-SB03) adjacent to the Camp Killpack grease pit (Figure 2-3). A ditch and nearby trees prevented access by the drilling rig. Two soil samples and a duplicate sample (GP-SB06-01) were collected, starting at the assumed depth of the bottom of the pit drain rock, based on the construction of a similar pit at the Camp Bonneville cantonment. The samples were collected from the 3- to 5-foot and 5- to 7-foot intervals. A third sample could not be collected because of auger refusal.

Field Observations

Camp Bonneville Grease Pit

The removed grease pit pipe was approximately 6 feet long and had extended approximately 3.5 feet into the ground. Debris (trash, including paper and food cans) was present on the surface of the drain rock inside the grease pit pipes. An attempt was made to drill down through center of the grease pit; however, the presence of large rocks (up to about 1 foot in diameter) prevented this. Several attempts were made to drill through the drain rock. Ultimately, it was necessary to drill just outside of the edge of the rock-filled area.

PID measurements for all sample locations were less than 1 ppm, and no sheen, staining, or odor was noted during drilling and sampling at the Camp Bonneville grease pits. Soils encountered in boring GP-SB01 consisted of 5 feet of soft, brown, slightly sandy, clayey silt, underlain by 5 feet of dense, brown, slightly sandy, clayey, gravelly silt with scattered organics. Andesite was encountered from 10 to 12.5 feet (bottom of boring). Soils encountered in borings GP-SB02 and GP-SB02A consisted of 3.5 to 4.5 feet of soft, brown, slightly sandy, gravelly, clayey silt with scattered organics, underlain to a depth of 5.5 feet by medium dense, brown and gray, silty, gravelly sand. Between 5.5 and 8 feet bgs, the sand became very dense and slightly clayey. From 8 to 9 feet, the soil was dense, brown and gray, slightly clayey to clayey, sandy, silty gravel. Bedrock was encountered at 9 feet bgs.

Groundwater was not encountered in the subsurface soils. However, occasional wet seams were present between 5 and 10 feet deep in GP-SB01, and iron staining (indicative of wet season water levels) was observed below about 3.5 feet at GP-SB02 and GP-SB02A.

Camp Killpack Grease Pit

The explorations adjacent to the Camp Killpack grease pit encountered brown, silty to slightly silty sand with scattered cobbles. Occasional creosote-treated wood fibers were found below 5 feet bgs. The explorations could not be advanced below a depth of 7 feet because of the presence of cobbles. No staining, odors, sheen, or PID readings above 0 ppm were noted during drilling and sampling. No groundwater was encountered.

Analytical Results

Four soil samples and one duplicate/split sample were collected from the two grease pits. All samples were analyzed for TPH, SVOCs, PCBs/pesticides, VOCs, and priority pollutant metals. The results of these analyses are summarized in Table 3-8 and described in this section.

TPH was not detected in any soil sample, with the exception of sample GP-SB03-01. Unknown hydrocarbons were detected in sample GP-SB03-01 at a concentration of 82 mg/kg (quantitated as diesel range), which is below the MTCA Method A cleanup level. The laboratory noted that the chromatographic profile was not consistent with reference field standards.

One SVOC was detected at estimated concentrations in two samples. Diethyl phthalate was detected in samples GP-SB02-01 and GP-SB03-02, at concentrations below regulatory screening criteria; diethyl phthalate is a common laboratory contaminant.

VOCs and PCBs were not detected in any of the samples. No pesticides were detected in any of the samples with the exception of sample GP-SB02-02, in which gamma-BHC (lindane) was detected at concentrations of 2.0 mg/kg and 3.6 mg/kg for first and second column confirmation, respectively. These concentrations are below the regulatory screening criteria.

Arsenic, beryllium, chromium, and copper were detected at concentrations exceeding one or more of the regulatory screening criteria. However, the detected concentrations of chromium and beryllium did not exceed background levels. Additionally, the chromium data were qualified because of method blank contamination. Arsenic slightly exceeded the background level of 7 mg/kg in sample GP-SB03-02 (7.9 mg/kg). This arsenic concentration also exceeded the MTCA Method B and EPA Region 3 screening criteria.

Copper slightly exceeded the background concentration of 114 mg/kg in sample GP-SB02-01 (133 mg/kg). This copper concentration exceeded the MTCA Method B groundwater protection criterion. Thallium and barium were detected in three samples in excess of the MTCA Method B groundwater protection level; however, only sample GP-SB03-01 had a thallium concentration above the background level (but less than two times background). Barium exceeded the background level of 257 mg/kg in both samples collected from boring GP-SB02 (369 and 374 mg/kg). Antimony, cadmium, lead, nickel, selenium, silver, and zinc were detected in most or all of the samples, but at concentrations below the regulatory criteria.

3.3.2.7 Former Sewage Pond

Site Investigations

A UXO avoidance/screening survey was performed in the Former Sewage Pond area on July 8, 1998, by two UXO specialists (Figure 2-4). Magnetic anomalies were flagged and avoided during subsequent activities at the site. A large area (including access to the site) was initially surveyed. The UXO specialists surveyed additional areas, as needed, as the fieldwork progressed.

An EM survey was performed in the suspected pond area on July 9 and 10, 1998. GPR equipment was not used because of the high natural ground conductivity and uneven terrain at the site.

Soil borings were drilled at five locations in the Former Sewage Pond area between July 17 and 20, 1998. The borings were drilled to characterize subsurface conditions and to collect samples for chemical analyses. Three of these borings (SP-SB01, SP-SB02/2A, and SP-SB03/3A) were drilled within the apparent former pond area. Using a hand auger, UXO personnel advanced borings SP-SB01, SP-SB02, and SP-SB03 to depths of at least 6 feet bgs. The hollow-stem auger drill rig was then used to complete the drilling and sampling of SP-SB01, SP-SB02A (drilled adjacent to SP-SB02), and SP-SB03. After completion of hollow-stem auger drilling at SP-SB03, a 4.5-foot-deep hand auger borehole (designated SP-SB03A) was drilled adjacent to SP-SB03 to collect a sample at the apparent pond bottom depth, along with duplicate and split samples.

The two other soil borings (SP-SB04 and SP-SB05) were drilled to collect soil samples for chemical analysis and for the installation of monitoring wells. The direction of groundwater flow was assumed to be to the south-southeast, based on site topography and the proximal position of Lacamas Creek. One well was installed in a location assumed to be downgradient of the Former Sewage Pond (SP-SB04/SP-MW01). The other well (SP-SB05/SP-MW02) was installed in an assumed upgradient location. Using a hand auger, UXO personnel advanced each of these borings to a depth of 5 feet bgs. The hollow-stem auger drilling rig was then used to complete the borings and well installations.

Three samples were collected from each boring. The uppermost sample was collected from the apparent pond bottom depth or the approximate water table interface (whichever came first), as noted during hand augering. Because of the shallow water table and the safety requirement for initial advancement of the boreholes by UXO specialists using a hand auger, the upper one or two soil samples for chemical analysis at each boring were collected from the hand auger barrel. The remaining samples were collected by using a split-spoon sampler from the drill rig.

Field Observations

During the UXO survey, a roughly circular area of magnetic anomalies was detected. Several fence posts were identified in this area of anomalies, lying horizontally, just under the ground surface. The roughly circular pattern of anomalies also roughly coincided with a slight elevation rise near the center of the old parade grounds. Although the initial UXO survey activities were directed in the southeastern portion of the old parade grounds, after finding these features, efforts were concentrated in the slightly mounded area.

The current facility manager said he had been told that the pond was filled to form a slight rise, although he was not aware that it had been fenced. The location of the anomalous area detected by the UXO magnetometers agreed with the location previously related to the facility manager. Results of the EM survey were inconclusive at this site.

Soil

The pond area borings were drilled into volcanic rock, at depths of up to 21.5 feet bgs. Soil samples were collected from each (assumed) pond interior boring at the apparent pond bottom (approximately ¼-inch-thick horizon of dark soil) at approximately 4 to 5 feet bgs. Two additional samples were collected at each location at greater depths. No sheen, odor, or elevated PID readings were observed during field screening of soil samples from the borings.

Fill soils were encountered in the borings drilled within the assumed footprint of the Former Sewage Pond. Fill at borings SP-SB01 through SP-SB03A consists of 4.5 to 5 feet of brown,

slightly sandy, clayey silt. A thin, dark layer of soil was generally identified near the base of the fill; this layer was interpreted as the former pond bottom. The soils present between 0 and 5 feet bgs in the upgradient and downgradient borings (SP-SB04 and SP-SB05) consisted of brown, clayey silt with minor sand and gravel. Iron staining and/or mottling was typically observed in shallow soils (both fill and native).

The native soils encountered below the fill at the assumed pond site, and below 5 feet at the other locations, consist of about 4 to 9.5 feet of very stiff to hard or medium dense to very dense, mottled brown and gray, sandy, clayey silt, with scattered organics. This unit is commonly iron-stained. This silt grades downward into a medium dense to very dense, silty, sandy gravel/gravelly sand, generally between 3 and 6 feet thick, encountered at depths of approximately 9 to 15 feet bgs. This gravelly unit is underlain by highly weathered andesite.

Groundwater

Groundwater was encountered at depths of about 4 to 5.5 feet in most of the Former Sewage Pond borings. The silt below this depth was moist, with scattered wet zones at some locations. The sand/gravel unit was saturated, and the underlying rock was moist. Groundwater levels were measured twice in the wells in August 1998. These groundwater levels were similar to those measured during drilling. No sheen, odor, or PID readings above 1 ppm were noted in groundwater during well development or sampling.

The groundwater elevation decreases by nearly 3 feet from the upgradient well to the downgradient well, supporting the previous assumption that groundwater flow is generally to the south or southeast, toward Lacamas Creek. As with the nearby Landfill 2 and Landfill 3 sites, the groundwater flow direction is probably influenced by Lacamas Creek. At least one additional crossgradient well would be required at the Former Sewage Pond site in order to determine more precisely the magnitude and direction of the groundwater gradient. The iron staining and mottling observed in shallow soil samples indicate that the typical wet season water table is probably within a foot of the ground surface over most of the site. Consequently, the lagoon would have been in direct contact with the water table for much, if not all, of the year.

Another round of water level measurements was made in the wells in December 1998. The water levels in the upgradient well and downgradient well were 2.61 feet and 2.29 feet higher, respectively, than when measured in August 1998. These results indicate an even greater hydraulic gradient between the two wells than during the summer.

Analytical Results

Subsurface Soil Samples

Fifteen soil samples and two duplicate/split samples were collected at the site. All samples were analyzed for TPH, SVOCs, VOCs, PCBs/pesticides, and priority pollutant metals. The results of these analyses are summarized in Table 3-9 and discussed in this section.

No TPH, SVOCs, PCBs, or pesticides were detected in the Former Sewage Pond samples. Two VOCs were detected at concentrations below the screening criteria. Specifically, sample SP-SB03-03 contained acetone at 0.0037 mg/kg, and sample SP-SB05-03 contained carbon disulfide at 0.0052 mg/kg. Both are common laboratory contaminants. No other VOCs were detected.

Arsenic, beryllium, chromium, copper, and thallium were detected at concentrations above one or more of the regulatory screening criteria. However, only arsenic, copper, and thallium were detected at a concentration that exceeded the background level. Arsenic was detected in all samples; however, only one sample (SP-SB03-02) contained arsenic at an elevated concentration (above the screening levels and background). Copper also was detected in all soil samples, with only one sample (SP-SB05-03) exceeding the MTCA Method B groundwater protection criterion and background. Thallium was detected in five samples, with four samples containing thallium at estimated concentrations above the MTCA Method B groundwater protection level, one of which (SP-SB03-03) also exceeded the background concentration (but not two times background).

Antimony, cadmium, lead, nickel, silver, and zinc were detected in all samples at concentrations below regulatory screening levels. Mercury was detected in two samples at concentrations below regulatory screening levels; and selenium was detected in one sample at a concentration below the regulatory screening level.

Groundwater

Groundwater samples collected from the two monitoring wells at the Former Sewage Pond site were analyzed for TPH, VOCs, SVOCs, priority pollutant metals (total and dissolved), water quality parameters, fecal coliform, and fecal streptococcus. The results of these analyses are summarized in Table 3-10 and discussed below.

No TPH, VOCs, or SVOCs were detected in any of the groundwater samples. Both total and dissolved arsenic were detected in the upgradient well sample (SP-MW02-01) at concentrations below the MCL but exceeding MTCA Methods A and B, and EPA Region 3 regulatory screening levels. Arsenic was not detected in the downgradient well. Barium, chromium, copper, nickel, selenium, and zinc were detected in both monitoring wells, at concentrations below regulatory screening criteria. Lead also was detected in sample SP-MW02-01 at a concentration below the regulatory screening criteria.

Water quality results were similar in both the upgradient and downgradient wells. Alkalinity was detected at 112 mg/L in the sample from well SP-MW01 and 94.3 mg/L in the sample from well SP-MW02. Cyanide, nitrates, and orthophosphates were not detected in either well. Fecal coliform was detected in samples SP-MW01-01 and SP-MW02-01 at concentrations of 2 mg/L and 8 mg/L, respectively. Fecal streptocuccus was only detected in sample SP-MW02-01 (from the upgradient well) at 4 mg/L. Fecal coliform and fecal streptococcus are not regulated by MTCA or CERCLA.

3.3.2.8 Hazardous Materials Accumulation Point – Building 4476

Site Investigations

Surface soil samples were collected on February 27, 1998, from two locations directly in front of the Hazardous Material Accumulation Point building (Figure 2-3). Sample HM-SS-01-01 was collected directly in front of the building, approximately 10 inches from the edge of the concrete floor pad. Sample location HM-SS-02 also was collected directly in front of the building, west of sample HM-SS-01-01. The samples were collected from approximately 0 to 6 inches bgs. A duplicate/split sample and MS/MSD samples were collected from location HM-SS-01. Two

samples of the liquid and sludge in the sump were collected for analysis to determine the appropriate means of disposal.

Field Observations

The soil encountered from 0 to 6 inches bgs in both sample locations was fill material consisting of dense, moist, brown, silty, clayey gravel with scattered roots. PID headspace screening was conducted on both samples. The PID results were 13.2 ppm for sample HM-SS-01-01 and 23 ppm for sample HM-SS-02-01. No odor or staining was observed in the samples.

