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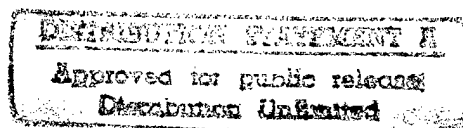


Final

Alternatives Analysis Report for Fort Douglas

Fort Douglas
Environmental Investigation/Alternatives Analysis

Contract No. DAAA15-90-D-0018
Task Order 0005, Data Item A009



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FINAL ALTERNATIVES ANALYSIS REPORT
FOR FORT DOUGLAS

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ENVIRONMENTAL INVESTIGATION/ALTERNATIVES ANALYSIS

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LIST OF ACRONYMS

AA	Alternatives Analysis
Admin.	Administrative
USAEC	U.S. Army Environmental Center (formerly USATHAMA)
AHPA	Archeological and Historical Preservation Act of 1974
Ann.	Annotated
ARAR	Applicable or Relevant and Appropriate Requirement
ARPA	Archeological Resources Protection Act of 1979
BRAC	Base Closure and Realignment Act of 1988
BTEX	Benzene, toluene, ethylbenzene, and xylene
CDI	Chronic Daily Intake
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980, also known as Superfund: Amended in 1986 by the Superfund Amendments and Reauthorization Act (SARA)
CFR	Code of Federal Regulations
COC	Chemical of Potential Concern
CRS	Cultural Resource Survey
DOMW	(Fort) Douglas Monitoring Well
EI/AA	Environmental Investigation/Alternative Analysis
ESA	Endangered Species Act of 1973
FR	Federal Register
FS	Feasibility Study
ft bgs	feet below ground surface
GC/MS	Gas Chromatography/Mass Spectrometry
HUD	Department of Housing and Urban Development
ICF	ICF Technology Inc.
LDR	Land Disposal Restriction
LSA	low specific activity
NAAQS	National Ambient Air Quality Standards
NCP	National Oil and Hazardous Substances Contingency Plan
NEPA	National Environmental Policy Act of 1969
NHPA	National Historic Preservation Act of 1966
NPDES	National Pollutant Discharge Elimination System

LIST OF ACRONYMS (continued)

O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Act of 1970
OSWER	USEPA Office of Solid Waste and Emergency Response
PA	Preliminary Assessment
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PL	Public Law
ppm	parts per million
RA	Remedial Action
RAP	Remedial Action Plan
RCRA	Resource Conservation and Recovery Act of 1976
RfD	Reference Dose
RI/FS	Remedial Investigation/Feasibility Study
RLSA	R.L. Stollar and Associates, Inc. (currently WJE)
SARA	Superfund Amendments and Reauthorization Act of 1986 (See CERCLA)
SHPO	State Historic Preservation Officer
SVOC	Semivolatile Organic Compound
TBC	To Be Considered
TMV	Toxicity, Mobility, and Volume
TPH	Total Petroleum Hydrocarbons
TSCA	Toxic Substances Control Act
TSD	Treatment, Storage, or Disposal
$\mu\text{g/g}$	micrograms per gram (equivalent to parts per million)
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USC	United States Code
USDOT	U.S. Department of Transportation
USEPA	U.S. Environmental Protection Agency
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WJE	Watkins-Johnson Environmental, Inc. (formerly RLSA)
Westech	Westech Fuel Equipment

EXECUTIVE SUMMARY

Fort Douglas, located east of Salt Lake City, Utah, was established in 1862 as an Army installation. The primary mission of Fort Douglas has been to garrison troops, house prisoners of war, serve as headquarters for military units, and function as a support detachment for military activities in the region. No major industrial activities have been conducted at Fort Douglas. Only light industrial operations associated primarily with the maintenance and repair of base facilities and vehicles have been conducted. Fort Douglas is a subinstallation of Fort Carson, Colorado.

Fort Douglas was recommended for closure and realignment by the Defense Secretary's Commission on Base Realignment and Closure in December 1988. As stipulated by Section 120(h) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)(42 United States Code (USC) §§ 9601 *et seq.*), the closure and transfer of the property must be preceded by an evaluation of hazardous substances which are known or suspected to be present at the site. Therefore, under the management of the U.S. Army Environmental Center (formerly U.S. Army Toxic and Hazardous Materials Agency [USATHAMA]), an Environmental Investigation (EI) and Alternatives Analysis (AA) have been conducted for the excessed area of Fort Douglas, approximately 51 acres. The EI involved the collection, testing, and assessment of media in the excessed area of Fort Douglas. As part of the EI, a risk assessment was performed. The AA involved the identification and detailed evaluation of potential remedial alternatives.

The excessed acreage was conveyed to the University of Utah on November 5, 1991, in accordance with Public Laws 101-510 and 101-519. The remaining acreage is retained by the federal government for use as a military Reserve Center for the 96th Army Reserve Command, and four acres will remain as the post cemetery. Upon completion of potential remedial actions, the title and deed for the excessed area will be formally transferred to the University of Utah.

Under the Base Closure Program, previous investigations of Fort Douglas, including an Enhanced Preliminary Assessment, conducted in 1989, and a Final Environmental Impact Statement, conducted in 1991, were used in the design of the EI/AA field program. The EI/AA integrates information from site visits, personnel interviews and previous studies.

The objective of this AA report is to identify and evaluate remedial alternatives for the excessed area of Fort Douglas. The preferred options for remediating the sites are identified in the Remedial Action Plan. The AA was prepared in general accordance with U.S. Environmental Protection Agency (USEPA) guidance documents for activities performed under CERCLA as amended by the Superfund Amendments and Reauthorization Act (SARA), the National Environmental Policy Act of 1969 (NEPA) (42 USC §§ 4321 *et seq.*) and its implementing regulations the President's Council on Environmental Quality regulations (40 Code of Federal Regulations (CFR) §§ 1500 *et seq.*). In addition, the procedures used in the study are consistent with the Department of Army policy toward integrating the NEPA and CERCLA process.

The AA is based on the nature and extent of chemicals in areas of potential environmental concern, the baseline risk assessment, and the analysis of applicable or relevant and appropriate requirements (ARARs). Contaminants that were detected during the EI investigation include 1) polychlorinated biphenyls (PCBs) contained in two pole-mounted electric utility transformers, 2) lead-based paint on exterior and interior building surfaces, 3) petroleum hydrocarbons, which include total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAHs), in the soil near the former wash rack/oil change/degreasing area, and 4) petroleum hydrocarbons and heavy metals near the southeast fence line area of Fort Douglas.

The risk assessment concluded that the cancer risk for levels of PAHs detected in the soils at Fort Douglas fall within or below the acceptable cancer risk range of 10^{-6} to 10^{-4} as determined by the USEPA in the National Oil and Hazardous Substances Contingency Plan (NCP). Risk estimates for noncancerous effects were also well within acceptable limits. Based on this quantitative evaluation, the concentrations of PAHs in the soils are considered to be protective of human health. In addition, the only metal determined to be a chemical of potential concern was lead, and its concentrations were well below USEPA health guidelines for soil. The remainder of the hydrocarbons that were detected by the TPH analysis, but were not evaluated in the risk assessment, are not known to be of concern to human health and the environment. The PCB-contaminated transformers were not evaluated in the risk assessment because 1) they are not considered environmental media, and 2) release of oil to the soil was not observed; therefore, typical area residents, workers, and visitors would not be exposed. A quantitative risk assessment was not performed for the buildings containing lead-based paint; however, the lead-based paint is regulated by the Lead-Based Paint Poisoning Prevention Act.

Two sites were selected for remedial action: 1) two pole-mounted electrical utility transformers that contain PCBs, and 2) residential buildings with lead-based paint.

The remedial actions for the lead-based paint sites were developed based on ARARs. The remedial actions for the PCB-contaminated transformer oil were based on protectiveness of human health and the environment with the disposal regulated by ARARs. General response actions were identified as No Action, Institutional Actions/Controls, Containment, Treatment, and Removal/Disposal. The response actions were assembled into remedial alternatives. Subsequently these alternatives were evaluated for nine criteria: overall protection of human health; compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility or volume; short-term effectiveness; implementability; cost; state acceptance; and community acceptance. This was followed by a comparative analysis performed to evaluate the remedial alternatives for each site.

Two PCB-contaminated transformers were found to contain oil which contained 200 ppm of PCBs. The TSCA regulations must be followed for disposal of PCBs and PCB-contaminated items with concentrations between 50 and 500 ppm. According to TSCA regulations, the transformers may remain in service; however, disposal of PCBs and PCB-contaminated items are regulated. The two PCB-contaminated transformers are still in service and are not a health risk to humans. However, because they are in poor condition, the preferred alternative is Removal, Disposal, and Replacement (Alternative 2). This alternative will ensure that no contaminated oil will reach the ground in the future.

Residential buildings were found to contain lead-based paint on exterior and interior surfaces. Defective lead-based paint surfaces need to be remediated as regulated by federal law (the Lead-Based Paint Poisoning Prevention Act). The preferred alternative is Lead-Based Paint Abatement (Alternative 2). This alternative will comply with ARARs and will be protective of human health and the environment by remediating the hazards associated with defective paint surfaces.

The State reviewed the draft final version of this report, and did not have comments related to the remedial alternatives.

1.0 INTRODUCTION

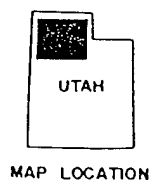
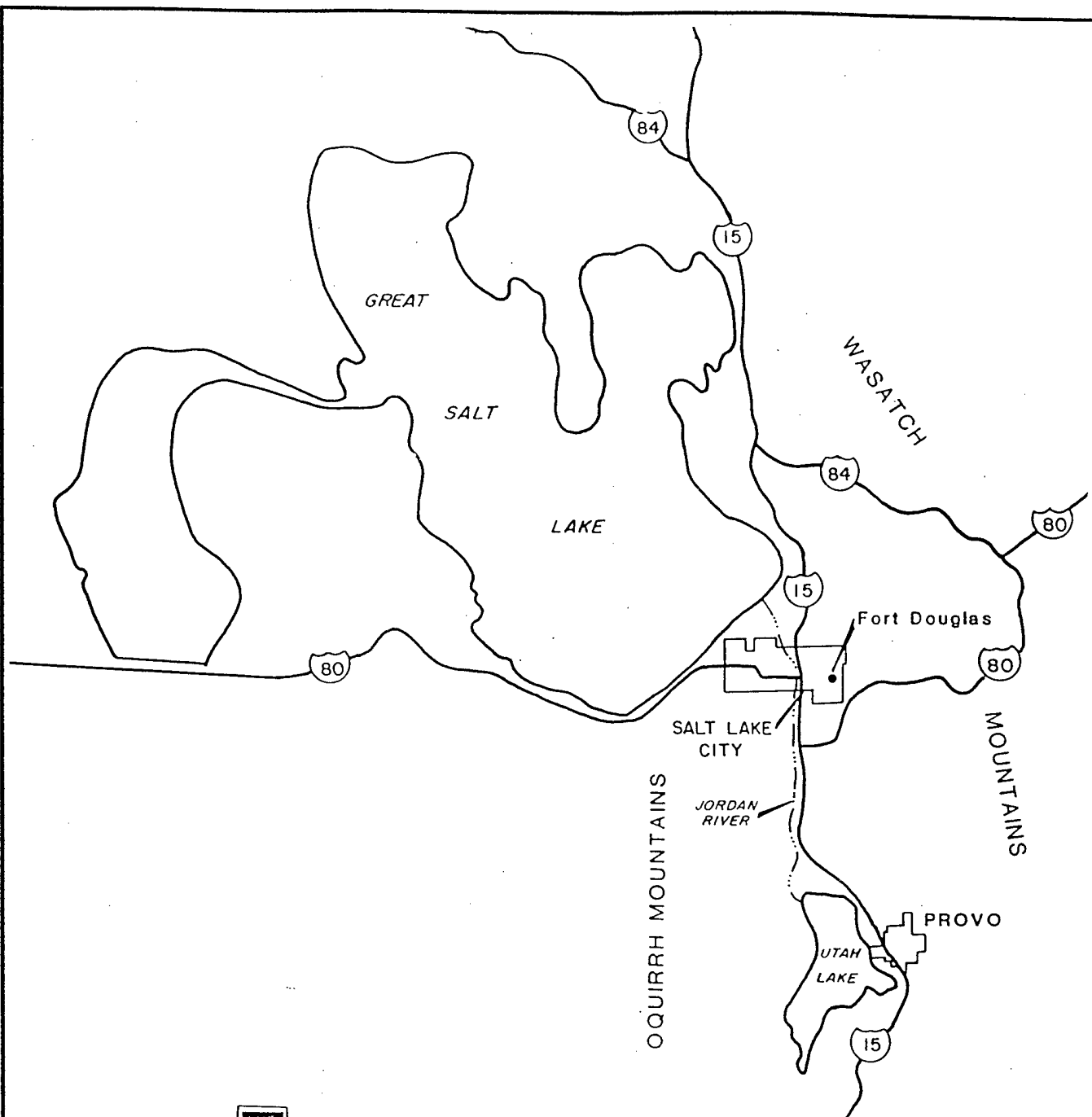
Fort Douglas, an Army installation located east of Salt Lake City, Utah, (Figure 1-1) was recommended for closure and realignment by the U.S. Secretary of Defense's Commission on Base Realignment and Closure in December 1988. The closure and realignment of Fort Douglas, a subinstallation of Fort Carson, Colorado, has resulted in the reassignment of its functions to other installations. Fort Carson has, and will continue to provide environmental support to Fort Douglas. Upon closure on November 5, 1991, 51 acres of the 119-acre Fort Douglas installation were conveyed to the University of Utah, however the title has not yet been transferred (Figure 1-2). This transferred property is known as the excessed area. The remaining acreage is retained by the federal government for use as a military Reserve Center for the 96th Army Reserve Command, and four acres will remain as the post cemetery.

In order to facilitate the closure of Fort Douglas, an Enhanced Preliminary Assessment (PA) and Final Environmental Impact Statement were completed. Based on the recommendations of the PA, an Environmental Investigation/Alternatives Analysis (EI/AA) program was conducted. This program is administered by the U.S. Army Environmental Center (USAEC) (formerly U.S. Army Toxic and Hazardous Materials Agency [USATHAMA]), which has the authority for centrally managing the environmental investigation portion of the Base Closure Program.

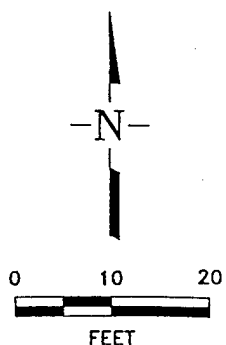
1.1 PURPOSE

The purpose of the Fort Douglas EI/AA is to identify potential environmental liabilities associated with the transfer of the excess property. The EI/AA was conducted by Watkins-Johnson Environmental (WJE) (formerly R.L. Stollar and Associates [RLSA]) in three phases: an environmental investigation (EI), a risk assessment, and an alternatives analysis (AA). The EI involved the collection, testing and assessment of environmental media on Fort Douglas to determine the nature and extent of areas of environmental concern. The risk assessment involved the characterization of risk to human health. The contamination assessment and risk assessment are contained in the EI report. The AA is presented in this report and involves the development and evaluation of applicable remedial strategies.

Under the same task, an asbestos evaluation was conducted by WJE prior to and independently of the EI/AA. An Asbestos Sampling Plan (RLSA, 1991a) was developed, and the results and risk assessment were presented in a separate document, the Asbestos Survey Results report (RLSA, 1991b). Based on



MAP LOCATION



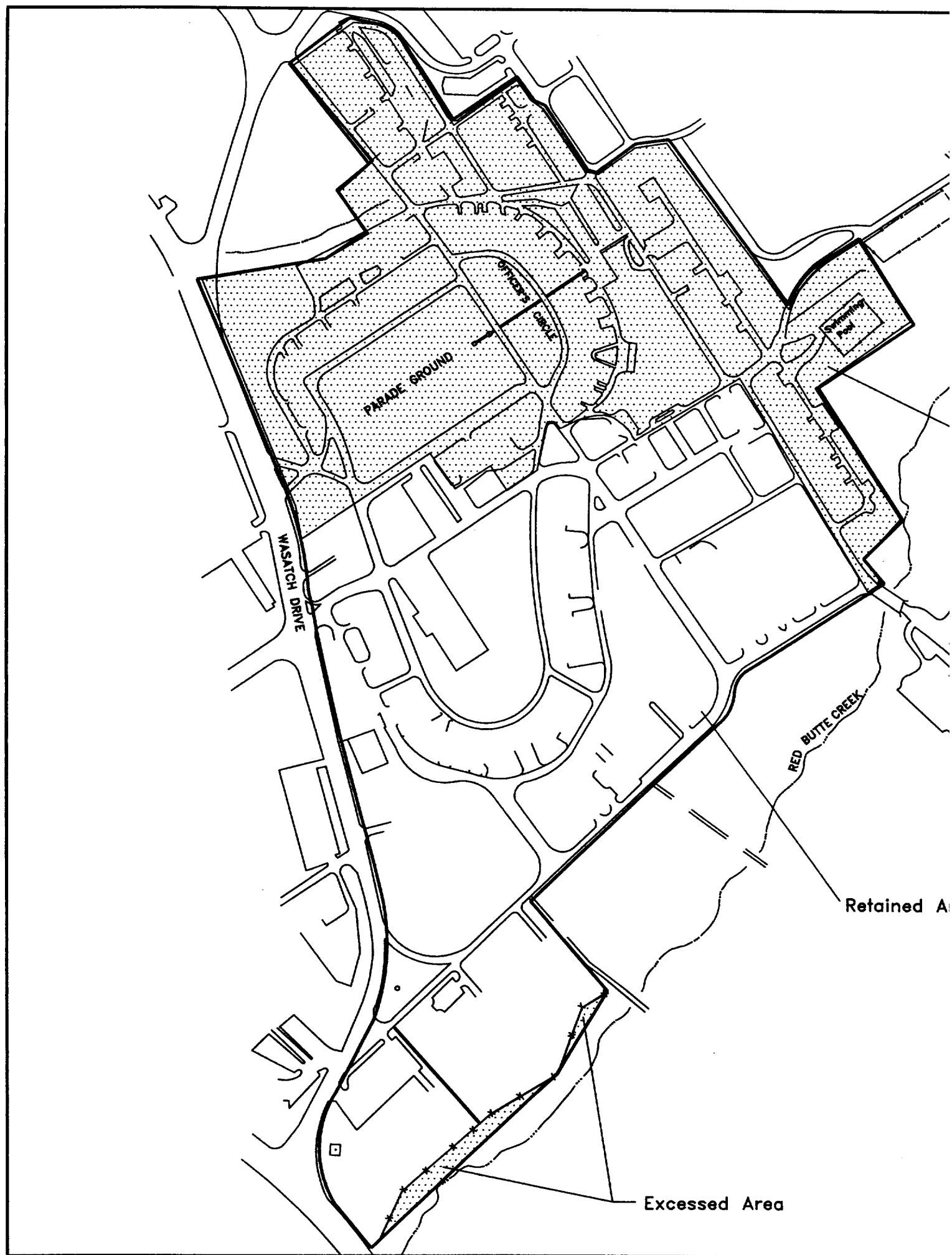
WATKINS-JOHNSON ENVIRONMENTAL, INC.
Groundwater Consulting, Environmental Engineering,
Remediation Services

FORT DOUGLAS LOCATION MAP

FTD35001\DV1

Date: March 1994

Figure 1-1

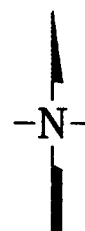
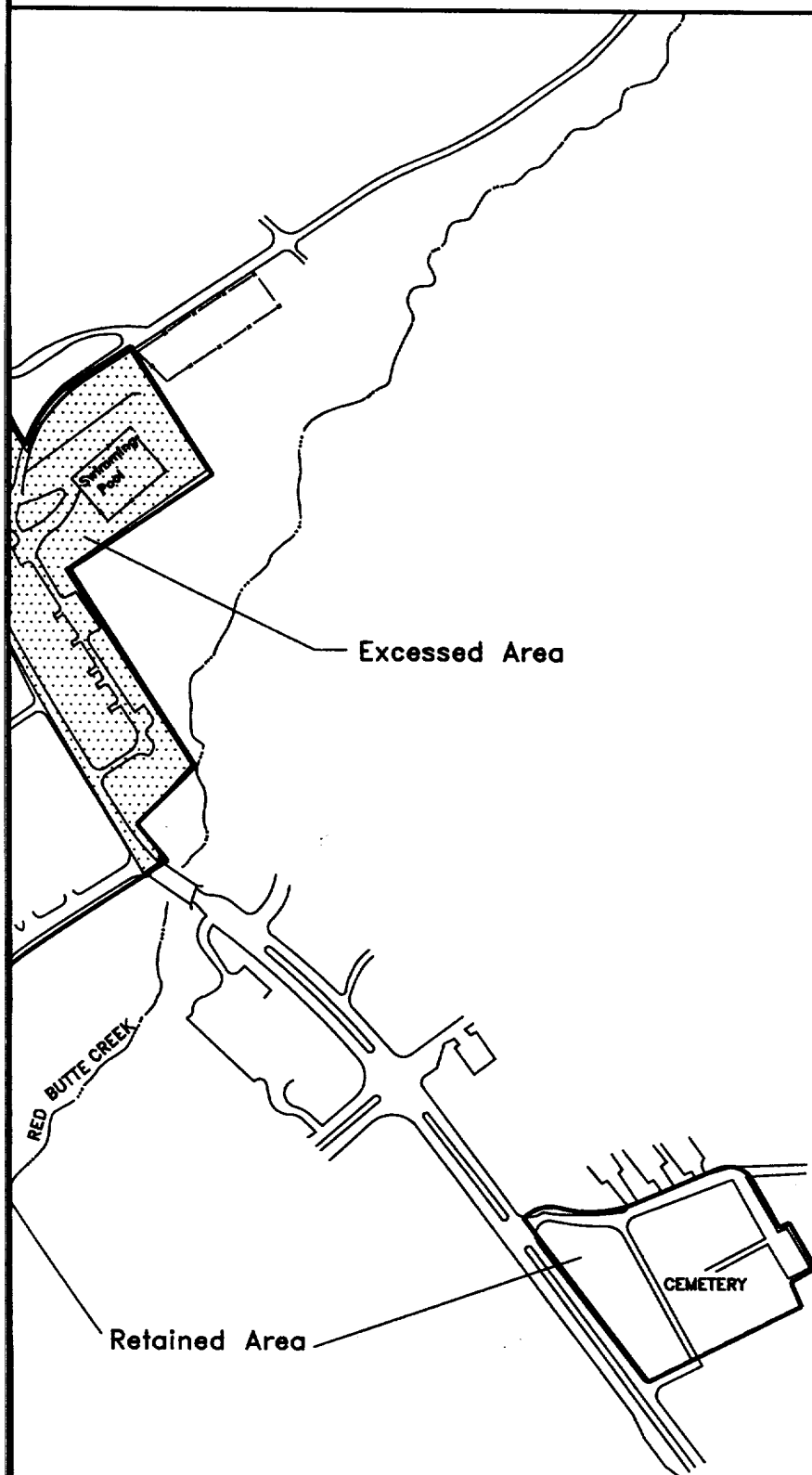


EXPLANATION

— Fort Douglas Boundary



Excessed Area



0 200 400
FEET



WATKINS-JOHNSON ENVIRONMENTAL, INC.
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Remediation Services

SITE PLAN FORT DOUGLAS

FTD35002\DV3

Date: March 1994

Figure 1-2

recommendations contained in the Asbestos Survey Results report, Fort Carson conducted remedial activities in some of the excessed structures. These remedial actions are described in Appendix C of the EI Report (WJE, 1994).

1.2 REPORT ORGANIZATION

Section 2.0 of this AA report contains a summary of the EI results for Fort Douglas. The section is organized by source area. Section 3.0 is a summary of the risk assessment. Federal, state, and local applicable or relevant and appropriate requirements (ARARs) are discussed in detail in Section 4.0. Section 5.0 presents the remedial action objectives for each group of sites. Section 5.1 presents the individual sites which have been selected for the AA based on the risk assessment results and the ARARs. The volumes of contaminated materials are estimated in Section 5.4. General response actions, which are defined as measures that will satisfy the remedial action objectives and cleanup goals, are discussed in Section 6.0. Section 7.0 presents the range of remedial alternatives for each site. Section 8.0 discusses the components of a detailed analysis and comparison of alternatives. The ranking of the remedial alternatives is presented in Section 9.0.

Each remedial alternative undergoes a detailed analysis and comparison with other alternatives in Appendix A.

1.3 SITE HISTORY

Fort Douglas was established as Camp Douglas on October 26, 1862, near Salt Lake City, Utah, primarily to guard the Overland Mail route and protect the lines of communication that linked the East and West Coasts. In addition, the presence of the camp served to quell any opposition to the federal government from the Mormon settlers. The camp was officially redesignated as Fort Douglas in 1878. In the first 50 years of the 20th century, Fort Douglas was used to garrison troops, house prisoners of war, and serve as headquarters for military units.

Original site boundaries included approximately 2,560 acres. Additional land acquisitions occurred primarily between 1867 and 1909 when Fort Douglas reached a maximum size of approximately 7,900 acres.

The first structures at Fort Douglas were hastily constructed primarily of logs or adobe. In the 1870s, most of the original structures were replaced with buildings constructed of locally quarried red sandstone. Many of these buildings remain intact today. Additional building programs were implemented primarily between 1904 and 1910, from 1928 through the 1930s, and in 1941.

In 1948, activities at Fort Douglas were curtailed to the point that the United States Government decided to turn over a large portion of Fort Douglas to the War Assets Administration. Since that time, Fort Douglas has been used as headquarters for Reserve and National Guard units and a support detachment for military activities in the region. Prior to closure of the post as an active duty fort on November 5, 1991, the acreage of Fort Douglas was approximately 119 acres. Excessed properties have been transferred primarily to other government agencies and the University of Utah. Currently, 68 acres, including the four-acre post cemetery, are retained by the federal government.

1.4 REGULATORY FRAMEWORK

The environmental investigations in support of the Fort Douglas closure are being managed by USAEC under the Base Closure Program. As required, the EI/AA is being conducted in general accordance with the requirements of the National Oil and Hazardous Substance Pollution Contingency Plan (NCP) and the National Environmental Policy Act of 1969 (NEPA) and is structured according to guidelines provided by the U.S. Environmental Protection Agency (USEPA) and USAEC. The AA was also prepared in accordance with the Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended in 1986 by the Superfund Amendments and Reauthorization Act (SARA) (USEPA, 1988a).

The closure and transferral of the property must be conducted in accordance with the provisions of Section 120(h), "Federal Facilities, Property Transferred by Federal Agencies" of CERCLA. This section stipulates that the transferral of federal properties depends on the evaluation of hazardous substances which are known or suspected to be present at the site. It also requires that all remedial action necessary to protect the environment and human health with respect to any such substance remaining on the property has been taken before the date of such transfer.

Two Acts signed into law by Congress and the President, Public Law (PL) 101-510 and PL 101-519, specify that all rights, titles, and interest in the excessed Fort Douglas property be conveyed to the University of Utah upon the closure of Fort Douglas. These acts also stipulated that the conveyance be made within one year of enactment, which was November 5, 1990. In accordance with these acts, the property was conveyed to the University of Utah. However, the EI/AA and potential environmental remediation work were not completed by the required November 5, 1991 transfer date. The memorandum of agreement between the Secretary of the Army, and the University of Utah, State of Utah, and the Utah State Historical Preservation Office states that the Army "...agrees to perform all remedial action and clean up the areas identified pursuant to the preliminary assessment (PA) and environmental investigation/alternatives analysis (EI/AA)."

2.0 ENVIRONMENTAL INVESTIGATION SUMMARY

Previous environmental investigations conducted at Fort Douglas indicated the presence of chemicals of potential concern (COCs) on the excessed area (ESE, 1983; Weston, 1988; Weston, 1989; Dames and Moore, 1991). The potential contaminants include hydrocarbons, degreasing solvents, polychlorinated biphenyls (PCBs), lead (in lead-based paint and/or gasoline), radon, and asbestos. Potential sources of these contaminants include underground storage tanks (USTs) and a wash rack/oil change/degreasing area in the Building 39 Area, waste storage and maintenance areas near the southeast fence line of Fort Douglas, transformers or drums in the University of Utah's storage yard adjacent to the northeast border of Fort Douglas, pole-mounted transformers throughout the excessed area, and buildings that may contain lead-based paint, radon, and asbestos.

