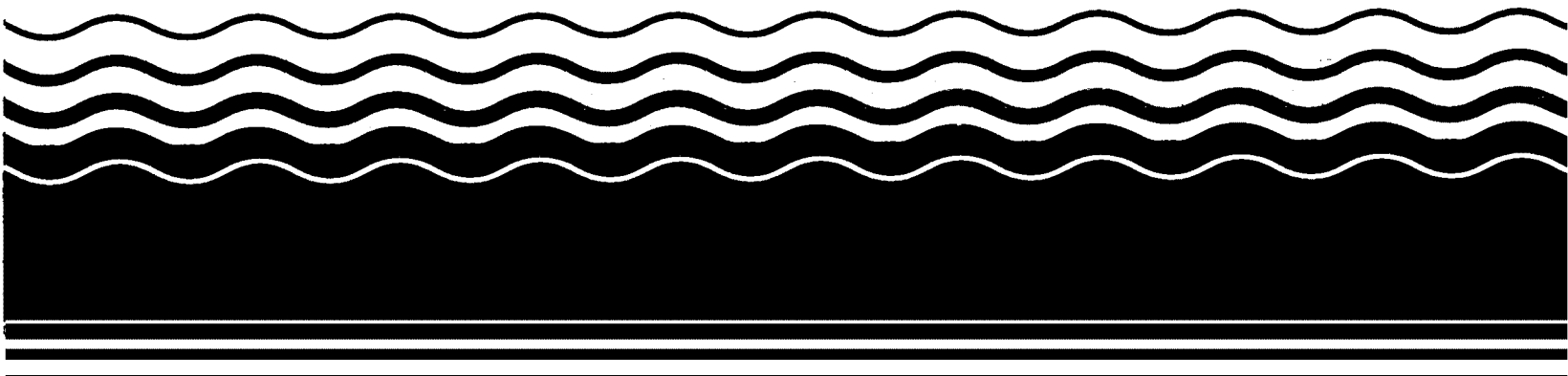




Superfund Record of Decision:

**Fairchild Air Force Base 4
Areas (Operable Unit 1), WA**



REPORT DOCUMENTATION PAGE		1. REPORT NO. EPA/ROD/R10-93/053	2	3. Recipient's Accession No.																			
4. Title and Subtitle SUPERFUND RECORD OF DECISION Fairchild Air Force Base 4 Areas (Operable Unit 1), WA First Remedial Action - Final				5. Report Date 02/11/93																			
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12. Sponsoring Organization Name and Address U.S. Environmental Protection Agency 401 M Street, S.W. Washington, D.C. 20460				13. Type of Report & Period Covered 800/800																			
				14.																			
15. Supplementary Notes PB94-964604																							
16. Abstract (Limit: 200 words) <p>The Fairchild Air Force Base 4 Areas (Operable Unit 1) site is located approximately 12 miles west of Spokane, Washington. Land use in the area is predominantly agricultural. An estimated 135 people reside in a trailer park located within 1,500 feet of the site. The upper and lower aquifers in the immediate vicinity and downgradient from the site are used for municipal and residential water supplies. The inactive Craig Road Landfill (CRL) occupies approximately 100 acres of the Base and contains three inactive disposal areas. These areas previously were used to dispose of various types of wastes, including miscellaneous sanitary and industrial waste, construction and demolition debris, coal ash from power plants, solvents, dry cleaning filters paints, thinners, and possibly electrical transformers. The northeast landfill was active from the late 1950s to early 1960s and the southwest landfill was active from the late 1960s to the late 1970s. As part of the U.S. Air Force Installation Restoration Program (IRP), onsite environmental investigations of past disposal practices were initiated. Sampling indicated that offsite residential wells, located directly northeast of the CRL, were contaminated with TCE above drinking water standards. The Air Force immediately connected these residences to an alternate water supply. In 1991, the Air Force initiated a removal action at the site and began pumping water from the upper</p> <p>(See Attached Page)</p>																							
17. Document Analysis <table border="0"> <tr> <td>a. Descriptors</td> <td colspan="5">Record of Decision - Fairchild Air Force Base 4 Areas (Operable Unit 1), WA First Remedial Action - Final Contaminated Media: soil, debris, gw Key Contaminants: VOCs (benzene, TCE)</td> </tr> <tr> <td>b. Identifiers/Open-Ended Terms</td> <td colspan="5"></td> </tr> <tr> <td>c. COSATI Field/Group</td> <td colspan="5"></td> </tr> </table>						a. Descriptors	Record of Decision - Fairchild Air Force Base 4 Areas (Operable Unit 1), WA First Remedial Action - Final Contaminated Media: soil, debris, gw Key Contaminants: VOCs (benzene, TCE)					b. Identifiers/Open-Ended Terms						c. COSATI Field/Group					
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18. Availability Statement		19. Security Class (This Report) None		21. No. of Pages 68																			
		20. Security Class (This Page) None		22. Price																			

Abstract (Continued)

aquifer to remove contaminants and to minimize migration. Additionally, an air stripping treatment system was constructed onsite to treat the extracted ground water. Construction of a pipeline to divert wastewater from the Base wastewater treatment plant (WWTP) is underway currently, and will eliminate the discharge of the Base's WWTP effluent to the infiltration pond and trenches on the landfill property. This ROD addresses the source areas associated with subsurface disposal at the CRL, as well as onsite and offsite ground water, as OU1. Future RODs will address the remaining contamination at the Base. The primary contaminants of concern affecting the soil, debris, and ground water are VOCs, including benzene and TCE.