After the contents of the sump were removed, the sump was visually inspected for any evidence of cracks or outlets where leaking or discharges from the sump could occur. The concrete was observed to be in good condition, with no pipes or outlets evident.

Analytical Results

Soil

Two surface soil samples and one duplicate/split sample were collected from the Hazardous Materials Accumulation Point area. These samples were analyzed for TPH, SVOCs, PCBs/pesticides, and priority pollutant metals. The results of these analyses are summarized in Table 3-11 and described in this section.

Sample HM-SS-01-01 and the duplicate sample contained TPH (identified as unknown hydrocarbons and quantitated in the diesel range) at concentrations below MTCA Method A cleanup levels. The only other organic constituent detected in the soil samples was bis(2-ethylhexyl)phthalate. This SVOC was detected only in the duplicate sample, at a concentration of 0.033 mg/kg, which is below the regulatory screening criterion. This detection may be due to laboratory or sampling contamination, since phthalates are common laboratory and field sampling contaminants.

Metals detected in the surface soil samples included antimony, barium, cadmium, chromium, copper, lead, nickel, silver, and zinc, all at concentrations below regulatory screening criteria. Arsenic and beryllium were detected at concentrations exceeding regulatory screening criteria but well below background levels.

Sump

One liquid sample collected from the sump was analyzed for TPH, SVOCs, VOCs, PCBs/pesticides, and metals. Results of the analyses are summarized in Table 3-10. Unknown hydrocarbons were detected at an estimated concentration of 51 mg/L, which exceeds the MTCA Method A value of 1 mg/L for groundwater. A review of the chromatogram for this sample indicated that some of the compounds fell within the diesel range (C_{10} to C_{24}) and some were heavier (the sample range equaled C_{16} to C_{40}). Therefore, the substance appears to be a weathered oil-based product or weathered diesel-oil mixture. Bis(2-ethylhexyl) phthalate, the only other organic analyte detected, was initially measured at a concentration of 52 mg/L, but upon reextraction and reanalysis, was reported at 10 mg/L. Both concentrations exceeded MTCA Method B and EPA Region 3 screening criteria for groundwater. Antimony, arsenic, beryllium, lead, and zinc were detected at concentrations above the groundwater screening criteria.

Table 3-1

90TH PERCENTILE NATURAL BACKGROUND VALUES FOR METALS IN SOILS (IN MG/KG)

METAL	STATEWIDE	CLARK COUNTY	CAMP BONNEVILLE
Antimony	NA	NA	0.12 [a]
Arsenic	7	6	NC
Barium	NA	NA	257
Beryllium	2	2	NC
Cadmium	1	1	NC
Chromium	42	27	NC
Copper	36	34	114
Lead	17	17	NC
Nickel	38	21	NC
Selenium	NA	NA	NC[b]
Silver	NA	NA	NC[b]
Thallium	NA	NA	0.27[a]
Zinc	86	96	NC
Mercury	0.07	0.04	NC

Notes:
aThe value indicated is the maximum value detected.
bNo value was calculated for this metal because the regulatory screening criteria were well above any concentrations detected in background samples.
mg/kg - milligrams per kilogram
NA - not available
NC - not calculated
Shading indicates that the concentration was selected for use as project background.

Table 3-2
BACKGROUND SOIL SAMPLE RESULTS
CAMP BONNEVILLE, VANCOUVER, WASHINGTON

Parameter	Units	Sample Concentration													
		BK-SS01-01	BK-SS01-02	BK-SS02-01	BK-SS02-02	BK-SS03-01	BK-SS03-02	BK-SS04-01	BK-SS04-02	BK-SS05-01	BK-SS05-02	BK-SS06-01	BK-SS06-02	BK-SS07-01	BK-SS07-02
Sample Date		12/10/97	12/10/97	12/10/97	12/10/97	12/13/97	12/13/97	12/17/97	12/17/97	12/15/97	12/15/97	12/15/97	12/15/97	12/17/97	12/17/97
Sample Depth (ft bgs)		0.25	1	0.25	1	0.25	1	0.25	1	0.25	1	0.25	1.3	0.25	1
Metals															
Antimony	mg/kg	0.074 J	0.084 J	0.074 J	0.052 J	0.071 J	0.075 J	0.013 J	0.093 J	0.088 J	0.072 J	0.075 J	0.045 J	0.12 J	0.082 J
Arsenic	mg/kg	**1.9**	**2.9**	**1.8**	**1.8**	**2.3**	**2.5**	**2.7**	**2.9**	**1.8**	**1.6**	**2.1**	**1.8**	**2.1**	**2.3**
Barium	mg/kg	**166**	**124**	**172**	**189**	**123**	**114**	**152**	109	**188**	**193**	98	74.8	**353**	**236**
Beryllium	mg/kg	**1.1**	**1.1**	**1.1**	**1.1**	**0.91**	**1.1**	**0.74**	**1.0**	**0.85**	**0.81**	**0.79**	**0.9**	**1.2**	**1.2**
Cadmium	mg/kg	0.072 J	0.038 J	0.085 J	0.082 J	0.072 J	0.057 J	0.030 J	0.010 J	0.093 J	0.083 J	0.053 J	0.021 J	0.11 J	0.042 J
Chromium	mg/kg	**26.9**	**31.0**	**30.7**	**30.8**	**31.8**	**32.0**	**24.0**	**27.5**	**30.8**	**30.2**	**19.2**	**15.8**	**26.4**	**33.2**
Copper	mg/kg	**72.7**	**82.5**	**78.5**	**74.9**	**75.2**	**67.1**	21.3	25.2	**117**	**125**	17.1	19.1	26.3	31.2
Lead	mg/kg	10.6	8.6	10.0	7.7	11.6	10.3	13.7	14.2	11.0	9.1	19.3	12.7	23.0	14.4
Nickel	mg/kg	11.2	10.3	12.2	12.4	15.8	13.7	11.7	13.0	11.9	12.1	8.9	7.1	10.7	13.3
Selenium	mg/kg	ND	ND	0.27 G,J	0.31 G,J	0.31 G,J	0.33 G,J	0.14 J	ND	ND	ND	ND	0.21 G,J	ND	ND
Silver	mg/kg	0.22	0.21	0.23	0.22	0.18	0.22	0.22	0.31	0.22	0.18	ND	.10 J	0.44	0.66 G
Thallium	mg/kg	ND	ND	ND	ND	0.027 J	0.020 J	**0.12 J**	0.010 J	ND	ND	ND	.060 J	**0.19**	**0.19**
Zinc	mg/kg	67.8	52.0	69.3	64.6	66.4	60.1	43.3	37.6	81.4	82.3	36.8	34.4	94.6	74.5
Mercury	mg/kg	0.046 J	0.037 J	0.051 J	0.047 J	0.072 J	0.065 J	0.058 J	0.054 J	0.052 J	0.065 J	0.093 J	0.060 J	0.082 J	0.047 J

Table 3-2
BACKGROUND SOIL SAMPLE RESULTS
CAMP BONNEVILLE, VANCOUVER, WASHINGTON
(Continued)

Parameter	Sample Concentration								Regulatory/Risked-Based Criteria			
	BK-SS08-01	BK-SS08-02	BK-SS09-01	BK-SS09-02	BK-SS10-01	BK-SS10-02	BK-SS11-01	BK-SS11-02	MTCA A	MTCA B	MTCA B-GW	EPA Reg. 3
							(dup SS04-01)	(dup SS04-02)				
Sample Date	12/18/97	12/18/97	12/18/97	12/18/97	12/18/97	12/18/97	12/17/97	12/17/97				
Sample Depth (ft bgs)	0.25	1	0.25	1	0.25	1	0.25	1				
Metals												
Antimony	0.098 J	0.082 J	0.11 J	0.096 J	0.062 J	0.056 J	0.065 J	0.085 J	NA	32 - 72[a]	0.64 - 1.44[a]	31
Arsenic	**2.4**	**2.3**	**2.7**	**3.5**	**1.8**	**1.7**	**2.7**	**2.9**	20	1.67	0.005	0.43
Barium	**261**	**260**	**162**	103	**138**	**151**	**158**	93.4	NA	5,600	112	5,500
Beryllium	**0.78**	**0.91**	**0.83**	**0.89**	**0.90**	**0.90**	**0.78**	**0.93**	NA	0.233	0.002	0.15
Cadmium	0.072 J	0.051 J	0.034 J	0.015 J	0.031 J	ND	0.016 J	ND	2	80	1.6	39
Chromium	**20.8**	**26.2**	**27.2**	**31.8**	**27.4**	**29.0**	**23.8**	**29.4**	100	80,000[b]/400[c]	1,600[b]/8[c]	78,000[b]/390[c]
Copper	**78.7**	**89.4**	30.7	40.6	18.5	24.4	18.2	22.9	NA	2,960	59.2	3,100
Lead	15.0	11.4	15.0	16.6	15.1	12.9	14.2	14.0	250	NA	NA	400[d]
Nickel	11.4	14.5	8.2	11.5	7.0	10.7	10.7	12.0	NA	1,600	32	1,600
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	NA	400	8	390
Silver	0.2	0.27	0.16	0.27	0.4	0.47	0.22	0.33	NA	400	8	390
Thallium	ND	ND	0.051 J	0.071 J	**0.27**	0.031 J	0.012 J	ND	NA	5.6	0.112	6.3 - 7[e]
Zinc	71.6	78.5	47.1	44.1	44.6	43.5	37.0	36.0	NA	24,000	480	23,000
Mercury	0.053 J	0.036 J	0.049 J	0.033 J	0.047 J	0.032 J	0.063 J	0.052 J	1	24	24	7.8[f]/23[g]

Table 3-2

BACKGROUND SOIL SAMPLE RESULTS
CAMP BONNEVILLE, VANCOUVER, WASHINGTON
(Continued)

Notes:

Shading indicates that the level exceeds one or more regulatory/risk-based criteria.

ft bgs = feet below ground surface (top of sampling interval)

EPA = U.S. Environmental Protection Agency

mg/kg = milligrams per kilogram

MTCA A = Washington State Model Toxics Control Act Method A criteria

MTCA B = Washington State Model Toxics Control Act Method B criteria

MTCA B-GW = Washington State Model Toxics Control Act Method B criteria for the protection of groundwater

ND = not detected above the method detection limit

[a] = Varies with the form of antimony

[b] = Chromium III

[c] = Chromium VI

[d] = EPA screening level based on Integrated Exposure Uptake Biokinetic (IEUBk) model

[e] = Varies with the form of thallium

[f] = Methyl mercury

[g] = Inorganic mercury

J = Result was detected below the reporting limit or is an estimated concentration.

G = Reporting limit was raised because of matrix interference.

Table 3-3
BRAC EBS PARCEL DESCRIPTIONS
BASE SITES
CAMP BONNEVILLE

BRAC PARCEL NO. AND NAME	ENVIRONMENTAL CONDITION CATEGORY NUMBER	BASIS FOR CATEGORY DESIGNATION
2(7)HR(P) Landfill No. 1	7	A cultural resources survey noted disturbed ground with indications of use as a sanitary type landfill. A historical artifact from this site dates its use to the early 1900s.
3(7)HR(P) Landfill No. 2	7	This landfill was discovered during excavation for the sewage lagoons. It is estimated that the landfill was used from the 1940s to 1950s; the type and quantity of disposed material is unknown.
5(7)HR(P) Landfill No. 3	7	This is a reported trash burial site. There is a lack of documentation supporting the existence of or the type and quantity of material buried at this site.
4(7)HR(P) Former Burn Area	7	This is a reported burn site. There is a lack of documentation supporting the existence of or the type and quantity of material burned at this site.
8(7)HR(P) Buildings 1962 and 1983	7	These building were located at Camp Bonneville, but destroyed by fire. There is a possibility of a release of lead or other substances associated with the buildings.
6(7)HR(P) Camp Bonneville Grease Pit	7	This grease pit consists of a corrugated metal pipe that extends into an underground pit filled with gravel. There is a possibility that substances other than grease may have been deposited here.
11(7)HR(P) Camp Killpack Grease Pit	7	This grease pit consists of a corrugated metal pipe that extends into an underground pit filled with gravel. There is a possibility that substances other than grease may have been deposited here.
17(7)HR(P) Former Sewage Pond	7	This area is the location of a former open sewage pond.
13(7)PR(P)/HR(P) Hazardous Materials Accumulation Point	7	This location stored 5-gallon drums of oil, antifreeze, and transmission fluid.