As part of the EI, environmental sampling was conducted in two phases to assess the potential contaminants and sources. During the initial EI field program conducted in September and October 1991, soil borings were drilled, and soil samples were collected from the Building 39 Area, the Southeast Fence Line Area, downslope from the storage yard, and in a location expected to represent background soil concentrations. Surface soil samples were analyzed for total petroleum hydrocarbons (TPH) (USEPA Method 418.1; USEPA, 1983), metals, and cyanide. Subsurface soil samples also were analyzed for volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) by Gas Chromatography/Mass Spectrometry (GC/MS). Table 2-1 shows the target compound list. Oil samples were collected from the pole-mounted transformers and analyzed for PCBs, and paint chips and wipes were collected from the buildings and analyzed for lead.

In July 1992, the supplemental EI field program was conducted to collect additional soil data that could be used in assessing any health risk which may impact future residents of Fort Douglas. This program consisted of the collection of surface soil samples in the Building 39 Area, the Southeast Fence Line Area, and at locations expected to represent background soil concentrations. All samples were analyzed for TPH, SVOCs, and metals. The target compounds and analytical methods were the same as stipulated for the initial EI field program; however, samples were not analyzed for cyanide, because this compound was not detected in samples collected during the initial EI field program.

The EI Report for Fort Douglas (WJE, 1994) presents detailed discussions of the site background, quality assurance and quality control, field and laboratory procedures, nature and extent of contamination,

Table 2-1 Target Compound List

<u>Volatile Organic Compounds</u>		<u>Metals</u>
Acetone	Di-n-butylphthalate	Aluminum
Benzene	1,3-Dichlorobenzene	Antimony
Bromodichloromethane	1,4-Dichlorobenzene	Arsenic
Bromoform	1,2-Dichlorobenzene	Barium
Bromomethane	3,3-Dichlorobenzidine	Beryllium
2-Butanone	2,4-Dichlorophenol	Cadmium
Carbon disulfide	Diethylphthalate	Calcium
Carbon tetrachloride	2,4-Dimethylphenol	Chromium
Chlorobenzene	Dimethylphthalate	Cobalt
Chloroethane	4,6-Dinitro-2-methylphenol	Copper
Chloroform	2,4-Dinitrophenol	Iron
Chloromethane	2,4-Dinitrotoluene	Lead
1,1-Dichloroethane	2,6-Dinitrotoluene	Magnesium
1,2-Dichloroethane	Di-n-octylphthalate	Manganese
1,1-Dichloroethene	Fluoranthene	Mercury
1,2-Dichloroethene	Fluorene	Nickel
1,2-Dichloropropane	Hexachlorobenzene	Potassium
cis-1,3-Dichloropropene	Hexachlorobutadiene	Selenium
1,3-Dichloropropene	Hexachlorocyclopentadiene	Silver
Ethylbenzene	Hexachloroethane	Sodium
2-Hexanone	Indeno(1,2,3-cd)pyrene	Thallium
Methylene chloride	Isophorone	Vanadium
4-Methyl-2-pentanone	2-Methylnaphthalene	Zinc
Styrene	2-Methylphenol (o-cresol)	
1,1,2,2-Tetrachloroethane	4-Methylphenol (p-cresol)	
Tetrachloroethene	Naphthalene	<u>Cyanide</u>
Toluene	2-Nitroaniline	
1,1,1-Trichloroethane	3-Nitroaniline	
1,1,2-Trichloroethane	4-Nitroaniline	
Trichloroethene	Nitrobenzene	
Vinyl acetate	2-Nitrophenol	<u>Miscellaneous</u>
Vinyl chloride	4-Nitrophenol	Total Petroleum Hydrocarbons
Xylene	N-Nitroso-di-n-propylamine	(TPH)
	N-Nitrosodiphenylamine	
	Pentachlorophenol	
	Phenanthrene	
	Phenol	
<u>Semivolatile Organic Compounds</u>	Pyrene	
Acenaphthene	1,2,4-Trichlorobenzene	
Acenaphthylene	2,4,5-Trichlorophenol	
Anthracene	2,4,6-Trichlorophenol	
Benzo(a)anthracene		
Benzo(b)fluoranthene	<u>PCB</u>	
Benzo(k)fluoranthene	Aroclor-1016	
Benzo(g,h,i)perylene	Aroclor-1221	
Benzo(a)pyrene	Aroclor-1232	
Bis(2-chloroethoxy)methane	Aroclor-1242	
Bis(2-chloroethyl)ether	Aroclor-1248	
Bis(2-chloroisopropyl)ether	Aroclor-1254	
Bis(2-ethylhexyl)phthalate	Aroclor-1260	
4-Bromophenyl phenyl ether		
Butyl benzyl phthalate		
Carbazole		
4-Chloroaniline		
2-Chloronaphthalene		
4-Chloro-3-methylphenol		
2-Chlorophenol		
4-Chlorophenyl phenyl ether		
Chrysene		
Dibenz(a,h)anthracene		
Dibenzofuran		

Note: PCBs were analyzed only in transformer oil samples.

and assessment of contamination and risk to human health and the environment. The EI Report includes a discussion of the soil, transformer oil, wipe and paint chip data collected during the EI field programs, and of radon data, which were collected independently of the EI by Fort Carson. No risk assessment was conducted for the radon data as part of the EI, because Fort Carson conducted remedial activities in some of the structures and is conducting follow-up monitoring to assess the effects of the remediation. Prior to the EI, sampling was conducted by WJE for asbestos in the excessed structures on Fort Douglas. These data were presented and assessed in the Asbestos Survey Results Report (RLSA, 1991b), and, based on recommendations contained in the report, Fort Carson conducted corrective actions in some of the structures. These activities are summarized in Appendix C of the EI Report (WJE, 1994).

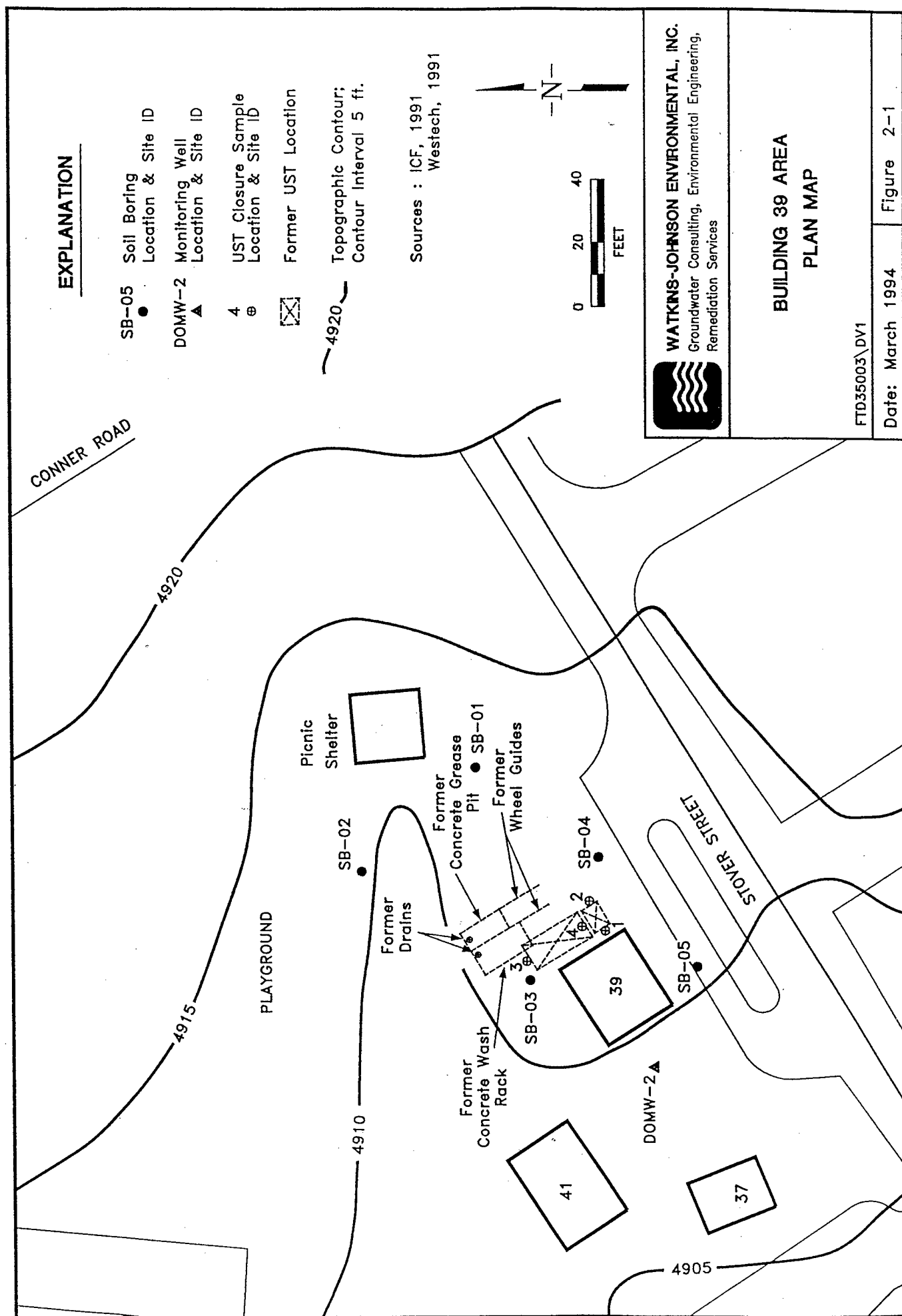
A summary of the EI data for soil, transformer oil, wipe, and paint chip samples, and assessment of the data is presented in the following subsections. A summary of asbestos and radon data are not included in this section, because remedial activities have already been conducted for these media.

2.1 BUILDING 39 AREA

The Building 39 Area (Figure 2-1) was historically used as a service station for vehicle refueling and maintenance. To support these operations, a 10,000-gallon UST was used to contain gasoline, and a 600-gallon UST possibly was used to contain oil or gasoline. A concrete vehicle wash rack and a concrete oil change/grease pit area were located northeast of the USTs. Drain holes were located on the north ends of the concrete areas. Additional information about the drainage is not available. No remnants of these operations are visible. The area is landscaped and picnic tables, benches, and a playground are nearby. Building 39 was built in 1876 and is located within the boundaries of a National Historic Landmark and is on the National Register of Historic Places.

2.1.1 PREVIOUS INVESTIGATIONS

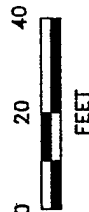
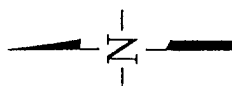
During a previous investigation conducted by ICF Technology Inc. (ICF), between September and December 1990, a soil gas survey was conducted, and 10 soil samples were collected from five borings in this area (SB-01 through SB-05; Figure 2-1). The borings were located in the vicinity of the USTs and the wash rack/oil change/degreasing area, based on results of the soil gas survey. The samples were analyzed for TPH and benzene, toluene, ethylbenzene, and xylenes (BTEX); no detectable concentrations



EXPLANATION

- SB-05 Soil Boring Location & Site ID
- DOMW-2 Monitoring Well Location & Site ID
- 4 UST Closure Sample Location & Site ID
- Former UST Location
- Topographic Contour; Contour Interval 5 ft.

Sources : ICF, 1991
Westech, 1991



WATKINS-JOHNSON ENVIRONMENTAL, INC.
Groundwater Consulting, Environmental Engineering,
Remediation Services

BUILDING 39 AREA PLAN MAP

FTD35003\DV1

Date: March 1994

Figure 2-1

were present in the soil samples. One monitoring well was installed (DOMW-2); however, it did not produce sufficient quantities of water to allow sample collection.

In August 1991, the tanks and associated piping were removed prior to the EI field work, in accordance with procedures required by the State of Utah Department of Health. The removal and associated sampling was conducted by Westech Fuel Equipment (Westech), a Utah state-certified tank handler, tank remover, and ground-water and soil sampler, under the supervision of Fort Carson. The large tank was free of holes and corrosion. Piping associated with the small tank indicated the tank may have been used for fuel. This tank, as stated in Westech's report, was corroded with several holes. There was no evidence of soil contamination near either tank (Westech, 1991). Closure samples in the UST area were taken from four locations (Site ID 1 through 4; Figure 2-1), and three composite samples of excavated fill were collected for analysis. All samples were analyzed for BTEX and TPH. No BTEX was detected. TPH was measured at a concentration of 80 micrograms per gram ($\mu\text{g/g}$) in a 6-point composite sample of excavated fill from the 600-gallon tank area; this excavated fill was disposed of at the Salt Lake County Landfill. No other TPH detections were reported. These analytical results indicate hydrocarbons were not released from the tanks.

2.1.2 EI PROGRAM

Potential leaks and spills from the USTs, associated piping, and the wash rack/oil change/degreasing area were investigated by drilling and sampling three soil borings in this area during the initial EI field program. Boring SB-29 was drilled to a depth of 29.5 feet below ground surface (ft bgs) to investigate the former USTs (Figure 2-2). Borings SB-28 and SB-31 were drilled to 15.2 and 3.2 ft bgs, respectively, to investigate the wash rack area. Pieces of black-stained concrete were recovered from boring SB-31. Due to the concrete, boring SB-31 could not be hand-augered deeper than 3.2 ft bgs. A drill rig could not be used at this location because of limited clearance under oak trees. During the supplemental EI field program, six surface soil samples (SS-03 through SS-08) were collected from the 0.0 to 0.5 ft interval below the sod in the vicinity of the wash rack/oil change/degreasing area (Figure 2-2).

TPH concentrations in the soil samples from boring SB-29, drilled to investigate potential releases from the USTs, did not exceed 100 $\mu\text{g/g}$ (Table 2-2). Organics that were detected in samples from this boring, phthalates and acetone, are common laboratory contaminants and are probably not related to

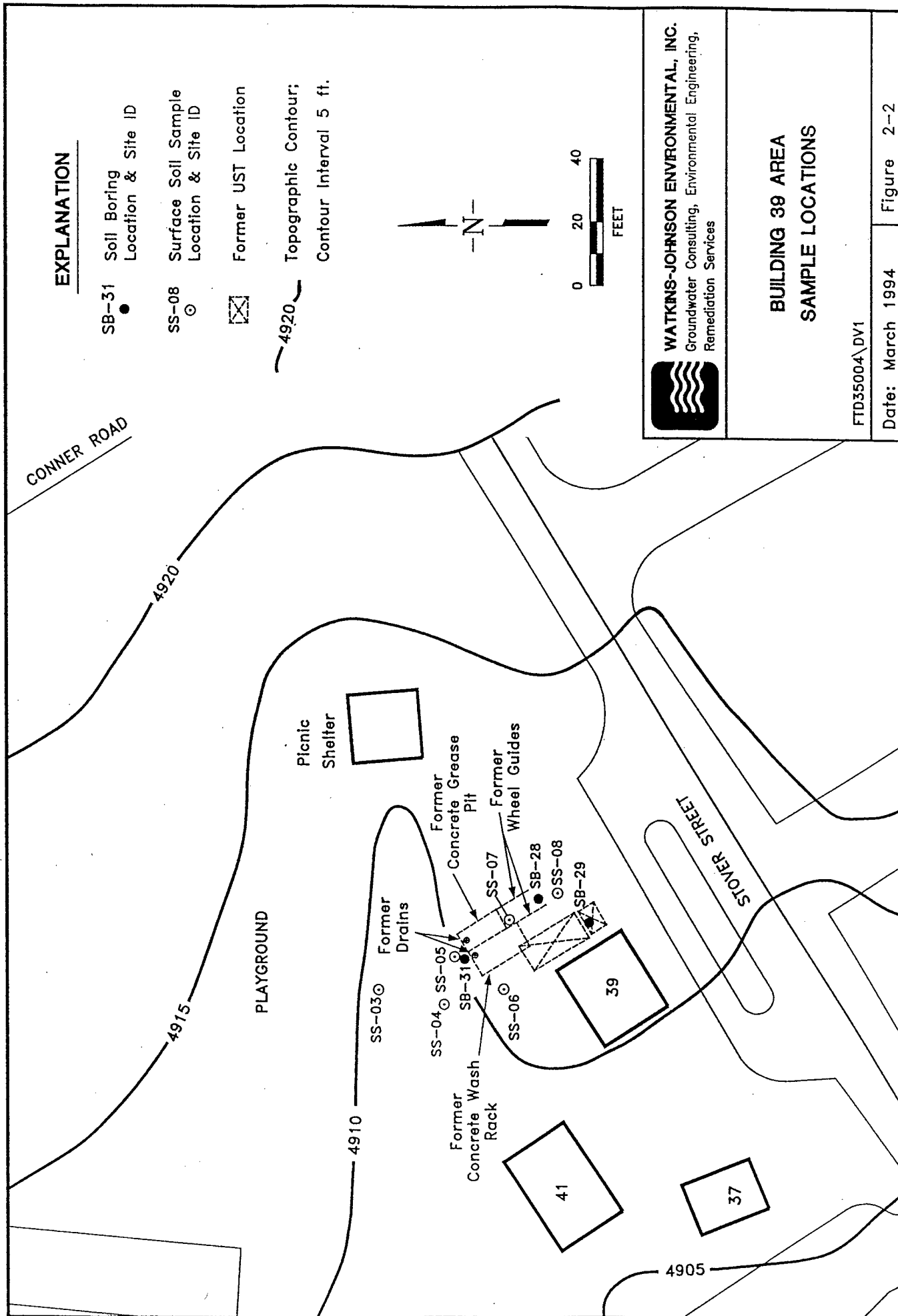


Table 2-2 Summary of Building 39 Area Soil Boring Sample Detections (Page 1 of 2)

Site ID	SB-28	SB-28	SB-29	SB-29	SB-29(D)	SB-29	SB-29	SB-31	SB-31
Sample Interval (ft)	0.0-0.5	0.5-5.0	9.7-9.9	14.0-18.7	14.0-18.7	19.0-21.1	24.0-26.6	0.0-0.5	0.5-3.2
Sample Date	10/01/91	10/01/91	10/02/91	10/02/91	10/02/91	10/02/91	10/02/91	10/08/91	10/08/91
ORGANICS (units in $\mu\text{g/g}$)									
Acenaphthene	NR	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	NR	0.057
Acetone	NR	<0.046	<0.046	0.051	<0.046	0.049	<0.046	NR	<0.046
Benzo(a)anthracene	NR	0.18	<0.033	<0.033	<0.033	<0.033	<0.033	NR	<0.033
Benzo(a)pyrene	NR	0.26	<0.033	<0.033	<0.033	<0.033	<0.033	NR	0.075
Benzo(b)fluoranthene	NR	0.14	<0.033	<0.033	<0.033	<0.033	<0.033	NR	<0.033
Benzo(k)fluoranthene	NR	0.22	<0.033	<0.033	<0.033	<0.033	<0.033	NR	<0.033
Bis(2-ethylhexyl) phthalate	NR	<0.39	<0.39	<0.39	<0.39	<0.39	0.68*	NR	<0.39
Dibenz(a,h)anthracene	NR	0.067	<0.033	<0.033	<0.033	<0.033	<0.033	NR	<0.033
Diethyl phthalate	NR	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19	NR	0.44*
Di-N-butyl phthalate	NR	3.5*	<0.92	2.4*	4.4	<0.92	2.1*	NR	<0.92
Fluoranthene	NR	0.35	<0.085	<0.085	<0.085	<0.085	<0.085	NR	0.16
Indeno[1,2,3-C,D] pyrene	NR	0.18	<0.033	<0.033	<0.033	<0.033	<0.033	NR	0.060
Phenanthrene	NR	0.091	<0.033	<0.033	<0.033	<0.033	<0.033	NR	0.14
Pyrene	NR	0.28	<0.033	<0.033	<0.033	<0.033	<0.033	NR	0.14
Total Petroleum Hydrocarbons	40	<10	70	100	<10	10	60	20	500 ¹

NR = not requested
 $\mu\text{g/g}$ = parts per million
 < = less than detection limit or certified reporting limit
 D = duplicate sample
 1 - dilution factor of 2
 2 - dilution factor of 200
 3 - dilution factor of 10
 4 - dilution factor of 100
 5 - dilution factor of 3
 * - also detected in the method blank for this lot and can be qualified as ubiquitous or a lab contaminant.

Table 2-2 Summary of Building 39 Area Soil Boring Sample Detections (Page 2 of 2)

Site ID	SB-28	SB-28	SB-29	SB-29(D)	SB-29	SB-29	SB-31	SB-31
Sample Interval (ft)	0.0-0.5	0.5-5.0	9.7-9.9	14.0-18.7	14.0-18.7	19.0-21.1	24.0-26.6	0.0-0.5
Sample Date	10/01/91	10/01/91	10/02/91	10/02/91	10/02/91	10/02/91	10/02/91	10/08/91
INORGANICS (units in µg/g)								
Aluminum	14,000 ²	15,000 ⁴	15,000 ²	16,000 ²	15,000 ²	14,000 ²	12,000 ⁴	16,000 ²
Arsenic	4.38	4.06	4.98	7.02	8.02	14 ¹	1.94	6.32
Barium	<190 ²	130 ⁴	<190 ²	<190 ²	<190 ²	<190 ²	<96 ⁴	<190 ²
Calcium	83,000 ²	49,000 ⁴	79,000 ²	85,000 ²	80,000 ²	86,000 ²	37,000 ⁴	100,000 ²
Iron	17,000 ²	18,000 ⁴	18,000 ²	21,000 ²	21,000 ²	20,000 ²	17,000 ⁴	20,000 ²
Lead	83 ³	14 ¹	19 ⁵	20 ⁶	13 ⁵	11.1	6.71	34 ³
Magnesium	12,000 ²	9,100 ⁴	16,000 ²	15,000 ²	16,000 ²	14,000 ²	13,000 ⁴	14,000 ²
Manganese	760 ²	680 ⁴	<400 ²	570 ²	<400 ²	<400 ²	400 ⁴	910 ²
Mercury	0.055	<0.027	<0.027	<0.027	<0.027	<0.027	<0.027	<0.027

NR = not requested
µg/g = parts per million
< = less than detection limit or certified reporting limit
D = duplicate sample
1 - dilution factor of 2
2 - dilution factor of 200
3 - dilution factor of 10
4 - dilution factor of 100
5 - dilution factor of 3
* - also detected in the method blank for this lot and can be qualified as ubiquitous or a lab contaminant.

contamination at the site. Metals were detected within or near levels measured in background soil samples (Table 2-3). This analytical data, and the results from the previous investigations of the UST area, indicate contaminants were not released from the USTs to environmental media.

At the wash rack/oil change/degreasing area, no elevated TPH concentrations were detected in the surface soil samples (0.0 to 0.5 ft bgs), but low concentrations (less than or equal to 0.12 $\mu\text{g/g}$) of polycyclic aromatic hydrocarbons (PAHs) were detected in two of these samples (SS-06 and SS-08) (Table 2-4). A TPH concentration of 500 $\mu\text{g/g}$ and low concentrations of several PAHs were detected in the 0.5 to 3.2 ft bgs sample from boring SB-31, which was drilled at the north end of the wash rack/oil change/degreasing area (Table 2-2). Phthalates were also detected in this boring; however, they are ubiquitous in soil, and are often laboratory derived. PAHs and phthalates also were detected in the 0.5 to 5.0 ft bgs sample from the boring drilled at the south end of the wash rack/oil change/degreasing area (SB-28). No TPH were detected in this sample. Metals were detected near the range of background concentrations in all soil boring and surface soil samples in this area.

The analytical results from the surface soil and soil boring samples indicate that releases from the wash rack/oil change/degreasing area to surface and subsurface soil have occurred. The detected PAHs typically are constituents of oil, gasoline, coal tar, coal, kerosene, diesel, and bitumen. Chromatogram fingerprints from GC/MS analysis indicate heavy oils, such as used motor oils or lubricants, are in the soil at the north and south ends of the area. The depth of hydrocarbons in the soil was not indicated by available data.

The migration potential is low for contaminants in the wash rack/oil change/degreasing area. The PAHs have low solubilities, and generally are immobile, persistent, and sorb to soil. Because the area is covered by sod, the primary potential migration pathway would be infiltration to ground water. However, the regional ground-water table is approximately 350 ft bgs; migration of contaminants to the regional aquifer is not likely. Four to six in. of perched ground water at approximately 25 ft bgs was measured in a nearby well (DOMW-2). The amount of water was insufficient to permit sample collection; migration of contaminants via these perched zones does not appear to be significant.

In addition, the distribution of the hydrocarbons is confined to a small area, as indicated by soil sample results from the EI and previous investigations. These factors support the conclusion that the migration of contaminants has not been extensive.

Table 2-3 Summary of Background Soil Detections (Page 1 of 2)

Site ID	BKG-SB-01	BKG-SB-01	BKG-SB-01	BKG-SB-01	BKG-SS-01	BKG-SS-02	BKG-SS-03	BKG-SS-04	Range of Concentrations	Highest Detected Concentration
Sample Interval (ft)	0.0-0.5	9.0-13.6	19.0-21.8	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5		
Sample Date	10/02/91	10/02/91	10/02/91	7/15/92	7/16/92	7/16/92	7/16/92	7/16/92		
Lithology	Silt with sand and clay (topsoil)	Clay	Gravelly clay with sand	Silt (topsoil)	Silt with gravel	Silt with gravel	Silt with gravel	Silt with sand and gravel		
ORGANICS (units in µg/g)										
Diethyl phthalate	NR	NR	0.69*	<0.19	<0.19	<0.19	<0.19	<0.19	<0.19-0.69	0.69
Di-N-butyl phthalate	NR	NR	2.0*	<0.92	<0.92	<0.92	<0.92	<0.92	<0.92-2.0	2.0
Pyrene	NR	NR	<0.033	0.042	<0.033	<0.033	<0.033	<0.033	<0.033-0.042	0.042
Total Petroleum Hydrocarbons	NR	NR	NR	20	20	20	<10	90	<10-90	90
INORGANICS (units in µg/g)										
Aluminum	10,000 ¹	14,000 ²	10,000 ³	21,000 ⁵	9,300 ⁶	8,300 ⁵	6,900 ⁵	6,900 ⁵	6,900-21,000	21,000
Arsenic	4.54	7.69	3.18	4.71	4.92	5.10	6.12	6.12	3.18-7.69	7.69
Barium	91 ¹	<96 ²	<190 ³	146	118	135	109	109	91-146	146
Beryllium	<25 ¹	<50 ²	<100 ³	1.73	0.914	0.927	0.910	0.910	0.910-1.73	1.73
Cadmium	<26 ¹	<52 ²	<100 ³	1.93	0.848	0.732	0.730	0.730	0.730-1.93	1.93
Calcium	14,000 ¹	81,000 ³	71,000 ³	25,000 ⁵	40,000 ⁴	62,000 ⁷	94,000 ⁷	94,000 ⁷	14,000-94,000	94,000
Chromium	<33 ¹	<67 ²	<130 ³	48.1	21.9	24.1	28.4	28.4	21.9-48.1	48.1
Cobalt	<33 ¹	<67 ²	<130 ³	22.3	14.1	13.6	11.3	11.3	11.3-22.3	22.3
Copper	<47 ¹	<94 ²	<190 ³	39.6	22.8	24.7	32.0	32.0	22.8-39.6	39.6
Iron	12,000 ¹	15,000 ²	12,000 ³	21,000 ⁵	11,000 ⁶	11,000 ⁶	8,500 ⁶	8,500 ⁶	8,500-21,000	21,000
Lead	82 ⁴	11.1	4.21	14 ⁵	25 ⁴	14 ⁵	73 ⁴	73 ⁴	4.21-82	82
Magnesium	5,300 ¹	14,000 ²	15,000 ³	7,400 ⁵	7,400 ⁶	8,800 ⁶	6,900 ⁶	6,900 ⁶	5,300-15,000	15,000

µg/g = parts per million

NR = not requested

< = less than certified reporting limit

1 = or detection limit

2 = dilution factor of 50

3 = dilution factor of 100

4 = dilution factor of 200

4 = dilution factor of 10

5 = dilution factor of 5

6 = dilution factor of 2

7 = dilution factor of 20

* = also detected in the method blank for this lot and can be qualified as ubiquitous or a lab contaminant.