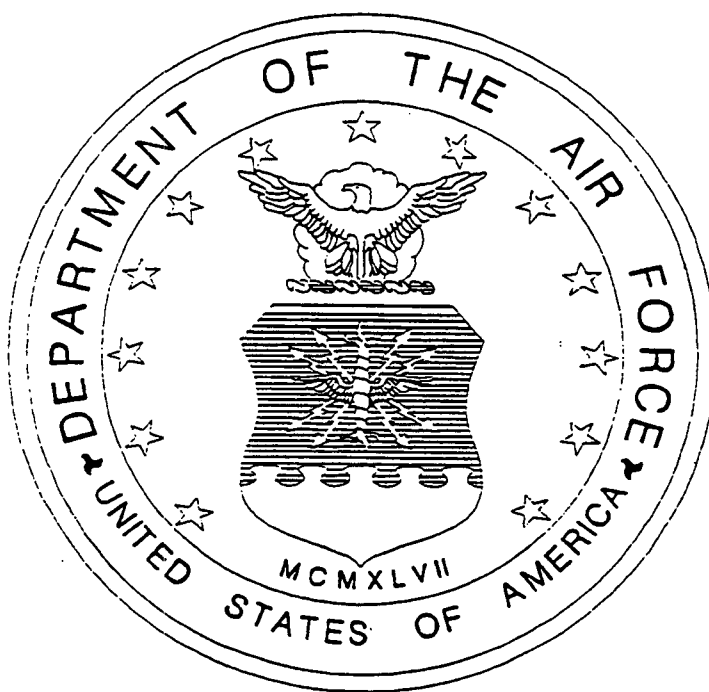
The selected remedial action for this site includes capping the northeast and southwest disposal areas at the landfill; performing a treatability study, then installing a soil vapor extraction system on the capped area; extracting and treating the contaminated ground water from the vapor aquifer onsite using air stripping, with offsite reinjection or discharge downgradient of the site; controlling air emissions using granular activated carbon, and disposing of any spent carbon offsite; inspecting, monitoring, reconstructing, and/or abandoning offsite supply wells, as necessary; providing point of use and/or an alternate water supply in the future, if needed; monitoring onsite and offsite ground water; and implementing institutional controls, including deed restrictions, and site access restrictions, including fencing. The estimated present worth cost for this remedial action is \$8,722,073, which includes an annual O&M cost ranging from \$46,000 to \$393,000 for 30 years.

PERFORMANCE STANDARDS OR GOALS:

Remedial Action Objectives (RAO's) for the CRL are based on CERCLA requirements, the State of Washington's Model Toxics Control Act (MTCA) Method B, and overall reduction of the cumulative excess cancer risk at the site to less than 10^{-5} . The chemical-specific ground water cleanup goal for TCE is 5 ug/l. Chemical-specific goals for soil were not provided.

United States Air Force

Environmental Restoration Program



Record of Decision

Craig Road Landfill (CRL)

Fairchild Air Force Base

February 1993

INSTALLATION RESTORATION PROGRAM (IRP)

**RECORD OF DECISION
CRAIG ROAD LANDFILL (CRL)
[Site ID No. LF-02 (SW8)]
FINAL**

For

**FAIRCHILD AIR FORCE BASE
Washington**

FEBRUARY 1993

Prepared By

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**BASE PROJECT NO. GJKZ90-5001
USAF Contract No. F33615-85-D-4543, Task Order No. 07**

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DECLARATION OF THE RECORD OF DECISION

SITE NAME AND LOCATION

Craig Road Landfill Operable Unit
Fairchild Air Force Base
Spokane County, Washington

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the Craig Road Landfill (CRL) operable unit, Fairchild Air Force Base (AFB), Spokane, Washington, which was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record for this site.

The lead agency for this decision is the U.S. Air Force. The U.S. Environmental Protection Agency (EPA) approves of this decision and, along with the state of Washington Department of Ecology (Ecology), has participated in the scoping of the site investigations and in the evaluation of remedial investigation data. The state of Washington concurs with the selected remedy.

ASSESSMENT OF THE SITE

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

DESCRIPTION OF THE SELECTED REMEDY

The selected remedy for the CRL includes elements from two different categories of actions. The first category is source controls, which are intended to minimize movement of contaminants from the fill material in the landfill to the groundwater and to prevent direct exposure to contaminated subsurface soil and debris. The second action category is groundwater controls. These controls are intended to prevent further movement of contaminated groundwater across the site boundary and to prevent consumption by area residents of groundwater exceeding maximum contaminant levels (MCL). The combination of both source control and groundwater control actions is necessary to achieve the broader objective of restoring contaminated groundwater in the upper aquifer to levels that are safe for drinking.

The major components of the selected remedy include:

- Capping the northeast and southwest disposal areas at the landfill

- Installing an active soil vapor extraction/treatment system in both capped areas
- Extracting contaminated groundwater from the upper aquifer at the landfill boundary and treating by air stripping and granular activated carbon; treated groundwater will be disposed of at an off-site location downgradient of the CRL property
- Monitoring off-site water supply wells within the off-site portion of the plume and providing point-of-use treatment and/or alternative water supply if needed in the future
- Monitoring groundwater in upper and lower aquifers
- Implementing institutional controls.

STATUTORY DETERMINATIONS

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. This remedy utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable for this site, and satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element.

Because this remedy will result in hazardous substances remaining on site above health-based levels, a review will be conducted within 5 years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

Signature sheet for the foregoing Craig Road Landfill Record of Decision between the U.S. Air Force and the U.S. Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

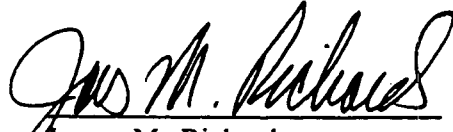
Dana Rasmussen

Dana Rasmussen
Regional Administrator, Region X
U.S. Environmental Protection Agency

FEB 11 1993

Date

Signature sheet for the foregoing Craig Road Landfill Record of Decision between the U.S. Air Force and the U.S. Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.


James M. Richards
Brigadier General, USAF
Commander

13 FEB 93
Date

Signature sheet for the foregoing Craig Road Landfill Record of Decision between the U.S. Air Force and the U.S. Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

Carol L. Fleskes

Carol L. Fleskes, Program Manager
Toxics Cleanup Program
Washington State Department of Ecology

2/5/93
Date

DECISION SUMMARY

INTRODUCTION

Fairchild Air Force Base (AFB) was listed on the National Priorities List (NPL) in March 1989 under CERCLA, as amended by SARA. The Craig Road Landfill (CRL) site at Fairchild AFB comprises the first operable unit for which a cleanup action has been selected.

In accordance with Executive Order 12580 (Superfund Implementation) and the NCP, the Department of the Air Force performed a Remedial Investigation (RI) for the CRL, which characterized the nature and extent of contamination in groundwater, soils, and air near the landfill. A baseline risk assessment, comprised of a human health risk assessment and an ecological risk assessment, was conducted as part of the RI to evaluate current and potential effects of the landfill contaminants on human health and the environment.

I. SITE LOCATION AND DESCRIPTION

Fairchild AFB is located approximately 12 miles west of Spokane, Washington. The CRL is located on property owned and operated by the U.S. Air Force as part of the Fairchild AFB installation. This property occupies approximately 100 acres and is located on the west side of Craig Road (Figure 1) approximately 0.7 mile south of U.S. Route 2 and 0.6 mile east of Rambo Road.