Table 3-4

LANDFILLS 2 AND 3, CONSTITUENTS DETECTED IN SOIL SAMPLES
CAMP BONNEVILLE, VANCOUVER, WASHINGTON

Parameter	Units	Sample Concentration									Regulatory/Risk-Based Criteria				Background
		L2-SB01-01	L2-SB02-01	L2-SB03-01	L3-SB01-01	L3-SB02-01	L3-SB03-01	L3-SB04-01	L3-SB05-01	L3-SB06-01	MTCA A	MTCA B	MTCA B-GW	EPA Reg. 3	
Sample Date		7/14/98	7/15/98	7/17/98	7/14/98	7/15/98	7/15/98	7/16/98	7/16/98	7/15/98					
Sample Depth	ft bgs	2.0	2.0	3.0	4.0	3.0	4.0	3.2	2.0	3.0					
TPH	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND					
VOCs	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND					
SVOCs	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND					
PCBs/Pesticides	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND					
Explosives	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND					
PETN	mg/kg	0.22 J	ND	ND	ND	ND	ND	ND	ND	ND	NA	NA	NA	NA	
PA	mg/kg	ND J-	ND J-	ND J-	ND J-	ND J-	ND J-	ND J-	ND J-	ND J-	NA	NA	NA	NA	
Cyanide	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND					
Metals															
Antimony	mg/kg	0.058 J	0.066 J	0.064 J	0.064 J-	0.056 J	0.042 J	0.079 J	0.062 J	0.065 J	NA	32 - 72[a]	0.64 - 1.44[a]	31	0.12
Arsenic	mg/kg	**3.9**	**3.5**	**4**	**3.8**	**3.2**	**4.5**	**3.8**	**3.5**	**3.6**	20	1.67	0.005	0.43	7
Barium	mg/kg	**253**	**194**	**255**	**196J**	**196**	**168**	**205**	**165**	**208**	NA	5,600	112	5,500	257
Beryllium	mg/kg	**1.1**	**1.2**	**1.1**	**1.3**	**1.2**	**1.1**	**1.2**	**0.98**	**1.2**	NA	0.233	0.002	0.15	2
Cadmium	mg/kg	0.13 J	0.12 J	0.062 J	0.10 J	0.12 J	0.077 J	0.091 J	0.12 J	0.12 J	2	80	1.6	39	1
Chromium	mg/kg	**26.7**	**22.3**	**29.2**	**26.8 J+**	**26.7**	**23.6**	**23.4**	**24.2**	**29.3**	100	80,000[b]/400[c]	1,600[b]/8[c]	78,000[b]/390[c]	42
Copper	mg/kg	**81.1**	**78.7**	**134**	**90**	**73.9**	**79.3**	**91.7**	58.5	**79.7**	NA	2,960	59.2	3,100	114

Table 3-4

LANDFILLS 2 AND 3, CONSTITUENTS DETECTED IN SOIL SAMPLES
CAMP BONNEVILLE, VANCOUVER, WASHINGTON

(continued)

Parameter	Units	Sample Concentration									Regulatory/Risk-Based Criteria				Background
		L2-SB01-01	L2-SB02-01	L2-SB03-01	L3-SB01-01	L3-SB02-01	L3-SB03-01	L3-SB04-01	L3-SB05-01	L3-SB06-01	MTCA A	MTCA B	MTCA B-GW	EPA Reg. 3	
Lead	mg/kg	9.1	5.8	7	6.5	6.2	4.3	6.7	13.1	6.1	250	NA	NA	400[d]	17
Nickel	mg/kg	12.7	11.2	14	12.7	10.8	10.8	12.3	11.1	12.1	NA	1,600	32	1,600	38
Selenium	mg/kg	ND	ND	ND	ND	ND	ND	ND	0.10 J	ND	NA	400	8	390	NA
Silver	mg/kg	0.19 J	0.14 J	0.24 J	0.18 J	0.17 J	0.19 J	0.20 J	0.16 J	0.18 J	NA	400	8	390	NA
Thallium	mg/kg	**0.14 J**	**0.16 J**	**0.13 J**	**0.16 J**	**0.13 J**	ND	ND	**0.13 J**	**0.13 J**	NA	5.6	0.112	6.3 - 7[e]	0.27
Zinc	mg/kg	92.3 B	71.9 BJ	53.9 B	78.1 BJ	14.2 BJ	54 B	66 B	60.6 B	77.3 BJ	NA	24,000	480	23,000	86
Mercury	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	24	24	7.8[f]/23[g]	0.07
TOC	mg/kg	1.2	1.3	0.36	1.3	1.3	1.1	0.62	1.1	1.2	NA	NA	NA	NA	

Notes:

This table includes only those constituents detected in the samples.

Concentrations in **bold** exceed one or more regulatory criteria but are below background.

Shading indicates that the value exceeds one or more regulatory criteria and background (if applicable).

See Table 6-17 for additional notes and acronyms.

Table 3-5

LANDFILLS 2 AND 3, CONSTITUENTS DETECTED IN GROUNDWATER SAMPLES
CAMP BONNEVILLE, VANCOUVER, WASHINGTON

Parameter	Units	Sample Concentration							Regulatory/Risk-Based Criteria			
		L2-MW01-01	L2-MW02-01	L3-MW01-01	L3-MW02-01	L3-MW03-01	L3-MW03-02	L3-MW04-01	MCL	MTCA A	MTCA B	EPA Reg. 3
		Downgradient	Downgradient	Downgradient	Downgradient	Downgradient	(dup MW03-01)	Upgradient				
Sample Date		8/4/98	8/4/98	8/4/98	8/4/98	8/4/98	8/4/98	8/4/98				
TPH	mg/L	ND	ND	ND	ND	ND	ND	ND				
VOCs												
Naphthalene	µg/L	ND	0.32 J	ND	0.36 J	ND	ND	ND	NA	NA	320	1,500
SVOCs	µg/L	ND	ND	ND	ND	ND	ND	ND				
Explosives	µg/L	ND	ND	ND	ND	ND	ND	ND				
PETN	µg/L	ND	ND	ND	ND	ND	ND	ND				
PA	µg/L	ND	ND	ND	ND	ND	ND	ND				
PCBs/Pesticides	µg/L	ND	ND	ND	ND	ND	ND	ND				
Cyanide	mg/L	ND	ND	ND	ND	ND	ND	ND	0.2	NA	0.32	0.18-7.3
Metals-Total												

Table 3-5

LANDFILLS 2 AND 3, CONSTITUENTS DETECTED IN GROUNDWATER SAMPLES CAMP BONNEVILLE, VANCOUVER, WASHINGTON

(continued)

Parameter	Units	Sample Concentration							Regulatory/Risk-Based Criteria			
		L2-MW01-01	L2-MW02-01	L3-MW01-01	L3-MW02-01	L3-MW03-01	L3-MW03-02	L3-MW04-01	MCL	MTCA A	MTCA B	EPA Reg. 3
Antimony	mg/L	ND	ND	ND	ND	ND	ND	ND	0.006	0.0014 - 0.008[a]	0.0014 - 0.008[a]	0.015
Arsenic	mg/L	**0.00053 J**	**0.00072 J**	**0.0035**	**0.0015 J**	**0.0011 J**	**0.00086 J**	ND	0.05	0.005	0.00005	0.000045
Barium	mg/L	0.038	0.00057 J	0.00085 J	0.0024	0.0051	0.0055	0.014	2	1.12	1.12	2.6
Beryllium	mg/L	ND	ND	ND	ND	ND	ND	ND	0.004	0.0000203	0.0000203	0.000016
Cadmium	mg/L	ND	ND	ND	ND	ND	ND	ND	0.005	0.008	0.008	0.018
Chromium	mg/L	0.0019	0.0019	0.00057 J	0.00074 J	0.0021	0.0016	0.00056 J	0.1	16 [b] (0.08)[c]	16 [b] (0.08)[c]	37[b] (0.18)[c]
Copper	mg/L	0.0017	0.00047 J	0.0014	0.00035 J	0.0042	0.0044	0.0027	1.3	0.592	0.592	1.5
Lead	mg/L	0.00031 J	ND	ND	0.00015 J	0.00024 J	0.00027 J	0.00031 J	0.015	NA	NA	0.015
Nickel	mg/L	0.0011	0.0011	0.00027 J	0.00033 J	0.00095 J	0.00093 J	0.00088 J	0.1	0.32	0.32	0.73
Selenium	mg/L	0.00019 J	ND	ND	0.00012 J	ND	ND	ND	0.05	0.08	0.08	0.18
Silver	mg/L	ND	ND	ND	ND	ND	ND	ND	NA	0.08	0.08	0.018
Thallium	mg/L	ND	0.00013 J	0.00022 J	0.00026	ND	ND	ND	0.002	0.00112	0.00112	0.0029-0.0033
Zinc	mg/L	0.0032 J	0.0017 J	0.0027 J	0.0025 J	0.0029 J	0.0039 J	0.0025 J	NA	4.8	4.8	11
Mercury	mg/L	ND	ND	ND	ND	ND	ND	ND	2	4.8	4.8	11[g]/3.7[f]
Metals-Dissolved												
Antimony	mg/L	ND	ND	0.00020 J	ND	ND	ND	ND	0.006	0.0014 - 0.008[a]	0.0014 - 0.008[a]	0.015
Arsenic	mg/L	**0.00053 J**	**0.00083 J**	**0.0035**	**0.0016 J**	**0.00089 J**	**0.0010 J**	ND	0.05	0.005	0.00005	0.000045
Barium	mg/L	0.032	ND	0.00046 J	0.0022	0.0021	0.0019	0.0093	2	1.12	1.12	2.6
Beryllium	mg/L	ND	ND	ND	ND	ND	ND	ND	0.004	0.0000203	0.0000203	0.000016
Cadmium	mg/L	ND	ND	ND	ND	ND	ND	ND	0.005	0.008	0.008	0.018
Chromium	mg/L	0.0019	0.0011	0.00062 J	0.00079 J	0.00089 J	0.00056 J	0.00042 J	0.1	16 [b] (0.08)[c]	16 [b] (0.08)[c]	37[b] (0.18)[c]

Table 3-5

LANDFILLS 2 AND 3, CONSTITUENTS DETECTED IN GROUNDWATER SAMPLES
CAMP BONNEVILLE, VANCOUVER, WASHINGTON

(continued)

Parameter	Units	Sample Concentration							Regulatory/Risk-Based Criteria			
		L2-MW01-01	L2-MW02-01	L3-MW01-01	L3-MW02-01	L3-MW03-01	L3-MW03-02	L3-MW04-01	MCL	MTCA A	MTCA B	EPA Reg. 3
Copper	mg/L	0.0047	0.0022	0.0063	0.0013	0.00093 J	0.0013	0.0030	1.3	0.592	0.592	1.5
Lead	mg/L	ND	ND	ND	ND	ND	ND	ND	0.015	NA	NA	0.015
Nickel	mg/L	0.0016	0.0013	0.0015	0.00053 J	0.00063 J	0.00060 J	0.0012	0.1	0.32	0.32	0.73
Selenium	mg/L	ND	ND	ND	ND	ND	ND	ND	0.05	0.08	0.08	0.18
Silver	mg/L	ND	ND	ND	ND	ND	ND	ND	NA	0.08	0.08	0.018
Thallium	mg/L	ND	ND	0.00011 J	0.00015 J	ND	ND	ND	0.002	0.00112	0.00112	0.0029-0.0033
Zinc	mg/L	0.0043 J	0.0022 J	0.0031 J	0.0017 J	0.0038 J	0.0012 J	0.0019 J	NA	4.8	4.8	11
Mercury	mg/L	ND	ND	ND	ND	ND	ND	ND	2	4.8	4.8	11[g]/3.7[f]

Notes:

This table includes only those constituents detected in the samples.

Shading indicates that the value exceeds one or more regulatory criteria.

See Table 6-17 for additional notes and acronyms.

Table 3-6

BURN AREA, CONSTITUENTS DETECTED IN SOIL SAMPLES
CAMP BONNEVILLE, VANCOUVER, WASHINGTON

Parameter	Units	Sample Concentration													Regulatory/Risk-Based Criteria		Back-ground
		BA-SS-01-01	BA-SS-01-02	BA-SS-02-01	BA-SS-02-02	BA-SS-03-01	BA-SS-03-02	BA-SS-04-01	BA-SS-04-02	BA-SS-05-01	BA-SS-05-02	BA-SS-06-01	MTCA A	MTCA B	MTCA B-GW	EPA Reg. 3	
												dup of SS03-01					
Sample Date		12/16/97	12/16/97	12/16/97	12/16/97	12/16/97	12/16/97	12/16/97	12/16/97	12/16/97	12/16/97	12/16/97					
Sample Depth	ft bgs	0.2	1.2	0.2	1.2	0.3	1.2	0.2	1.5	0.2	1.2	0.3					
TPH	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	100/200	NA	NA	NA	
VOCs																	
Acetone	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	.013 J	ND	NA	8,000	80	7,800	
Toluene	mg/kg	ND	ND	ND	.0020 J	ND	ND	ND	ND	ND	.00072 J	ND	40	16,000	160	16,000	
m- & p-xylenes	mg/kg	.0025 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	20	160,000	1,600	160,000	
o-xylene	mg/kg	ND	ND	ND	.0026 J	ND	ND	ND	ND	ND	.0012 J	ND	20	160,000	1,600	160,000	
SVOCs	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND					
PCBs/Pesticides	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND					
Explosives	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND					

Table 3-6

BURN AREA, CONSTITUENTS DETECTED IN SOIL SAMPLES
CAMP BONNEVILLE, VANCOUVER, WASHINGTON
(continued)

Parameter	Units	Sample Concentration													Regulatory/Risk-Based Criteria		Background
		BA-SS-01-01	BA-SS-01-02	BA-SS-02-01	BA-SS-02-02	BA-SS-03-01	BA-SS-03-02	BA-SS-04-01	BA-SS-04-02	BA-SS-05-01	BA-SS-05-02	BA-SS-06-01	MTCA A	MTCA B	MTCA B-GW	EPA Reg. 3	
PETN	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND					
PA	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND					
Metals																	
Antimony	mg/kg	0.078	0.058	0.065	0.064	0.052	0.095	0.054	0.074	0.10 R	0.064	0.05	NA	32 - 72[a]	0.64 - 1.44[a]	31	0.12
Arsenic	mg/kg	**2.7**	**2.2**	**3.4**	**3**	**2.2**	**2.8**	**2.1**	**2.8**	**2.8**	**2.6**	**2.3**	20	1.67	0.005	0.43	7
Beryllium	mg/kg	**0.97**	**1.2**	**1.1**	**1.3**	**1.2**	**0.94**	**1.1**	**0.95**	**1.2**	**1**	**1.2**	NA	0.233	0.002	0.15	2
Cadmium	mg/kg	0.14	0.11	0.19	0.15	0.16	0.064	0.15	0.082	0.18	0.11	0.16	2	80	1.6	39	1
Chromium	mg/kg	**29.2**	**30.1**	**28.5**	**30.1**	**29**	**30.5**	**26.3**	**30**	**33.8**	**29.7**	**29.2**	100	80,000[b]/400[c]	1,600[b]/8[c]	78,000[b]/390[c]	42
Copper	mg/kg	**73.4**	**73**	**89.8**	**91.5**	**90.4**	**99.6**	**90.8**	**104**	**95.3**	**100**	**91.3**	NA	2,960	59.2	3,100	114
Lead	mg/kg	14.8	9.8	13.1	9	8.9	7.4	11.1	9.6	17.9	11	9.2	250	NA	NA	400[d]	17
Nickel	mg/kg	15.1	12.3	14.5	15	11.7	13.1	11.7	14.2	13.1	12.9	12.1	NA	1,600	32	1,600	38
Selenium	mg/kg	0.11	ND	ND	ND	ND	ND G	ND	0.23 G	ND	0.027	ND G	NA	400	8	390	NA
Silver	mg/kg	0.19	0.21	0.23	0.25	0.25	0.24	0.26	0.23	0.24	0.25	0.26	NA	400	8	390	NA
Thallium	mg/kg	**0.17**	ND	ND	ND	ND	ND	ND	0.015	**0.29**	0.037	ND	NA	5.6	0.112	6.3 - 7[e]	0.27
Zinc	mg/kg	86.1	76.4	96.1	91.9	182	83	91.9	74.5	99.7	87	166	NA	24,000	480	23,000	86
Mercury	mg/kg	.053 J	.044 J	.062 J	.070 J	.050 J	.049 J	.056 J	.046 J	.064 J	.050 J	.047 J	1	24	24	7.8[f]/23[g]	0.07

Notes:
This table includes only those constituents detected in the samples.
Concentrations in **bold** exceed one or more regulatory criteria but are below background.
Shading indicates that the value exceeds one or more regulatory criteria and background (if applicable).
See Table 6-17 for additional notes and acronyms.