Table 2-3 Summary of Background Soil Detections (Page 2 of 2)

Site ID	BKG-SB-01	BKG-SB-01	BKG-SB-01	BKG-SB-01	BKG-SB-01	BKG-SS-01	BKG-SS-02	BKG-SS-03	BKG-SS-04	Range of Concentrations	Highest Detected Concentration
Sample Interval (ft)	0.0-0.5	9.0-13.6	19.0-21.8	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5		
Sample Date	10/02/91	10/02/91	10/02/91	10/02/91	10/02/91	10/02/91	10/02/91	10/02/91	10/02/91		
Lithology	Silt with sand and clay (topsoil)	Clay	Gravelly clay with sand	Silt (topsoil)	Silt with gravel	Silt with gravel	Silt with gravel	Silt with gravel	Silt with sand and gravel		
Manganese	470 ¹	390 ²	900 ³	702	516	443	408			390-900	900
Mercury	<0.027	<0.027	<0.027	0.052	<0.027	<0.027	<0.027	<0.027	<0.027	<0.027-0.052	0.052
Nickel	<77 ¹	<150 ²	<310 ³	25.4	17.2	16.8	12.9			12.9-25.4	25.4
Potassium	<6,000 ¹	<12,000 ²	<24,000 ³	5,040	2,440	1,870	1,830			1,830-5,040	5,040
Silver	<26 ¹	<52 ²	<100 ³	0.875	<0.521	0.746	1.26			<0.521-1.26	1.26
Sodium	<2,200 ¹	<4,500 ²	<9,000 ³	370	147	102	<44.8			<44.8-370	370
Thallium	<740 ¹	<1,500 ²	<2,900 ³	84.9	43.7	42.3	37.7			37.7-84.9	84.9
Vanadium	<89 ¹	<180 ²	<350 ³	33.6	18.2	19.5	15.4			15.4-33.6	33.6
Zinc	<97 ¹	<190 ²	<390 ³	87.9	55.8	46.8	147			46.8-147	147

¹ $\mu\text{g/g}$ = parts per million
² NR = not requested
³ < = less than certified reporting limit
⁴ or detection limit
⁵ 1 - dilution factor of 50
⁶ 2 - dilution factor of 100
⁷ 3 - dilution factor of 200
⁸ 4 - dilution factor of 10
⁹ 5 - dilution factor of 5
¹⁰ 6 - dilution factor of 2
¹¹ 7 - dilution factor of 20
¹² * - also detected in the method blank for this lot and can be qualified as ubiquitous or a lab contaminant.

Table 2-4 Summary of Building 39 Area Surface Soil Sample Detections

Site ID	SS-03	SS-04	SS-04(D)	SS-05	SS-06	SS-07	SS-08
Sample Interval (ft)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
Sample Date	7/15/92	7/15/92	7/15/92	7/15/92	7/15/92	7/15/92	7/15/92
ORGANICS (units in $\mu\text{g/g}$)							
Benzo(a)anthracene	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	0.055
Benzo(a)pyrene	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	0.076
Benzo(b)fluoranthene	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	0.067
Benzo(k)fluoranthene	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	0.11
Phenanthrene	<0.033	<0.033	<0.033	<0.033	<0.033	<0.033	0.051
Pyrene	<0.033	<0.033	<0.033	<0.033	0.041	<0.033	0.12
Total Petroleum Hydrocarbons	<10	<10	<10	<10	<10	30	50
INORGANICS (units in $\mu\text{g/g}$)							
Aluminum	12,000 ¹	17,000 ¹	13,000 ¹	16,000 ¹	13,000 ¹	15,000 ¹	9,300 ⁵
Arsenic	4.13	3.90	4.13	6.00	5.35	5.67	4.82
Barium	145	139	152	170	103	167	83.2
Beryllium	1.03	1.43	1.12	1.30	1.03	1.10	1.06
Cadmium	1.27	1.49	1.30	1.03	1.20	1.15	0.949
Calcium	110,000 ²	59,000 ³	71,000 ²	92,000 ²	77,000 ²	100,000 ²	>50,000 ³
Chromium	36.6	35.7	31.2	36.1	33.7	37.0	26.9
Cobalt	16.5	20.9	18.1	21.0	17.4	20.6	13.6
Copper	25.9	30.8	33.1	23.3	25.6	26.7	27.0
Iron	15,000 ¹	21,000 ³	15,000 ¹	19,000 ¹	16,000 ¹	20,000 ¹	12,000 ⁵
Lead	36 ³	53 ³	54 ³	19 ⁴	40 ³	34 ³	52 ³
Magnesium	8,100 ¹	9,600 ¹	8,300 ¹	9,500 ¹	25,000 ²	10,000 ¹	9,600 ⁵
Manganese	571	665	667	860	514	769	380
Mercury	<0.027	0.044	0.040	<0.027	0.062	<0.027	0.047
Nickel	19.0	23.2	21.7	23.7	24.9	23.0	16.6
Potassium	3,060	4,620	3,250	4,370	3,760	3,540	2,190
Silver	1.72	0.843	0.835	1.62	1.25	1.52	1.23
Sodium	<44.8	200	183	<44.8	83.2	<44.8	113
Thallium	76.4	79.3	62.5	86.9	64.8	85.3	59.6
Vanadium	23.1	29.1	23.0	25.7	23.7	26.8	19.4
Zinc	72.9	89.7	88.2	70.0	74.2	81.8	84.1

$\mu\text{g/g}$ = parts per million
 < = less than detection limit or certified reporting limit
 D = duplicate sample
¹ - dilution factor of 3
² - dilution factor of 20
³ - dilution factor of 10
⁴ - dilution factor of 5
⁵ - dilution factor of 2

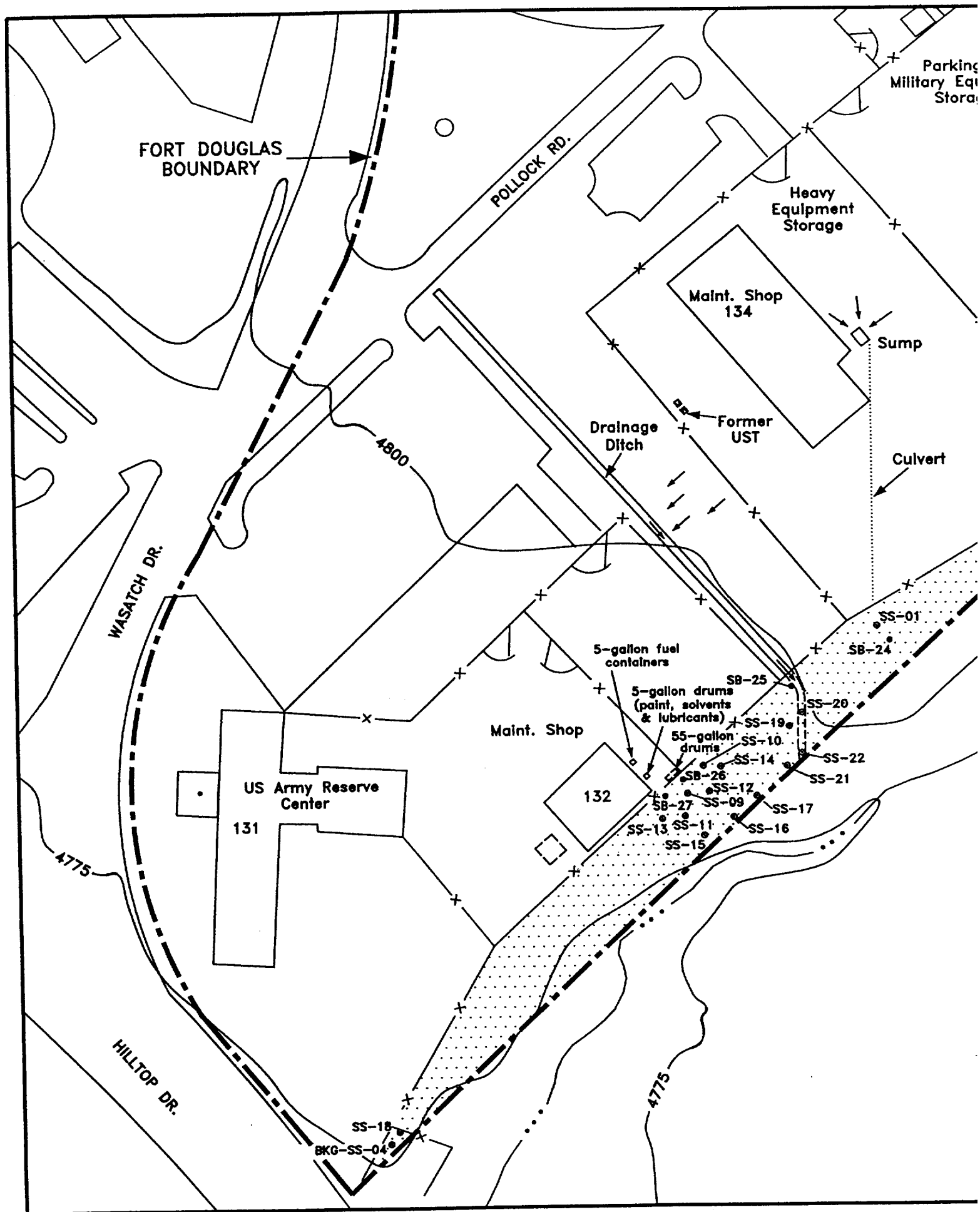
2.2 SOUTHEAST FENCE LINE AREA

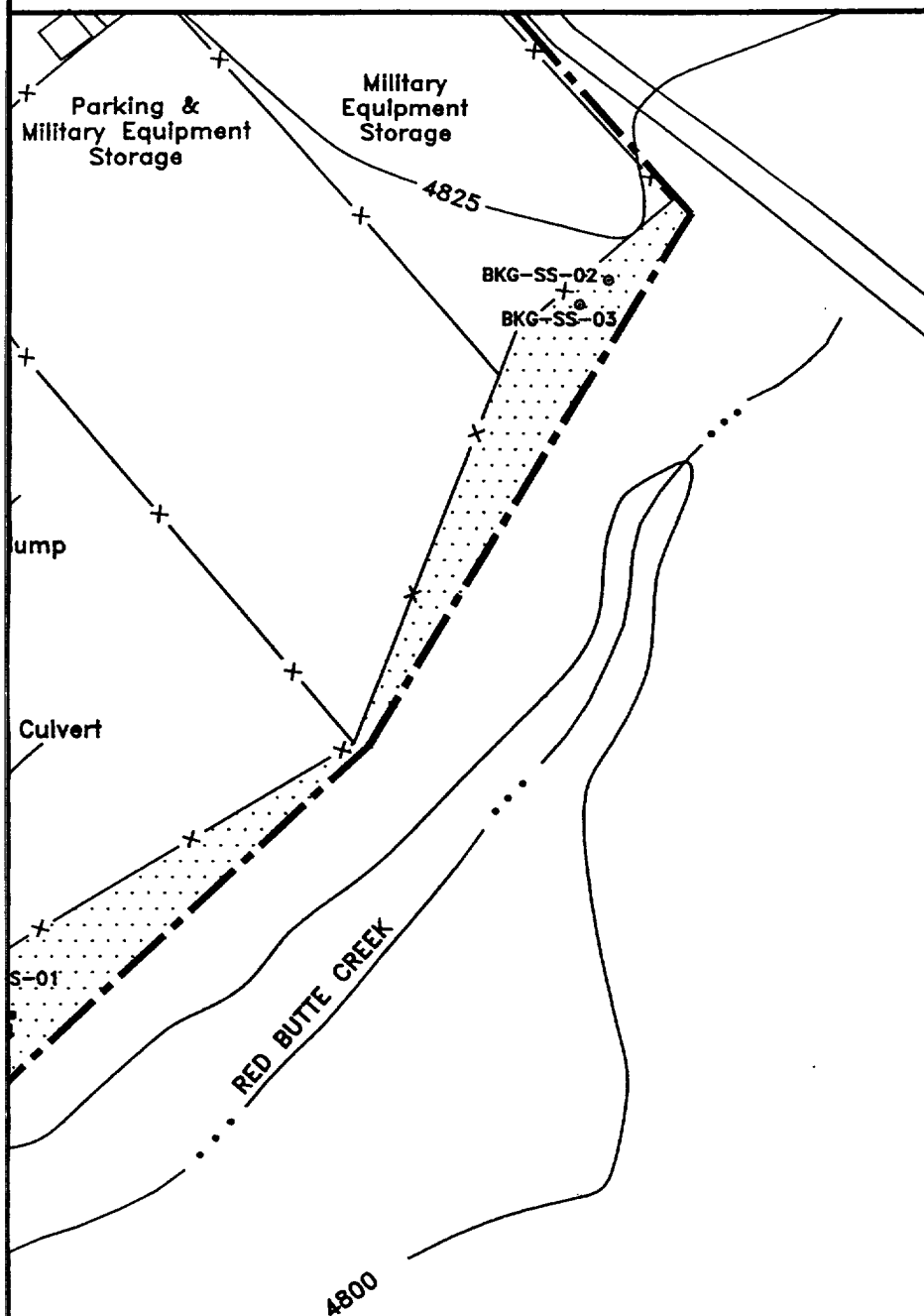
Several maintenance areas and hydrocarbon storage areas are located near the Southeast Fence Line Area of Fort Douglas (Figure 2-3). During a site visit and interviews in June 1991, activities in the retained area were described as maintenance of heavy and light equipment, and storage of heavy equipment and drums. Some of the drums were labeled as fuels, solvents, lubricants, and paints. A site assessment conducted in 1988 identified four waste site locations (on the retained area) that were within 300 ft of the excessed area. These locations included fresh oil storage, a wash rack, and a storage area for contaminated waste oil, antifreeze, and JP-4 (jet fuel). The Supplemental EI Field Program found that portions of the Southeast Fence Line Area were used for disposal of debris (including coal, ceramics, bottles, animal bones, and rifle casings, as found during the supplemental EI field program). The disposal apparently occurred prior to the use of this area for maintenance and storage. The disposal of debris was not mentioned in previous reports or interviews. According to Jess McCall, curator of the Fort Douglas Military Museum, Fort Douglas post trash was dumped near Red Butte Creek until approximately 1940. Potential releases from all of these sites that could impact the excessed area are summarized in the following sections.

2.2.1 BUILDING 132 DRUM AND FUEL STORAGE AREA

An area historically identified as fresh oil storage is adjacent to Building 132 and the excessed area. Four drums, several 5-gallon buckets (two of which were identified as methanol and lube oil enamel), a plastic container possibly containing oil, a battery, and several 5-gallon fuel containers were observed on the pavement in this area during the initial EI field program. Two surface stains were noted in the vicinity. Three used oil filters were noted on the excessed area. No previous investigations were conducted in this area prior to the EI.

During the initial EI field program, two borings (SB-26 and SB-27) were hand augered to a depth of 3.4 ft bgs (Figure 2-3). Synthetic materials, including pieces of brick, ceramic, coal, cast-iron pipe, and masonry were present in the soil samples, indicating this area may have been used for disposal of post waste. Surface soil samples (0.0 to 0.5 ft bgs) and composite, subsurface soil samples (0.5 to 3.4 ft bgs from SB-26, 0.5 to 3.0 ft bgs from SB-27) were collected for analysis. During the supplemental EI field program, nine surface soil samples (SS-09 through SS-17) were collected along the fence line. Two used oil filters were observed on the ground surface near sample location SS-12.





EXPLANATION

SB-27 • Soil Boring Location & Site ID

SS-22 • Surface Sample Location & Site ID

↙ Surface Runoff Flow Direction

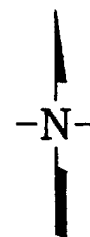
x-x Fence

—4800— Topographic Contour; Contour Interval 25 ft.

Excessed Area

Concrete Drainage Ditch, dashed where approximately located

BKG Background Sample ID



0 50 100
FEET



WATKINS-JOHNSON ENVIRONMENTAL, INC.
Groundwater Consulting, Environmental Engineering,
Remediation Services

SOUTHEAST FENCE LINE AREA SAMPLE LOCATIONS

FTD35005\DV2

Date: March 1994

Figure 2-3

TPH concentrations in the samples ranged from 20 to 6,000 $\mu\text{g/g}$ (Tables 2-5 and 2-6). Several PAHs were detected at low concentrations (less than 0.3 $\mu\text{g/g}$). The PAHs are similar to those detected in the Building 39 Area, as typical constituents of gasoline, oil, coal tar, coal, lubricants, kerosene, diesel, and bitumen. Phthalates were also detected; however, they are ubiquitous in soil, and are often laboratory derived. Metals detected at concentrations higher than two times the levels measured in the background soil samples include zinc (410 to 1,100 $\mu\text{g/g}$), lead (290 to 320 $\mu\text{g/g}$), and mercury (0.142 to 0.285 $\mu\text{g/g}$). Chromium also was detected above background at a concentration of 150 $\mu\text{g/g}$ in the surface soil sample from SB-27, and silver was detected above background (14.0 $\mu\text{g/g}$) in surface soil sample SS-14. Chromatogram fingerprints from GC/MS analysis of these samples indicate that hydrocarbons released to the soils primarily were heavy oils. However, soil from SB-26 also showed an additional peak that is indicative of a slightly lighter weight oil generated by hydrocarbons. The hydrocarbons and metals may have been transported by surface water from spills or leaks from storage containers in the adjoining storage areas, and/or may have been released to the soils from the synthetic materials or oil associated with the oil filters. Samples deeper than 3.4 ft bgs were not collected due to auger refusal; hydrocarbons were detected in the deepest sampled intervals.

The PAHs and metals have low solubilities, and generally are immobile, persistent, and sorbed to soil. Contaminated surface soil could be carried as suspended sediment in surface water runoff, and discharged off site into Red Butte Creek. This creek is not used for human consumption; swimming is not permitted, however, this is not strictly controlled. Additional potential pathways include direct contact with the soil by humans, and air and biota pathways. Air transport of contaminants sorbed to surface soil is expected to be of minor significance because of the natural vegetation and the absence of vehicular traffic. Little migration from subsurface soil is expected to occur because of the low solubilities of the PAHs and metals. In addition, as discussed in Section 2.1.2, the regional ground water table is deep, approximately 350 ft bgs, and only limited amounts of shallow perched ground water have been measured in monitoring wells. Migration to Red Butte Creek via discharge of perched groundwater (seeps) is not likely. Red Butte Creek generally is considered a losing stream in this stretch, recharging ground water.

2.2.2 BUILDING 134 DRAINAGE DITCH

Southwest of Building 134 in the retained area, a 1,000-gallon UST was formerly used for the temporary storage of waste oil and possibly solvents (Figure 2-3). The 1988 site assessment also identified fresh oil storage and a storage area for waste oil, antifreeze, and JP-4 (jet fuel). The tank was taken out of

Table 2-5 Summary of Southeast Fence Line Area Soil Boring Sample Detections (Page 1 of 2)

Site ID	SB-24	SB-24	SB-25	SB-25	SB-26	SB-26	SB-27	SB-27
Sample Interval (ft)	0.0-0.5	0.5-1.0	0.0-0.5	0.5-4.0	0.0-0.5	0.5-3.4	0.0-0.5	0.5-3.0
Sample Date	10/03/91	10/03/91	10/03/91	10/03/91	10/07/91	10/07/91	10/07/91	10/07/91
ORGANICS (units in µg/g)								
1-Methylnaphthalene**	NR	<0.033	NR	<0.033	NR	0.055	NR	<0.033
Benzo(a)anthracene	NR	<0.033	NR	<0.033	NR	<0.033	NR	0.15
Benzo(a)pyrene	NR	<0.033	NR	<0.033	NR	0.044	NR	0.19
Benzo(b)fluoranthene	NR	<0.033	NR	<0.033	NR	0.076	NR	0.25
Butylbenzyl phthalate	NR	<0.033	NR	<0.033	NR	<0.033	NR	0.27
Benzo(k)fluoranthene	NR	<0.033	NR	<0.033	NR	<0.033	NR	0.049
Diethyl phthalate	NR	<0.19	NR	<0.19	NR	<0.19	NR	0.34*
Di-N-butyl phthalate	NR	2.6	NR	1.9	NR	1.5*	NR	1.7*
Fluoranthene	NR	<0.085	NR	<0.085	NR	<0.085	NR	0.22
Indeno[1,2,3-C,D] pyrene	NR	<0.033	NR	<0.033	NR	<0.033	NR	0.097
Methylene chloride	NR	<0.040	NR	<0.040	NR	0.075*	NR	<0.040
Naphthalene	NR	<0.033	NR	<0.033	NR	0.053	NR	0.041
Phenanthrene	NR	<0.033	NR	<0.033	NR	0.050	NR	0.040
Pyrene	NR	<0.033	NR	<0.033	NR	0.045	NR	0.25
Total Petroleum Hydrocarbons	30	20	600 ¹	20	6,000 ²	1,000 ³	900 ²	700 ²

µg/g = parts per million
NR = not requested
< = less than certified reporting limit or detection limit
* = also detected in the method blank for this lot and can be qualified as ubiquitous or a lab contaminant.
** = not a target compound, but is an isomer of target compound 2-methylnaphthalene, which was not analyzed.

¹ - dilution factor of 2
² - dilution factor of 20
³ - dilution factor of 10
⁴ - dilution factor of 200

⁵ - dilution factor of 400
⁶ - dilution factor of 4
⁷ - dilution factor of 100
⁸ - dilution factor of 50

Table 2-5 Summary of Southeast Fence Line Area Soil Boring Sample Detections (Page 2 of 2)

Site ID	SB-24	SB-24	SB-25	SB-25	SB-26	SB-26	SB-27	SB-27
Sample Interval (ft)	0.0-0.5	0.5-1.0	0.0-0.5	0.5-4.0	0.0-0.5	0.5-3.4	0.0-0.5	0.5-3.0
Sample Date	10/03/91	10/03/91	10/03/91	10/03/91	10/07/91	10/07/91	10/07/91	10/07/91
INORGANICS (units in $\mu\text{g/g}$)								
Aluminum	7,600 ⁴	5,000 ⁴	8,600 ⁷	8,900 ⁷	9,600 ⁷	12,000 ⁷	11,000 ⁷	12,000 ⁷
Arsenic	4.60	4.03	3.93	4.02	7.19	5.14	11.6	6.36
Barium	<190 ⁴	<190 ⁴	110 ⁷	<96 ⁷	140 ⁷	160 ⁷	150 ⁷	<96 ⁷
Calcium	150,000 ⁴	130,000 ⁵	63,000 ⁴	47,000 ⁷	44,000 ⁷	45,000 ⁷	62,000 ⁴	40,000 ⁷
Chromium	<130 ⁴	<130 ⁴	<67 ⁷	<67 ⁷	<67 ⁷	<67 ⁷	150 ⁷	<67 ⁷
Iron	12,000 ⁴	8,400 ⁴	12,000 ⁷	12,000 ⁷	14,000 ⁷	21,000 ⁷	20,000 ⁷	15,000 ⁷
Lead	34 ⁵	5.55	42 ³	15 ⁶	290 ⁷	120 ³	320 ³	68 ³
Magnesium	<7,400 ⁴	9,800 ⁴	8,200 ⁷	9,900 ⁷	7,800 ⁷	7,300 ⁷	12,000 ⁷	7,300 ⁷
Manganese	<400 ⁴	<400 ⁴	380 ⁷	330 ⁷	450 ⁷	660 ⁷	500 ⁷	520 ⁷
Mercury	<0.027	<0.027	0.038	<0.027	0.034	0.151	0.036	0.200
Zinc	<390 ⁴	<390 ⁴	<190 ⁷	<190 ⁷	410 ⁷	780 ⁷	1,100 ⁷	<190 ⁷

$\mu\text{g/g}$
 NR = parts per million
 < = not requested
 * = less than certified reporting limit or detection limit
 ** = also detected in the method blank for this lot and can be qualified as ubiquitous or a lab contaminant.
 - not a target compound, but is an isomer of target compound 2-methylnaphthalene, which was not analyzed.
 1 - dilution factor of 2
 2 - dilution factor of 20
 3 - dilution factor of 10
 4 - dilution factor of 200
 5 - dilution factor of 400
 6 - dilution factor of 4
 7 - dilution factor of 100
 8 - dilution factor of 50

Table 2-6 Summary of Southeast Fence Line Area Surface Soil Sample Detections (Page 1 of 4)

Site ID	SS-01	SS-09	SS-10	SS-11	SS-12	SS-12(D)	SS-13	SS-14
Sample Interval (ft)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
Sample Date	10/04/91	7/15/92	7/15/92	7/15/92	7/15/92	7/15/92	7/15/92	7/15/92
ORGANICS (units in µg/g)								
2-Methylnaphthalene	NR	0.090	<0.033	0.049	0.076	0.073	<0.033	0.14
Benzo(a)anthracene	NR	<0.033	<0.033	<0.033	<0.2 ⁴	<0.2 ⁴	<0.033	0.057
Benzo(a)pyrene	NR	<0.033	<0.033	<0.033	<0.2 ⁴	<0.2 ⁴	<0.033	0.054
Benzo(b)fluoranthene	NR	<0.033	<0.033	<0.033	<0.2 ⁴	<0.2 ⁴	<0.033	<0.033
Bis(2-ethylhexyl)phthalate	NR	<0.39	<0.39	<0.39	<2 ⁴	<2 ⁴	0.58	<0.39
Benzo(k)fluoranthene	NR	<0.033	<0.033	<0.033	<0.2 ⁴	<0.2 ⁴	<0.033	0.058
Fluoranthene	NR	<0.085	<0.085	<0.085	<0.4 ⁴	<0.4 ⁴	<0.085	<0.085
Indeno[1,2,3-c,d] pyrene	NR	<0.033	<0.033	<0.033	<0.2 ⁴	<0.2 ⁴	<0.033	<0.033
Naphthalene	NR	0.074	<0.033	0.037	0.061	0.059	<0.033	0.12
Phenanthrene	NR	0.060	<0.033	0.046	0.041	<0.2 ⁴	<0.033	0.058
Pyrene	NR	<0.033	<0.033	0.088	<0.2 ⁴	<0.2 ⁴	<0.033	0.087
Total Petroleum Hydrocarbons	10	400	70	200	2,000	2,000	60	30

D = duplicate sample
 NR = not requested
 µg/g = parts per million
 < = less than certified reporting limit or detection limit
 1 = dilution factor of 200
 2 = dilution factor of 4
 3 = dilution factor of 10
 4 = dilution factor of 5

6 = dilution factor of 20
 6 = dilution factor of 50
 7 = dilution factor of 3
 8 = dilution factor of 2

Table 2-6 Summary of Southeast Fence Line Area Surface Soil Sample Detections (page 2 of 4)

Site ID	SS-15	SS-16	SS-17	SS-18	SS-19	SS-20	SS-21	SS-22
Sample Interval (ft)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
Sample Date	7/15/92	7/15/92	7/16/92	7/16/92	7/16/92	7/16/92	7/16/92	7/16/92
ORGANICS (units in µg/g)								
2-Methylnaphthalene	0.078	0.052	0.11	<0.033	<0.033	<0.033	0.16	<0.033
Benzo(a)anthracene	<0.033	<0.033	0.071	<0.033	<0.033	0.16	<0.033	0.071
Benzo(a)pyrene	<0.033	<0.033	0.075	<0.033	<0.033	0.14	<0.033	0.069
Benzo(b)fluoranthene	<0.033	<0.033	0.11	<0.033	<0.033	0.19	<0.033	0.12
Bis(2-ethylhexyl)phthalate	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39	<0.39
Benzo(k)fluoranthene	<0.033	<0.033	0.042	<0.033	<0.033	0.11	<0.033	0.053
Fluoranthene	<0.085	<0.085	<0.085	<0.085	<0.085	0.37	<0.085	0.11
Indeno[1,2,3-C,D] pyrene	<0.033	<0.033	<0.033	<0.033	<0.033	0.049	<0.033	<0.033
Naphthalene	0.060	0.043	0.073	<0.033	<0.033	<0.033	0.095	<0.033
Phenanthrene	0.038	<0.033	0.065	<0.033	<0.033	0.17	0.048	<0.033
Pyrene	0.067	<0.033	0.073	<0.033	<0.033	0.30	<0.033	0.099
Total Petroleum Hydrocarbons	50	20	90	30	<10	90	10	200