The CRL contains three inactive waste disposal areas. Municipal and industrial wastes were buried in trenches on about 6 acres in the northeast corner and in a low area of about 13 acres in the southwest corner. Demolition debris from the runway reconstruction was deposited on the ground surface in the southeast corner covering an area of about 20 acres (Figure 2).

The Base wastewater treatment plant (WWTP) is located in the northwest corner of the property (Figure 2). Treated wastewater from the plant is discharged to an infiltration pond and a series of percolation trenches located on the landfill property adjacent to the northeast disposal area.

II. SITE HISTORY AND ENFORCEMENT

The CRL was a former disposal location for Fairchild AFB and was used for general purpose landfilling. Detailed documentation of waste types disposed within the CRL does not exist. However, waste types reportedly included miscellaneous sanitary and industrial waste, and construction and demolition debris. Various specific items suspected of disposal in the CRL are coal ash from the power plants, solvents, dry cleaning filters, paints, thinners, and possibly electrical transformers.

The northeast landfill area was active from the late 1950s into the early 1960s. Landfilling in this area proceeded by trench-and-fill, soil cover, and grading. Depths of landfilling, based on soil borings, exceed 30 feet below the existing ground surface.

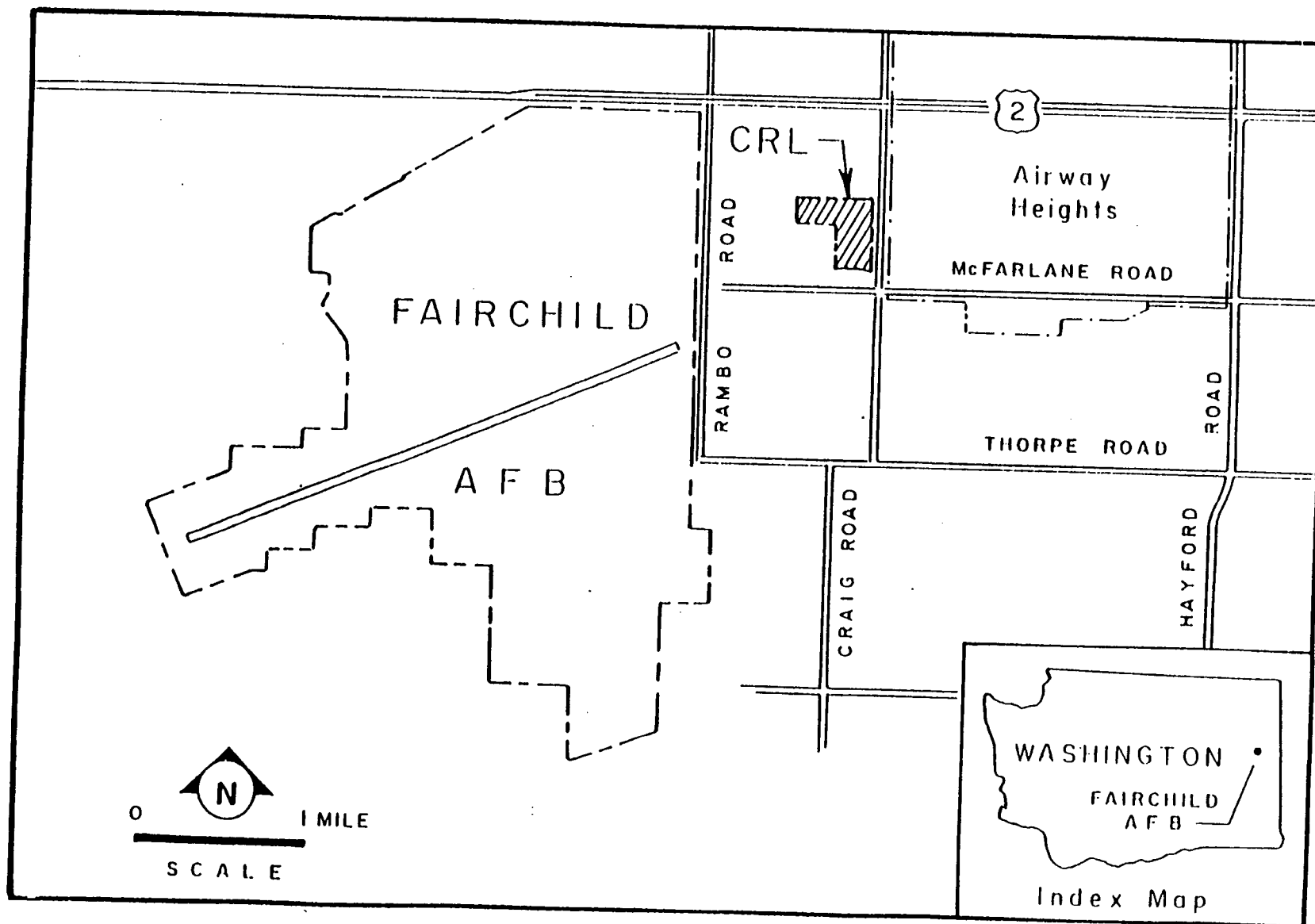
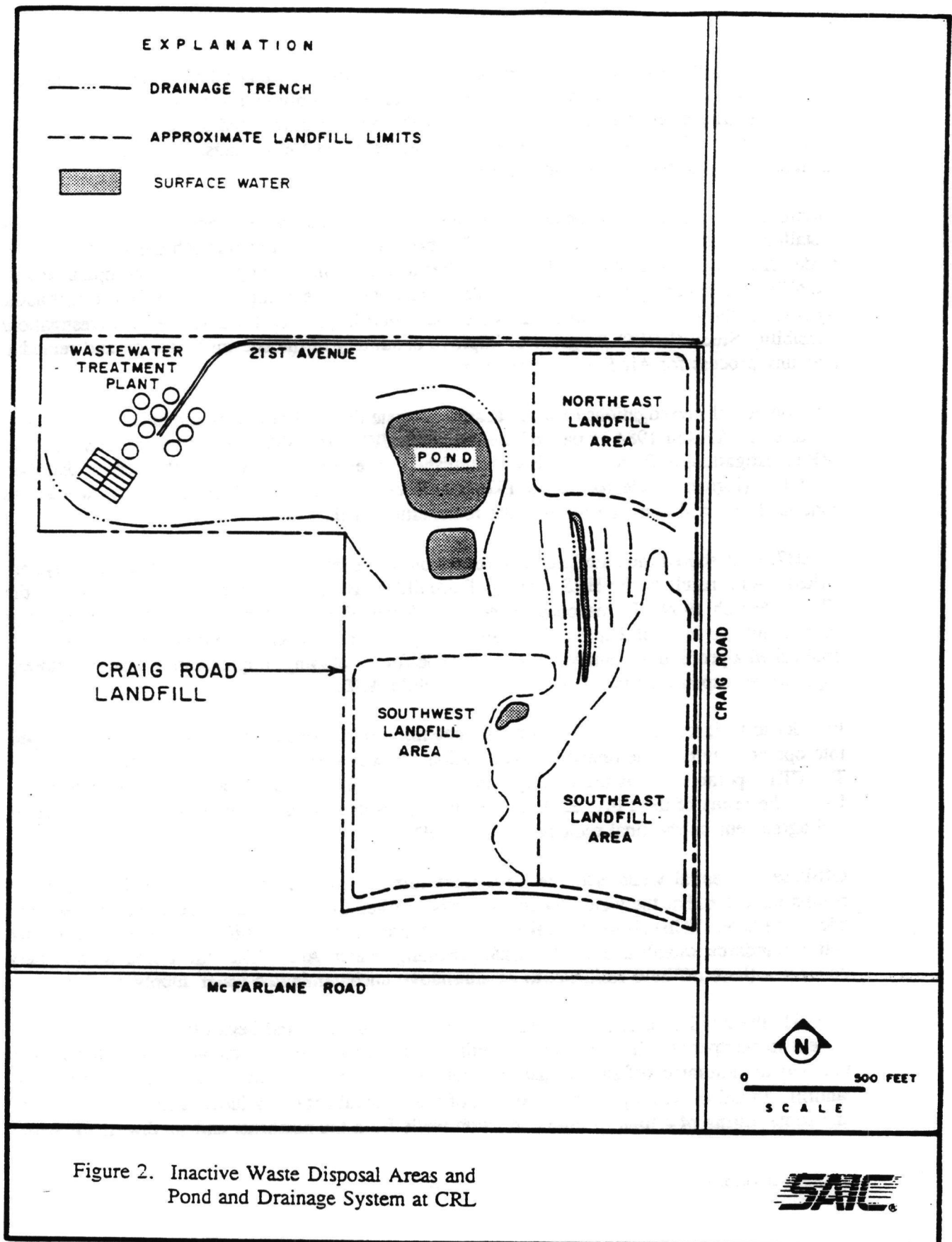