Table 3-7

FORMER BUILDINGS 1962 AND 1983, CONSTITUENTS DETECTED IN SOIL SAMPLES
CAMP BONNEVILLE, VANCOUVER, WASHINGTON

Parameter	Units	Sample Concentration										
		BD-SS01-01	BD-SS02-01	BD-SS03-01	BD-SS04-01	BD-SS05-01	BD-SS06-01	BD-SS06-02	BD-SS06-03	BD-SS07-01	BD-SS07-02	BD-SS08-01
									(dup SS06-01)			
Sample Date		2/25/98	2/25/98	2/25/98	2/25/98	2/25/98	2/25/98	2/25/98	2/25/98	2/25/98	2/25/98	2/25/98
Sample Depth	ft bgs	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0	0.0
Asbestos	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SVOCs	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead	mg/kg	24.3	49.2	23.3	37.6	38.6	99.9	11.3	149	99.5	12.4	40.7

Parameter	Units	Sample Concentration					Regulatory/Risk-Based Criteria				Background
		BD-SS08-02	BD-SS09-01	BD-SS09-02	BD-SS10-01	BD-SS10-02	MTCA A	MTCA B	MTCA B-GW	EPA Reg. 3	
Sample Date		2/25/98	2/25/98	2/25/98	2/25/98	2/25/98					
Sample Depth	ft bgs	1.0	0.0	1.0	0.0	1.0					
Asbestos	mg/kg	ND	ND	ND	ND	ND					
SVOCs	mg/kg	ND	ND	ND	ND	ND					
Lead	mg/kg	13.3	61.7	14.2	30.2	12.8	250	NA	NA	400	17

Notes:

This table includes only those constituents detected in the samples.

See Table 6-17 for additional notes and acronyms.

Table 3-8

GREASE PITS, CONSTITUENTS DETECTED IN SOIL SAMPLES
CAMP BONNEVILLE, VANCOUVER, WASHINGTON

Parameter	Units	Sample Concentration					Regulatory/Risk-Based Criteria				Background
		GP-SB02-01	GP-SB02-02	GP-SB03-01	GP-SB06-01	GP-SB03-02	MTCA A	MTCA B	MTCA B-GW	EPA Reg. 3	
					(dup SB03-01)						
Sample Date		8/4/98	8/4/98	8/3/98	8/3/98	8/3/98					
Sample Depth	ft bgs	3.5	6.0	3.0	3.0	5.0					
TPH											
Unknown hydrocarbon	mg/kg	ND	ND	82 YJ	ND	ND	100/200	NA	NA	NA	
VOCs	mg/kg	ND	ND	ND	ND	ND					
SVOCs											
Diethyl phthalate	mg/kg	0.081 J	ND	ND	ND	0.058 J	NA	64,000	1,280	63,000	
PCBs/Pesticides											
gamma-BHC (Lindane)	mg/kg	ND	2.0	ND	ND	ND	1,000	769	6.73	490	
Metals											
Antimony	mg/kg	0.066 J	0.071 J	0.068 J	0.088 J	0.069 J	NA	32 - 72[a]	0.64 - 1.44[a]	31	0.12
Arsenic	mg/kg	**2.5**	**1.6**	**3.1**	**3.5**	**7.9**	20	1.67	0.005	0.43	7
Barium	mg/kg	**369**	**374**	95.5	96.4	**232**	NA	5,600	112	5,500	257
Beryllium	mg/kg	**1.2**	**1**	**0.72 J**	**1.2**	**0.9 J**	NA	0.233	0.002	0.15	2
Cadmium	mg/kg	0.055 J	0.025 J	0.030 J	0.031 J	0.028 J	2	80	1.6	39	1
Chromium	mg/kg	**24.0 B**	**19.5 B**	**19.0 BJ**	**24.2 B**	**19.5 BJ**	100	80,000[b]/400[c]	1,600[b]/8[c]	78,000[b]/390[c]	42
Copper	mg/kg	**133**	**103**	45.0 J	42.3	**92.3 J**	NA	2,960	59.2	3,100	114
Lead	mg/kg	16.5	5.8	24.4 J	13.4	17 J	250	NA	NA	400[d]	17
Nickel	mg/kg	19.9	16.1	6.2	7.4	15.0	NA	1,600	32	1,600	38

Table 3-8

GREASE PITS, CONSTITUENTS DETECTED IN SOIL SAMPLES
CAMP BONNEVILLE, VANCOUVER, WASHINGTON

(continued)

Parameter	Units	Sample Concentration					Regulatory/Risk-Based Criteria				Background
		GP-SB02-01	GP-SB02-02	GP-SB03-01	GP-SB06-01	GP-SB03-02	MTCA A	MTCA B	MTCA B-GW	EPA Reg. 3	
Selenium	mg/kg	ND	ND	0.17 J	0.34 J	0.12 J	NA	400	8	390	NA
Silver	mg/kg	0.24 J	0.17 J	0.13 J	0.15 J	0.18 J	NA	400	8	390	NA
Thallium	mg/kg	0.11 J	ND	**0.28 J**	**0.16 J**	**0.18 J**	NA	5.6	0.112	6.3 - 7[e]	0.27
Zinc	mg/kg	78.1	65.6	32.0 J	36.8	61.6 J	NA	24,000	480	23,000	86
Mercury	mg/kg	ND	ND	ND	ND	ND	1	24	24	7.8[f]/23[g]	0.07

Notes:

This table includes only those constituents detected in the samples.

Concentrations in **bold** exceed one or more regulatory criteria but are below background.

Shading indicates that the value exceeds one or more regulatory criteria and background (if applicable).

See Table 6-17 for additional notes and acronyms.

Table 3-9

FORMER SEWAGE POND, CONSTITUENTS DETECTED IN SOIL SAMPLES
CAMP BONNEVILLE, VANCOUVER, WASHINGTON

Parameter	Units	SP-SB01-01	SP-SB01-02	SP-SB01-03	SP-SB02-01	SP-SB02-02	SP-SB02-03	SP-SB03-01	SP-SB07-01	SP-SB03-02	SP-SB03-03	SP-SB04-01
Sample Date		7/17/98	7/17/98	7/17/98	7/17/98	7/17/98	7/20/98	7/20/98	7/20/98	7/20/98	7/20/98	7/20/98
Sample Depth	ft bgs	4.0	5.0	9.5	4.5	5.0	12.5	3.5	3.5	9.0	12.0	4.0
TPH	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
VOCs												
Acetone	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0037 J	ND
Carbon disulfide	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
SVOCs	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCBs/Pesticide	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Metals												
Antimony	mg/kg	0.071 J	0.11 J	0.082 J	0.088 J	0.10 J	0.084 GJ	0.074 GJ	0.056 GJ	0.24 GJ	0.17 GJ	0.13 GJ
Arsenic	mg/kg	**3.6**	**4.5**	**4.4**	**3.4**	**4.0**	**4.0 G**	**3.9 G**	**3.9 G**	**7.2 G**	**6.2 G**	**4.9 G**
Beryllium	mg/kg	**0.86**	**0.84**	**0.57**	**0.93**	**0.86**	**0.52 G**	**0.92 G**	**1.0 G**	**0.81 G**	**1.1 G**	**0.91 G**
Cadmium	mg/kg	0.11 J	0.041 J	0.071 J	0.073 J	0.059 J	1.0 G	1.2 G	1.2 G	1.3 G	0.99 G	1.0 G
Chromium	mg/kg	**22.0**	**27.0**	**22.0**	**31.4**	**23.9**	**18.2 G**	**27.5 G**	**25.5 G**	**26.3 G**	**27.3 G**	**26.2 G**
Copper	mg/kg	**60.5**	56.6	**77.3**	**89.7**	**67.8**	**79.5 GB**	**60.4 GB**	54.6 GB	31.9 GB	**110 G**	**61.4 J**
Lead	mg/kg	13.2	11.0	6.6	9.2	9.4	4.2 G	9.2 G	9.0 G	12.5 G	8.3 G	7.9 G
Nickel	mg/kg	11.9	15.8	13.0	11.1	12.3	11.3 G	14.4 G	12.4 G	20.5 G	23.3 G	13.7 G
Selenium	mg/kg	ND	ND	ND	ND	ND	ND G	ND	0.13 GJ	ND G	ND G	ND G
Silver	mg/kg	0.17 J	0.17 J	0.21 J	0.20 J	0.18 J	0.21 GJ	0.19 GJ	0.19 GJ	0.32 GJ	0.16 GJ	0.19 GJ
Thallium	mg/kg	**0.12 J**	**0.19 J**	0.097 J	**0.21 J**	ND	ND G	ND G	ND G	ND G	**0.36 GJ**	ND G
Zinc	mg/kg	67.8 B	56.6 B	56.2 B	53.9 B	44.7 B	49.7 G	60.9 G	59.0 G	70.1 G	73.4 G	43.8 J
Mercury	mg/kg	0.038 J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 3-9

FORMER SEWAGE POND, CONSTITUENTS DETECTED IN SOIL SAMPLES
CAMP BONNEVILLE, VANCOUVER, WASHINGTON
(continued)

Parameter	SP-SB06-01	SP-SB04-02	SP-SB-04-03	SP-SB05-01	SP-SB05-02	SP-SB05-03	MTCA A	MTCA B	MTCA B-GW	EPA Reg. 3	**Back-ground**
	(dup SB04-01)										
Sample Date	7/20/98	7/20/98	7/20/98	7/20/98	7/20/98	7/20/98					
Sample Depth	4.0	7.5	10.0	4.0	10.0	12.5					
TPH	ND	ND	ND	ND	ND	ND	200	NA	NA	NA	
VOCs											
Acetone	ND	NA	ND	ND	NA	ND	NA	8,000	80	7,800	
Carbon disulfide	ND	NA	ND	ND	NA	0.0052 J	NA	8,000	80	7,800	
SVOCs	ND	ND	ND	ND	ND	ND					
PCBs/Pesticide	ND	ND	ND	ND	ND	ND					
Metals											
Antimony	0.17 GJ	0.084 GJ	ND G	0.18 GJ	0.14 GJ	0.067 GJ	NA	32 - 72[a]	0.64 - 1.44[a]	31	0.12
Arsenic	**6.3 G**	**3.1 G**	**3.5 G**	**6.4 G**	**3.2 G**	**3.4 G**	20	1.67	0.005	0.43	7
Beryllium	**1.1 G**	**0.70 G**	**0.47 GJ**	**0.88 G**	**0.77 G**	**0.82 G**	NA	0.233	0.002	0.15	2
Cadmium	1.2 G	1.1 G	0.62 G	1.2 G	1.1 G	1.5 G	2	80	1.6	39	1
Chromium	**28.3 G**	**24.3 G**	**11.5 G**	**25.9 G**	**26.1 G**	**28.7 G**	100	80,000[b]/400[c]	1,600[b]/8[c]	78,000[b]/390[c]	42
Copper	**71.7 GB**	**84.3 GB**	**68.4 G**	48.4 GB	44.1 GB	**123 GB**	NA	2,960	59.2	3,100	114

Table 3-9

FORMER SEWAGE POND, CONSTITUENTS DETECTED IN SOIL SAMPLES
CAMP BONNEVILLE, VANCOUVER, WASHINGTON
(continued)

Parameter	SP-SB06-01	SP-SB04-02	SP-SB-04-03	SP-SB05-01	SP-SB05-02	SP-SB05-03	MTCA A	MTCA B	MTCA B-GW	EPA Reg. 3	**Back-ground**
Lead	9.0 G	7.7 G	3.0 G	8.4 G	10.3 G	6.7 G	250	NA	NA	400[d]	17
Nickel	14.9 G	13.1 G	7.8 G	18.0 G	17.8 G	11.7 G	NA	1,600	32	1,600	38
Selenium	ND G	ND G	ND G	ND G	ND G	ND G	NA	400	8	390	NA
Silver	0.21 GJ	0.24 GJ	0.085 GJ	0.25 GJ	0.29 GJ	0.26 GJ	NA	400	8	390	NA
Thallium	ND G	ND G	ND G	ND G	ND G	ND G	NA	5.6	0.112	6.3 - 7[e]	0.27
Zinc	52.0 G	65.7 G	39.0 G	52.5 G	65.7 G	80.2 G	NA	24,000	480	23,000	86
Mercury	ND	ND	ND	0.037 J	ND	ND	1	24	24	7.8[f]/23[g]	0.07

Notes:

This table includes only those constituents detected in the samples.

Concentrations in **bold** exceed one or more regulatory criteria but are below background.

Shading indicates that the value exceeds one or more regulatory criteria and background (if applicable).

See Table 6-17 for additional notes and acronyms.