D = duplicate sample
 NR = not requested
 µg/g = parts per million
 < = less than certified reporting limit or detection limit
 1 = dilution factor of 200
 2 = dilution factor of 4
 3 = dilution factor of 10
 4 = dilution factor of 5
 5 = dilution factor of 20
 6 = dilution factor of 50
 7 = dilution factor of 3
 8 = dilution factor of 2

Table 2-6 Summary of Southeast Fence Line Area Surface Soil Sample Detections (page 3 of 4)

Site ID	SS-01	SS-09	SS-10	SS-11	SS-12	SS-12(D)	SS-13	SS-14
Sample Interval (ft)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
Sample Date	10/04/91	7/15/92	7/15/92	7/15/92	7/15/92	7/15/92	7/15/92	7/15/92
INORGANICS (units in µg/g)								
Aluminum	5,400 ¹	11,000 ⁷	8,300 ⁷	12,000 ⁷	13,000 ⁷	9,400 ⁸	9,400 ⁷	15,000 ⁴
Arsenic	3.55	4.89	6.32	7.02	4.22	5.06	6.55	6.09
Barium	<190 ¹	118	121	143	191	175	96.8	199
Beryllium	<100 ¹	1.09	1.04	0.884	1.08	0.929	0.828	1.21
Cadmium	<100 ¹	1.72	0.667	2.21	1.40	1.29	0.801	1.53
Calcium	89,000 ¹	65,000 ⁶	48,000 ³	85,000 ⁶	33,000 ³	>50,000 ³	94,000 ⁶	39,000 ³
Chromium	<130 ¹	29.9	22.6	33.2	24.4	25.6	31.2	27.2
Cobalt	<130 ¹	15.0	15.5	16.4	16.7	13.9	14.4	18.8
Copper	<190 ¹	36.3	44.9	47.7	33.9	35.6	24.8	37.2
Iron	8,400 ¹	13,000 ⁷	14,000 ⁷	16,000 ⁷	16,000 ⁷	13,000 ³	14,000 ⁷	19,000 ⁴
Lead	23 ²	71 ³	52 ⁴	90 ³	150 ⁵	170 ⁵	70 ³	120 ⁵
Magnesium	10,000 ¹	7,400 ⁷	8,300 ⁷	8,900 ⁷	6,600 ⁷	5,900 ⁸	9,100 ⁷	6,500 ⁴
Manganese	<400 ¹	471	386	656	669	594	443	645
Mercury	<0.027	0.085	0.101	0.077	0.142	0.152	<0.027	0.285
Nickel	<310 ¹	16.9	17.8	18.2	17.3	15.3	17.5	17.7
Potassium	<24,000 ¹	2,800	2,060	2,790	3,530	2,910	2,610	3,730
Silver	<100 ¹	1.14	0.891	1.65	0.715	1.09	1.34	14.0
Sodium	<9,000 ¹	203	110	109	198	108	<44.8	313
Thallium	<2,900 ¹	56.0	68.5	68.4	64.4	59.7	57.3	81.2
Vanadium	<350 ¹	21.7	16.6	21.5	24.1	17.7	20.5	24.9
Zinc	<390 ¹	121	72.2	173	177	158	77.7	129

D = duplicate sample
 < = less than certified reporting limit or detection limit
 > = greater than certified reporting limit
 1 = dilution factor of 200
 2 = dilution factor of 4
 3 = dilution factor of 10
 4 = dilution factor of 5
 NR = not requested
 µg/g = parts per million
 5 = dilution factor of 20
 6 = dilution factor of 50
 7 = dilution factor of 3
 8 = dilution factor of 2

Table 2-6 Summary of Southeast Fence Line Area Surface Soil Sample Detections (page 4 of 4)

Site ID	SS-15	SS-16	SS-17	SS-18	SS-19	SS-20	SS-21	SS-22
Sample Interval (ft)	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5	0.0-0.5
Sample Date	7/15/92	7/15/92	7/16/92	7/16/92	7/16/92	7/16/92	7/16/92	7/16/92
INORGANICS (units in µg/g)								
Aluminum	13,000 ⁷	12,000 ⁷	8,300 ⁸	6,400 ⁸	5,500 ⁸	5,700 ⁸	8,200 ⁸	8,600 ⁷
Arsenic	3.94	4.03	4.68	6.20	5.20	3.15	3.86	6.70
Barium	155	146	174	80.0	66.6	77.9	141	138
Beryllium	1.18	1.12	0.904	0.819	0.575	0.575	0.907	0.903
Cadmium	1.30	1.18	1.18	0.864	<0.515	1.24	0.902	1.77
Calcium	33,000 ³	33,000 ³	49,000 ⁵	>100,000 ⁵	60,000 ⁵	58,000 ⁵	42,000 ³	71,000 ⁵
Chromium	26.2	23.8	21.6	29.9	21.3	22.0	19.9	29.6
Cobalt	17.8	15.4	12.5	10.5	11.6	10.1	11.8	15.7
Copper	29.9	26.6	31.2	19.8	29.1	16.4	23.4	42.1
Iron	16,000 ⁷	14,000 ⁷	11,000 ⁸	7,900 ⁸	8,300 ⁸	7,000 ⁸	9,300 ⁸	12,000 ⁷
Lead	83 ³	92 ³	320 ⁸	55 ³	10 ⁴	45 ³	61 ³	130 ⁵
Magnesium	6,600 ⁷	6,300 ⁷	5,800 ⁸	6,000 ⁸	9,400 ⁸	7,200 ⁸	6,200 ⁸	8,900 ⁷
Manganese	592	554	451	414	227	268	435	512
Mercury	0.201	0.220	0.216	0.062	<0.027	<0.027	0.151	0.072
Nickel	18.2	17.8	13.5	12.5	15.1	13.9	13.6	20.9
Potassium	3,590	3,580	2,800	1,660	1,410	1,270	2,280	2,130
Silver	0.758	0.747	0.589	1.56	0.598	0.672	<0.521	0.851
Sodium	264	196	302	<44.8	51.5	99.3	172	123
Thallium	64.9	66.5	43.5	30.6	39.4	39.9	42.9	54.0
Vanadium	25.5	21.4	16.7	14.5	12.6	12.8	16.1	20.2
Zinc	97.8	89.1	114	70.8	31.0	57.6	66.2	133

D = duplicate sample
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 1 = dilution factor of 200
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 4 = dilution factor of 5
 NR = not requested
 µg/g = parts per million
 5 = dilution factor of 20
 6 = dilution factor of 50
 7 = dilution factor of 3
 8 = dilution factor of 2

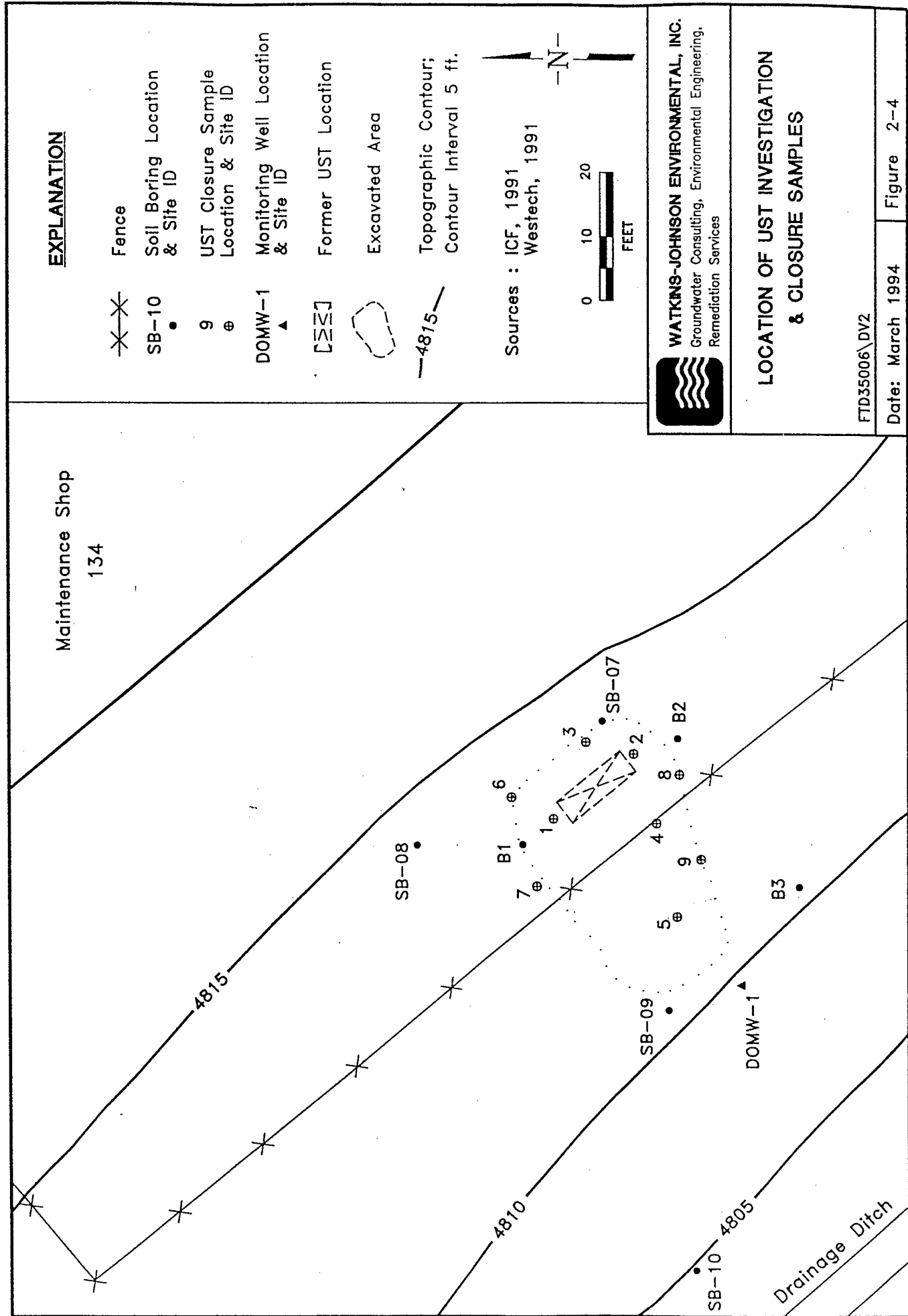
service around 1986 after the contents were removed. This tank and another UST in the same location were reported to have leaked. Potential releases from the tank area could impact the excessed area via a concrete drainage ditch.

An investigation of the UST was conducted in December 1990 by ICF. The locations of four borings (SB-07 through SB-10) and a monitoring well (DOMW-1) in the retained area were determined on the basis of results from a soil gas survey (Figure 2-4). TPH as total recoverable petroleum hydrocarbons ($480 \mu\text{g/g}$) were detected in a sample collected within 15 ft of the tank at a depth corresponding to the bottom of the tank pit (SB-07; Figure 2-4; Table 2-7). No TPH or BTEX were detected in any other soil samples (Table 2-7). Insufficient water was available for collection of ground-water samples.

This tank, associated piping, and contaminated soil were removed in August and September 1991 by Westech. The tank was corroded and had several holes. Contaminated soil was visible at the surface and also was present beneath the tank (Westech, 1991). Concentrations of TPH as oil and grease measured at the north and south ends of the tank were 10,000 and 7,400 $\mu\text{g/g}$, respectively (Site ID 1 and 2; Figure 2-4; Table 2-7). Additional soil was excavated, and clean soil was reached on the east, north and west sides of the tank area. Trees, power poles and lines, and a fence prevented excavation of all stained soil south of the tank. Over-excavation confirmation samples were collected and analyzed for BTEX and TPH. At the south edge of the excavation, TPH concentrations were less than 500 $\mu\text{g/g}$, and no BTEX were detected. Three borings were drilled (B1, B2, B3) and sampled at the north, south, and southwest perimeters of the excavation; no TPH or BTEX were measured in samples from the borings.

During the initial EI field program, boring SB-25 was hand augered to a depth of 4.0 ft bgs in the Southeast Fence Line Area where drainage from the southwest side of Building 134, potentially containing contaminants from the UST area, flows onto the excessed area via a concrete ditch (Figure 2-3). During the supplemental EI field program, four surface soil samples were collected from and adjacent to the ditch. The concrete ditch was only visible near the outfall, which is located at the southeast boundary of the excessed area. As measured in the excessed area, the ditch is covered by 0.5 to 1.5 ft of soil.

A TPH concentration of 600 $\mu\text{g/g}$ was detected in the surface soil sample (0.0 to 0.5 ft bgs) from boring SB-25 (Table 2-5). In the subsurface composite soil sample (0.5 to 4.0 ft bgs) from this boring, TPH were detected within the range of background concentrations (20 $\mu\text{g/g}$). No VOCs or SVOCs were



Maintenance Shop
134

4815

SB-08

4810

SB-07

B2

B3

SB-09

DOMW-1

SB-10

4805

Drainage Ditch

Table 2-7 Analytical Results for Soil Samples from Building 134 UST Investigation and Closure

Site ID	Total Depth (ft-bgs)	Sample Number	Sample Depth (ft-bgs)	Benzene	Ethylbenzene	Toluene	m-Xylene	Xylene	TPH (recoverable) (418.1) ¹	TPH (GC) (8020/8015) ²	TPH (oil and grease) (413.1) ¹
<u>UST Site Investigation (ICF)</u>											
SB-07	51.5	DOSS-7A	15-16.5	< 0.085	< 0.160	< 0.190	< 0.260	< 0.390	480	NR	NR
SB-07	51.5	DOSS-7B	50-51.5	< 0.085	< 0.160	< 0.190	< 0.260	< 0.390	< 10	NR	NR
SB-08	40.5	DOSS-8A	15-16.5	< 0.085	< 0.160	< 0.190	< 0.260	< 0.390	< 10	NR	NR
SB-08	40.5	DOSS-8B	38-40	< 0.085	< 0.160	< 0.190	< 0.260	< 0.390	< 10	NR	NR
SB-09	21.5	DOSS-9	15	< 0.085	< 0.160	< 0.190	< 0.260	< 0.390	< 10	NR	NR
SB-10	55.1	DOSS-10A	10	< 0.085	< 0.160	< 0.190	< 0.260	< 0.390	< 10	NR	NR
SB-10	55.1	DOSS-10B	45	< 0.085	< 0.160	< 0.190	< 0.260	< 0.390	< 10	NR	NR
<u>UST Closure (Westech)</u>											
1	NA	7107-03	15	NR	NR	NR	NR	NR	NR	NR	10,000
2	NA	7107-04	15	NR	NR	NR	NR	NR	NR	NR	7,400
<u>Over-Excavation Confirmation (Westech)</u>											
3	NA	7853-01	18	0.2	0.2	0.5	NR	1.4	NR	69	NR
3	NA	7853-02	18	NR	NR	NR	NR	NR	NR	NR	< 100
4	NA	7853-03	15	< 0.1	< 0.1	< 0.1	NR	0.2	NR	< 2.0	NR
5	NA	7853-04	14	0.5	5.7	6.2	NR	43	NR	2,500	NR
6	NA	8445-01	6	NR	NR	NR	NR	NR	7.5	NR	NR
7	NA	8445-02	ND	< 0.1	< 0.1	< 0.1	NR	< 0.1	93	< 2.0	NR
8	NA	8445-03	ND	< 0.1	< 0.1	< 0.1	NR	< 0.1	420	< 2.0	NR
9	NA	8473-01	12	< 0.1	< 0.1	< 0.1	NR	< 0.1	450	69	NR
<u>Borehole (Westech)</u>											
B1	NI	8144-01	14-15.5	NR	NR	NR	NR	NR	< 1.0	NR	NR
B2	NI	8144-02	16.25-17.0	< 0.1	< 0.1	< 0.1	NR	< 0.1	< 1.0	< 2.0	NR
B3	NI	8144-03	13.5-15.0	< 0.1	< 0.1	< 0.1	NR	< 0.1	< 1.0	< 2.0	NR

Units in µg/g

< = less than certified reporting limit or detection limit

TPH = total petroleum hydrocarbons

GC = gas chromatography

NR = not requested

NA = not applicable

ND = not documented; however, collected within the capillary fringe (Westech, 1991)

NI = no information available

¹ - EPA, 600/4-79-020, 1983

² - SW-846; EPA, 1986

detected, with the exception of a laboratory-derived or naturally occurring phthalate (di-N-butyl phthalate). Several PAHs were detected in surface soil samples SS-20, SS-21, and SS-22 (Table 2-6). Concentrations did not exceed 0.4 $\mu\text{g/g}$; the highest concentrations were detected in a sample collected from soil infilling the concrete ditch. TPH concentrations in these samples ranged from 10 to 200 $\mu\text{g/g}$. Mercury was detected above levels measured in the background soils, at a concentration of 0.151 $\mu\text{g/g}$ in SS-21. Chromatogram fingerprints from GC/MS analysis indicate the hydrocarbons are primarily heavy oils. These data indicate that the contaminants may have been transported by surface water from the Building 134 UST area through the drainage ditch to the surface soil in the Southeast Fence Line Area. However, vertical migration of the contaminants to deeper soils appears to be limited.

Contaminated surface soil could be carried as suspended sediment in surface-water runoff, since the contaminants potentially were transported by surface water to the sample collection location. The contaminants could be discharged off-site to Red Butte Creek. Additional potential pathways include direct contact with the soil by humans, and air and biota pathways. Air transport of contaminants adsorbed to surface soil is expected to be of minor significance because of the natural vegetation and the absence of vehicular traffic. Vertical migration of the contaminants to deeper soils, and the lateral distribution of the contaminants appear to be limited.

2.2.3 BUILDING 134 MAINTENANCE AREA

A culvert extends from a sump in the wash rack area at Building 134 to the excessed Southeast Fence Line Area. Prior investigations did not assess potential contaminants and releases in this area. During the initial EI field program, boring SB-24 was hand augered on the excessed area and sampled to a depth of 1.0 ft bgs, approximately 15 ft from the end of the culvert. Deeper samples could not be obtained due to gravel in the subsurface soils. An additional surface sample (SS-01) was collected directly below the culvert outlet because SB-24 could not be augered to a depth sufficient to assess possible vertical contaminant migration. TPH and metals concentrations were near or within the range of background soil concentrations in all samples. Di-N-butyl phthalate was detected in the 0.5 to 1.0 ft bgs sample from SB-24; however, it may be a result of laboratory contamination, based on method blank data, or indicative of naturally occurring concentrations.

The analytical results indicate the parking/storage lot area near Building 134 has not been a source of soil contaminants at the outlet of the culvert.

2.2.4 MISCELLANEOUS AREAS

As discussed in Section 2.2, coal and other debris were observed in much of the excessed portion of the Southeast Fence Line Area during the supplemental EI field program. Samples from borings SB-26 and SB-27, sampled during the initial EI field program, contained synthetic materials, as discussed in Section 2.2.1. No investigations were conducted in this area prior to the EI.

Surface soil sample SS-18 was collected near the southwest edge of the excessed Southeast Fence Line Area to distinguish potential soil contamination associated with the debris; the other soil samples were collected to investigate the recent storage and maintenance operations in the Southeast Fence Line Area (Figure 2-3). This sample was observed to contain coal or coal-like fragments. Analysis indicated TPH were detected at a concentration of 30 $\mu\text{g/g}$ but no PAH were detected (Table 2-6). Concentrations of metals were near the ranges detected in the background soil samples. These results indicate that the coal and other debris disposed of during the same period are not likely sources of the PAHs and the elevated levels of TPH and metals that were detected in other locations in the Southeast Fence Line Area.

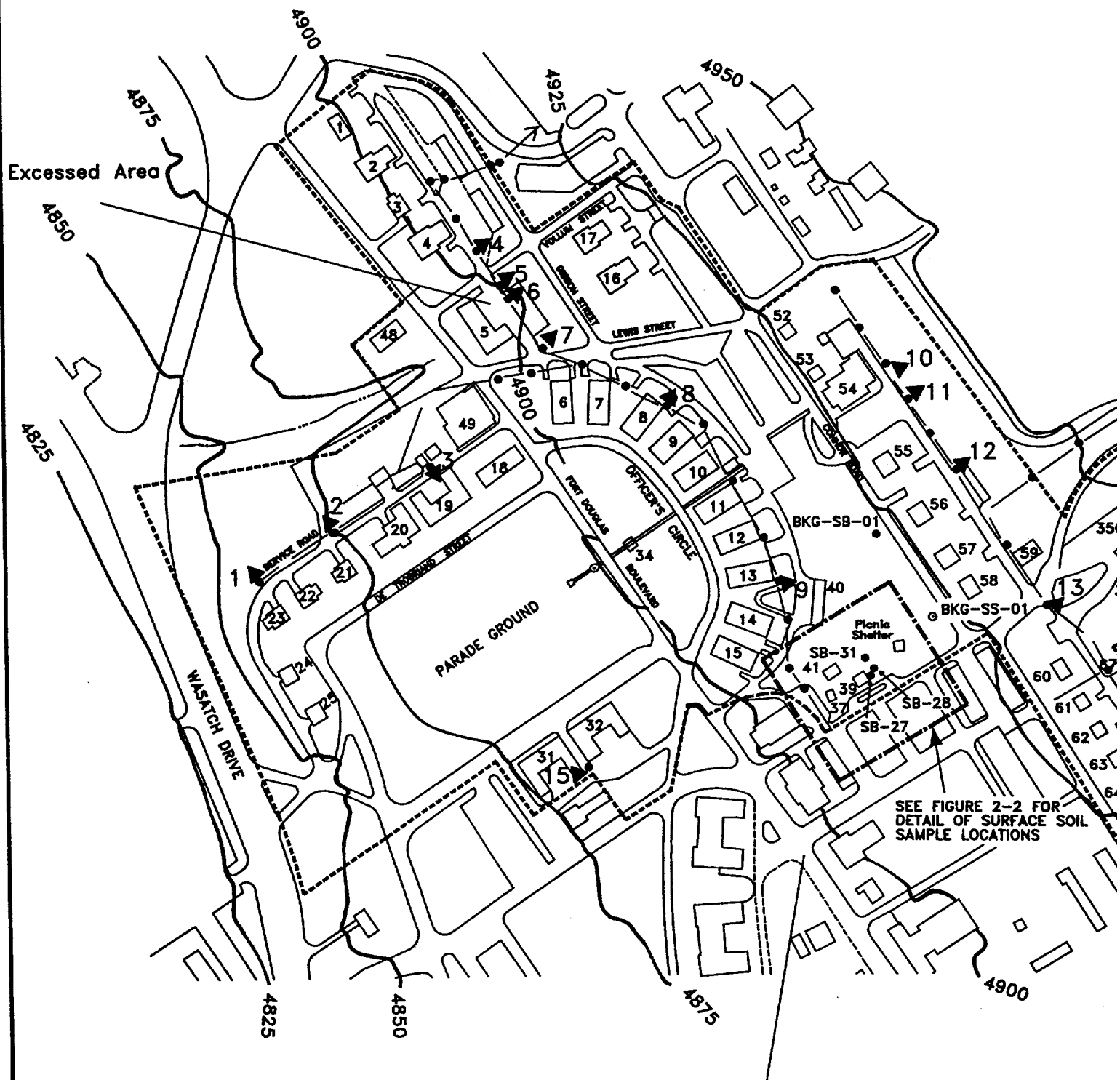
2.3 STORAGE YARD

A storage yard owned by the University of Utah is located off post, adjacent to the northeast boundary of Fort Douglas (Figure 2-5). Aerial photos indicated the storage yard was constructed after 1968.

Miscellaneous equipment, poorly marked drums, and transformers were observed in the storage yard during an initial EI/AA site visit. At the time of the initial EI field program, the storage yard was a fenced area, approximately 20 by 55 ft. Approximately 40 drums, labeled "radioactive LSA" (low specific activity) and "hold", typically sealed and all in good condition, were neatly stacked on pallets inside the fence. Five-gallon containers of hydraulic fluid and lubricating oil were also present.

Absorbent material appeared to be scattered around the perimeter of the storage yard. Potential contaminants typically stored in this yard could not be confidently identified with available information, but may have included PCBs and hydrocarbons based on the initial EI/AA site visit.

Soil boring SB-30 was drilled to a depth of 29.3 ft bgs inside the Fort Douglas property line, downslope of the storage area to measure potential releases. Boring SB-30 was located on an asphalt parking lot;



Retained Area

EXPLANATION

- SB-31 • Soil Boring Location & Site ID
- SS-02 ○ Surface Soil Sample Location & Site ID
- 15 ▼ Transformer Sample Location & Pole Number
- Fort Douglas Excessed Area Boundary
- Electrical Line with Pole
- ~5000~ Topographic Contour; Contour Interval 5 ft.
- 56 Sampled Structure with Number
- BKG Background Sample ID

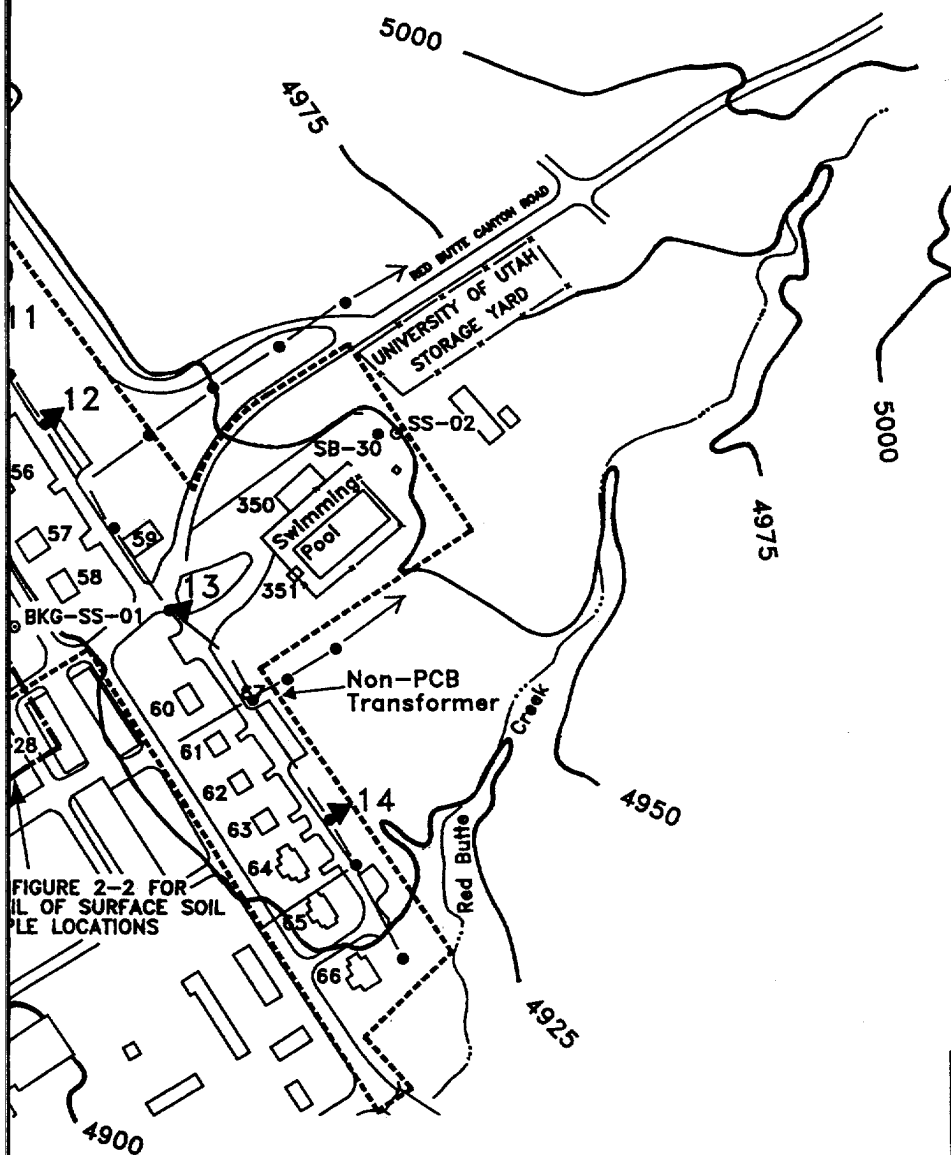


FIGURE 2-2 FOR
IL OF SURFACE SOIL
PLE LOCATIONS



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Remediation Services

NORTHERN EXCESSSED AREA SAMPLE LOCATIONS FORT DOUGLAS

FTD35007\DV1

Date: March 1994

Figure 2-5

therefore, a surface soil sample (0.0 to 0.5 ft bgs) was collected at a nearby location (SS-02). TPH were measured at 60 and 20 $\mu\text{g/g}$ in the surface soil sample and the 0.5 to 5.0 ft bgs sample from SB-30, respectively; no other TPH detections were reported (Table 2-8). These levels are within those measured in other soils that are interpreted to be free of site-related contaminants. Di-N-butyl phthalate, reported in three samples from SB-30 and also in the method blank, likely is a laboratory artifact or naturally occurring. Pyrene was detected at a concentration of 0.080 $\mu\text{g/g}$ in the 0.5 to 5.0 ft bgs sample. Because this sample was collected directly below the asphalt and no deeper samples contained pyrene, it may have been derived from the asphalt. Metals were detected near or within levels measured in the background soil samples. These results indicate that investigated contaminants related to the University of Utah's storage yard have not been released to soil on Fort Douglas.