Figure 1. Location of Fairchild AFB and CRL



The southwest landfill area was active from the late 1960s into the late 1970s. Disposal methods consisted of fill-and-cover in a topographical low area, possibly with some excavation. The soil cover was graded and then overlain in areas with concrete blocks and asphalt from the runway reconstruction. Depth of landfilling in this area, based on soil borings, is estimated to exceed 25 feet below the present ground surface.

Environmental problems associated with the CRL were discovered under the U.S. Air Force Installation Restoration Program (IRP). This program was initiated through the 1981 Executive Order 12316 that directed the military branches to design their own program of compliance with the NCP established by CERCLA. In order to respond to the changes in the NCP brought about by SARA, the IRP was modified in November 1986 to provide for a Remedial Investigation/Feasibility Study (RI/FS) Program to improve continuity in the site investigation and remedial planning process for Air Force installations.

Environmental investigations of past hazardous waste disposal practices and sites were initiated at Fairchild AFB in 1984 as part of the Air Force IRP. In 1985, the first report summarizing IRP investigations at Fairchild AFB was published. Preliminary findings in this report identified the CRL (formerly referred to as IRP Site SW-8) for additional investigation, which has continued and will continue through the remediation of the site.

In 1987, EPA scored the Fairchild AFB (based on four sites) using their Hazard Ranking System (HRS). As a result of the HRS scoring, Fairchild AFB, including the CRL, was added to the NPL in March 1989. In response to the NPL designation, the Air Force, EPA, and Ecology entered into a Federal Facility Interagency Agreement (FFA) in March 1990. The FFA established a procedural framework and schedule for developing, implementing, and monitoring appropriate response actions conducted at Fairchild AFB.

In order to facilitate the CERCLA process, potential source areas at the Base have been grouped into operable units. The remedial investigation for each operable unit has a separate schedule. The CRL operable unit is the first operable unit for which a cleanup action has been selected. Under the terms of the FFA, EPA and Ecology provided oversight of subsequent RI activities and agreement on the final remedy for this ROD.

Off-base residential wells near the CRL were sampled in 1989 as part of the RI. Sampling results indicated that the wells, located directly northeast of the CRL, were contaminated with trichloroethene (TCE) above federal maximum contaminant levels (MCLs), which are drinking water standards established by the Safe Drinking Water Act. The Air Force immediately connected these off-base residents to an alternative uncontaminated water supply system.

In 1991, the Air Force initiated a Removal Action at the site and began the development of a system to pump water from the upper aquifer and remove the contaminants. This action was initiated to minimize off-site release of contaminants found in the groundwater beneath the landfill. Initial activities performed as part of the removal action included drilling, completion, and some testing of a total of nine extraction wells from the northeast and southwest fill areas.

In addition, an air stripping treatment unit was constructed on site to treat extracted groundwater. This system became operational in October 1992.

Construction of a pipeline to divert wastewater from the Base WWTP to the Spokane Regional WWTP is currently underway. Completion of this system, estimated for February 1993, will eliminate the discharge of treated effluent from the Base WWTP to the infiltration pond and trenches on the landfill property.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

The Air Force developed a Community Relations Plan (CRP) in March 1990 as part of the overall management plan for the CRL RI/FS. The CRP was designed to promote public awareness of the investigations and public involvement in the decision-making process. The CRP summarizes concerns that Fairchild AFB, in coordination with EPA and Ecology, is aware of based on community interviews and comments obtained at a public workshop. Since this initial workshop Fairchild AFB has sent out numerous fact sheets and has held annual workshops in an effort to keep the public informed and to hear concerns on the CRL issues. The CRP was updated in September 1992.

On July 1, 1991, Fairchild AFB made available for public review and comment the draft Engineering Evaluation/Cost Analysis (EE/CA) that recommended a removal action for contaminated groundwater at the CRL. The public was notified of this document's availability through a fact sheet mailed to local, interested persons and in a public announcement published in *The Spokesman-Review*. The public comment period ended July 31, 1991.