Table 3-10

FORMER SEWAGE POND AND SUMP, CONSTITUENTS DETECTED IN GROUNDWATER SAMPLES, CAMP BONNEVILLE, VANCOUVER, WASHINGTON

Parameter	Units	Sewage Pond		Sump	Regulatory/Risk-Based Criteria			
		SP-MW01-01	SP-MW02-01	HM-SU01-01	MCL	MTCA A	MTCA B	EPA Reg. 3
		Downgradient	Upgradient					
Sample Date		8/6/98	8/5/98	8/6/98				
TPH								
Unknown Hydrocarbons	mg/L	ND	ND	**51 YJ**	NA	1	NA	NA
VOCs								
Bromoform	µg/L	ND	ND	ND	100/80	NA	5.54	2.4
Dibromochloromethane	µg/L	ND	ND	ND	100/80	NA	0.521	0.13
SVOCs								
bis(2-ethylhexyl)phthalate	µg/L	ND	ND	**52/10***	6	NA	6.25	4.8
PCBs/Pesticides	µg/L	NA	NA	ND				
Explosives	µg/L	NA	NA	ND				
PETN	µg/L	NA	NA	NA	NA	NA	NA	NA
Picric Acid	µg/L	NA	NA	NA				
Organophos. Pest.	µg/L	NA	NA	NA				
Cl. Herbicides	µg/L	NA	NA	NA				
Metals - Total								
Antimony	mg/L	ND	ND	**0.002**	0.006	0.0014 - 0.008[a]	0.0014 - 0.008[a]	0.015
Arsenic	mg/L	ND	**0.0012 J**	**0.01**	0.05	0.005	0.00005	0.000045
Barium	mg/L	0.0066	0.039	0.097	2	1.12	1.12	2.6
Beryllium	mg/L	ND	ND	**0.00027 J**	0.004	0.0000203	0.0000203	0.000016
Cadmium	mg/L	ND	ND	0.0021	0.005	0.008	0.008	0.018
Chromium	mg/L	0.00099 J	0.0035	0.0096	0.1	16[b] (0.08)[c]	16[b] (0.08)[c]	37[b] (0.18)[c]
Copper	mg/L	0.00033 J	0.0051	0.069 B	1.3	0.592	0.592	1.5
Lead	mg/L	ND	0.00056 J	**0.12**	0.015	NA	NA	0.015
Nickel	mg/L	0.00069 J	0.0032	0.0095	0.1	0.32	0.32	0.73
Selenium	mg/L	0.00016 J	0.00016 J	0.0014 J	0.05	0.08	0.08	0.18
Silver	mg/L	ND	ND	0.00013 J	NA	0.08	0.08	0.018
Thallium	mg/L	ND	ND	ND	0.002	0.00112	0.00112	0.0029-0.0033
Zinc	mg/L	0.0018 J	0.0056 J	**12.0 B**	NA	4.8	4.8	11
Mercury	mg/L	ND	ND	ND	2	4.8	4.8	11[d]/3.7[e]
Metals - Dissolved				NA				
Antimony	mg/L	ND	0.00017 J		0.006	0.0014 - 0.008[a]	0.0014 - 0.008[a]	0.015
Arsenic	mg/L	ND	**0.0017 J**		0.05	0.005	0.00005	0.000045

Table 3-10
FORMER SEWAGE POND AND SUMP, CONSTITUENTS DETECTED IN GROUNDWATER SAMPLES, CAMP BONNEVILLE, VANCOUVER, WASHINGTON (continued)

Parameter	Units	Sewage Pond		Sump	Regulatory/Risk-Based Criteria			
		SP-MW01-01	SP-MW02-01	HM-SU01-01	MCL	MTCA A	MTCA B	EPA Reg. 3
Barium	mg/L	0.0082	0.031		2	1.12	1.12	2.6
Beryllium	mg/L	ND	ND		0.004	0.0000203	0.0000203	0.000016
Cadmium	mg/L	ND	ND		0.005	0.008	0.008	0.018
Chromium	mg/L	0.0012	0.00099 J		0.1	16 [b] (0.08)[c]	16 [b] (0.08)[c]	37[b] (0.18)[c]
Copper	mg/L	0.0040	0.0041		1.3	0.592	0.592	1.5
Lead	mg/L	ND	ND		0.015	NA	NA	0.015
Nickel	mg/L	0.0014	0.0030		0.1	0.32	0.32	0.73
Selenium	mg/L	ND	ND		0.05	0.08	0.08	0.18
Silver	mg/L	ND	ND		NA	0.08	0.08	0.018
Thallium	mg/L	ND	ND		0.002	0.00112	0.00112	0.0029-0.0033
Zinc	mg/L	0.0024 J	0.0053 J		NA	4.8	4.8	11
Mercury	mg/L	ND	ND		2	4.8	4.8	11[d]/3.7[e]
WQ Parameters								
Alkalinity, Total	mg/L	112	94.3	NA	NA	NA	NA	NA
Alk, Bicarb. as CaCO3	mg/L	112	94.3	NA	NA	NA	NA	NA
Alk, Carb. as CaCO3	mg/L	ND	ND	NA	NA	NA	NA	NA
Alk, Hydrox.. as CaCO3	mg/L	ND	ND	NA	NA	NA	NA	NA
Chloride	mg/L	1.3	1.6	NA	250	NA	NA	NA
Cyanide	mg/L	NA	NA	NA	0.2	NA	0.32	0.18-7.3
Fluoride	mg/L	0.17	0.12	NA	1.4 - 2.4	NA	0.96	2.2
Nitrate as N	mg/L	ND	ND	NA	10	NA	25.6	58
Orthophosphate as P	mg/L	ND	ND	NA	NA	NA	NA	NA
Sulfate	mg/L	0.27 J	1.2	NA	250	NA	NA	NA
Total Suspended Solids	mg/L	ND	10.0	NA	NA	NA	NA	NA
Calcium	mg/L	20.9	18.2	NA	NA	NA	NA	NA
Iron	mg/L	0.13	8.1	NA	NA	NA	NA	NA
Magnesium	mg/L	9.5	8.1	NA	NA	NA	NA	NA
Manganese	mg/L	0.86	1.2	NA	NA	NA	2.24	1.7
Potassium	mg/L	0.77 J	1.5 J	NA	NA	NA	NA	NA
Sodium	mg/L	10.0	8.9	NA	NA	NA	NA	NA
Fecal Coliform	mg/L	2	8	NA	NA	NA	NA	NA
Fecal Strep	mg/L	ND	4	NA	NA	NA	NA	NA

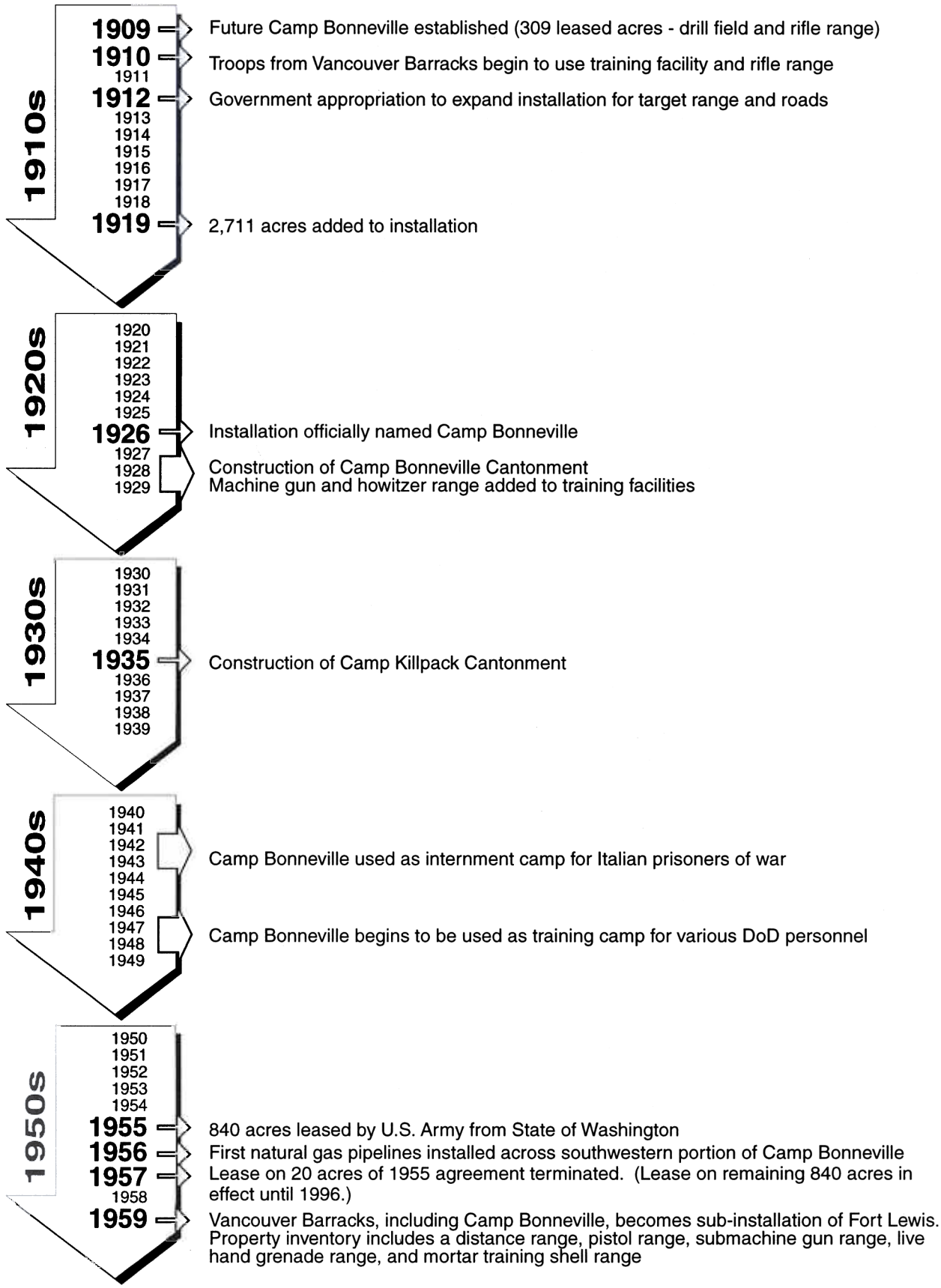
Notes:
This table includes only those constituents detected in the samples.
Shading indicates that the value exceeds one or more regulatory criteria.
*Includes initial results and results on re-extraction and re-analyses.
See Table 6-17 for additional notes and acronyms.

Table 3-11

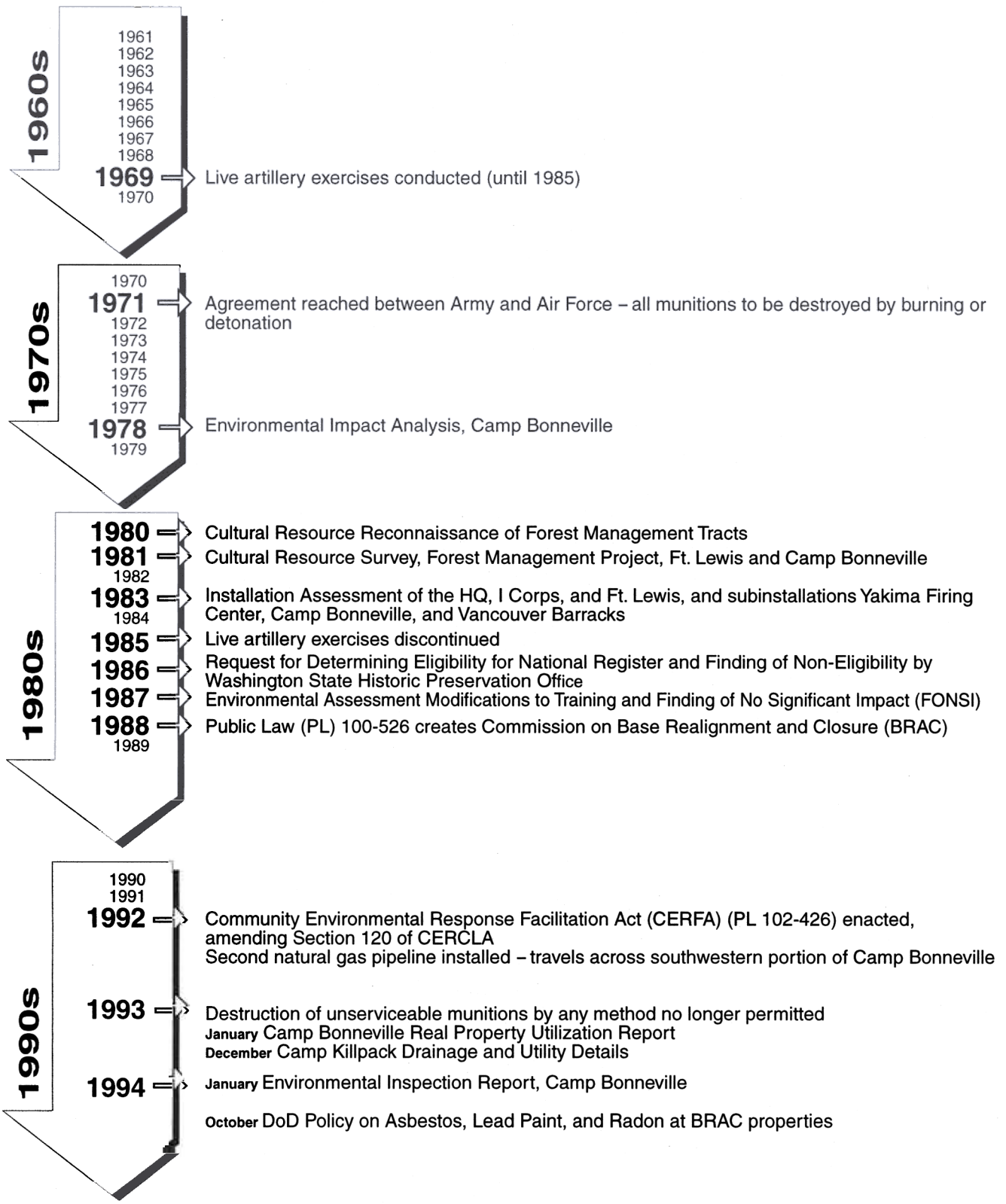
HAZARDOUS MATERIAL ACCUMULATION POINT, CONSTITUENTS DETECTED IN SOIL SAMPLES
CAMP BONNEVILLE, VANCOUVER, WASHINGTON