2.4 TRANSFORMERS

Pole-mounted transformers are located throughout Fort Douglas. One or three transformers of various ages are mounted on each pole. Previous sampling and current labeling of the transformers at Fort Douglas indicated that PCBs may be present in the transformer oil (Weston, 1989). No historical releases of potentially PCB-containing oil have been reported. In order to determine if any remedial measures may be necessary, sampling was planned for all but one of the transformers on the excessed area. Manufacturing information for the transformer not sampled was current and stated that this type of transformer does not contain PCBs. This transformer is located near the swimming pool shown on Figure 2-5.

A total of 25 transformers at 15 pole locations were to be sampled. One of the transformers was not on the pole at the time of sampling (5-01); therefore, a total of 24 transformers was sampled and analyzed for PCBs. The pole numbers are shown on Figure 2-5. Sampled transformers are identified by the pole number, followed by a number designating a specific transformer on the pole. Seven mixtures of PCBs (1016, 1221, 1232, 1242, 1248, 1254, 1260) were analyzed. PCB 1260 was detected in two of the transformer oil samples. A concentration of 200 $\mu\text{g/g}$ was measured in transformers 15-02 and 15-03 (Table 2-9). No other detections of PCBs were reported at the detection limit of 5 $\mu\text{g/g}$.

Transformer 15-02 was observed to be in poor condition. The transformer fluid level was approximately 4 in. lower than observed inside other transformers, about 4 in. below the bushings. No stains were observed on the lower end (approximately 1 ft) of the transformer, indicating the oil had not reached the

Table 2-8 Summary of Soil Sample Detections, Downgradient of Storage Yard

Site ID	SS-02	SB-30	SB-30	SB-30	SB-30
Sample Interval (ft)	0.0-0.5	0.5-5.0	5.0-9.5	15.0-20.0	25.0-25.8
Sample Date	10/04/91	10/01/91	10/01/91	10/01/91	10/01/91
ORGANICS (units in $\mu\text{g/g}$)					
Di-N-butyl phthalate	NR	<0.92	2.0*	6.0*	3.9*
Pyrene	NR	0.080	<0.033	<0.033	<0.033
Total Petroleum Hydrocarbons	60	20	<10	<10	<10
INORGANICS (units in $\mu\text{g/g}$)					
Aluminum	12,000 ¹	11,000 ³	11,000 ³	9,800 ⁴	13,000 ³
Arsenic	6.98	1.33	2.51	2.55	2.42
Barium	<190 ¹	<96 ³	<96 ³	<380 ⁴	160 ³
Calcium	63,000 ¹	73,000 ¹	72,000 ¹	60,000 ⁴	36,000 ³
Iron	16,000 ¹	16,000 ³	15,000 ³	13,000 ⁴	17,000 ³
Lead	20 ²	4.47	5.15	6.24	6.06
Magnesium	10,000 ¹	18,000 ³	18,000 ³	<15,000 ⁴	12,000 ³
Manganese	460 ¹	510 ³	590 ³	<800 ⁴	720 ³

NR = not requested

$\mu\text{g/g}$ = parts per million

< = less than detection limit or certified reporting limit

¹ - dilution factor of 200

² - dilution factor of 4

³ - dilution factor of 100

⁴ - dilution factor of 400

* - also detected in the method blank for this lot and can be qualified as ubiquitous or a lab contaminant

Table 2-9 Summary of PCB Detections in Transformer Oil

Site ID	Sample Date	PCB 1260
01-01	10/08/91	ND(5)
02-01	10/08/91	ND(5)
02-01(D)	10/08/91	ND(5)
03-01	10/08/91	ND(5)
03-02	10/08/91	ND(5)
03-03	10/08/91	ND(5)
04-01	10/07/91	ND(5)
06-01	10/07/91	ND(5)
06-02	10/07/91	ND(5)
06-03	10/07/91	ND(5)
07-01	10/07/91	ND(5)
08-01	10/07/91	ND(5)
09-01	10/07/91	ND(5)
10-01	10/07/91	ND(5)
10-01(D)	10/07/91	ND(5)
10-02	10/07/91	ND(5)
10-03	10/07/91	ND(5)
11-01	10/07/91	ND(5)
12-01	10/07/91	ND(5)
13-01	10/08/91	ND(5)
13-02	10/08/91	ND(5)
13-03	10/08/91	ND(5)
14-01	10/07/91	ND(5)
14-01(D)	10/07/91	ND(5)
15-01	10/08/91	ND(5)
15-02	10/08/91	200 ¹
15-03	10/08/91	200 ¹

Units are in $\mu\text{g/g}$ $\mu\text{g/g}$ = parts per million

D = duplicate sample

¹ = dilution factor of 5

ND(5) - not detected at the detection limit in parenthesis

Note: No other PCBs were detected.

ground. Heavy oil stains were noted around all bushings on this transformer and about 4 inches below the bushings. The fluid level in transformer 15-03 was approximately 1 in. below the standard level, and there was a minor residue around the bushings. No stained soil was observed below these transformers; however, future migration could occur through leakage to the soil and direct contact by humans.

2.5 LEAD-BASED PAINT

Many types of house paint included lead as a major ingredient in the years prior to and through World War II. Beginning in 1971, the content of lead in paint was regulated. Based on the age of the buildings at Fort Douglas, lead-based paints were suspected to be present in all of the buildings; however, no previous sampling was conducted. Where the paint is in a state of disrepair, lead dust, which is an inhalation and ingestion hazard, may be released. Paint chip and wipe samples were collected from all the excessed buildings (with the exception of the garages) and were analyzed for lead to provide information regarding potential lead content. The condition of the painted surfaces also was assessed. In general, the paint was in good condition. Family housing units were painted often by Fort Douglas, typically every three years.

One paint chip or wipe sample was collected from each excessed structure, excluding detached garages. Multiple samples from structures containing two or more housing units were not planned. A total of 31 wipe and 18 paint chip samples (not including QC samples) were collected from the interiors of 49 structures. Two exterior paint chip samples were collected. Lead was detected in all wipe samples and in all but one of the paint chip samples (64A-001); however, the detection limit for this sample ($400 \mu\text{g/g}$) was higher than the concentrations detected in four other paint chip samples (Table 2-10). Concentrations of lead in the interior paint chip samples ranged from $20 \mu\text{g/g}$ in Building 23 (0.002 weight percent) to $400,000 \mu\text{g/g}$ or 40 percent lead by weight in Building 10B. Lead in the wipe samples was measured from $0.002 \mu\text{g/cm}^2$ ($2 \mu\text{g/ft}^2$) in Building 9A to $0.5 \mu\text{g/cm}^2$ ($400 \mu\text{g/ft}^2$) in Building 60A. The lead concentration in exterior paint chip samples was measured at $500 \mu\text{g/g}$ (0.05 weight percent) in a sample from Building 10B, and at $50,000 \mu\text{g/g}$ (5 weight percent) in a sample from Building 56A.

These results indicate that lead-based paint is present in all of the excessed buildings on Fort Douglas, and lead also is contained in exterior paint. However, most of the buildings at Fort Douglas are constructed of brick or sandstone, and porches, eaves, and trim typically are the only painted exterior surfaces. Lead also was found to be present in the dust inside all of the excessed buildings sampled with

Table 2-10 Summary of Paint Chip and Wipe Detections (Page 1 of 3)

Site ID	Sample Date	Lead Concentration			
		Paint Chip		Wipe	
		$\mu\text{g/g}$	weight %	$\mu\text{g/cm}^2$	$\mu\text{g/ft}^2$
1B-001	10/03/91	1,000 ²	0.1	-	-
2B-001	10/04/91	-	-	0.2	100
3-001	10/03/91	-	-	0.06	60
4-001	10/04/91	-	-	0.4	300
5-001	10/04/91	7,000 ⁴	0.7	-	-
6B-001	10/02/91	-	-	0.07	60
7B-001	10/02/91	-	-	0.006	6
8A-001	10/01/91	-	-	0.07	60
8A-001(D)	10/01/91	-	-	0.06	60
9A-001	10/02/91	-	-	0.002	2
10B-001	10/01/91	400,000 ¹	40	-	-
10B-001(D)	10/01/91	400,000 ¹	40	-	-
10B-002*	10/01/91	500 ²	0.05	-	-
11A-001	10/01/91	-	-	0.1	100
12A-001	10/01/91	-	-	0.09	80
13A-001	10/01/91	-	-	0.08	80
14B-001	10/02/91	-	-	0.01	10
15A-001	10/01/91	-	-	0.07	60
16A-001	10/02/91	-	-	0.03	20
17B-001	10/03/91	-	-	0.06	50
18C-001	10/03/91	-	-	0.2	200
19B-001	10/01/91	30 ²	0.003	-	-
20-001	10/04/91	80,000 ²	8	-	-

¹ - dilution factor of 100² - dilution factor of 2³ - dilution factor of 50⁴ - dilution factor of 200

D = duplicate sample

< = less than detection limit

* exterior sample

Notes: Conversion of wipe results from $\mu\text{g/cm}^2$ to $\mu\text{g/ft}^2$ was performed using results in the IRDMIS, not the rounded values reported in this table.AA-F.TB1
02/28/94

Table 2-10 Summary of Paint Chip and Wipe Detections (Page 2 of 3)

Site ID	Sample Date	Lead Concentration			
		Paint Chip		Wipe	
		$\mu\text{g/g}$	weight %	$\mu\text{g/cm}^2$	$\mu\text{g/ft}^2$
21-001	10/03/91	-	-	0.02	20
22-001	10/03/91	-	-	0.02	20
23-001	10/03/91	20 ²	0.002	-	-
24-001	10/01/91	-	-	0.04	30
25-001	10/01/91	-	-	0.05	50
31-001	10/03/91	-	-	0.05	40
32-001	10/02/91	300,000 ³	30	-	-
37-001	10/04/91	90,000 ²	9	-	-
39-004	10/03/91	30 ²	0.003	-	-
41-001	10/03/91	10,000 ²	1	-	-
S48-001	10/04/91	200,000 ³	20	-	-
49-001	10/04/91	-	-	0.02	20
52-001	10/01/91	-	-	0.02	20
53-001	10/05/91	-	-	0.2	200
54-001	10/04/91	80,000 ²	8	-	-
55-001	10/04/91	7,000 ²	0.7	-	-
56A-001	10/01/91	-	-	0.02	20
56A-002*	10/01/91	50,000 ²	5	-	-
57B-001	10/02/91	-	-	0.01	10
58A-001	10/02/91	400 ²	0.04	-	-
59-001	10/02/91	-	-	0.006	6
60A-001	10/05/91	-	-	0.5	400
61-001	10/03/91	30,000 ²	3	-	-

¹ - dilution factor of 100

² - dilution factor of 2

³ - dilution factor of 50

⁴ - dilution factor of 200

D = duplicate sample

< = less than detection limit

* = exterior sample

Notes: Conversion of wipe results from $\mu\text{g/cm}^2$ to $\mu\text{g/ft}^2$ was performed using results in the IRDMIS, not the rounded values reported in this table.

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Table 2-10 Summary of Paint Chip and Wipe Detections (Page 3 of 3)

Site ID	Sample Date	Lead Concentration			
		Paint Chip		Wipe	
		$\mu\text{g/g}$	weight %	$\mu\text{g/cm}^2$	$\mu\text{g/ft}^2$
62-001	10/02/91	-	-	0.02	20
63-001	10/02/91	-	-	0.03	20
64A-001	10/02/91	< 400 ⁴	< 0.04	-	-
65B-001	10/05/91	-	-	0.06	50
66B-001	10/02/91	40,000 ²	4	-	-
350-001	10/04/91	200 ²	0.02	-	-
351-001	10/04/91	-	-	0.004	4

¹ - dilution factor of 100

² - dilution factor of 2

³ - dilution factor of 50

⁴ - dilution factor of 200

D = duplicate sample

< = less than detection limit

* = exterior sample

Notes: Conversion of wipe results from $\mu\text{g/cm}^2$ to $\mu\text{g/ft}^2$ was performed using results in the IRDMIS, not the rounded values reported in this table.

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wipes. The most likely migration pathway of lead is the air, through use of the buildings, by abrasion of the paint and subsequent dispersion in the building interiors. Release of lead from building exteriors to the soil is likely from deterioration, as paint chips were noted on the ground on the perimeter of a few of the buildings.

2.6 CONCEPTUAL SITE MODEL

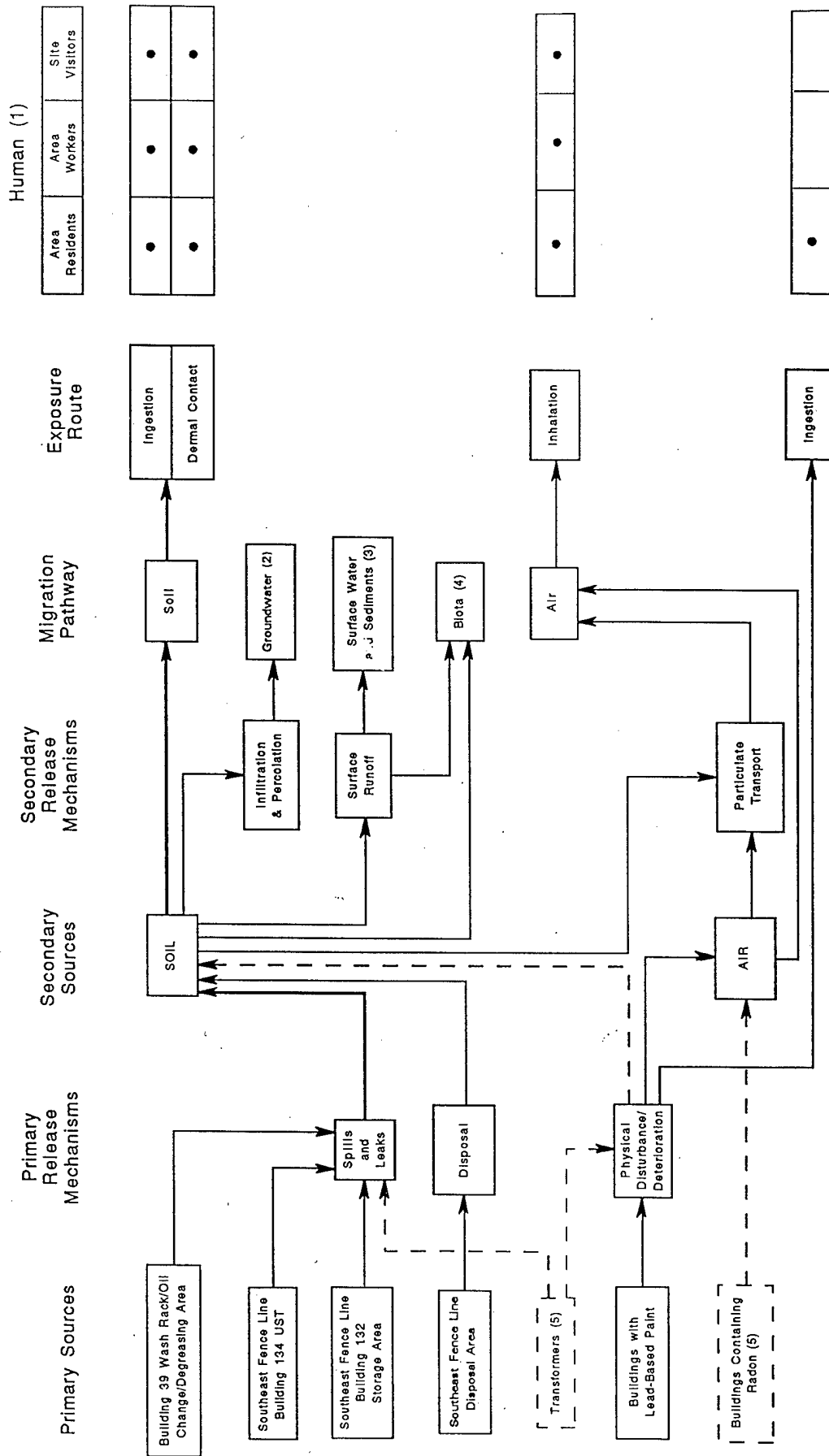
The sources of contaminants, release mechanisms, and pathways of migration presented above can be summarized in a conceptual site model. Exposure routes to potential receptors and risk scenarios for sources of contamination can be identified from this model. Asbestos in Fort Douglas buildings is not presented in this site model because asbestos was assessed in the Asbestos Survey Results Report (RLSA, 1991b), and Fort Carson conducted abatement in some of the buildings (see Appendix C of the EI Report; WJE, 1994).

Figure 2-6 is the conceptual site model for Fort Douglas. The major pathway (soil) to receptor populations is shown by a bold line. Minor pathways are shown by a lighter line. The migration pathways from transformers and from buildings containing radon to receptor populations are shown by dashed lines. These pathways are not addressed by the risk assessment for the following reasons:

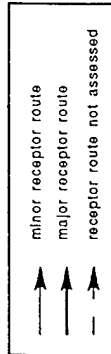
- Buildings with elevated radon levels (as indicated by USEPA guidance) have been remediated by Fort Carson and will be retested; and
- It is inappropriate to conduct a risk assessment on the transformers, as they are not considered environmental media. Additionally, release of transformer oil to the soil was not observed; therefore, typical area residents, workers and visitors would not be exposed to the transformer oil.

The following factors were considered in developing the model (USEPA, 1987):

- spacial distribution of contaminants;
- potential routes of exposure;



- Impacts on biota are not considered because the site is an urban residential/institutional area.
- Exposure routes relative to groundwater use are incomplete due to the use of city water and the depth of the aquifer.
- No surface water bodies are on-site and potential exposure to off-site surface water and sediments in Red Butte Creek is considered minimal; therefore, no exposure routes are considered.
- Human exposure to biota and agricultural products is incomplete because the site is an urban residential/institutional area and potential foods produced on-site are not expected to constitute a significant percentage of a resident's diet.
- Exposure routes/risk are not assessed (see Section 2.6).



Note: Buildings containing asbestos are addressed in the report of the Asbestos Survey Results (RLSA, 1991b) and the Fort Carson Information paper (Appendix C of the EI Report, WJE, 1994).

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Figure 2-6
Conceptual Site Model

- amount, concentrations, properties, environmental fate of chemicals at each source;
- geologic and hydrogeologic factors;
- extent of contaminant migration in the environmental media;
- primary and secondary contaminant release mechanisms for each source; and
- human and environmental populations potentially affected.

The primary sources of contaminants, based on the EI, are shown on the left side of Figure 2-6. The primary release mechanism is spills and leaks to soils; the soils may be secondary sources. As indicated on the right side of Figure 2-6, the primary pathway that may release contaminants is soil. Human receptors may be exposed by ingestion and dermal contact. Another potential migration pathway is air, where contaminated particulates on the surface could be entrained and inhaled by humans; however, the sites are covered by sod or natural vegetation, and there is no vehicular traffic in these areas, reducing the potential of this pathway. Human exposure to biota and agriculture products are not major exposure pathways because the site is an urban residential/institutional area. Exposure through ingestion of contaminated foods is a possibility, but is not likely to be a major exposure route because the two contaminated areas are unlikely to be used for residential gardening. In addition, the ground-water, surface-water and sediments, and biota pathways are incomplete for the following reasons: 1) city water is used on site and the aquifer depth is approximately 350 ft bgs; 2) no surface-water bodies exist on-site, and potential exposure to off-site surface water and sediments in Red Butte Creek is considered minimal because the creek is typically not used for human consumption, and swimming is not permitted; and 3) the site is an urban residential/institutional area and has a vegetative landscape of lawns and trees and biota which is easily adapted to urban habitats.

3.0 RISK ASSESSMENT SUMMARY

The objectives of the risk assessment were to provide an analysis of the potential health risks associated with current, unremediated soil contamination at Fort Douglas, and to provide a basis for determining the need for remediation at the site. The risks associated with lead-based paint in the buildings were not assessed quantitatively; however, levels measured in the samples were compared to the Department of Housing and Urban Development (HUD) guidelines for public and Indian housing (55 Federal Register (FR) 14556; April 18, 1990). Risks associated with radon were not addressed, because Fort Carson has remediated the structures with levels exceeding USEPA guidelines, and additional monitoring is being performed in order to determine if remedial activities attained the desired reduction in radon levels. Asbestos was assessed in the Asbestos Survey Results Report (RLSA, 1991b), and because corrective actions were recommended, Fort Carson conducted remedial activities in some of the excessed structures. The risk assessment is presented in its entirety in the EI, (WJE, 1994) and as a result, is only summarized here.

3.1 EXPOSURE ASSESSMENT

Three separate exposure scenarios were evaluated in the risk assessment: a residential, an industrial, and a recreational scenario. These scenarios were chosen as a basis for estimating exposure at the site based on current and projected (i.e., future) land uses. Two exposure pathways were evaluated quantitatively under each of the three exposure scenarios: incidental ingestion of contaminated soil and dermal absorption of contaminants in soil. Exposure to the contaminated areas in the Building 39 Area and the Southeast Fence Line Area was assessed separately.

3.2 TOXICITY ASSESSMENT

A toxicity assessment of the soil COCs indicated that both cancerous and noncancerous adverse health effects are of potential concern at the site, if exposure were to occur in sufficient quantities. Some of the COCs are classified as probable human carcinogens (USEPA class "B2"), but none are classified as known human carcinogens (USEPA class "A"). In addition, some of the COCs are associated with systemic toxicity (i.e., noncancerous effects), including alterations in liver function, kidney function, and hematopoietic (i.e., blood) parameters.

The risk characterization revealed that the potential for cancerous effects was highest under the residential scenario. The probability of developing cancer for potential residents of Fort Douglas was calculated to be 10^{-6} for the Building 39 Area and 2×10^{-6} for the Southeast Fence Line Area, assuming a 30-year on-site residency. The probability of developing cancer under the industrial and recreational scenarios was calculated to be 4×10^{-7} and 3×10^{-7} , respectively, for the Building 39 Area, and 6×10^{-7} and 4×10^{-7} , respectively, for the Southeast Fence Line Area. All of these cancer risk estimates fall within or below the acceptable range of 10^{-6} to 10^{-4} as defined by the USEPA and indicate that remedial action is not warranted. In addition, the only metal determined to be a COC was lead, and its concentrations were well below USEPA health guidelines for soil.

The noncarcinogenic risk (Hazard Quotient) was also evaluated. This quotient is expressed as the ratio of the estimated exposure over a specified period (i.e., the chronic daily intake (CDI)) to the reference dose derived for a similar exposure period (i.e., the chronic reference dose (RfD)). There may be a concern for noncarcinogenic health effects when the CDI exceeds the RfD (i.e., Hazard Quotient > 1.0).

All of the Hazard Quotients calculated for Fort Douglas were markedly less than one. The highest Hazard Quotient was calculated to be 0.00009 for adverse kidney effects under the residential scenario. These results indicate that the likelihood of an individual developing systemic toxic effects while residing, working, or recreating on Fort Douglas is very small, and that remedial action is therefore not warranted.

The known carcinogenic constituents of TPH are PAHs and BTEX. PAHs are also known to cause adverse, noncancerous health effects in humans. As such, the PAHs typically drive risk assessments that are based on petroleum hydrocarbon contamination. The risk assessment conducted on the excessed area soils shows that the levels of PAHs detected do not pose a cancer risk to humans. BTEX was not detected in the soil. Although PAHs and BTEX constitute a small amount or none of the TPH detected at the site, the remainder of the hydrocarbons detected by the TPH analysis are not known to be of concern to human health or the environment.

While soil lead levels at the site are well below current federal guidelines as established by Office of Solid Waste and Emergency Response (OSWER) Directive 9355.4-02, lead-based paint, located on residential

buildings at a federal facility, is regulated by federal law (Lead-Based Paint Poisoning Prevention Act) when the property is sold (or transferred).

4.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The ARARs pertaining to the Fort Douglas AA are identified and briefly described in this section. Section 121(d) of CERCLA specifies that remedial actions must meet any Federal or State standards, requirements, criteria, or limitations under environmental laws which are "applicable or relevant and appropriate" to a specific site. State environmental or facility siting laws must be more stringent than Federal environmental laws, otherwise the Federal laws will take precedence. Other criteria, advisories, guidance, and/or proposed standards that are not legally binding are "to be considered" (TBC) and may be used in developing a remedy (40 Code of Federal Regulations (CFR) § 300.400(g)(3)).

Environmental laws may be either "applicable" or "relevant and appropriate", but not both. Applicable requirements are defined as those cleanup standards and other substantive requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, contaminant, remedial action, location, or other circumstance at a site (USEPA, 1988b). For the purposes of this report, promulgated means legally enforceable. Relevant and appropriate requirements are the Federal and State laws and regulations that are not directly applicable to the site, but address a situation or condition that is sufficiently similar at the site.

The USEPA (1988b) identifies three basic types of ARARs: chemical-specific, location-specific, and action-specific. Chemical-specific ARARs are generally health- or risk-based numerical values that establish the acceptable amount or concentration of a chemical that may be found in or discharged to the ambient environment. The most stringent value for a chemical is used if there is more than one ARAR. These requirements generally consider a single chemical (or closely-related group of chemicals), but do not consider mixtures of chemicals. Examples of possible chemical-specific ARARs include the Federal Safe Drinking Water Act and the Toxic Substances Control Act.

Location-specific ARARs are restrictions placed on remedial activities or the concentrations of hazardous substances solely because of their specific locations. Wetlands, historic places, and floodplains are examples of special locations. Examples of possible location-specific ARARs include the National Historic Preservation Act of 1966 and the Archaeological and Historical Preservation Act of 1974.

Action-specific ARARs are technology- or activity-based requirements or limitations on actions taken with respect to hazardous materials. This type of ARAR does not determine the remedial alternative, but

indicates how a selected alternative must be achieved. Examples of possible action-specific ARARs include the National Environmental Policy Act and the Endangered Species Act of 1973.

In addition to the identification of ARARs, nonpromulgated advisories or guidance issued by Federal or State agencies are identified. Even though TBCs are not enforceable or legally binding and do not have the same status as ARARs, they may provide useful information, recommended procedures, and/or protective cleanup levels in the absence of ARARs or where ARARs are not sufficiently protective to develop cleanup goals (USEPA, 1988b). TBC material (guidance or policy documents) may be considered and used as appropriate, where necessary to ensure protectiveness. TBCs should only be used in setting protective cleanup levels after ascertaining that they have not been superseded.

The final determination of ARARs is an evolving process with guidance from the lead regulatory agency and interaction with other Federal, State, and local regulatory agencies. The final ARARs and TBCs, in conjunction with the evaluation of public health requirements, will be given primary consideration when selecting a remedial action.