The RI Report for the CRL was released to the public in April 1992; the FS and Proposed Plan were released on August 10, 1992. These documents, as well as previous reports from the RI/FS investigation, were made available to the public in both the Administrative Record and the Information Repository maintained at the locations listed below:

ADMINISTRATIVE RECORD (contains all project deliverables):

Fairchild AFB Library
Building 716
Fairchild AFB, WA 99011

Spokane Falls Community College Library
W. 3410 Fort George Wright Drive
Spokane, WA 99204

INFORMATION REPOSITORY (contains limited documentation):

Airway Heights City Hall
S. 1208 Lundstrom
Airway Heights, WA 99101

The notice of the availability of these documents was published in *The Spokesman-Review* on August 9, 1992. The public comment period was held from August 10, 1992, through September 8, 1992. In addition, a public meeting was held on August 25, 1992. At this meeting, representatives from the Air Force, EPA, and Ecology answered questions about problems at the site and the remedial alternatives under consideration. A response to the comments received during the public comment period is included in the Responsiveness Summary, which is part of this ROD. This decision document presents the selected remedial action for the CRL at Fairchild AFB, Spokane, Washington, chosen in accordance with CERCLA, as amended by SARA, and to the extent practicable, the NCP. The decision for this site is based on the Administrative Record.

IV. SCOPE AND ROLE OF RESPONSE ACTION WITHIN SITE STRATEGY

Potential source areas at Fairchild AFB have been grouped into separate operable units. A different schedule has been established for the operable units. The CRL site comprises the first operable unit at Fairchild AFB for which a final cleanup action has been selected. Selection of cleanup actions for five operable units is scheduled to be made in the spring of 1993 and, for the remaining operable units, in the spring of 1995.

The cleanup actions for the CRL described in this ROD address both on-site and off-site groundwater contamination and source areas associated with subsurface disposal at the site. A groundwater extraction and treatment action was initiated at this site in 1991 as part of a removal action. The groundwater cleanup actions described in this ROD are consistent with and will expand upon the existing groundwater treatment system. The cleanup actions described in this ROD address all known current and potential risks to human health and the environment associated with the CRL site.

V. SUMMARY OF SITE CHARACTERISTICS

The center of the city of Airway Heights is approximately 0.5 mile northeast of the CRL and its western city limit coincides with Craig Road. The current population of Airway Heights is approximately 2,000. Land use in the vicinity of the CRL is primarily agricultural, with the exception of housing developments within Airway Heights and some small trailer parks beyond the city limits. One mobile home park, housing about 135 residents, is located approximately 1,500 feet from the southwest fill area. Other land uses surrounding the CRL include surface mining for sand and gravel and light industry. No historical or archeological resources are located within the CRL boundaries. In addition, the site is not within a 100-year floodplain.

The upper and lower basalt aquifers in the immediate vicinity and downgradient of the site are used for residential and municipal water supplies. Four residential wells are located within 1 miles downgradient of the site. Municipal drinking water wells for the city of Airway Heights are located approximately 5,000 feet downgradient of the site.

A. Site Geology and Hydrogeology

The CRL is situated on the northeastern edge of the Columbia Plateau about 5 miles west of Spokane. The Columbia Plateau is composed of a thick sequence of Tertiary-aged lava flows known as the Columbia River Basalt Group. Average elevation at the site is approximately 2,390 feet above mean sea level (msl). The topography surrounding the CRL is relatively flat and slopes gently to the southeast, east, and northeast (Figure 3). The area surrounding the landfill is drained by poorly defined, small, intermittent drainageways that have been modified locally into man-made ditches. There are a few drainage trenches (used for infiltration of discharge from the Base WWTP) within the property boundaries defining the landfill; none leave the site (Figure 3). All surface water related to the site either evaporates or infiltrates into the soil on the CRL.

Groundwater investigations were limited to the top two aquifers. The upper aquifer is comprised of the uppermost, highly fractured basalt layer (Basalt Flow A) and the overlying alluvium. The water table of the upper aquifer roughly coincides with the bedrock surface. The Basalt Flow A thickness ranges from 90 to 140 feet. The depth to the current water table (prior to turning off the WWTP) ranges from 15 feet below ground surface (bgs) beneath the CRL to 50 feet bgs at the eastern boundary of the landfill to 150 feet bgs in the channel.

A 16- to 20-foot low permeability clay interbed, Interbed A, separates the upper aquifer from the deeper, underlying aquifer in Basalt Flow B. Basalt Flow B is approximately 180 feet thick and is confined where capped by Interbed A. The depth to the potentiometric surface of the lower aquifer ranges from 130 to 150 feet bgs. In general, there is no flow from the upper aquifer into the lower aquifer except where Interbed A has been breached. One known breach in Interbed A has occurred in the unused residential wells to the northeast of the CRL boundary; a potential breach could be along the suspected fault to the south of the landfill.

East of the CRL, the Basalt Flow A and Interbed A are cut by a channel and replaced by a thick sequence of alluvial sand and gravel. Figure 4 shows the shape of the bedrock surface and position of the channel. The inset diagrammatic cross section illustrates the approximate shape and depth of the channel. The water table elevation in the channel averages approximately 2,250 feet above mean sea level (msl), while the water table elevation at the CRL is approximately 2,350 feet above msl (Figure 5). This relatively large difference in water levels between the CRL and the channel result in large hydraulic gradients east toward the channel. Therefore, the dominant controls on groundwater flow direction are the shape of the bedrock surface and water level in the channel. Figure 6 shows the general relationship between the Basalt A and Basalt B aquifers.

Local flow deviations from the general groundwater flow direction may occur within discrete fractures or fracture zones if the fracture orientation differs from the general groundwater flow direction. However, these differences average out and on the large scale the fractured media behaves as an equivalent porous medium. Hydraulic conductivities from slug tests on monitoring wells at the CRL ranged from 0.3 to 8.6 ft/day. These values are close to the median hydraulic conductivity of 3.3 ft/day for the Columbia River Basalt Group. Trans-