Parameter	Units	Sample Concentration							
		HM-SS-01-01	HM-SS-01-02	HM-SS-02-01	MTCA A	MTCA B	MTCA B-GW	EPA Reg. 3	**Background**
			(dup of SS01-01)						
Sample Date		2/27/98	2/27/98	2/27/98					
Sample Depth	ft bgs	0.0	0.0	0.0					
TPH	mg/kg	15 JY	20 JY	ND	200	NA	NA	NA	
SVOCs									
bis (2-ethylhexyl) -phthalate	mg/kg	ND	0.033 J	ND	NA	71.4	0.625	46	
PCBs/Pesticides	mg/kg	ND	ND	ND					
Metals									
Antimony	mg/kg	0.054 J	0.043 J	0.062 J	NA	32 - 72[a]	0.64 - 1.44[a]	31	0.12
Arsenic	mg/kg	**0.53**	**0.63**	**0.96**	20	1.67	0.005	0.43	7
Barium	mg/kg	91.8	73.5	64.2	NA	5,600	112	5,500	257
Beryllium	mg/kg	**0.36**	**0.32**	**0.3**	NA	0.233	0.002	0.15	2
Cadmium	mg/kg	1.3	1	1.1	2	80	1.6	39	1
Chromium	mg/kg	6.1	5.9	5.5	100	80,000[b]/400[c]	1,600[b]/8[c]	78,000[b]/390[c]	42
Copper	mg/kg	48.5 J	22 J	19.6	NA	2,960	59.2	3,100	114
Lead	mg/kg	12.4 J	7.3 J	4	250	NA	NA	400[d]	17
Nickel	mg/kg	7	6.8	13.7	NA	1,600	32	1,600	38
Selenium	mg/kg	ND	ND	ND	NA	400	8	390	NA
Silver	mg/kg	0.21 J	0.17 J	0.16 J	NA	400	8	390	NA
Thallium	mg/kg	ND	ND	ND	NA	5.6	0.112	6.3 - 7[e]	0.27
Zinc	mg/kg	51.5	41	44.2	NA	24,000	480	23,000	86
Mercury	mg/kg	ND	ND	ND	1	24	24	7.8[f]/23[g]	0.07

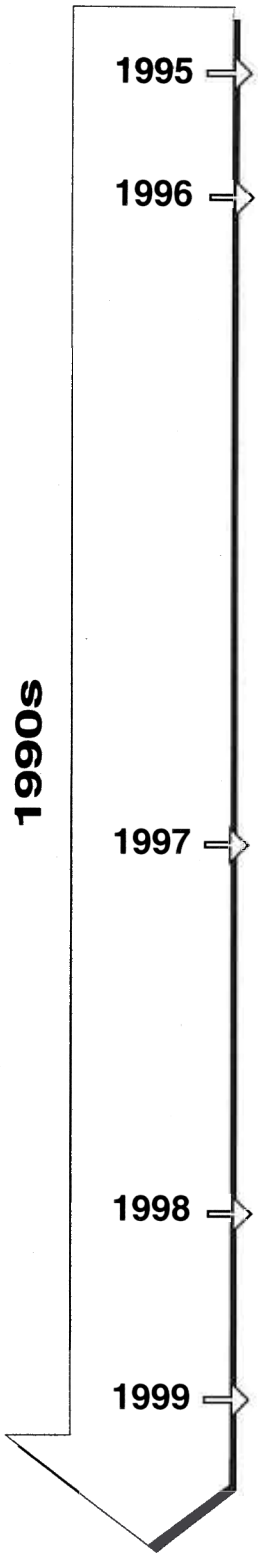
Notes:
This table includes only those constituents detected in the samples.
Concentrations in **bold** exceed one or more regulatory criteria but are below background.
Shading indicates that the value exceeds one or more regulatory criteria and background (if applicable).
See Table 6-17 for additional notes and acronyms.



Camp Bonneville Washington	Project No. 53F0072250	Chronology of Events at Camp Bonneville Since 1909	Figure 3-1
URS			



Camp Bonneville Washington	Project No. 53F0072250	Chronology of Events at Camp Bonneville Since 1909	Figure 3-1
URS			



1995

Camp Bonneville selected for closure under BRAC 95 Program
FBI constructs and begins use of small arms target range

February — Sensitive Species Field Guide, Camp Bonneville Military Installation

December — Spotted Owl Survey for 1994-1995 on Ft. Lewis and Camp Bonneville

1996

March — Proposed and Listed Threatened and Endangered Species, Species of Concern, Camp Bonneville

Potential drum and paint/solvent burial areas southeast of Camp Killpack

May — Management Plan - Petroleum Contaminated Soil Investigation, Building 4475, Tank No. 7

June — Revised Management Plan for Lead-Based Paint and Soil Metals Survey, Camp Bonneville

July — Project Management Plan - Camp Bonneville Drum Burial Site RA
Project Management Plan - Camp Bonneville Paint/Solvent Burial Site RA
Project Management Plan - Camp Bonneville Environmental Baseline Survey
Project Management Plan - Camp Bonneville - BRAC Cleanup Plan
Project Management Plan - Camp Bonneville - PCS/LUST Investigation
Project Management Plan - Camp Bonneville - CS Gas Building Decontamination
Project Management Plan - Camp Bonneville - Landfill #3 RA
Project Management Plan - Camp Bonneville - Landfill #2 RA
Project Management Plan - Camp Bonneville - Burn Site Remediation

August — Field Report Volume I Fort Lewis UST Removals

September — Petroleum-Contaminated Soil Investigation, Former Tank 7 - CMPBN, Building No. 4475

October — Local Reuse Authority (LRA) Survey of Camp Bonneville's Trails and Gravel Roads
Project Plan to Remove Drain Line and PCS Camp Bonneville

1997

January — Environmental Baseline Survey Final Report

February — Archive Search Report - Findings, Conclusions, and Recommendations
Pre-Demolition Survey CS Gas Chamber Building, Camp Bonneville
Lead-Based Paint and Soil - Metals Survey, Camp Bonneville
Camp Bonneville training activities cease, site under caretaker status

March — UXO (LAW Round) found at Camp Bonneville Sewage Treatment Lagoon
Camp Bonneville – Ideas for its Future

July — Management Plan for Asbestos Surveys
Project Management Plan – UXO Survey/Removal

August — Final Management Plan – Multi-Sites I Investigation 7 Landfills, Burn Areas, and Drum Burial Site, Camp Bonneville

November — Asbestos Surveys for Camp Bonneville

1998

February — Final Management Plan – Multi-Sites II Investigation, Camp Bonneville

June — Final Management Plan – Multi-Sites III Investigation, Camp Bonneville

October — Supplemental Archive Search Report – Draft Report
Technical Memorandum – Evaluation and Analysis of Rocket Motors and Propellants

November — Draft Report - Multi-Sites Investigation, Camp Bonneville

1999

July — Final Report - Multi-Sites Investigation, Camp Bonneville

August — Supplemental Archive Search Report - Final Report
Volume 1, Landfill 4 Investigation Report,Camp Bonneville, Washington

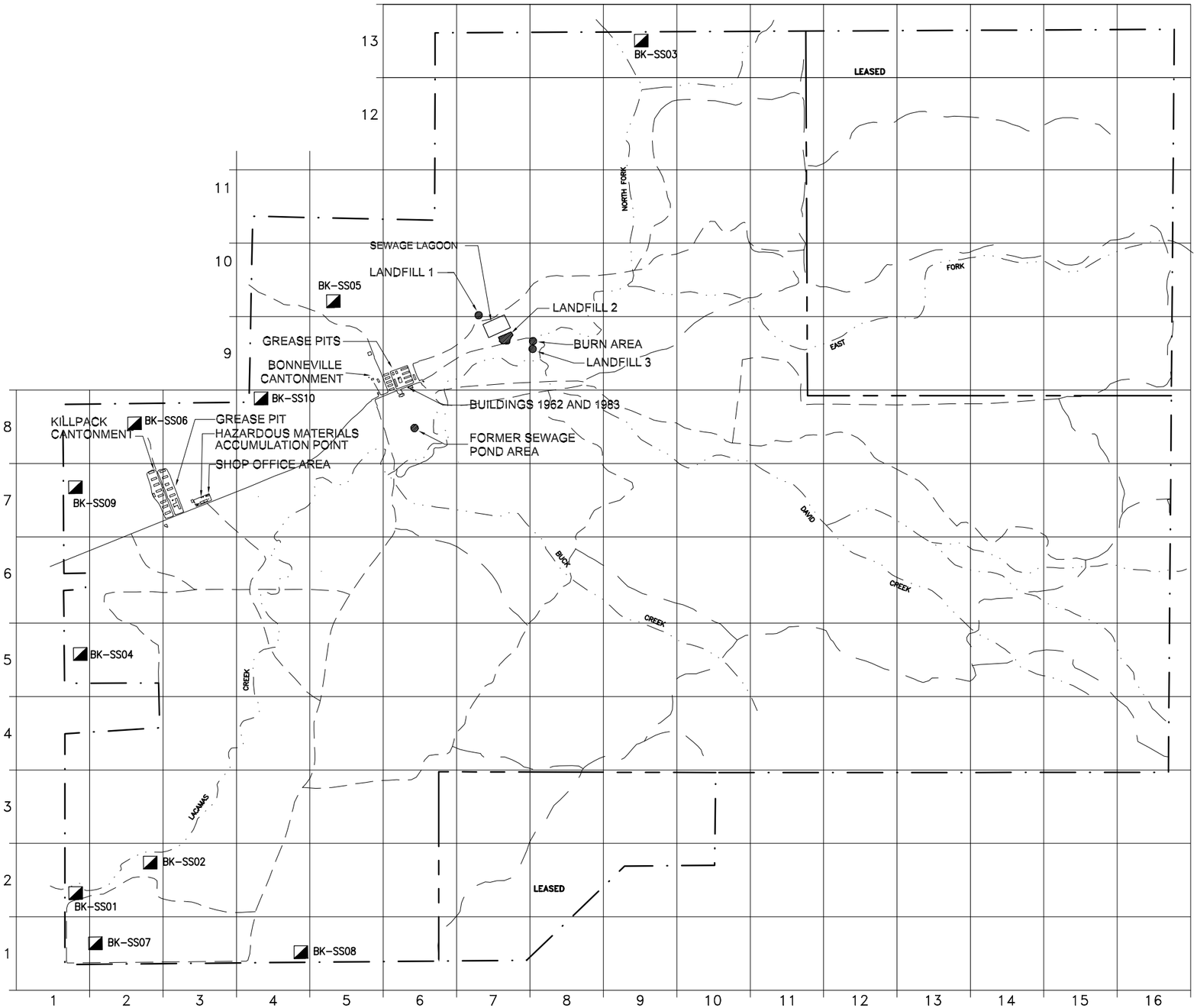
September — Environmental Assessment for Disposal and Reuse of Camp Bonneville, Washington Draft Report

October — Draft Management Plan for Ammunition Storage Magazines and Demolition Areas 2 and 3 – Site Investigation

2000

March — Project Completed Report, Surface Water Investigation of Lavamas Creek, Camp Bonneville,Washington – Final Report

Camp Bonneville Washington	Project No. 53F0072250	Chronology of Events at Camp Bonneville Since 1909	Figure 3-1
URS			



N

LEGEND

- INSTALLATION PROPERTY BOUNDARY
- LEASED AREAS BOUNDRY
- ALL WEATHER, HARD SURFACE, ASPHALT ROAD
- ALL WEATHER, LOOSE SURFACE, GRAVEL ROAD
- FAIR WEATHER, LOOSE SURFACE, EARTHEN ROAD
- CREEKS
- BACKGROUND SAMPLING LOCATION AND DESIGNATION

NOTE

REFERENCE: SHANNON AND WILSON

0 400 800 1600 3200
SCALE IN FEET

FILENAME: Q:\COE\Camp Bonneville\Bonn-120.dwg
EDIT DATE: 09/21/00 AT: 11:36

Camp Bonneville Location, WA	Project No. 53F0072250.00	Background Soil Sample Locations Camp Bonneville, Washington	Figure 3-2
URS			

A conceptual site model (CSM) defines the exposure pathways for a site. A complete exposure pathway must exist before there is risk to human or ecological receptors. The components of an exposure pathway include (1) primary contaminant source(s) and release mechanisms; (2) secondary sources; (3) mechanisms of contaminant retention in, or transport to, exposure media, (4) receptors that may contact contaminants in exposure media; and (5) routes of intake of contaminated media by receptors. If any one of these elements is missing, a given exposure pathway is incomplete. A summary of the potential sources, release mechanisms, and receptors is provided in Figure 4-1.

4.1 PRIMARY SOURCES AND RELEASE MECHANISMS

The release mechanisms include spills or other releases from aboveground and belowground sources. The aboveground sources include the following:

- Hazardous materials in material storage and handling areas (Hazardous Materials Accumulation Point)
- Burned buildings and other burned materials (Former Burn Area and Former Buildings 1962 and 1983)

The belowground sources include the following:

- Landfills and other debris burial sites (Landfills 1, 2, and 3)
- Belowground waste disposal areas (Grease Pits and Former Sewage Pond)

The investigation for Landfill 1 by Shannon & Wilson (1999) revealed a small shallow depression that appeared to be used for disposal of household items, such as bottle fragments. Evidence of a larger landfill was not found. Investigation efforts to locate Landfills 2 and 3 by Shannon & Wilson (1999) indicated that both areas were covered with soil and/or vegetation although at both areas solid waste such as wires, pipes, vehicle parts, and corrugated metal sheets were found at the surface. Considering these field observations, it was concluded in the Shannon & Wilson Multi-Sites Final Report (1999) that the landfills represented only below ground potential contaminants sources.

Several of the belowground sources may release contaminants directly into shallow groundwater that is in contact with the source materials.

4.2 SECONDARY SOURCES

In addition to serving as a direct exposure medium, soils are a secondary source from which chemicals may potentially be released to other environmental media, such as groundwater. Groundwater may also serve as a secondary source from which chemicals may be released to other media such as surface water.

4.3 MECHANISMS OF RETENTION IN OR TRANSPORT TO EXPOSURE MEDIA

The mechanisms of chemical retention, transfer, or transport at a site are based on the general geology and hydrogeology of the site, and chemical properties of the contaminants. Soil is a retention medium at the site and a potential secondary source from which chemicals may migrate

to other media. Infiltrating rainwater may dissolve chemicals, resulting in their transfer from soils to groundwater. Contaminants in surface soil may migrate via surface runoff to nearby streams and creeks. If site-related chemicals are present in groundwater, they may be subsequently transported via groundwater flow to nearby streams and creeks.

At this time, air (volatilization) is not included as a migration pathway because most of the contaminants of concern are non-volatile compounds, and many of the chemical releases occurred belowground. In addition, most of the releases occurred many years ago, so volatile constituents at or near the surface would have volatilized already.