The general outline for the listing of ARARs in the following subsections consists of a listing of the governing statute followed by (in a bulleted format) the associated implementing regulations with a brief summary. It is assumed that the listed ARARs include all applicable amendments and revisions.

4.1 CHEMICAL-SPECIFIC ARARs

FEDERAL ARARs:

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), 42 United States Code (USC) §§ 9601 *et seq.* as amended by Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 USC §§ 11000 *et seq.* and Public Law (PL) 99-499, Oct. 17, 1986.

- 40 CFR § 300.430(e)(2)(i)(A)(2). This subsection of the NCP is applicable to the selection of feasibility study (FS) sites and determination of remediation goals. The acceptable exposure levels for known or suspected carcinogens are between 10^{-4} and 10^{-6} lifetime cancer risks. Generally, remedial action is not warranted at a site where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure

for both current and future land use is less than 10^{-4} , and the noncarcinogenic hazard quotient is less than 1. At sites where the cancer risk exceeds 10^{-4} , the remediation goal should be 10^{-6} risk.

Clean Water Act of 1977 (also known as Federal Water Pollution Control Act), 33 USC §§ 1251 *et seq.*

- 40 CFR §§ 122 — 125. Provides regulations for the National Pollutant Discharge Elimination System (NPDES) Program. Includes provisions for permit requirements, procedures for approval of State programs, and sets standards for discharge.
- 40 CFR § 136. The Guidelines Establishing Test Procedures for the Analysis of Pollutants identify the USEPA-approved analytical methodologies for analyzing water and wastewater.

Clean Air Act, 42 USC §§ 7401 *et seq.*

- 40 CFR § 50. Defines primary and secondary ambient air quality standards for lead, particulate matter, and other pollutants.
- 40 CFR § 61. Sets standards for monitoring, emissions, recordkeeping, reporting, and compliance for designated hazardous air pollutants. This regulation is not applicable since there are no air emission facilities and none of the hazardous air pollutants are a human health concern at Fort Douglas.

Toxic Substances Control Act (TSCA), 15 USC §§ 2601 *et seq.*

- 40 CFR § 761.60 — .79 (Subpart D, Storage and Disposal). Does not require removal of PCBs, and PCB items for the sole purpose of disposal. However, if the PCBs and PCB items are removed from service and disposed of, disposal must comply with the regulations in this subpart. Disposal of PCB materials are regulated as follows:
- 40 CFR § 761.60(a)(2). Mineral oil dielectric fluid from PCB contaminated equipment containing more than 50 parts per million (ppm) but less than 500 ppm

PCB must be disposed of by incineration, chemical waste landfilling, or combustion in a high efficiency boiler.

- 40 CFR § 761.60(b)(1). Transformers shall be disposed of by incineration or chemical waste landfilling.
- 40 CFR § 761.60(b)(5). Articles containing more than 50 ppm but less than 500 ppm PCB must be disposed of by incineration or chemical waste landfilling.

STATE ARARs:

Utah Solid and Hazardous Waste Act, Utah Code Annotated (Ann.) §§ 19-6-101 *et seq.*

- Establishes a regulatory scheme designed to facilitate the promulgation and implementation of substantive requirements.

Utah Water Quality Act, Utah Code Ann. §§ 19-5-101 *et seq.*

- Utah (Administrative) Admin. Code § R448-1. Establishes requirements for discharge of wastewater, waste, or other substances. Requires a permit for treatment or discharge of wastewater. Sets water quality standards for discharge of wastes into state waters.
- Utah Admin. Code § R448-2. Sets standards pertaining to water quality that apply to all waters of the State. Comparable to sections of the Federal CWA.
- Utah Admin. Code § R317-6. Governs pollutants that may contaminate groundwater. Establishes regulations and procedures for cleanup of polluted groundwater.
- Utah Admin. Code § R317-8. Comparable to promulgated rules pursuant to the Federal CWA. Requires permits for the discharge of pollutants into State waters.

Utah Air Conservation Act, Utah Code Ann. §§ 19-2-101 *et seq.*

- Utah Admin. Code § R446-1-3.3.2 Natural Ambient Air Quality Standards (NAAQS). Air emissions must meet standards. Temporary or permanent treatment for polluted air may be necessary.
- Utah Admin. Code § R446-1-3.1.8. Use of Best Available Control Technology. To the extent the preferred remedial alternative involves the construction, modification, installation, or operation of air emission sources, then the regulation would be applicable, unless otherwise exempt by regulation (e.g., *de minimus* emissions from air strippers and soil venting projects, R446-6-1 *et seq.*).
- Air Conservation Regulations, Utah Admin. Code §§ R307-1 *et seq.* Requires control of fugitive dust during demolition activities. Sets visible emissions standards for abrasive blasting techniques.

4.2 LOCATION-SPECIFIC ARARs

FEDERAL ARARs:

National Historic Preservation Act of 1966 (NHPA), 16 USC §§ 470 *et seq.*

- National Register of Historic Places, 36 CFR § 60. The National Register is used as a guide to identify cultural resources and to indicate what properties should be considered for protection from destruction. The evaluation is carried out by the lead agency or its consultant in consultation with the State Historic Preservation Officer (SHPO), and the National Park Service, with input from professional archaeologists/historians, Native Americans, and other concerned parties. The process normally includes a Needs Determination, a preliminary review of several factors and consultations to determine the need to conduct a more comprehensive survey. The Cultural Resource Survey (CRS) identifies cultural resources within the project area and, where necessary, the information required to apply the National Register's criteria for evaluation. After the CRS is completed, a preliminary case report identifying possible eligible sites is submitted to the

SHPO. The ultimate determination of "no effect", "no adverse effect", or "adverse effect" is accomplished through consultation with acknowledged local experts and the SHPO. Checklists are published by the SHPO to assist in the evaluation of the adequacy of archaeological testing programs, site significance evaluations, and mitigation reports.

- Protection of Historic and Cultural Properties, 36 CFR § 800. These regulations specify the procedures and requirements federal agencies must satisfy pursuant to their obligations under the NHPA and Executive Order 11593 (discussed below). The procedures include requirements to: identify all properties that are eligible for the National Register and that may be affected by the agency's project; evaluate the probable effects of the project on those National Register properties within the project area; and to avoid impacts or develop mitigation measures to offset any adverse effects on those properties.
- Under § 800.13 of this regulation, a Programmatic Agreement can be used to fulfill an agency's Section 106 and 110 responsibilities for a particular program.

Programmatic Agreement Among Department of the Army, the Advisory Council on Historic Preservation, and the National Conference of State Historic-Preservation Officers Concerning Realignment and Closure of Army Installations in Accordance with the Base Closure and Realignment Act, as authorized under 36 CFR § 800.13.

- Under this agreement, the Army will ensure that the NHPA regulations are carried out through (1) identification and evaluation of historic properties, (2) determination of the effect of base closure on the historic properties, and (3) development and implementation of appropriate treatment and management plans for the historic properties. During this process, the SHPO, Council, and other interested persons will be consulted. If possible, the Army will carry out the terms of this agreement prior to finalization of a remedial plan. No remedial actions that could result in adverse effects on historic properties will be undertaken until the terms of this agreement have been carried out.

Executive Order 11593, May 13, 1971

- Directs land-holding federal agencies to: (1) identify and nominate historic properties to the National Register, (2) consult with the Advisory Council on Historic Preservation prior to transferring, selling, demolishing or substantially altering the properties, (3) initiate measures and procedures to provide for maintenance through preservation, rehabilitation, or restoration of the federally owned sites, and (4) cooperate with purchasers and transferees of property listed on the National Register of Historic Places to meet preservation objectives.

Antiquities Act of 1906, 16 USC §§ 431 — 433.

- 43 CFR § 3. Establishes a system of permits for conducting archaeological investigations on federal land and specifies penalties for noncompliance. Some antiquities permits issued under this law remain in effect. New permits are now issued under the Archaeological Resources Protection Act of 1979 and its implementing regulation (43 CFR § 7).

Archaeological Resources Protection Act of 1979 (ARPA), 16 USC §§ 470aa-ll.

- 43 CFR § 7, 32 CFR § 229. Establishes standards, procedures, uniform definitions, and a permitting program (excavation/removal) for Federal land managers of archaeological resources on public lands or Indian lands. The ARPA requires that federal permits be obtained before cultural resource investigations are initiated on federal land and that the investigators consult with the appropriate Native American groups prior to initiating archaeological studies on sites of Native American origin.

Historic Sites Act of 1935, 16 USC §§ 461 — 467.

- 36 CFR § 62. Sets procedures and criteria to identify national natural landmarks. Encourages the preservation of significant ecological and geological features that constitute the nation's natural heritage.

- 36 CFR § 65. Establishes the national policy to "preserve for public use historic sites, buildings, and objects of national significance" through the National Historic Landmarks Program.

Archaeological and Historical Preservation Act of 1974 (AHPA), 16 USC § 469a — 469c-1.

- The AHPA, which amends the Reservoir Salvage Act of 1960, deals only with the preservation of data, not of historic properties as physical entities, that might otherwise be lost as a result of dam construction or alterations of the terrain. The lead federal agency responsible for activities in connection with any construction project or federally approved project that may cause irreparable loss of significant scientific, prehistorical, or archaeological data, is mandated to preserve the data or request the Department of the Interior to do so.

STATE ARARs:

Utah State Antiquities Statutes, Utah Code Ann. §§ 9-2 through 9-4

- These statutes relate to protection of archeological, anthropological and paleontological resources. No remedial activities shall be proposed that may cause irreparable loss or destruction of significant scientific, prehistorical, historical, or archeological data. Establishes a State Register of Historic and Cultural Sites. Any agency of the state proposing projects that may destroy or materially affect any district, site, building, or object included in, or eligible for, the state or national registers shall, at an early planning stage and before repair or construction is commenced, notify the Division of State History. The Division of State History will make recommendations regarding the projects and provide to the agency and the Historic and Cultural Sites Review Committee suggestions of alternatives that will preserve the historical qualities of the district, sites, buildings, or objects.

4.3 ACTION-SPECIFIC ARARs

FEDERAL ARARs:

CERCLA, 42 USC §§ 9601 *et seq.* as amended by SARA, 42 USC §§ 11000 *et seq.* and PL 99-499, Oct. 17, 1986.

- 40 CFR § 300. The NCP governs all work and work products of the remedial investigations/feasibility studies (RI/FS). The NCP establishes the method and criteria for determining the appropriate extent of the response authorized by CERCLA to hazardous substance releases.
- 40 CFR § 302 (Designation, Reportable Quantities, and Notification). Applicable for reporting spills which may occur during site investigation or remediation. Establishes notification requirements if a reportable quantity of any listed hazardous substance is released on or from the site during the RI/FS and any subsequent activities.

Resource Conservation and Recovery Act of 1976 (RCRA), 42 USC §§ 6901 *et seq.*

- 40 CFR § 257. Provides criteria and guidelines for solid waste management to prevent adverse effects on health or environment. Areas of concern include floodplains, endangered species, surface water, groundwater, and air. The regulations specify that solid waste disposal facilities and disposal practices shall not cause or contribute to the taking (i.e. harassing, harming, wounding, killing, capturing, collecting, etc.) of any endangered or threatened species of plants, fish, or wildlife listed as such pursuant to Section 4 of the Endangered Species Act of 1973. In addition, the facility or disposal practices shall not result in the destruction or adverse modification of the critical habitat of a listed species.
- 40 CFR § 261. Identification and Listing of Hazardous Waste defines solid wastes which are subject to regulation as hazardous wastes under RCRA. Lists hazardous wastes and characteristics of hazardous wastes.

- 40 CFR §§ 262 — 263. Standards Applicable to Generators and Transporters of Hazardous Waste include requirements for hazardous waste determination, manifest preparation, pre-transportation arrangements, recordkeeping and reporting, and hazardous waste export/import.
- 40 CFR § 264.90 — 264.120. Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal (TSD) Facilities establishes a monitoring and response program, and closure and post-closure standards for hazardous waste management units.
- 40 CFR § 268. Land Disposal Restrictions (LDRs) establish land disposal restrictions and treatment standards for land disposal of RCRA hazardous waste.

Base Closure and Realignment Act of 1988 (BRAC), 10 USC § 2687

- Establishes guidelines for the closure or realignment of military installations.

Defense Environmental Restoration Program, 10 USC § 2701

- Establishes that all identification, investigation, research and development, and cleanup of contamination from hazardous substances, pollutants, and contaminants will comply with § 120 of CERCLA. Sets policy to correct environmental problems where there is substantial endangerment to the public health or welfare of the environment. Provides guidelines for the demolition and removal of unsafe buildings and structures.

Armed Forces, 10 USC § 3012

- 32 CFR §§ 650 — 651. Establishes policies, assigns responsibilities, and establishes procedures for the protection and preservation of environmental quality for the Army in peacetime. Sets policy for Army to comply with all provisions of NEPA and all other Federal environmental laws, executive orders, and regulations. Prescribes policy for integrating environmental considerations into Army planning and decision-making.

Occupational Safety and Health Act of 1970 (OSHA), 29 USC §§ 655 *et seq.*

- OSHA, 29 CFR § 1910. The Hazardous Waste Operations and Emergency Response regulations are applicable to all site investigation and remediation activities. They govern all aspects of on-site health and safety for personnel during the RI/FS and any subsequent remedial actions.

National Environmental Policy Act of 1969 (NEPA), 42 USC §§ 4321 *et seq.*

- 40 CFR §§ 1500 *et seq.* Establishes policies and goals for the protection of the environment. The NEPA process includes the systematic examination of possible and probable environmental consequences of implementing a proposed remedial action.

Hazardous Materials Transportation Act, 49 USC §§ 1801 *et seq.*

- 49 CFR §§ 171 — 177. The U.S. Department of Transportation (USDOT) governs transportation aspects of hazardous materials. Provides definitions of hazardous materials for transportation purposes, and listings of proper shipping names and identification numbers. Sets requirements for preparing hazardous materials for shipment by air, highway, rail, or water, or any combination thereof.

Endangered Species Act of 1973 (ESA), 16 USC §§ 1531 *et seq.*

- 50 CFR § 17. Identifies those species of wildlife and plants to be endangered or threatened with extinction. Protects the proposed and listed threatened or endangered species of fish, wildlife, and plants. The ESA defines an endangered species as "any species which is in danger of extinction through all or a significant portion of its range"; and a threatened species as "any species which is likely to become an endangered species within the foreseeable future".
- 50 CFR § 424. Provides rules for revising the lists of Endangered and Threatened Wildlife and Plants, revising their critical habitats, and determining species to be endangered or threatened.

Lead-Based Paint Poisoning Prevention Act, 42 USC §§ 4821 — 4846

- 24 CFR § 35.50 — 35.56 (Subpart E). Elimination of Lead-Based Paint Hazards in Federally-Owned Properties Prior to Sale for Residential Habitation, specifies requirements as follows:
 - 24 CFR § 35.56(a)(1) All applicable surfaces (intact and nonintact interior and exterior painted surfaces) of residential structures constructed prior to 1978 should be inspected to determine if defective (peeling, cracking, scaling, chalking, chipping, or loose) paint surfaces exist. These surfaces should be assumed to be immediate hazards.
 - 24 CFR § 35.56(a)(2) Treatment necessary to eliminate hazards of lead-based paint shall consist of covering or removal of defective paint surfaces. Covering may include adding a layer of wallboard to the wall surface or, depending on the wall condition, permanently attaching a wall covering. Covering or replacing trim surfaces is also permitted. Paint removal may be accomplished by scraping, heat treatment, or chemicals. Machine sanding and use of propane or gasoline torches are not permitted. Washing and repainting without thorough removal or covering does not constitute adequate treatment. In the case of defective paint spots, scraping and repainting the defective areas is considered adequate treatment.
 - 24 CFR § 35.56(a)(3) Prospective purchasers are to be notified: (1) that the property was constructed prior to 1978, (2) that the property may contain lead-based paint, (3) of the hazards of lead-based paint, (4) of the symptoms and treatment of lead-based paint poisoning, and (5) of the precautions to be taken to avoid lead-based paint poisoning.

STATE ARARs:

Utah Occupational Safety and Health Act of 1973, Utah Code Ann. § 35-9-1 *et seq.*

- Utah Admin. Code §§ R574 *et seq.* Regulates worker health and safety. Health and safety requirements of the Act apply to all remedial actions.

Utah Solid and Hazardous Waste Act, Utah Code Ann. §§ 19-6-101 *et seq.*

- Utah Admin. Code §§ R450-1 through -50. Identifies those solid wastes which are subject to regulation as a hazardous waste. Hazardous waste TSD facilities must be approved by the State. Requires a manifest for hazardous waste during transportation. States that USDOT transportation regulations will be followed for hazardous wastes. Establishes standards that define acceptable management of hazardous waste for owners or operators of facilities which treat, store, or dispose of hazardous waste. General Facility Standards such as waste analyses, inspections, and personnel training. Establishes the requirements for a contingency plan and emergency procedures for owners and operators of hazardous waste management facilities.
- Utah Admin. Code § R450-101. Corrective action cleanup standards policy for RCRA, UST, and CERCLA sites. Corrective action must be taken to eliminate the source of contamination either through removal or appropriate source control.

Utah Solid Waste Management Act, Utah Code Ann. §§ 19-6-501 *et seq.*

- Utah Admin. Code § R315-101. Sets standards for cleanup.
- Utah Admin. Code § R315-301. Solid waste must be disposed of at a facility which is in compliance with these regulations. Sets standards for disposal and incineration facility siting operations.

Utah Hazardous Substances Mitigation Act, Utah Code Ann. §§ 19-6-301 *et seq.*

- Establishes the requirements that remedial investigations and remedial action plans be consistent with substantive requirements of CERCLA.

4.4 "TO BE CONSIDERED" GUIDANCE

Lead-Based Paint: Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing, 55 Federal Register (FR) 14,556 (1990) as amended by 55 FR 39,874 (1990); 57 FR 29774 (1992); and 57 FR 28910 (1992).

- Provides information regarding the identification and abatement of lead-based paint in HUD's Public and Indian Housing Programs. Sets standards for technical protocols, practices, and procedures on testing, abatement, worker protection, cleanup, and disposal of lead-based paint in residential structures. These guidelines are recommended protocols which will assist housing authorities in implementing the requirements of the Lead-Based Paint Poisoning Prevention Act and its implementing regulations.

The following TBC is included for informational purposes only. The Act has not yet been promulgated.

Residential Lead-Based Paint Hazard Reduction Act of 1992, PL 102-550, Oct. 28, 1992; HR 5334; 106 Stat. 3897

- Section 1013 amends the Lead-Based Paint Poisoning Prevention Act. Beginning on January 1, 1995, it requires inspection of federally owned residential housing constructed prior to 1960, and abatement of any lead-based paint hazards. A "lead-based paint hazard" is any condition that causes exposure to lead from (1) lead-contaminated dust, (2) lead-contaminated soil, or (3) lead-contaminated paint that is deteriorated or present on friction surfaces, impact surfaces, or an interior or exterior surface that is accessible for a young child to mouth or chew. Beginning on January 1, 1995, this section also requires an inspection for lead-based paint and lead-based paint hazards in all federally-owned residential homes constructed between 1960 and 1978.

- Section 1021 amends the Toxic Substances Control Act and requires federal agencies having jurisdiction over properties containing lead-based paint hazards to be subject to and comply with all federal, state, interstate, and local requirements, both substantive and procedural (including any requirement for certification, licensing, record keeping, or reporting).

5.0 REMEDIAL ACTION OBJECTIVES

The development of remedial action objectives is the first step after selection of applicable sites in the AA process. The site selection process is based on the risk assessment (Section 3) and ARARs (Section 4). This section and succeeding sections of this document were prepared in general accordance with the Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (USEPA, 1988a).

Remedial action objectives are developed to protect the environment and human health from COCs detected at the site. These objectives, as well as the subsequent development of response actions to satisfy these objectives, must comply with the NCP and the requirements of CERCLA as amended by SARA. As stated in the NCP, remedial action objectives must specify:

- COCs;
- Exposure routes and receptors; and
- An acceptable contaminant level or range for each of the chemicals of concern.

The general remedial action objective for the Fort Douglas AA is to provide adequate protection of the environment and human health by reducing the risks posed by the COCs via the exposure pathways identified in the baseline risk assessment, and to comply with ARARs.

5.1 SITE SELECTION

Where a cumulative carcinogenic site risk to an individual, for either current or future land use, exceeds the upper bound of the acceptable lifetime excess cancer risk range, 10^{-4} , action under CERCLA (i.e., conducting an alternatives analysis) is generally warranted at the site (USEPA, 1991). If the cumulative risk is less than 10^{-4} , action generally is not warranted but may be warranted if a chemical-specific standard (e.g., maximum contaminant level) that defines acceptable risk is violated or if there are noncarcinogenic effects or adverse environmental impacts that warrant action (USEPA, 1991).

Based upon the risk assessment, no sites were identified that presented a carcinogenic risk greater than 10^{-4} or a hazard quotient greater than 1.0. However, existing ARARs provide criteria for site selection.

TSCA does not require that operating PCB-contaminated transformers be taken out of service; however, TSCA mandates the disposal of PCBs and PCB-items where contamination exceeds 50 ppm (40 CFR § 761). PCB sites were selected to be protective of human health and the environment, based on the possibility of future leakage of the PCBs from the transformers. PCB sites are listed in Table 5-1. Transformers 15-02 and 15-03, located on pole 15, were found to contain PCBs in excess of 50 ppm. The location of pole 15 is shown in Figures 2-5 and 5-1.

According to regulations promulgated under the Lead-Based Paint Poisoning Prevention Act, hazards associated with defective (peeling, cracking, scaling, chalking, chipping, or loose) surfaces of lead-based paint are required to be eliminated prior to transfer of federally-owned residential property. These surfaces include both interior and exterior painted surfaces. Lead-based paint (defined as containing greater than 0.5 percent by weight of lead) was detected in samples from 65 percent of the buildings. However, due to the age of the buildings (construction dates vary from 1873 through 1954), the pervasive use of lead-based paint prior to 1960, the ambiguities in collecting representative paint chip samples, and the limited number of samples, it is assumed that all Fort Douglas residential buildings in the excessed area contain lead-based paint. The Lead-Based Paint Poisoning Prevention Act (24 CFR § 35, Subpart E) is applicable to all federally owned properties to be sold and intended to be used for residential habitation. As defined in the act, a residential structure is any house, apartment, or structure intended for human habitation, including any nondwelling facility commonly used by children under seven years of age, such as a child care center. For the purposes of this report, a residential building includes any structure that has been used either historically or recently for housing. Descriptions of structures located in the excessed area that were sampled for lead-based paint are found in Table 5-2. The locations of residential buildings located within the excessed area are shown in Figures 5-1 and 5-2.

Soils were not selected as a site because the results of the risk assessment indicated the chemicals detected in the soil do not pose a known risk to human health or the environment, and there are no federal or state laws requiring their cleanup. Therefore, no remedial alternatives were developed for soils.

5.2 TRANSFORMERS

TSCA states that PCB fluid concentrations of more than 50 ppm but less than 500 ppm in a transformer that is to be removed from service and disposed of, must be disposed of by incineration or at a chemical

Table 5-1 Fort Douglas Sites Selected for the Alternatives Analysis

SITE NAME	PCB CONCENTRATION	SELECTION CRITERIA
Transformer 15-02	200	Toxic Substances Control Act; and PCB > 50
Transformer 15-03	200	Toxic Substances Control Act; and PCB > 50
Lead-Based Paint	NA	Lead-Based Paint Poisoning Prevention Act

Units in $\mu\text{g/g}$ (parts per million)

PCB = Polychlorinated Biphenyl

NA = Not Analyzed

Table 5-2 Description of Excessed Structures Sampled for Lead-Based Paint (page 1 of 2)

Structure Number	Original Use	Use Prior to Excessing ¹	Number of Housing Units	Year Built
1	Officer Quarters	NCO Quarters	2	1910
2	Officer Quarters	NCO Quarters	2	1884
3	Officer Quarters	Officer Quarters	1	1931
4	CO Quarters	Administrative Offices	-	1876
5	BO Quarters	Administrative Offices	-	1904
6	Officer Quarters	Officer Quarters	2	1876
7	Officer Quarters	Officer Quarters	2	1876
8	Officer Quarters	Officer Quarters	2	1876
9	Officer Quarters	Officer Quarters	2	1876
10	Officer Quarters	Officer Quarters	2	1876
11	Officer Quarters	Officer Quarters	2	1876
12	Officer Quarters	Officer Quarters	2	1876
13	Officer Quarters	Officer Quarters	2	1876
14	Officer Quarters	Officer Quarters	2	1876
15	Officer Quarters	Officer Quarters	2	1876
16	Officer Quarters	NCO Quarters	2	1884
17	Officer Quarters	NCO Quarters	2	1884
18	Barracks	Officer Quarters	3	1873
19	Barracks	Officer Quarters	3	1875
20	Barracks	CO Quarters	1	1875
21	Officer Quarters	Officer Quarters	1	1931
22	Officer Quarters	Officer Quarters	1	1931
23	Officer Quarters	Officer Quarters	1	1931
24	Officer Quarters	Officer Quarters	1	1931
25	Officer Quarters	Officer Quarters	1	1931
31	Barracks	Administrative Offices	-	1875
32	Barracks	Museum	-	1875
37	Storehouse	Offices	-	1918
39	Oil House	Latrine	-	1876
41	Gas Valve Building	Vacant	-	1954
48	Chapel	Post Chapel	-	1884
49	Post Headquarters	Officers' Mess	-	1876
52	Steward Quarters	NCO Quarters	1	1893
53	Steward Quarters	NCO Quarters	1	1910
54	Post Hall	Community/Family Center	-	1933
55	CO Quarters	Administrative Offices	-	1863

¹ = Source: Dames and Moore, 1991

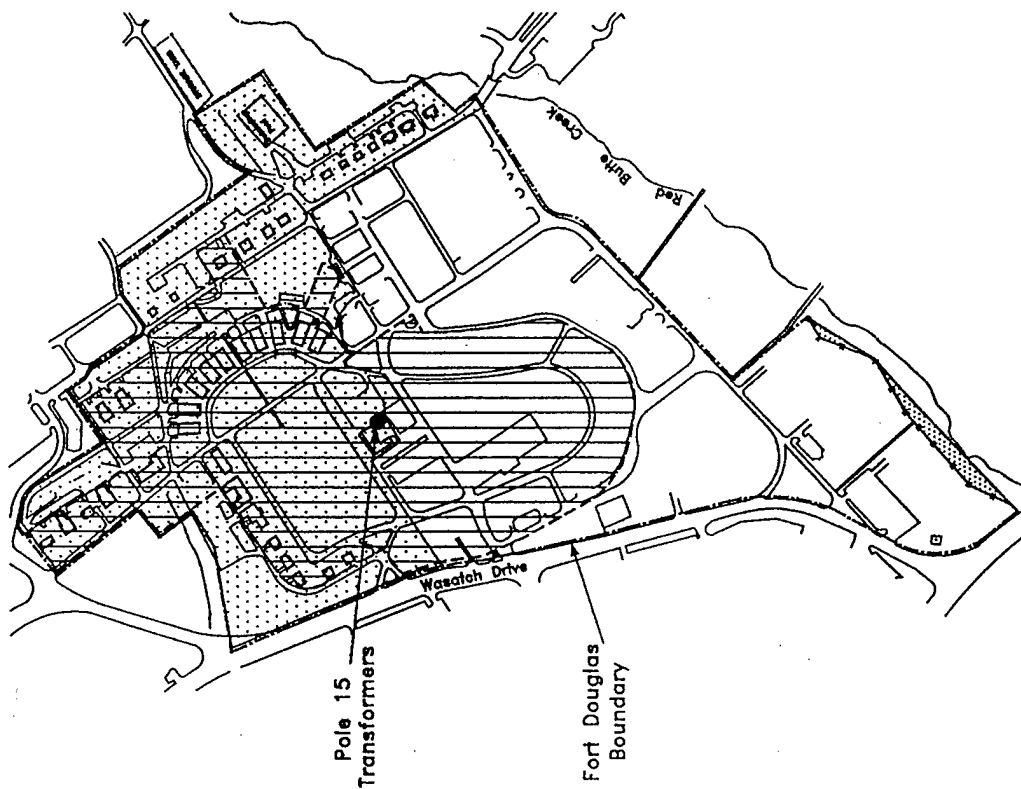
NOTES: Shading indicates buildings not designed for residential purposes.
Structures not sampled include garages and a bandstand.