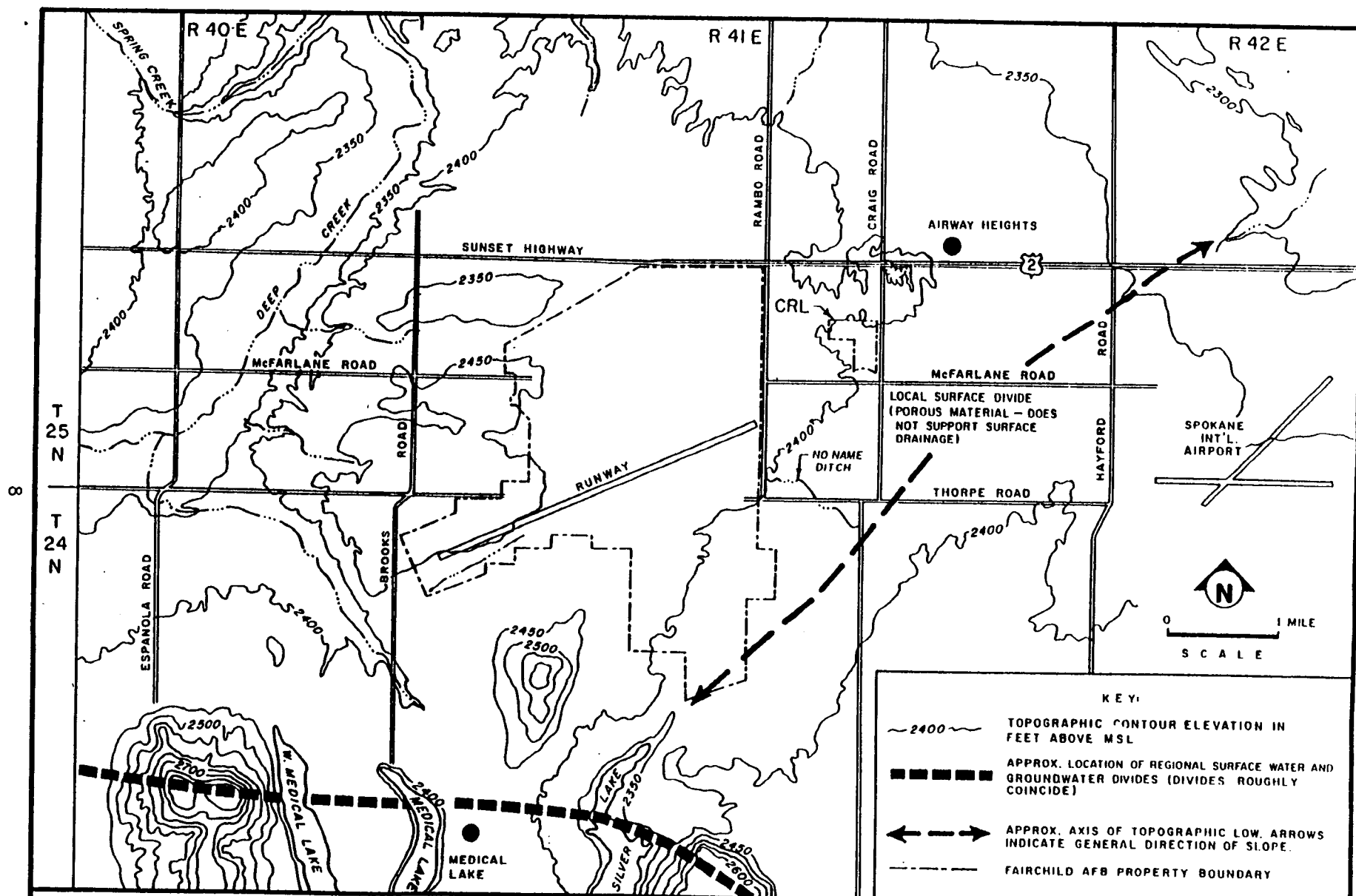
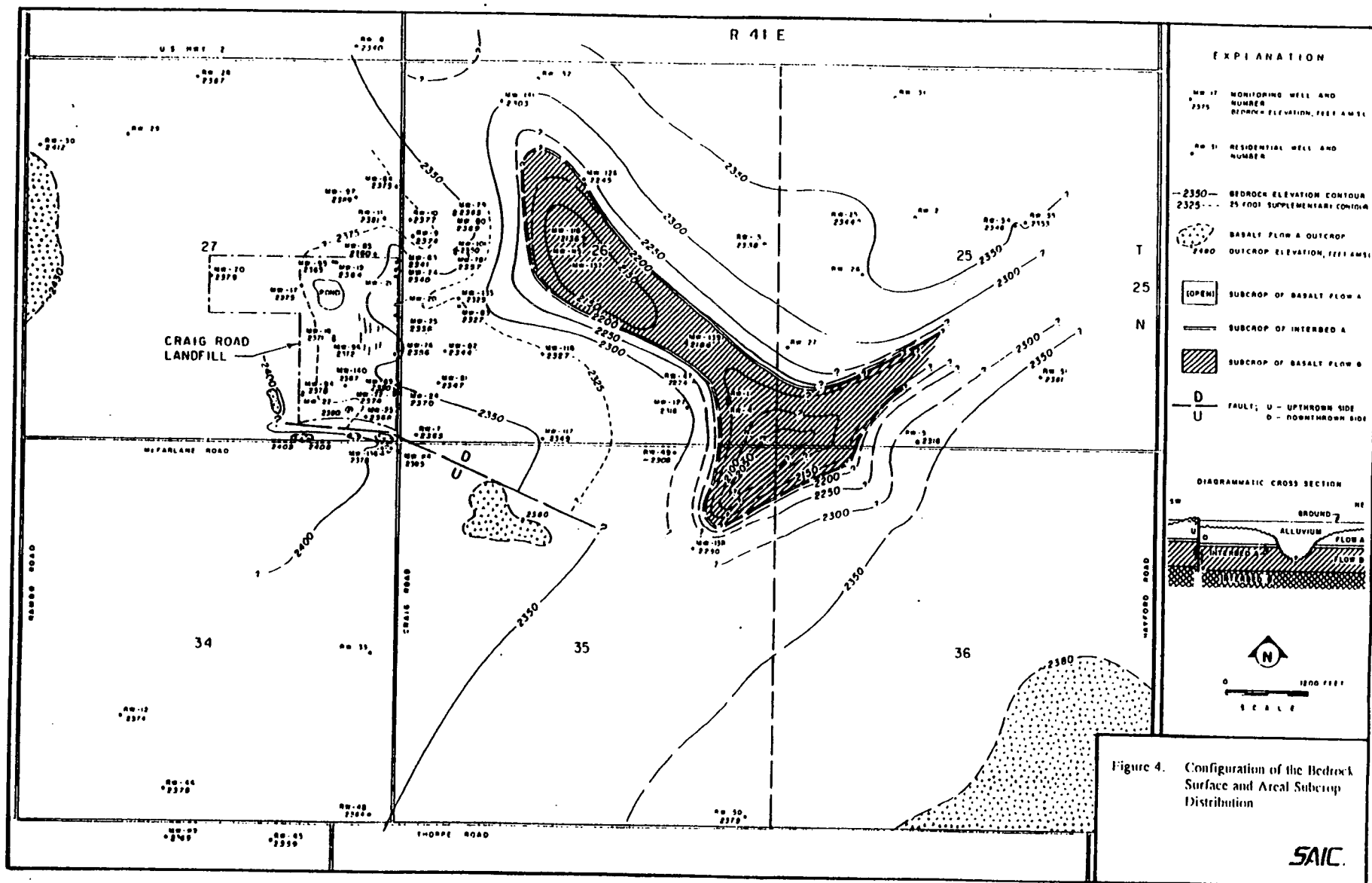