Exposure to surface soils was not considered as a complete or viable exposure pathway or release mechanism for two primary reasons. The BRAC Cleanup Team, which includes representatives from the Washington State Department of Ecology and U.S. Environmental Protection Agency Region 10, has agreed that no further action is necessary at the landfills. The agreement is contingent on the provision that future users would not build on or excavate the area underlain by landfill debris. Institutional controls will also be implemented for reuse that will focus on protection of human health and the environment after transfer of the property. In addition, under the current reuse plan for Camp Bonneville by Clark County, the eastern portion of the site, which includes Landfills 2 and 3, includes timber management and hiking and equestrian trails. Reuse activities with more potential for human exposure, such as camping and outdoor instructional areas, are planned for the western portion of the site, near the Camp Bonneville and Camp Killpack cantonments. As such, the potential exposure to surface soil from Landfills 2 and 3 were considered to be incomplete or non-viable.

4.4 RECEPTORS AND EXPOSURE ROUTES

There are no permanent residents at Camp Bonneville. Although the facility is not currently open to site visitors or recreational users, future use plans may allow such activities; therefore, site visitors are included as potential human receptors. Site workers are present occasionally at the sites at this time and may be present more frequently in the future. Site workers could be exposed to affected subsurface soil and groundwater during excavation activities at the site. Terrestrial and aquatic biota are present in the site area and therefore may be receptors.

Potential exposure routes include ingestion of affected media and dermal contact with affected media. If surface water or sediments were affected, ingestion of fish from the neighboring creeks would be another potential exposure route.

4.5 EVALUATION OF CSM FOR EIGHT BASE SITES

Discussion of the CSMs for each of the eight base sites is provided below, including a presentation of complete and significant pathways based on subsurface findings and analytical results.

4.5.1 Landfill 1

This landfill was not located by geophysical methods or visual reconnaissance. The previously cited information is consistent with a small debris pile associated with a former residence.

4.5.2 Landfill 2

The approximate area of debris disposal was identified by geophysical surveying. The depth of the material could not be determined; however, some of the debris was shallow, with metal observed protruding at the ground surface. Because groundwater was encountered in the site area at depths of only a few feet bgs, at least some of the debris at Landfill 2 site can be expected to be in contact with groundwater. Therefore, contaminant migration via shallow groundwater is expected to be the primary release mechanism at this site. Contaminants from the landfill also may discharge to soil with subsequent transport to groundwater. Groundwater appears to occur under perched conditions at the site, and based on topography it is assumed to flow toward and discharge to Lacamas Creek, located roughly 200 feet south of the landfill perimeter.

As shown in Table 3-5, results of subsurface soil sampling in soil borings downgradient of the landfill (with samples collected at the soil-groundwater interface) did not indicate the presence of constituents at concentrations above the regulatory/risk-based screening criteria and background levels (where applicable). Copper was detected at a concentration above the lowest regulatory screening criterion and slightly exceeding the background concentration (but less than two times background) in a soil sample from the upgradient soil boring. Sampling of downgradient groundwater indicated the presence of elevated concentrations of arsenic only (at concentrations exceeding the risk-based criteria but below the MCL). The upgradient well was dry and could not be sampled. Elevated concentrations of arsenic have been detected in groundwater from several wells (both upgradient and downgradient) at different sites at Camp Bonneville and may be related to natural background. Institutional controls appropriate for the future selected reuse of Camp Bonneville will be implemented at Landfill 2 to protect human health and the environment after transfer of the property. These controls may include physical, legal, and/or administrative mechanisms that restrict the use of, or limit access to, real property.

4.5.3 Landfill 3

The approximate area of debris disposal was identified by geophysical surveying and appears to roughly correspond with the mounded area at the site. The depth of the material could not be determined; however, some of the debris is shallow, with metal observed on and protruding from the ground surface. Because groundwater was encountered in the site area at depths of only a few feet bgs, at least some of the debris at the Landfill 3 site can be expected to be in contact with groundwater. Therefore, contaminant migration via shallow groundwater is expected to be the primary release mechanism at this site. Contaminants from the landfill also may discharge to soil with subsequent transport to groundwater. Groundwater appears to occur under perched conditions at the site and is assumed to flow toward and discharge to Lacamas Creek, located immediately south and east of the landfill area.

As shown in Table 3-5, results of subsurface soil sampling (with samples collected at the soil-groundwater interface) did not indicate the presence of any constituents at concentrations above the regulatory/risk-based screening criteria and background levels (where applicable). Sampling of downgradient groundwater indicated the presence of elevated concentrations of arsenic only (at concentrations above the risk-based criteria but below the MCL). Arsenic was not detected in groundwater from the upgradient monitoring well. Elevated concentrations of arsenic have been detected in groundwater from several wells (both upgradient and downgradient) at different sites at Camp Bonneville, and may be related to natural background. Institutional controls appropriate

for the future selected reuse of Camp Bonneville will be implemented at Landfill 3 to protect human health and the environment after transfer of the property. These controls may include physical, legal, and/or administrative mechanisms that restrict the use of, or limit access to, real property.

4.5.4 Burn Area

The Burn Area site is located immediately north of Landfill 3 and approximately 50 feet west of Lacamas Creek. Surface debris at the site was removed prior to the field investigation. Because the source materials were aboveground, contaminants released from materials stored or burned at the site would either enter underlying soil or migrate via surface water runoff. Because runoff from the site appears to pond on or immediately adjacent to the site, direct runoff to Lacamas Creek appears unlikely. Any contaminated surface runoff would likely only impact nearby soil.

Surface and near-surface soil samples were collected from within the former Burn Area, as well as upslope and downslope of the site. Only one constituent, thallium, in one sample, which was collected at the ground surface, was detected at a concentration above the regulatory/risk-based screening criteria and background (but less than two times background) (Table 3-6). A sample collected 1 foot beneath this sample did not contain elevated thallium.

4.5.5 Buildings 1962 and 1983

Buildings 1962 and 1983 burned down and were removed from the site an unknown number of years ago. Because the source materials were aboveground, any contaminants released from the buildings or during combustion of the buildings would either have entered underlying soil or migrated via surface water runoff. Any contaminated surface runoff would likely only impact nearby soil.

Surface and near-surface soil samples were collected from within the apparent footprints of Former Buildings 1962 and 1983, as well as upslope and downslope of the former buildings. No constituents were detected at concentrations above the regulatory/risk-based screening criteria in the soil samples (Table 3-7).

4.5.6 Grease Pits

The three grease pits were constructed of perforated metal pipes extending vertically into drain rock. The pipe length observed in one of the pits extended to a depth of approximately 4 feet bgs. Any contaminants released from the grease pits would enter subsurface soil. These contaminants in soil could migrate to groundwater. However, groundwater at the grease pit sites was not encountered during sampling (to depths of 12.5 feet bgs at Camp Bonneville and 7 feet bgs at Camp Killpack).

Four subsurface soil samples were collected from locations immediately adjacent to the grease pits, at depths corresponding to the apparent sides and bottoms of the pits. As shown in Table 3-8, although several metals were detected in one sample at concentrations exceeding both background and one or more of the screening levels, none of these concentrations exceeded two times background. Only barium exceeded the background level, as well as the regulatory criterion for groundwater protection, in more than one soil sample (in the Camp Bonneville cantonment area).

4.5.7 Former Sewage Pond

The apparent location of the Former Sewage Pond was determined using field evidence of soil disturbance (mounded soil) and the presence of a roughly circular outline of buried fence posts. The apparent depth of the pond bottom was approximately 4 to 5 feet bgs, based on the presence of a thin horizon of dark soil.

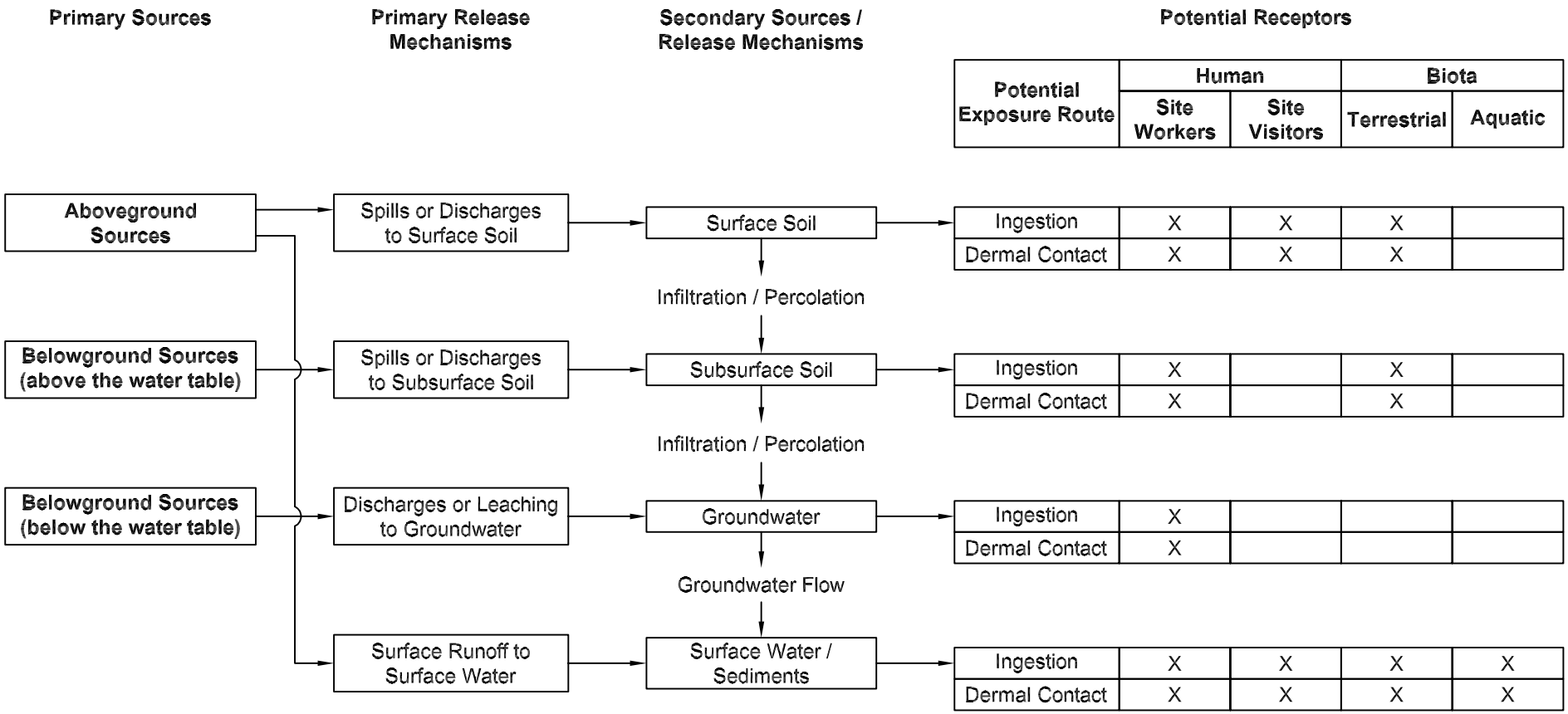
Groundwater at the site appears to be perched over highly weathered volcanic rock. Groundwater is assumed to flow generally to the south, toward Lacamas Creek, located approximately 200 feet from the site. Groundwater was encountered at depths of 4 to 4.5 feet bgs in the Former Sewage Pond area during the field investigation (in the dry season) and was measured more than two feet higher in two on-site monitoring wells during the rainy season. Therefore, it appears that the Former Sewage Pond was in contact with groundwater, at least seasonally. Therefore, contaminants from the pond could have migrated into subsurface soil or discharged directly to groundwater.

Both soil and groundwater samples were collected from the site for analysis. Therefore, arsenic, copper, and thallium were detected in subsurface soil samples at concentrations exceeding one or more of the regulatory/risk-based screening criteria (Table 3-9). Each of these metals was detected at a concentration slightly above background (but less than two times background) in only one soil sample each. Groundwater samples were collected from one upgradient and one downgradient well at the site. Arsenic was detected in groundwater at a concentration exceeding the screening criteria, but only in the sample from the upgradient well (Table 3-10). Slightly elevated concentrations of metals detected in soil and groundwater may be related to natural variability in background concentrations.

4.5.8 Hazardous Materials Accumulation Point – Building 4476

The Hazardous Material Accumulation Point building is currently used for empty drum storage. The building has a sloping floor that drains to a blind sump. Any spills within the building would drain to this sump. The sump was cleaned out during the investigation and the contents were disposed of off site. No evidence of significant contamination was found in the material removed. In addition, no cracks or outlets were observed within the sump, which could allow the release of contaminants to the underlying soil. Any contaminants released during handling of drums outside of the building could either enter underlying soil or migrate via surface water runoff. Surface water runoff from the site likely flows to the south to a ditch on the north side of the facility access road, then toward a small stream immediately west of the shop office.

Two surface soil samples were collected from in front of the Hazardous Material Accumulation Point building. No constituents were detected at concentrations above the regulatory/risk-based screening criteria and background levels (where applicable) (Table 3-11).



Reference: Shannon & Wilson

Camp Bonneville Location, WA	Project No. 53F0072250.00	CONCEPTURAL SITE MODEL	FIGURE 4–1
URS			

FILENAME: Q:\COE\Camp Bonneville\Bonn–117.dwg
EDIT DATE: 09/21/00 AT: 11:32

The multi-sites investigation was conducted in 1998 and 1999 to evaluate the potential for contamination resulting from past uses at Camp Bonneville. The investigation was directed at evaluating potential environmental impacts from known or suspected activities at the site. The primary objectives of the investigation were to evaluate whether each site poses a potential risk to human health or the environment, and to provide recommendations for further actions (where appropriate) for site remediation or for the performance of further investigations to better evaluate the need for and extent of remediation.

No further action (NFA) is recommended for the eight base sites discussed in this site closure report because either no evidence or minimal evidence of contamination was detected. At most of these sites, constituents of concern either were not detected or were detected at concentrations below the project screening levels. The specific sites and their rationale for NFA are provided in Table 5-1.

Normal background concentrations of several metals in soil exceeded one or more of the project screening levels, including arsenic, barium, beryllium, chromium, copper, and thallium. However, under MTCA (WAC173-340-7407(e)), in instances where only a single sample exceeds the background value but does not exceed two times the background value, and where less than 10 percent of the sample concentrations exceed the background value, the concentrations are considered to meet the cleanup level. At some of the sites, one or more of these metals were detected at concentrations only slightly exceeding the background level in a minimal number of samples. These slightly elevated concentrations may be representative of the normal variability of metals concentrations in soil. Although they exceed screening criteria, these constituents do not appear to pose a risk to human health and the environment, either because there is no exposure pathway under normal use scenarios, or because the constituents detected do not appear to be site specific.