Table 5-2 Description of Excessed Structures Sampled for Lead-Based Paint (page 2 of 2)

Structure Number	Original Use	Use Prior to Excessing ¹	Number of Housing Units	Year Built
56	NCO Quarters	NCO Quarters	2	1916
57	NCO Quarters	NCO Quarters	2	1916
58	NCO Quarters	NCO Quarters	2	1930
59	Fire Station	NCO Quarters	1	1917
60	NCO Quarters	NCO Quarters	2	1930
61	NCO Quarters	NCO Quarters	1	1891
62	NCO Quarters	NCO Quarters	1	1891
63	NCO Quarters	NCO Quarters	1	1891
64	NCO Quarters	NCO Quarters	2	1930
65	NCO Quarters	NCO Quarters	2	1930
66	NCO Quarters	NCO Quarters	2	1933
350	Bath House	Bath House	-	1936
351	Water Treatment	Water Treatment Building	-	1942

¹ = Source: Dames and Moore, 1991

NOTES: Shading indicates buildings not designed for residential purposes.
Structures not sampled include garages and a bandstand.



EXPLANATION



National Historic Landmark



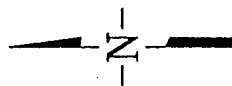
Excessed Area



Lead-Based Paint
Residential Structure



PCB-Containing
Transformers



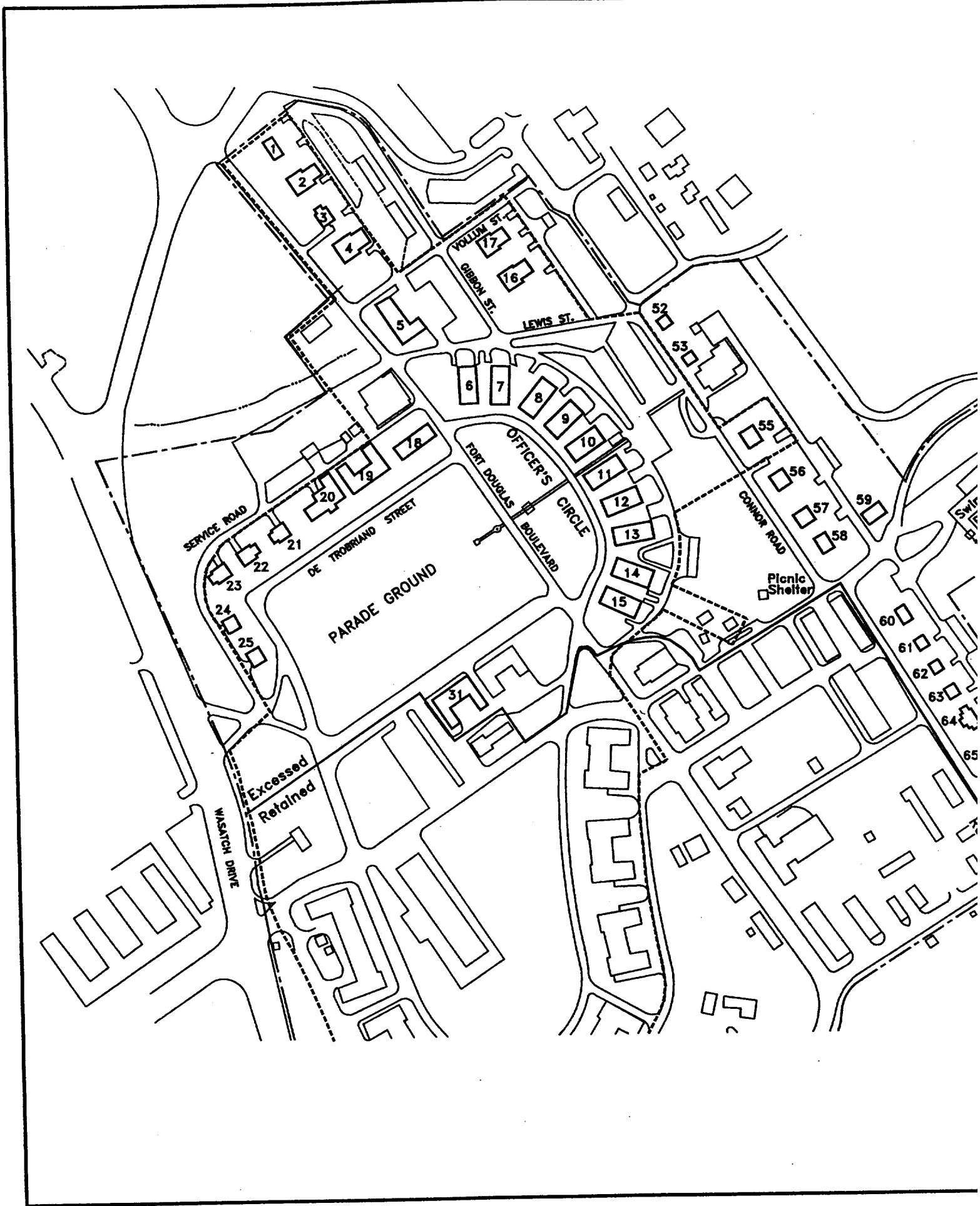
WATKINS-JOHNSON ENVIRONMENTAL, INC.
Groundwater Consulting, Environmental Engineering,
Remediation Services

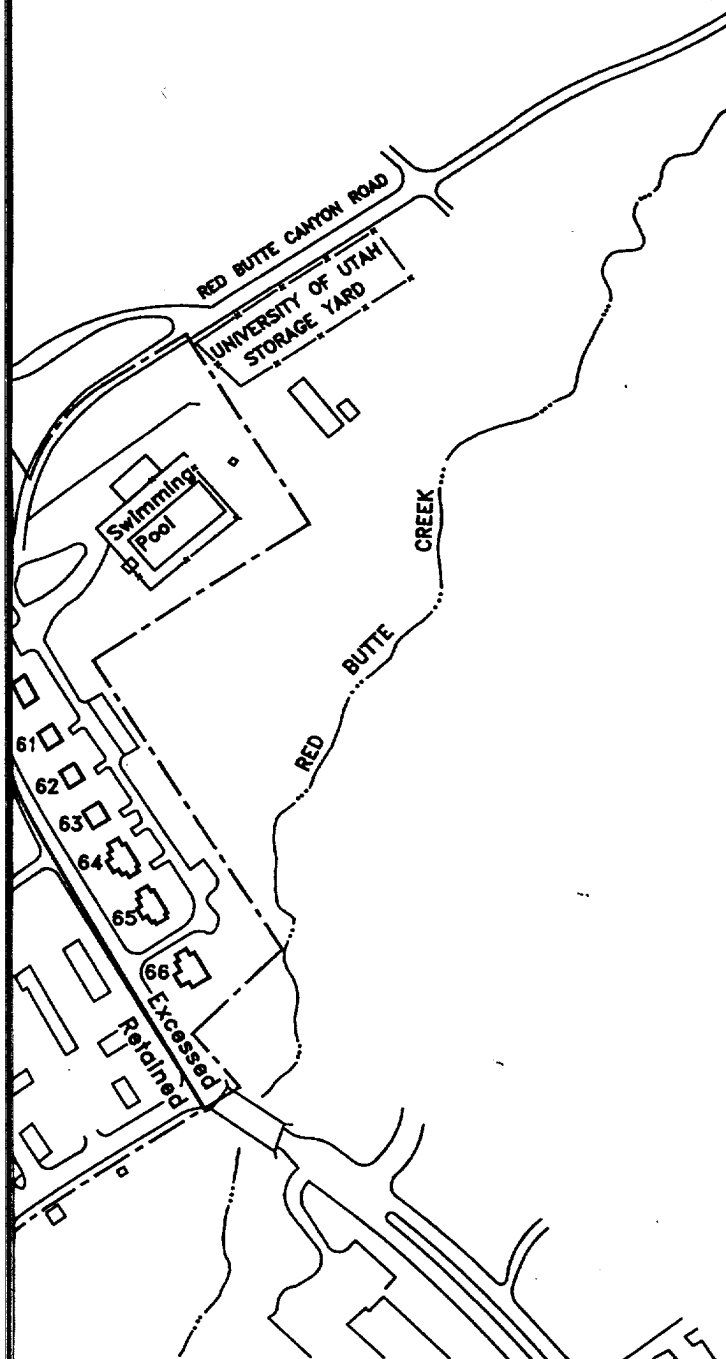
LOCATION OF PROPOSED REMEDIAL ACTION SITES

FTD35008\DV2

Date: March 1994

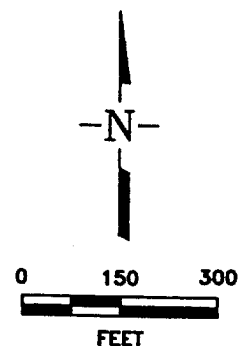
Figure 5-1





EXPLANATION

- National Historic Landmark Boundary
- . - . - . Fort Douglas Boundary
- _____ Excessed/Retained Areas Boundary
- 56 Structure Targeted for Lead-Based Paint Abatement



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Groundwater Consulting, Environmental Engineering,
Remediation Services

LOCATION OF STRUCTURES TARGETED FOR LEAD-BASED PAINT ABATEMENT

FTD35009\DV1

Date: March 1994

Figure 5-2

waste landfill, and transformers shall be disposed of by incineration or chemical waste landfilling. Therefore, the remedial action objectives for PCB-contaminated transformers are:

- Remove and dispose of PCB-contaminated transformers and liquids according to TSCA regulations to eliminate any future human health or environmental hazards.
- Be protective of human health and the environment during remediation activities.
- Comply with all other ARARs; and
- Provide the most cost-effective remedial alternative for complying with ARARs and providing the required level of protection.

5.3 LEAD-BASED PAINT

Hazards associated with lead-based paint must be eliminated before federally owned residential property may be transferred. During remediation activities, the potential exists to generate hazardous levels of lead-contaminated dust. Therefore, the remedial action objectives for structures that have been used for housing at Fort Douglas are:

- Comply with the Lead-Based Paint Poisoning Prevention Act by eliminating the hazards associated with defective lead-based paint surfaces;
- Be protective of human health and the environment during remediation activities;
- Comply with all other ARARs; and
- Provide the most cost-effective remedial alternative for complying with ARARs and providing the required level of protection.

5.4 ESTIMATED VOLUMES OF CONTAMINATED MEDIA

An initial determination of volumes of media to which general response actions might be applied is essential to the development of alternatives. The following sections present preliminary estimates of volumes of potentially contaminated media at one transformer site and residential buildings with lead-based paint at Fort Douglas; these sites were identified in Section 5.1.

5.4.1 TRANSFORMERS

The oil from transformers on pole 15 were sampled for the presence of PCBs. The analytical results are presented in Table 2-9. Transformers 15-02 and 15-03 were found to contain PCBs at a concentration of 200 $\mu\text{g/g}$. The location of pole 15 is shown in Figures 2-5 and 5-1.

Each transformer was estimated to contain 50 gallons of fluid and 200 pounds of casing.

5.4.2 LEAD-BASED PAINT RESIDENTIAL STRUCTURES

An estimate of the actual volume (or area) of defective paint surfaces in residential structures with lead-based paint was not obtained; no inventory was taken to determine the total area associated with defective paint. However, the number of structures containing defective lead-based paint surfaces are estimated, and the total area for each structure is provided.

Lead-based paint has been found in 40 residential structures within the excessed area (Figure 5-1). Three of these buildings have been used historically for housing, but the numbers of housing units per building are unknown. For the purposes of this report, these three buildings will be considered to consist of one housing unit each (or a total of three housing units). The remaining 37 buildings include 62 housing units, making a total of 65 housing units requiring remediation. A housing unit may be defined as a separate residential dwelling unit that is occupied or intended to be used as the home or residence of one or more persons. For example, a duplex house is a single structure, yet contains two housing units. Generally, there are two to four bedrooms per housing unit, the structures are two stories high with areas ranging from 1,409 to 17,640 ft^2 , and the buildings have basements (Table 5-3). Twenty-seven of these structures are located within the National Historic Landmark boundary (Figure 5-2).

Table 5-3 Construction of Residential Structures

Structure Number	Number of Housing Units	Type of Construction ¹	Total Square Feet ²	Number of Bedrooms per Unit ³	Number of Stories (excluding basement) ³
1*	2	Brick	5,918	3	2
2*	2	Frame	8,196	4	2
3*	1	Brick	4,052	4	2
4*	-	Adobe/Stone/Brick	8,144	NA	2
5*	-	Brick	17,640	NA	2
6*	2	Stone/Brick	7,798	4	2
7*	2	Stone/Brick	9,456	4	2
8*	2	Stone/Brick	9,532	4	2
9*	2	Stone/Brick	9,422	4	2
10*	2	Stone/Brick	9,348	4	2
11*	2	Stone/Brick	9,422	4	2
12*	2	Stone/Brick	9,422	4	2
13*	2	Stone/Brick	9,584	4	2
14*	2	Stone/Brick	9,362	4	2
15*	2	Stone/Brick	8,172	4	2
16*	2	Frame	9,104	4	2
17*	2	Frame	9,104	4	2
18*	3	Stone	9,996	3-6	3
19*	3	Stone	8,223	2	1
20*	1	Stone/Frame	8,501	7	2
21*	1	Brick	4,186	4	2
22*	1	Brick	4,186	4	2
23*	1	Brick	4,186	4	2
24*	1	Brick	4,186	4	2
25*	1	Brick	4,186	4	2
31*	-	Stone	8,838 ^a	NA	1
52	1	Frame	2,309	2	2
53	1	Brick	2,260	2	2
55*	-	Adobe	2,181	3	1
56	2	Stucco	3,916	2	2
57	2	Stucco	4,028	2	2
58	2	Brick	3,590	2	2
59	1	Frame	1,409	2	1
60	2	Brick	3,216	2	2
61	1	Frame	1,859	3	2
62	1	Frame	1,878	3	2
63	1	Frame	1,878	3	2
64	2	Brick	3,216	2	2
65	2	Brick	3,216	2	2
66	2	Brick	4,396	3	2

¹ = Source: Dames and Moore, 1991

² = Source: ICF, 1991

³ = Based on blueprints of various dates

^a = Estimated from blueprints of floor plan

* = Building is within National Historic Landmark (Dames and Moore, 1991)

NA = Not applicable; most recent use was not residential

During the EI investigation, most of the interior paint appeared to be in fairly good condition with defective paint chips usually being noted in the basements and near and on the windows. All but two of the structures have basements, and there are approximately 25 windows per housing unit or structure. The number of windows ranged from 11 to 91 per housing unit/structure. The EI investigation also noted defective paint on the exterior of the structures. Poor paint conditions were noted on window trim, porches, eaves, entranceways, and open surfaces. The exterior surfaces consist of non-painted brick for many of the homes; however, most of the homes have painted wooden trim and porches. Table 5-3 lists the main type of construction material for each structure.

The potential number of structures containing defective lead-based paint are:

Interior surfaces:

Number of housing units = 65

Exterior surfaces:

Number of structures = 40

6.0 GENERAL RESPONSE ACTIONS

General response actions are defined as measures that will satisfy the remedial action (RA) objectives and cleanup goals described in Section 4.0. While the contaminants and conditions vary with each of the sites under consideration, the development of overall response actions is the first step toward identifying the remedial technology types and process options applicable to each site. Generally, the purpose of the RA is to assure the protection of the environment and human health. The PCB-contaminated transformers are not a risk to human health since the transformers are sealed, and human exposure to the transformer oil would not normally occur. Therefore, the general response actions address the methods to reach the RA objectives as developed by the ARARs. The general response actions for lead-based paint should satisfy the RA objectives, which were developed to comply with ARARs and to be protective of human health and the environment.

Any RA at the site should be carried out in general accordance with the NCP, which stipulates that a range of alternatives with respect to ARARs must be evaluated in the AA to the extent that it is both possible and appropriate. The NCP also states that acceptable exposure levels are the residual concentration levels that represent an excess cancer risk to an individual of 10^{-6} to 10^{-4} . All of the cancer risk estimates for Fort Douglas soil sites fall within or below the acceptable range (10^{-6} to 10^{-4}). The following response actions are under consideration and will be discussed in general terms below:

- No-Action
- Institutional Actions/Controls
- Containment
- Treatment
- Removal/Disposal

The screening of remedial technology types and process options will be bypassed because there are a limited number of RAs for transformer disposal and lead-based paint remediation. Remedial alternatives are assembled in Section 7.0.

6.1 NO ACTION

CERCLA requires that a no action response be evaluated as a potential RA. The no action alternative serves as a baseline for comparison of other RAs developed. Strictly speaking, under the no action alternative the current status of the site would not change. There would be no additional measures taken to physically restrict access to contaminated areas or to reduce risks to human health and the environment. However, the no action response may be combined with institutional actions such as access restrictions and environmental monitoring to provide a limited action alternative. This general response action applies to both transformers and lead-based paint.

6.2 INSTITUTIONAL ACTIONS/CONTROLS

Institutional actions may include but are not limited to:

- Restrictions on portions of the Fort Douglas excessed property defining the conditions under which future development of the property could occur, limitations on the future use of the buildings, and other restrictive measures;
- Environmental monitoring such as periodic soil sampling to assure the continued protection of human health and the environment. The monitoring program would include evaluation of the effectiveness of RAs and investigation into the need for additional and/or new remediation activities.

In general, these institutional actions would not be effective by themselves, but could be used to maintain and enhance the effectiveness of the other technical response actions. Institutional actions may be an integral part of a remedial action alternative. This general response action is potentially applicable to remediation of lead-based paint sites.

6.3 CONTAINMENT

Containment refers to reducing the movement of contaminated media through the use of a physical barrier, thereby restricting the migration of the contaminant itself. This general response action is potentially applicable to remediation of lead-based paint sites.

Lead-based paint can be contained and made inaccessible through enclosure/encapsulation. Enclosure may consist of covering lead-based paint surfaces with mechanically affixed durable materials such as gypsum wallboard, plywood paneling, fiberglass, sheet metal, or exterior siding (aluminum, vinyl, or wood). These lead-free surfaces must be caulked or sealed to prevent (or control) chalking or flaking of lead-containing surfaces; this prevents lead dust from being incorporated into house dust and prevents accessibility to residents (especially children). The encapsulation method uses a durable coating that seals the surface. These bonded surfaces are formulated to be elastic, long-lasting, and resistant to cracking, peeling, algae, and fungi. Encapsulants include acrylic and epoxy coatings, and flexible wall coverings. Encapsulants are not widely accepted, but their effectiveness is currently being studied. Neither wallpaper nor a coat of new paint are acceptable for enclosure/encapsulation. The effectiveness of this technology is uncertain, based primarily on the possibility of infrequent or inadequate maintenance; accidental exposure through home repair, leaking pipes, scratched/chipped seals, etc.; and future exposure due to renovations. Effectiveness could be enhanced through an inspection and maintenance program, and restriction of activities that could disturb the seal and/or paint surface. Enclosure/encapsulation generates a minimal amount of lead-contaminated dust because painted surfaces are not breached. This method does not involve any hazardous waste disposal.

6.4 TREATMENT

Treatment response actions reduce or eliminate the toxicity, mobility or volume of a contaminant, and can be implemented on site (direct treatment), in place (in-situ treatment), or off site, as part of a disposal alternative. Both on-site and in-situ treatment are considered more protective of human health and the environment than off-site treatment because of decreased materials-handling requirements. In-situ treatment further reduces materials handling through the treatment of materials in-place without excavation. Treatment methods may use physical/chemical, biological, or thermal technologies. Brief descriptions of each of the various treatment response actions under consideration are presented in the following paragraphs. This general response action is potentially applicable for remediation of transformers, and lead-based paint sites.

6.4.1 PHYSICAL/CHEMICAL TREATMENT

Physical treatment removes contamination by mechanical means. Physical removal of lead-based paint can be achieved by scraping, sanding, sandblasting, or hydroblasting. Machine sanding is not permitted.

A high-efficiency particulate accumulator (HEPA) filter must be used in conjunction with sanding or sandblasting to collect lead-contaminated dust. Hydroblasting is acceptable only if resultant debris and water are contained. In the case of defective paint spots, physical treatment such as scraping followed by repainting is considered adequate.

Chemical treatment involves the addition of a chemical compound(s), either on-site or in-situ, to a contaminated medium. The injected chemical either bonds with, isolates, or destroys the contaminant, permanently altering the chemical structure of the contaminant. Lead-based paint can also be chemically removed using applied caustic strippers (on site) or by soaking in a diptank (off site). In order to use the off-site chemical diptank, the object covered with lead-based paint must be carefully removed, transported to the diptank, treated, transported back to the site, and reinstalled. Wooden objects (such as doors) are sometimes rendered unusable or difficult to use after being soaked in a chemical diptank. Lead residue, which is difficult to remove, may remain on the treated surface, thereby reducing the effectiveness of this technology.

6.4.2 BIOLOGICAL TREATMENT

Bioremediation generally refers to the treatment of a contaminated medium by microorganisms. This technique is used to degrade some organic compounds. Microorganisms are introduced to the contaminated medium degradation of specific organic compounds. An appropriate microbial population and a suitable environment for the microorganism must be maintained. The molecular size and chemical structure of the contaminant affects the ability of a bacteria to metabolize the contaminants and grow. This general response action is applicable for remediation of PCBs.

6.4.3 THERMAL TREATMENT

This technique involves the thermal degradation or oxidation of contaminated material by heat. Heat, typically from heating coils and hot-air guns, can be used to remove lead-based paint. Propane or gasoline torches (open flame methods) may not be used, because high temperatures may produce toxic lead fumes. Electric heat guns must be used at a low setting to avoid this problem. Lead residue, which is difficult to remove, may remain on the treated surface, thereby reducing the effectiveness of this technology. This general response action is applicable for remediation of lead-based paint sites.

This general response action consists of removal and subsequent disposal of the contaminated media, followed by replacement of the contaminated objects (if applicable). Disposal response actions include containerization (optional) and placement of the affected media into a secured enclosure. Approved landfilling, in compliance with the ARARs requirements, is a disposal method for solid hazardous waste. Disposal methods vary, however, depending upon the type, volumes and category of waste, and can be costly depending upon the contamination levels and haul distance. This general response action is applicable to transformers and lead-based paint sites.

Removal/disposal at lead-based paint sites refers to the complete removal of components covered with lead-based paint, such as windows, doors, trim, baseboards, stairs, mantels, moldings, and cabinetry, followed by replacement with components free of lead-containing paint. The lead-based paint-covered object that is removed must be disposed of properly. In some cases, historical character of the structure may be lessened by removal of original components.

7.0 ASSEMBLY OF REMEDIAL ALTERNATIVES

General response actions for transformers contaminated with PCBs and residential buildings containing lead-based paint are developed into a range of remedial alternatives in this section. Alternatives are developed for each group of sites and are summarized in the remedial alternative tables.

Remedial alternatives are usually developed through a screening process. Generally, this process includes the selection of a wide variety of technology types and process options that are identified for each environmental media. During this initial screening process, process options and entire technology types are eliminated from further consideration based on technical implementability. Site-specific information collected during the EI is considered to help screen out technology types and/or process options that cannot be effectively implemented. Broad technology types are categorized to form a "General Response Action." For example, the physical/chemical, biological, and thermal treatment remedial technology types represent the treatment general response action.

This screening process will be bypassed, and the development and assembly of remedial alternatives will be discussed in this section. The screening process for transformers is skipped because there are a limited number of remedial actions for disposal. Remedial actions for lead-based paint would require a combination of technology types and process options. This combination would probably vary from building to building, depending on historical requirements, construction techniques, and the location and condition of the lead-based paint. Therefore, screening of alternatives for lead-based paint is not discussed. The development of remedial alternatives for the buildings containing lead-based paint proceeds directly to the assembly of remedial alternatives.

7.1 RANGE OF OPTIONS

Under the NCP, a range of alternatives should be developed during an AA. The alternatives should ideally represent distinct, viable approaches to managing site problems. Ideally, the range of options regarding source control and response actions include alternatives such as treatment, containment, and no action.

Final revisions to the NCP (40 CFR 300.430) provide guidance for the development of the range of alternatives. Whenever practicable, treatment should be favored to address principal threats posed by a

site. Principal threats for which treatment is most likely to be appropriate include liquids containing hazardous substances, areas contaminated with high concentrations of toxic compounds, and highly mobile materials. Engineering controls, such as containment, are favored for waste that poses a relatively low long-term threat or where treatment is impracticable. Treatment alternatives should range from remedies treating the major threats to human health and the environment to remedies that completely destroy, detoxify, or immobilize the hazardous substances, resulting in a cleanup level such that no long term management or monitoring is required.

The typical range of remedial alternatives was not developed for the transformers or the buildings containing lead-based paint because few alternatives are available.

7.2 REMEDIAL ALTERNATIVES FOR TRANSFORMERS

Table 7-1 contains the remedial alternatives for the two PCB-contaminated transformers. These two transformers have elevated concentrations of PCBs (200 $\mu\text{g/g}$) and are both located on pole 15 (Figures 2-5 and 5-1). All of the alternatives are potentially implementable for both transformers when they are removed from service.

Alternative #1 is the no action alternative.

Alternative #2 consists of removal, detoxification, and recycling of the PCB fluid, removal and disposal (by smelting) of the transformer, and replacement of the transformer.

7.3 REMEDIAL ALTERNATIVES FOR LEAD-BASED PAINT BUILDINGS

Table 7-2 contains the remedial alternatives for the interior (65 housing units) and exterior (40 structures) surfaces containing lead-based paint. These buildings are shown on Figure 5-2 and are listed in Table 5-3. All of the alternatives are implementable.

Alternative 1 is the no action alternative.

Alternative 2 is the remediation of lead-based paint by a combination of containment (enclosure/encapsulation), physical/chemical treatment, and removal/replacement techniques. A

Table 7-1 Remedial Alternatives for Transformers

Alternative	Description
Alternative 1 — No Action	1. Leave transformers with PCB fluid in place.
Alternative 2 — Removal, Disposal, and Replacement	1. Drain PCB contaminated liquid. 2. Detoxify and recycle liquid as a fuel. 3. Remove transformer and dispose of by smelting. 4. Replace with new transformer.

Table 7-2 Remedial Alternatives for the Lead-Based Paint Buildings

Alternative	Description
Alternative 1 — No Action	1. Leave buildings with lead-based paint in place and conduct no abatement.
Alternative 2 — Lead-Based Paint Abatement	1. Conduct a detailed investigation to determine actual locations and areas of defective paint surfaces. 2. Plan the abatement technique to be used in each defective paint area. 3. Use a combination of all lead abatement techniques: encapsulation, paint removal, removal and replacement of objects covered with lead-based paint. 4. Properly dispose of all waste and debris. 5. Conduct postabatement cleanup and sampling.

combination of all three techniques is expected to be used for the Fort Douglas buildings, depending on the extent of the defective areas, the overall condition of the buildings, the historical value of the components requiring remediation, and budgetary factors.

8.0 DISCUSSION OF THE DETAILED ANALYSIS AND COMPARISON OF ALTERNATIVES

A range of general response actions was identified in Section 6.0. The remedial alternatives for each group of sites were assembled in Chapter 7.0. The NCP and the RI/FS guidance document (USEPA, 1988a), allow for further screening of remedial alternatives for effectiveness, implementability and cost prior to detailed analysis. However, the guidance also states that for those sites (or groups of sites) with a limited number of alternatives, screening may be eliminated and the AA may proceed directly to the detailed analysis of remedial alternatives.

The remedial alternatives will be evaluated, in detail, in general accordance with criteria developed on the basis of statutory requirements of Section 121 of SARA; on earlier program initiatives promulgated in the NCP, 40 CFR § 300.430(e); and on-site specific experience gained in the Superfund Program. These criteria are:

- Overall Protection of Human Health
- Compliance with ARARs
- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility or Volume
- Short-Term Effectiveness
- Implementability
- Costs
- State Acceptance
- Community Acceptance

The first two criteria are threshold criteria which must be met. The succeeding five are balancing criteria, and the remaining two are modifying criteria. A detailed analysis of the remedial alternatives for each group of sites is provided in Appendix A.