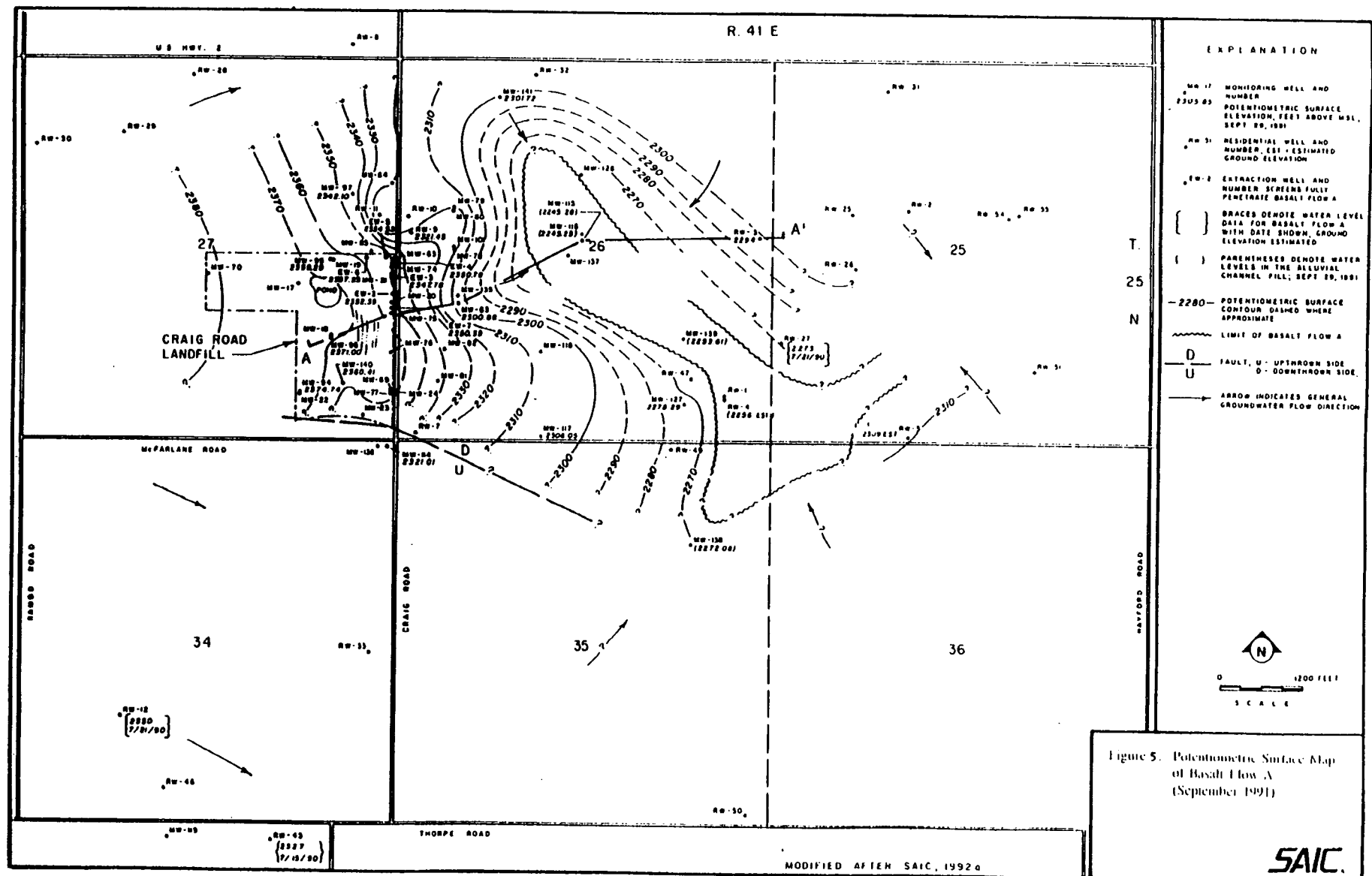