Total and dissolved arsenic was detected in one or more monitoring wells at each of the three sites where groundwater was sampled (Landfill 2, Landfill 3, and Former Sewage Pond). In one case (at the Former Sewage Pond site), arsenic was detected in the upgradient well but not in the downgradient well. Because the MDL and RL for arsenic in groundwater exceed the MTCA Method B value and EPA Region 3 screening criteria, all detected arsenic concentrations exceeded these criteria. However, none of the detected arsenic concentrations exceeded the MCL (which is also the MTCA Method A value for arsenic). No natural background concentration is available for arsenic in groundwater at Camp Bonneville. The natural background concentration for arsenic in soil exceeds the MTCA Method B groundwater protection, MTCA Method B direct contact, and EPA Region 3 criteria (but not MTCA Method A). Based on this, it appears that the detected concentrations of arsenic in groundwater may be due to natural conditions.

An NFA decision for the landfills should be contingent on the land use provision (institutional control) that future users would not build on or excavate into the area underlain by landfill debris.

Table 5-1
RATIONALE FOR NO FURTHER ACTION

SITE	RATIONALE FOR NO FURTHER ACTION
Landfill No. 1	• The landfill was not located by reconnaissance and geophysical methods. • Previously collected information is interpreted to be consistent with the presence of a small debris pile associated with a former residence.
Landfill No. 2	• The soil gas survey indicated no impact to air and no evidence of volatile organics in the landfill materials. • Metals were the only constituents detected in downgradient borings, and none were detected at concentrations above the screening criteria and background. • Both total and dissolved arsenic was detected in both groundwater wells sampled at concentrations exceeding risk-based criteria but below the MCL. • Arsenic concentrations in area wells are typically slightly elevated, which may be related to background conditions.
Landfill No. 3	• The soil gas survey indicated no impact to air and no evidence of volatile organics in the landfill materials. • Metals were the only constituents detected in downgradient borings, and none were detected at concentrations above the screening criteria and background. • Total and dissolved arsenic was detected in the downgradient groundwater wells at concentrations exceeding risk-based criteria but below the MCL. • Total and dissolved arsenic concentrations in area wells are typically slightly elevated, which may be related to background conditions
Burn Area	• Metals were the only constituents detected in soil in downgradient borings, and only thallium was found at a concentration above the screening criteria and background • Thallium was detected in one surface soil sample at a concentration slightly above background and the MTCA Method B groundwater protection criterion, but less than two times background. Slightly elevated thallium, detected in one surface soil sample, may not exceed the actual natural concentration in site soils. • Arsenic was detected in one nearby downgradient landfill groundwater well at a concentration exceeding risk-based criteria, but below the MCL. • The site does not appear to pose a threat to groundwater. Arsenic concentrations in area wells are typically slightly elevated, which may be related to background conditions.
Former Buildings 1962 and 1983	• Only lead was detected in the surface and near-surface soil samples; concentrations detected did not exceed the screening criteria.
Camp Bonneville Grease Pits	• No organics in soil were detected at concentrations above the screening criteria. • Barium and copper were detected in soil above the MTCA Method B groundwater protection level and slightly above background levels in soil, but less than two times background. • Groundwater was not encountered in the boring, which extends to volcanic rock.
Camp Killpack Grease Pit	• No organics were detected at concentrations above the screening criteria in soil. • Arsenic was detected in one soil sample at a concentration above the screening criteria and slightly above background, but less than two times background. • Thallium was detected at a concentration above the MTCA Method B groundwater criterion and slightly above background in one soil sample, but less than two times background. • Groundwater was not encountered in the boring.

SITE	RATIONALE FOR NO FURTHER ACTION
Former Sewage Pond	• Thallium was detected in one soil sample at a concentration above the MTCA Method B groundwater protection level and slightly above background, but less than two times background. • Arsenic was detected in one soil sample at a concentration above the screening levels and slightly above background, but less than two times background. • Copper was detected above the MTCA Method B groundwater protection criterion and slightly above background in one subsurface soil sample from the upgradient boring, but less than two times background. • Arsenic, copper, and thallium, detected in only one soil sample each at concentrations only slightly above background, may be representative of natural conditions. • No organic compounds were detected in groundwater samples. • The only metal detected in groundwater above screening criteria was arsenic in the upgradient well. The arsenic concentration exceeded both MTCA and Region 3 risk-based criteria but was well below the MCL. • Arsenic was not detected in the downgradient groundwater well. • Arsenic concentrations in groundwater at Camp Bonneville typically appear to be slightly elevated and may be related to background conditions. Arsenic was detected only in the upgradient well at this site.
Hazardous Material Accumulation Point	• The only organics detected in surface soil samples were low concentrations of TPH and bis(2-ethylhexyl) phthalate (below screening levels). • No metals were detected at concentrations above the screening levels and background.

Notes:
MCL - maximum contaminant level
MTCA - Washington State Model Toxics Control Act
TPH - total petroleum hydrocarbons

Cecon. 1997. Field Report, Drain Line and PCS Soil Removal Camp Bonneville, Washington. Contract No. DACA67-96-M-0890, December 1997.

Cecon. 1996. Field Report, Fort Lewis UST Removals, Fort Lewis, Washington. Contract No. DACA67-93-D-1021, August 1996.

Department of Defense. 1995. BRAC Cleanup Plan (BCP) Guidebook.

Ecology, Washington State Department. 1992. Statistical guidance for Ecology site managers; Toxics Cleanup Program, Olympia, Washington, August, 100 p.

———. 1994. Natural background soil metals concentrations in Washington state: Olympia, Washington, Ecology publication no. 94-115, October.

———. 1993. Implementation memo No. 1 from Carol Kraege, "Guidance on the Use of MCLs as cleanup Levels." March 15, 1993. Available at http://www.epa.gov/ECOLOGY/tcp/policies/mcl.html.

Hart Crowser. 1996. Final Report, Petroleum Contaminated Soil Investigation, Former Tank No. 7-CMPN, Building No. 4475, Camp Bonneville, Washington. Contract No. DACA67-D-1004, September 1996.

Larson, L.L. 1980. Cultural resource reconnaissance of forest management tracts on Fort Lewis and Camp Bonneville: Seattle, Wash., University of Washington, Office of Public Archaeology, Reconnaissance Report no. 34.

QST Environmental Inc. 1997. Final Technical Memorandum for Miscellaneous Surplus OU Study Areas, Fort Sheridan, Illinois. November 7, 1997.

Shannon and Wilson. 1997. Final Management Plan, Multi-Sites I Investigation of Landfills, Burn Areas, and Drum Burial Sites Camp Bonneville, Washington. Contract No. DACA67-94-D-1014. August 1997.

———. 1998a. Final Management Plan, Multi-Sites II Camp Bonneville, Washington. Contract No. DACA67-94-D-1014. February 1998.

———. 1998b. Final Management Plan, Multi-Sites III Camp Bonneville, Washington. Contract No. DACA67-94-D-1014. June 1998.

———. 1999. Final Report Volume I, Multi-Sites Investigation Report, Camp Bonneville, Washington. Contract No. DACA67-94-D-1014. July 1999.

SPSS. 1997. SPSS Base 7.5 for Windows user's guide; SPSS, Inc., Chicago.

URS Greiner Woodward-Clyde Federal Services. 1999. Electronic Database Version 1.9, Camp Bonneville Administrative Record Database Application, February 1999.

U.S. Environmental Protection Agency (EPA) Region 3. 2000. Accessed May 2000 at web site http://www.epa.gov/reg3hwmd/risk/riskmenu.htm.

———. 1996b. Model Toxics Control Act Cleanup Levels and Risk Calculation (CLARC II) update: Olympia, Washington, Ecology publication no. 94-145, February. Also found May 20, 2000, on web at http://www.wa.gov/ECOLOGY/tcp/960201c2.xls/.

Woodward-Clyde Federal Services. 1997. Final Environmental Baseline Survey, Camp Bonneville, Washington. January 30, 1997.

Appendix A

Response To Comments On Draft Report

September 14, 2000
53-F0072250

Mr. Rodney Taie
U.S. Army Corps of Engineers, Seattle District
CENWS-PM-HW
4735 E. Marginal Way South
Seattle, WA 98134-2385

Re: Response to Comments
Draft BRAC Site Closure Report – Base Sites, Camp Bonneville
Contract No. DACA67-98-D-1005 (D.O. No. 0043)

Dear Mr. Taie:

This letter presents URS Corporation's (URS) response to comments on our "Draft BRAC Site Closure Report, Camp Bonneville, Washington," dated September 2000. Comments were received from the U.S. Army Corps of Engineers (USACE) on September 12, 2000. Responses are included below for each comment.

USACE COMMENTS

Sandy Lemlich

1. Page 3-9, Par 2, 1st Line. From Figure 2-1 it appears as though the soil borings were obtained from areas outside the landfill itself. Please correct the text in this paragraph and/or modify Figure 2-1 to better illustrate the boundaries of the landfill.

URSGWC Response:

The text has been revised to state that the soil borings were drilled outside of the estimated perimeter of Landfill 2.

2. Page 3-13, Par 6, 1st Line. From Figure 2-1 it appears as though the soil borings were obtained from areas outside the landfill itself. Please correct the text in this paragraph and/or modify Figure 2-1 to better illustrate the boundaries of the landfill.

URSGWC Response:

The text has been revised to state that the soil borings were drilled outside of the estimated perimeter of Landfill 3.

3. Page 4-1, Section 4.1, 2nd Paragraph. Please revise the text to explain why the landfills are only considered a "below ground source"? Are these landfills covered? Was any debris/refuse observed on the surface of these landfills? Is enough known about the history of landfill use to rule out any surface disposal?

URSGWC Response:

The investigation for Landfill 1by Shannon & Wilson (1999) revealed a small shallow depression that appeared to be used for disposal of household items (such as bottle fragments). Evidence of a larger area, more aptly termed landfill, was not found. Investigation efforts to locate Landfills 2 and 3 by Shannon & Wilson (1999) indicated that both areas were covered with soil and/or vegetation although at both areas solid waste such as wires, pipes, vehicle parts, and corrugated metal sheets were found at the surface. Considering these field observations, it was concluded in the Draft BRAC Site Closure and the Shannon & Wilson Multi-Sites Final Report (1999) that the landfills represented only below ground potential contaminants sources.

4. Page 4-2, Section 4.5, Par 1. Please include exposure to surface soils.

URSGWC Response:

Exposure to surface soils was not considered as a complete or viable exposure pathway or release mechanism for two primary reasons. The BRAC Cleanup Team (BCT), which includes representatives from the Washington State Department of Ecology and U.S. Environmental Protection Agency Region 10, has agreed that no further action is necessary at the landfills. The agreement is contingent on the provision that future users would not build on or excavate the area underlain by landfill debris. Institutional control will also be implemented for reuse that will focus on protection of human health and the environment after transfer of the property. In addition, under the current reuse plan for Camp Bonneville by Clark County, the eastern portion of the site (which includes Landfills 2 and 3), includes timber management and hiking and equestrian trails. Reuse activities with more potential for human exposure, such as camping and outdoor instructional areas, are planned for the western portion of the site, near the Bonneville and Killpack cantonments. As such, the potential exposure to surface soil from Landfills 2 and 3 were considered to be incomplete or non-viable.

5. Page 4-3, Section 4.5.2, Par 1, Line 4. Please change “landfill 3” to “landfill 2”.

URSGWC Response:

The text has been modified to correctly refer to Landfill 2.

6. Page 4-3, Section 4.5.2, Par 2. Please discuss potential exposure to contaminated surface soil.

URSGWC Response:

Please see the response to comment 4.

7. Page 4-3, Section 4.5.3, Par 2. Please discuss potential exposure to contaminated surface soil.

URSGWC Response:

Please see the response to comment 4.

8. Page 5-3, Table 5-1. It appears to be premature to recommend no further action at Landfills 2 and 3 with no discussion of the surface soil pathway.

URSGWC Response:

Please see the response to comment 4.

DEPARTMENT OF ECOLOGY COMMENTS

Christopher Maurer

"…Institutional controls will be needed at Landfills 2 and 3."

URSGWC Response:

Institutional controls appropriate for the future selected reuse of Camp Bonneville will be implemented to protect human health and the environment after transfer of the property. These controls may include physical, legal, and/or administrative mechanisms that restrict the use of, or limits access to, real property.

The title of the report implies that it is the chemical and unexploded ordnance report for all of Camp Bonneville. The title should be revised to indicate that the report applies only to the eight Camp Bonneville sites included in the report.

URSGWC Response:

The title of the report has been revised to indicate that the report covers only the HTRW aspect of the sites. The new title is "BRAC HTRW Site Closure Report for Landfills 1, 2, and 3; Former Burn Area; Building 1962 and 1963; Grease Pits at the Camp Bonneville and Camp Killpack Cantonments; Former Sewage Pond; and Hazardous Materials Accumulation Point."

ENVIRONMENTAL PROTECTION AGENCY – REGION 10 COMMENTS

Harry Craig

The title of the report implies that it is the chemical and unexploded ordnance report for all of Camp Bonneville. The title should be revised to indicate that the report applies only to the eight Camp Bonneville sites included in the report.

URSGWC Response:

The title of the report has been revised to indicate that the report covers only the HTRW aspect of the sites. The new title is "BRAC HTRW Site Closure Report for Landfills 1, 2, and 3; Former Burn Area; Building 1962 and 1963; Grease Pits at the Camp Bonneville and Camp Killpack Cantonments; Former Sewage Pond; and Hazardous Materials Accumulation Point."

FORT LEWIS

Eric Waehling – BRAC Environmental Coordinator (BEC)

Please include a title block in the report. The title should include holding places for signatures from EPA, Ecology, the Fort Lewis BEC, and Colonel Conte, Director of Public Works.

URSGWC Response:

A title block with appropriate signature place holders will be included in the final report.

Please call me if you have any questions concerning this letter.

Sincerely,

URS

Steven P. Wolfe, R.G

Project Manager