8.1 OVERALL PROTECTION OF HUMAN HEALTH

This evaluation provides a final check to assess whether the remedial alternative provides adequate protection of human health from unacceptable risks by eliminating, reducing or controlling all potential risks posed by the site through each pathway of concern. Remediated sites should be usable without

engineering or institutional controls, and should allow for the accepted future use without limitations on the exposures for human and environmental receptors.

At sites where hazardous materials remain such that unrestricted use and unlimited exposure is not possible, institutional or engineering controls, or a combination of the two, must be used to control exposure to ensure reliable protection over time.

8.2 COMPLIANCE WITH ARARS

This evaluation criterion is used to determine whether each alternative will meet all of the Federal and State ARARs that have been identified in previous stages of the EI/AA process. The detailed analysis should summarize which requirements are applicable or relevant and appropriate to an alternative and describe how the alternative meets those requirements.

8.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

This evaluation criterion emphasizes the remedies that provide long-term protection of the environment and human health. It focuses on the risks remaining from the untreated materials and treatment residuals after the site remediation is completed. The criterion also includes analyses of the adequacy and reliability of institutional and engineering controls that will be employed to manage any hazardous wastes or materials remaining at the site.

8.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME

This evaluation criterion addresses the statutory preference for remedies that utilize treatment or recycling technologies to reduce toxicity, mobility, or volume of hazardous constituents which are highly toxic, present in significant concentrations, and mobile in the environment. The analysis will specifically examine the magnitude, significance and the irreversibility of the reductions.

8.5 SHORT-TERM EFFECTIVENESS

This criterion addresses the impact of each alternative, during construction and implementation, on the neighboring community, the on-site workers, and the immediate environment. The impact includes the

potential threats to the environment and human health associated with excavation, treatment and transportation of soil contaminated with hazardous wastes. The analysis will also consider the potential cross-media impact of the remedy and the time required to achieve protection of human health until RA objectives are achieved.

NEPA compliance is addressed here, as well as in the evaluation of ARARs for each remedy. NEPA issues which relate to short-term effectiveness include protection of threatened or endangered plant and animal species that could be impacted by the RA. Similarly, archaeological resources and historical buildings located adjacent to remediation sites must be protected during the implementation of any RA. Potential community impacts created by the RA, such as changes in traffic patterns and volume due to construction equipment, increased noise, air emissions, or other aesthetic factors, must be addressed here and in the evaluation of ARARs compliance. Short-term effects can be mitigated through the use of institutional controls along with other active measures that may include interim remedies or removal actions.

8.6 IMPLEMENTABILITY

This criterion considers the technical and administrative feasibility of each alternative and the availability of goods and services such as construction, monitoring, treatment, storage or disposal, on which the viability of the alternative depends.

Some of the areas to be addressed in the technical feasibility section include technical difficulties and unknowns associated with construction and operation of technology, reliability of technology, ease of undertaking the RA, and the ability to monitor the effectiveness of the remedy. The discussion on administrative feasibility should include activities which must be coordinated with other offices and agencies, and the ability and time required to obtain necessary approvals and permits from other agencies.

8.7 COSTS

This criterion evaluates both capital and annual operation and maintenance (O&M) costs. Capital costs include both direct construction and indirect non-construction and overhead costs. The annual O&M costs may include operating and labor costs, maintenance costs, energy costs, and laboratory costs. For

economic analysis, it is assumed that the O&M activities will continue for 30 years after the completion of the project.

The cost estimates have been developed based on a variety of cost-estimating data. Bases for developing cost estimates include generic unit costs, conventional cost-estimating guides, vendor information, and engineering judgment. Present worth analysis is used to evaluate the total costs for each alternative. For the present worth analysis, a discount rate of 5 percent has been used. The cost estimates are found in Appendix A.

8.8 STATE ACCEPTANCE

This criterion presents the requirements to provide for substantial and meaningful state involvement. This criterion includes the state's position and key concerns related to the preferred and other alternatives. These comments will be included in Appendix A of this report and the RAP.

8.9 COMMUNITY ACCEPTANCE

This criteria addresses the degree of acceptance by the general public and all interested parties. Prior to potential implementation of the preferred alternatives, community comments will be evaluated.

9.0 RANKING OF THE REMEDIAL ALTERNATIVES

This section ranks each remedial alternative in relation to the seven evaluation criteria listed below:

- Overall protection of human health,
- Compliance with ARARs,
- Long-term effectiveness and permanence,
- Reduction of toxicity, mobility, or volume,
- Short-term effectiveness,
- Implementability, and
- Costs.

These criteria are also included in Appendix A which provides a detailed analysis and comparison of alternatives.

The lowest ranking (1) is given to the alternative that does not meet the criterion, while the highest ranking (up to 2 depending upon the number of alternatives) is given to the alternative which most effectively addresses the criterion. For costs, the alternatives are ranked from highest cost (1) to lowest cost (2). These costs are presented in detail in Appendix A. The highest total ranking for each site may determine the alternative to be seriously considered as the preferred alternative, unless cost or other considerations dictate otherwise. Tables 9-1 and 9-2 present the ranking for the remedial alternatives for the soil sites (Building 39 and the transformers and lead-based paint structures). The preferred alternative for each site will be discussed in a separate document — the Remedial Action Plan.

Table 9-1 Ranking of Remedial Alternatives - Transformers

EVALUATION CRITERIA	ALTERNATIVES	
	1 No Action	2 Removal, Disposal, and Replacement
Protection of Human Health	1	1
Compliance with ARARS	1	1
Long-Term Effectiveness	1	2
Reduction of Toxicity, Mobility or Volume	1	2
Short-Term Effectiveness	2	2
Implementability	2	1
Costs	2	1
TOTAL RANKING	10	10

Note:

The lowest ranking (1) is given to the alternative that does not meet the criterion, while the highest ranking (2) is given to the alternative which most effectively addresses the criterion. For costs, the alternatives are ranked from highest cost (1) to lowest cost (2).

Table 9-2 Ranking of Remedial Alternatives - Lead-Based Paint Buildings

EVALUATION CRITERIA	ALTERNATIVES	
	1 No Action	2 Lead-Based Paint Abatement
Protection of Human Health	1	2
Compliance with ARARs	1	2
Long-Term Effectiveness	1	2
Reduction of Toxicity, Mobility or Volume	1	2
Short-Term Effectiveness	2	1
Implementability	2	1
Costs	2	1
TOTAL RANKING	10	11

Note:

The lowest ranking (1) is given to the alternative that does not meet the criterion, while the highest ranking (2) is given to the alternative which most effectively addresses the criterion. For costs, the alternatives are ranked from highest cost (1) to lowest cost (2).

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Appendix A

Detailed Analyses and Comparison of Alternatives

A-1 Transformers

A-2 Lead-Based Paint Structures

A-1 Transformers

The number and range of remedial alternatives developed for the transformers in Section 7 of this report are judged to be limited but complete. Therefore, the alternative screening section is skipped and this section proceeds directly to the detailed analyses of the remedial alternatives. Under TSCA regulations, remediation of the PCB-contaminated transformers and fluids is not required unless the transformers are to be removed from service and disposed of. Two remedial alternatives were assembled for these sites. The alternatives which will undergo detailed analysis in this section are:

- Alternative 1 — No Action
- Alternative 2 — Removal, Disposal and Replacement

A-1.1 Alternative 1 — No Action

The No Action alternative provides the baseline for comparing other alternatives. This alternative would not involve containment, removal or treatment of PCB-contaminated transformers on pole 15. The site would be left in its current condition.

- **Overall Protection of Human Health**

The No Action alternative does not present a risk to human health, because there is not an exposure pathway and the contaminated fluids are encased in the transformers, which are generally isolated from human contact.

- **Compliance with ARARs**

Under the No Action alternative, the recommended cleanup levels established in the remedial action objectives would not be met. Because no remediation will take place, there would be no action-specific ARARs. The No Action alternative does not contemplate any waste generation/handling activities, which would trigger RCRA land disposal restrictions. Because this alternative would not require the removal of the transformers, chemical-specific and disposal ARARs for PCB identified in Section 4.0 would be met as long as the transformers

remain in service. These ARARs would not be met if the transformers were not disposed of in compliance with TSCA regulations.

- **Long-Term Effectiveness and Permanence**

The target remediation levels would be achieved in the long term by this alternative if the transformers remained in service. There is no risk to human health since the PCB-contaminated fluids are inside the transformers. This alternative may not be reliable for adequate waste management if the transformers are taken out of service and not properly disposed of. The transformers were observed to be in poor condition and may leak in the future; long-term effectiveness and permanence may not be achieved.

- **Reduction of Toxicity, Mobility or Volume**

Under this alternative, no reduction of toxicity, mobility or volume would be achieved. It is unlikely that natural mechanisms would reduce toxicity, mobility or volume of the contaminant over time.

- **Short-Term Effectiveness**

This alternative is effective in the short term, because human health is protected by the inaccessibility of the PCB-contaminated fluid. The RA objectives would be reached immediately since nothing has to be done to implement this alternative.

- **Implementability**

Technical Feasibility: From a technical standpoint, the No Action alternative is readily implementable.

Administrative Feasibility: From an administrative standpoint, the No Action alternative is readily implementable.

- **Costs**

There are no costs associated with this alternative.

- **State Acceptance**

The State reviewed the draft final version of this report, and did not have any comments related to this alternative.

- **Community Acceptance**

Prior to potential implementation of the preferred alternatives, community comments will be evaluated.

A-1.2 Alternative 2 — Removal, Disposal and Replacement

This alternative involves the removal, detoxification, and recycling of the PCB-contaminated fluid, transformer disposal (by smelting), and replacement.

- **Overall Protection of Human Health**

Because this action results in the complete removal of the contaminant source, this alternative would provide overall protection of human health since the transformers are taken out of service and disposed of.

- **Compliance with ARARs**

This alternative complies with the TSCA ARAR for disposal of the PCB-contaminated transformer and liquid. Remedial activities in this alternative would be subject to RCRA restrictions. These restrictions are specified in Section 4.0 of this report.

- **Long-Term Effectiveness and Permanence**

Long-term effectiveness and permanence of this remedy would be provided by the complete removal of the contaminant.

- **Reduction of Toxicity, Mobility, or Volume**

Recycling and decontamination of the fluid, and destruction of the transformer would completely eliminate the toxicity, mobility, and volume of the contaminant at the site.

- **Short-Term Effectiveness**

This alternative is effective in the short term, because human health is protected by the inaccessibility of the PCB-contaminated fluid. The RA objectives would be reached in a minimal amount of time.

- **Implementability**

No special techniques, materials, permits, or labor would be required to implement this remedy from a technical standpoint. The equipment and the skills needed for this operation would be readily available in this area. Acquisition of the necessary transportation and disposal permits, and gaining public acceptance are some of the administrative issues that may affect implementability.

- **Costs**

The estimated costs for Alternative 2 are summarized below:

SITE	COST ESTIMATE
Pole Number 15	\$ 5,900

Detailed cost analyses are provided in Table A-1.1.

Table A-1.1 Cost Estimate for Transformers, Alternative 2, Removal, Disposal, and Replacement

Item Number	Description	Basis of Estimate						Amount(2)
		Quantity	Units	Rate(1)	Units	Quantity	Units	
I	SUPPORT FACILITIES							
	1. Office Trailers	1	site	\$400	per month	0.3	month	\$100
	2. Decontamination Trailer	1	site	\$1,000	per month	0.3	month	\$300
							Subtotal	\$400
II	TRANSFORMER REMOVAL AND DISPOSAL							
	1. Removal from Pole	5	hour	\$100	per hour	2	transformer	\$1,000
	2. Remove & Recycle Liquid	50	gallon	\$2.2	per gallon	2	transformer	\$200
	3. Remove & Dispose Casing (3)	200	pound	\$0.5	per pound	2	transformer	\$200
	4. Transportation (4)	1	truck	\$100	per transformer	2	transformer	\$200
							Subtotal	\$1,600
III	REPLACEMENT							
	1. Purchasing	2	transformer	\$1,000	per transformer	1	site	\$2,000
	2. Installation	4	hour	\$100	per hour	2	transformer	\$800
							Subtotal	\$2,800
	TOTAL DIRECT COST (TDC)							\$4,400
	Contingency at					20%	of TDCC	\$900
	Engineering at					10%	of TDCC	\$400
	Legal and Administrative at					5%	of TDCC	\$200
	TOTAL COST (TC)							\$5,900

1. 1992 dollars.
2. Rounded to nearest \$100.00.
3. Disposal by smelting
4. Transportation to Grassey, Utah

- **State Acceptance**

The State reviewed the draft final version of this report, and did not have any comments related to this alternative.

- **Community Acceptance**

Prior to potential implementation of the preferred alternatives, community comments will be evaluated.

A-1.3 Alternative Comparison

Table A-1.2 summarizes the relative advantages and disadvantages of each of the two alternatives analyzed for remediation of the PCB-contaminated transformers at Fort Douglas.

Table A-1.2 Comparison Matrix — Transformer Sites

EVALUATION CRITERIA	ALTERNATIVES	
	1 No Action	2 Removal, Disposal, Replacement
POTENTIALLY IMPLEMENTABLE	Pole 15	Pole 15
Protection of Human Health	Yes	Yes
Compliance with ARARS	Yes	Yes
Long-Term Effectiveness	Limited, transformers may eventually leak and be removed from service	Yes, complete removal of contaminants
Reduction of Toxicity, Mobility or Volume	None	Yes, complete removal and treatment of contaminated liquid and destruction of casing.
Short-Term Effectiveness	Yes	Yes
Implementability	Technically and Administratively Implementable	Technically and Administratively Implementable
Costs: Pole 15	None	\$ 5,900

A-2 Lead-Based Paint Structures

The number and range of remedial alternatives developed for the structures containing lead-based paint, presented in Section 7 of this report, are judged to be limited but complete; only three lead-based paint abatement technologies are acceptable. Therefore, the alternative screening section is skipped and this section proceeds directly to the detailed analyses of the remedial alternatives. Remediation of defective paint surfaces is required under the Lead-Based Paint Poisoning Prevention Act. Two remedial alternatives were assembled for these sites. The alternatives that will undergo detailed analysis in this section are:

- Alternative 1 — No Action
- Alternative 2 — Lead-Based Paint Abatement

A-2.1 Alternative 1 — No Action

The No Action alternative provides the baseline for evaluating other alternatives. This alternative would not involve containment, removal, or treatment of the lead-based paint. All lead-based paint surfaces in residential structures would remain in their present condition.

- **Overall Protection of Human Health**

All defective lead-based paint surfaces are assumed to be immediate hazards under 24 CFR § 35.56(a)(1). Defective surfaces of lead-based paint were present in some of the sampled buildings, constituting a hazard to human health as defined by these regulations. These hazards would not be eliminated under the No Action alternative. Intact paint surfaces are not defined as a hazard under these regulations. There are no health-based criteria for determining a permissible level of lead-contaminated house dust.

- **Compliance with ARARs**

Under the No Action alternative, the hazards associated with the lead-based paint would not be eliminated as required by 24 CFR § 35. Because no remediation would take place, no action-specific ARARs would govern disposal of waste and preservation of historic buildings.

- **Long-Term Effectiveness and Permanence**

The No Action alternative does not include remedial activities to reduce the hazards associated with the lead-based paint. In addition, if the paint condition was allowed to deteriorate due to a lack of maintenance, the number and extent of defective paint surfaces likely would increase. Consequently, the immediate hazards of defective lead-based paint as defined in the Lead-Based Paint Poisoning Prevention Act would increase.

- **Reduction of Toxicity, Mobility or Volume**

Under this alternative, no reduction of toxicity, mobility, or volume (TMV) would be achieved. It is unlikely that natural mechanisms would reduce toxicity, mobility or volume of the contaminant over time.

- **Short-Term Effectiveness**

This alternative is effective in the short term for the structures at which no defective paint surfaces exist. For other structures, where defective paint surfaces exist, this alternative would not meet the RA objectives.

- **Implementability**

The No Action alternative is readily implementable because there would be no changes (either administrative or technical) associated with the sites.

- **Costs**

There are no costs associated with this alternative.

- **State Acceptance**

The State reviewed the draft final version of this report, and did not have any comments related to this alternative.

- **Community Acceptance**

Prior to potential implementation of the preferred alternatives, community comments will be evaluated.

A-2.2 Alternative 2 — Lead-Based Paint Abatement

This alternative involves a combination of containment (enclosure/encapsulation), physical/chemical treatment (physical removal of paint by scraping or chemical stripping), and removal/replacement (of lead-contaminated objects) techniques to remediate defective lead-based paint surfaces. Based on a preliminary inspection conducted during the EI, most of the paint was in good condition. Exceptions included basements, where paint had been applied directly to masonry, trim on baseboards and windows, and exterior trim and porches. The level of effort required for remediation of lead-based paint at each housing unit will vary depending on the conditions and extent of defective paint. Inspections by qualified contractors should be conducted to estimate the costs, and evaluate the extent of abatement necessary and the techniques that would be most appropriate for each individual housing unit. Abatement should be conducted by workers and supervisors trained in abatement of lead-based paint.

Abatement may generate levels of lead-contaminated dust that are hazardous to occupants, especially to children and pregnant women; therefore, tenants may have to be relocated and furniture stored off site during the abatement. During remediation, lead-contaminated dust must be minimized and contained. Abatement waste must be disposed of properly. A thorough postabatement cleanup followed by sampling should ensure that the levels of lead-contaminated dust are safe.

In order to avoid accumulation of lead-contaminated dust after abatement, housing units should be kept clean; this can be facilitated by making dust control more manageable for the occupants. All lead-based paint in the housing units should be inspected periodically (perhaps once a year). This applies to intact paint as well as paint that has been enclosed or encapsulated. Also, household dust should be sampled periodically to ensure that lead-contaminated dust levels are within acceptable limits for human health.

In a mid-1980s study (Mariani, 1988), it was noted that some of the original windows and porches had been removed during previous maintenance and remodeling. These factors should be researched prior to developing a comprehensive abatement plan to avoid remediating paint that does not contain lead.

- **Overall Protection of Human Health**

Because the release of lead-based paint from existing defective surfaces can be controlled by this action, human health would be protected. However, additional hazardous dust containing lead will be created by these actions, particularly paint removal by physical and chemical methods. Also, since enclosure/encapsulation leaves the lead on site, a risk to human health remains if hazardous dust is generated during renovation or if the sealing materials fail.

Methods for controlling human exposure to dust include providing adequate worker protection during remedial activities; covering floors, air ducts, entranceways to non-abatement areas, and nonmovable objects that are not being abated; painting and sealing remediated surfaces and floors after abatement (to lock in any residual lead-contaminated dust and provide a smooth surface for cleaning); and conducting a thorough final cleanup after completion of remedial action. Household furnishings should be protected by sealing them within the work area, or, preferably, removing them from the work area. It is preferable to remove furniture from the work area. If abatement is conducted on a large scale, occupants should be relocated until postabatement clearance testing determines that the residence is safe. Adequate cleanup can be verified through postabatement visual inspections and collection and analysis of surface dust. Adherence to waste disposal regulations is also required to protect human health.

- **Compliance with ARARs**

This alternative complies with the provisions of the Lead-Based Paint Poisoning Prevention Act (42 USC 4822; 24 CFR § 35), which require the remediation of defective lead paint surfaces. The proposed remedial activities would be subject to review by federal and state agencies that oversee the preservation of historic structures as required by the National Historic Preservation Act (16 USC 470; 36 CFR § 60.4), Protection of Historic and Cultural Properties (36 CFR § 800; Executive Order 11593), Historical Preservation Act (Utah Code Ann. §§ 63-18a-1 through 6), State Antiquities Statutes (Utah Code Ann. §§ 63-18-18 through 38), and other ARARs. These and other potential ARARs are discussed in Section 4 of this

report. Waste disposal would be conducted in accordance with RCRA regulations (42 USC 6901; 40 CFR §§ 261 through 263; 40 CFR § 268; and other implementing regulations). Enclosure may be preferable if historical restoration is conducted after abatement.

- **Long-Term Effectiveness and Permanence**

This alternative would be adequate and reliable in managing the current hazards created by the lead-based paint. Removal/replacement of lead-contaminated objects and physical or chemical removal of lead-based paint would have the highest rating of long-term effectiveness and permanence because the lead-based paint would be removed from the housing units, in contrast to enclosure/encapsulation where the hazard remains on site. The length of time for which the lead-based paint hazard is deferred using the encapsulation/enclosure method would depend upon the durability of the encapsulants and enclosure materials, and by subsequent maintenance practices. Little empirical evidence is available on how long enclosure/encapsulation methods will be effective in containing hazards from lead-based paint.

It may be difficult to remove all lead dust generated by physical and chemical removal. The long-term effectiveness and permanence of this alternative can be enhanced by minimizing generation of lead-contaminated dust during abatement, routinely cleaning surfaces that may collect lead dust, and periodically inspecting remaining lead-based paint surfaces, including enclosed or encapsulated areas.

The housing units should be thoroughly cleaned to remove any lead dust that was generated during remediation. All surfaces should be mopped with a trisodium phosphate solution (which is effective in removing lead particles), vacuumed with a HEPA filter, and remopped. Protective plastic sheeting and abatement debris should be carefully removed and disposed of properly. Smooth, easily cleanable surfaces should be created during abatement to facilitate cleanup and control of household dust, which may contain lead particles. For example, window areas, which tend to collect dust, should be primed and covered with high-gloss paint. Wooden floors should be finished in polyurethane to seal in any remaining lead dust and simplify cleaning. These postabatement activities will be protective of human health.

- **Reduction of Toxicity, Mobility, or Volume**

Removal and replacement of objects covered by lead-based paint would reduce the TMV of lead at the site. However, the lead would still exist off the site (the TMV will not be reduced off site) and would have to be disposed of properly. Enclosure/encapsulation would reduce the mobility of lead at the site, but would have no effect on the toxicity or volume of lead. Physical and chemical paint removal would temporarily increase the mobility of lead by generating lead-contaminated dust; however, lead dust containment techniques are available. Since removal/replacement of lead-contaminated objects and physical/chemical removal of lead-based paint produces hazardous waste, and the waste typically would not be treated, there would be no overall reduction in the TMV of the lead contaminants removed from the site.

- **Short-Term Effectiveness**

The remediation of the lead-based paint is not effective in the short term with respect to human health due to the potential release of hazardous lead dust during remediation. Residents should be evacuated from the working area or temporarily relocated. Adequate worker protection should be provided during remedial activities. Workers should be trained in lead-based paint abatement, alerted to the hazards associated with abatement, and required to wear protective clothes and respirators. The abatement area should be sealed off using plastic sheeting and tape. These materials may become hazardous if lead particles have accumulated on them, and should be tested and properly disposed of. Many of the solutions used in chemical stripping are hazardous; if this technique is employed, care should be taken. Remediated surfaces and floors should be painted/sealed and a final cleanup should be conducted to verify that the residence meets postabatement clearance testing criteria.

Improper remediation of exterior painted surfaces can result in release of lead to the soil. Release of lead into the environment can be limited by polyethylene sheeting and waste containers. Remediation could take 3 to 9 weeks per structure, depending on the condition of the paint, number of layers of paint, extent of defective paint, and other factors. Extreme caution must be used to contain lead particles if hydroblasting is used.

- **Implementability**

Technical Feasibility: This lead abatement alternative is readily implementable. Procedures have been established for remediation of lead-based paint, and contractors familiar with these types of projects are available in the area. The integrity of all remediated surfaces and intact lead-based paint surfaces should be monitored periodically.

Administrative Feasibility: The remediation will require input from the federal and state agencies responsible for historic preservation, prior to any remediation. U.S. Department of Transportation permits may be required for transportation of hazardous waste. A permit may be needed to dispose of the waste at a hazardous waste landfill or incinerator.

- **Costs**

The current estimated costs for Alternative 2 are summarized below:

SITE	COST ESTIMATE
Lead-Based Paint Structures	\$ 1,625,000

These costs are preliminary estimates and are not expected to provide an accuracy of +50 percent to -30 percent, as is the usual goal of an FS process (USEPA, 1988a). Typically, this range of accuracy is necessary to rank the relative costs of each remedial alternative. However, in the case of the lead-based paint abatement, no cost comparison is necessary because only one action alternative is presented.

The costs for this alternative are based on costs for previous lead abatement projects. Costs have ranged from \$5,500 per unit (USHUD, 1990) to more than \$25,000 per unit (USHUD, 1990; Benderoff, 1990). The estimated cost of \$25,000 per unit or structure has been applied to the Fort Douglas structures. It is assumed that the abatement program generally will follow stringent HUD worker and environmental protection standards, including the use of

polyethylene sheeting, protective clothing, respirators, and waste disposal in accordance with federal, state, and local regulations.

A more accurate cost estimate for the structures would require an inspection of all the housing units by a qualified contractor, consultation with historic preservation organizations, and possibly a pilot study on one or more units. Some of the components of determining the abatement costs include: direct labor during abatement; labor costs associated with setup, daily cleanup, final cleanup, mobilization, demobilization, etc.; materials needed for abatement; materials needed for protection of workers and the environment such as polyethylene sheeting, tape, labels, and disposable protective clothing; overhead and profit of the contractor; postabatement clearance including a visual inspection and dust sampling and analysis; and cost of disposing of hazardous materials. Factors affecting the abatement costs and limitations in estimating the costs are described in the following paragraphs.

Abatement costs vary with the method used, the accessibility, location (interior, exterior), and extent of defective paint surfaces, and the quantity and types of building components. These variables would likely differ for each housing unit. Additional considerations include the size of the unit or structure, the number of stories, the height of the ceilings, and whether the building is a single-family or multiple-family structure.

Relocation of the occupants may also be a factor in costing abatement. In some cases, relocation costs could reach or exceed abatement costs. The location and extent of defective paint surfaces may determine if relocation is necessary. In some cases, occupants may be temporarily relocated, but their personal belongings may remain in the building if adequate measures are taken to protect them from lead dust. If not, costs for moving and storing personal belongings must be considered. The number of occupants needing relocation, if any, may depend on when abatement takes place. The length of time needed for the abatement of each unit also affects the relocation costs.

Disposal costs are another nebulous factor in the abatement project. The costs will vary based on the abatement method(s) used, which in turn affect the amount and type of waste generated. This factor will not be consistent by unit.

Any waste must be tested to determine if it is hazardous. The number of samples requiring analysis will depend on the amount and types of waste generated. Sampling will be based on U.S. Army Environmental Hygiene Agency (USAEHA) Sampling Protocol, Building Demolition Debris and Buildings Painted with Lead-Based Paint (USAEHA, 1992). If some of the waste is categorized as RCRA hazardous waste, the disposal options will be limited and the costs will increase. Transportation costs associated with disposal will depend upon the type and amount of waste generated and the location of the disposal facility.

- **State Acceptance**

The State reviewed the draft final version of this report, and did not have any comments related to this alternative.

- **Community Acceptance**

Prior to potential implementation of the preferred alternative, community comments will be evaluated.

A-2.3 Alternative Comparison

Table A-2 summarizes the relative advantages and disadvantages of each of the two alternatives analyzed for remediation of the lead-based paint buildings at Fort Douglas.

Table A-2 Comparison Matrix — Lead-Based Paint Structures

EVALUATION CRITERIA	ALTERNATIVES	
	1 No Action	2 Lead-Based Paint Abatement
POTENTIALLY IMPLEMENTABLE	Lead-Based Paint Structures	Lead-Based Paint Structures
Protection of Human Health	No	Yes
Compliance with ARARS	No	Yes
Long-Term Effectiveness	None	Yes, remediation of defective paint surfaces. However, abatement methods, routine cleaning, and periodic inspections need to be addressed.
Reduction of Toxicity, Mobility or Volume (TMV)	None	Mobility would be reduced with enclosure/encapsulation, but toxicity and volume would remain the same. Removal/replacement would reduce TMV on site, but would not change off site.
Short-Term Effectiveness	No	Yes, provided that proper remediation techniques are followed.
Implementability	Technically and Administratively Implementable	Technically and Administratively Implementable
Costs: Lead-Based Paint Structures	None	\$ 1,625,000