Figure 3. Topography and Drainage of Fairchild AFB and Surrounding Area

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CROSS SECTION A-A'

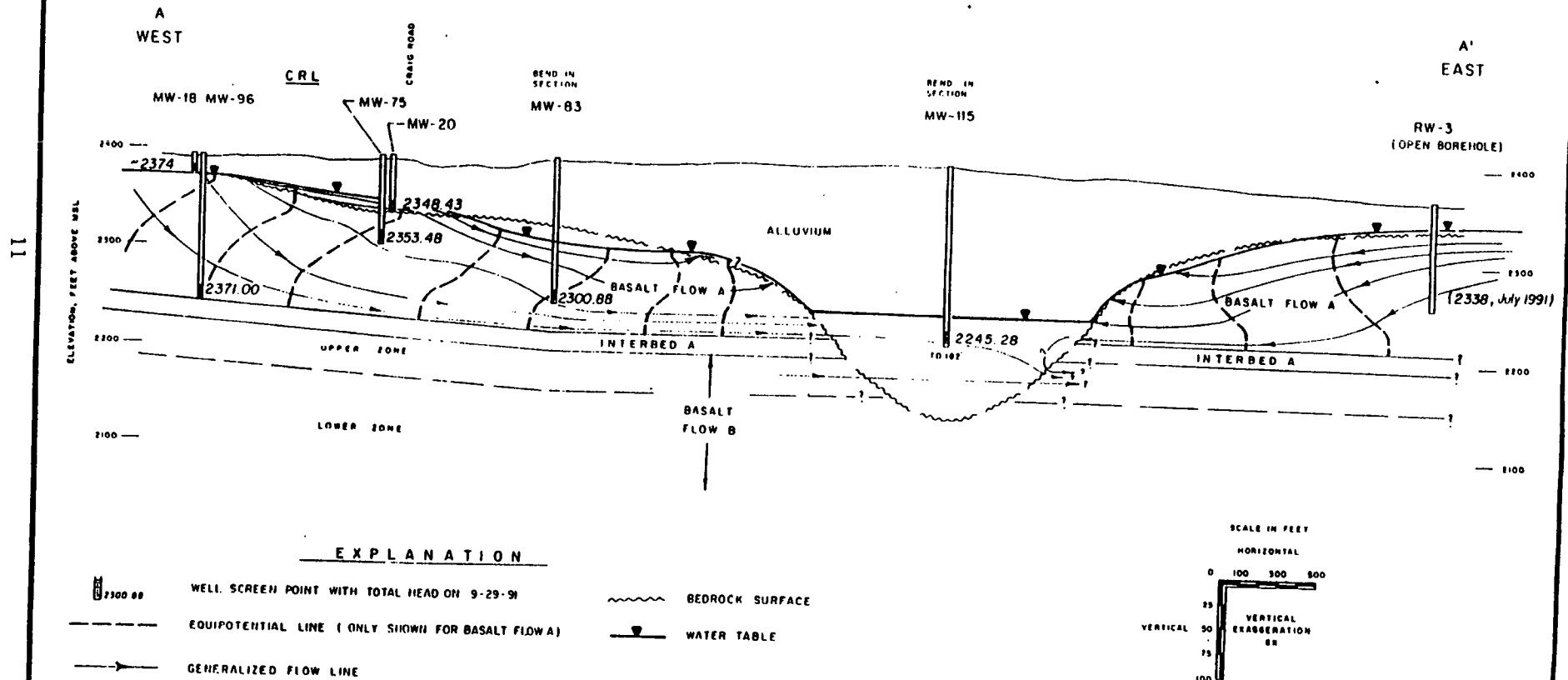


Figure 6. Generalized Relationship Between Basalt A and Basalt B Aquifers

SAIC

missivity values calculated from conductivity and thickness of Basalt Flow A range from 27 to 1,200 square feet per day (ft²/day).

The upper aquifer underlying the CRL is recharged from either discharge from the WWTP or precipitation that infiltrates through the landfill. Due to the recharge by approximately 1 million gallons per day of effluent from the Base WWTP to the infiltration pond and trenches, there is a local mounding of the water table in the upper aquifer below the CRL (Figure 5). As part of

Fairchild AFB's near-term plans, the existing Base WWTP will be closed and the effluent diverted to the city of Spokane publicly owned treatment works (POTW). The net hydrologic effect should be the elimination of the existing groundwater mound. Groundwater flow direction will still be east toward the channel.

B. Nature and Extent of Contamination

The two landfilled areas (northeast and southwest) within the CRL are the apparent sources of contamination at the site. The southeast landfill area was used for surface disposal of concrete debris from the runway reconstruction and has not been identified as a source of environmental contamination.

1. Groundwater

Groundwater samples were collected from 42 monitoring wells over 10 sampling rounds, which took place from 1986 through 1991. Of these 42 wells, 36 were screened in the upper aquifer, while 6 were screened in the lower Basalt B aquifer. A total of 17 monitoring wells were completed in the upper aquifer directly below the CRL property; only one well was completed in the lower aquifer below the site. All the remaining monitoring wells were installed beyond the CRL boundary. Sampling was conducted during each year (except 1988) on a varied schedule in order to accommodate both wet and dry season sampling. Samples were analyzed for volatile organic chemicals (VOCs) and semi-volatile organic chemicals (SVOC), metals, and common anions.

Basalt A Aquifer

VOCs detected in groundwater samples included vinyl chloride, 1,1-dichloroethene (1,1-DCE), 1,1-dichloroethane (1,1-DCA), trans-1,2-dichloroethene (t-1,2-DCE), 1,1,1-trichloroethane (1,1,1-TCA), TCE, benzene, tetrachloroethene (PCE), toluene, and chlorobenzene. Table 1 presents the detected compounds. SVOCs detected in groundwater samples, also presented in Table 1, were phenol, 1,4-dichlorobenzene (1,4-DCB), bis(2-ethylhexyl)phthalate (BEHP), and acetophenone. Although several metals were detected in groundwater samples, none were detected in concentrations exceeding background levels.

Table 1
Fairchild AFB - Craig Road Landfill
Summary of Groundwater Sampling Results
Organic Compounds (ug/L)

Analyte	Frequency of Detection (a)	Range of Concentrations	Mean of Concentrations	Range of Detection Limits
VOCs in Upper Aquifer:				
Benzene	1/110	0.6	0.6	0.2-5
Chlorobenzene	1/110	0.3	0.3	0.2-5
1,1-Dichloroethane	1/110	0.3	0.3	0.07-5
1,1-Dichloroethene	1/110	0.8	0.8	0.13-5
t-1,2-Dichloroethene	3/110	4-54	34	0.3-2
Tetrachloroethene	2/110	0.4-0.7	0.6	0.03-5
Toluene	3/110	0.2-0.5	0.3	0.2-5
1,1,1-Trichloroethane	1/110	0.4	0.4	0.03-1
Trichloroethene	55/110	0.3-2800	319	0.12-5
Vinyl chloride	1/110	2	2	0.18-10
VOCs in Lower Aquifer:				
Trichloroethene	6/16	4-67	18	0.12-5
SVOCs in Upper Aquifer:				
Acetophenone	2/83	19-22	20	3-50
BEHP	5/83	7-53	19	1-10
1,4-Dichlorobenzene	1/83	1	1	0.3-10
SVOCs in Lower Aquifer:				
Phenol	1/8	7	7	3-10

(a) Frequency of Detection = number of detections/number of samples analyzed, including field duplicates.

Background levels were derived from 23 groundwater samples collected from 11 monitoring wells installed in locations not suspected to have been effected by inorganic contamination. The method chosen to determine background levels was the upper 95 percent tolerance limit, calculated at a 95 percent confidence level in accordance with EPA guidance.

TCE is the most predominant contaminant in groundwater associated with the CRL. Figure 7 shows estimated levels of TCE in the upper aquifer, based on information from monitoring wells. Table 2 presents the groundwater area/volume calculations for the concentration intervals shown in Figure 7.

The other halogenated aliphatic compounds detected in groundwater samples collected at the CRL (vinyl chloride, PCE, 1,1-DCE, 1,1-DCA, t-1,2-DCE, and 1,1,1-TCA) were all detected in relatively small concentrations (≤ 4 ug/L) and in very few samples (≤ 3). Because of the high migration potential of these compounds in groundwater, it appears that they are either not present in large quantities in the landfill or, if they are, their containers have remained intact for a longer period of time than those holding TCE. Biodegradation products of TCE include 1,1-DCE, t-1,2-DCE, and vinyl chloride. Under more typical circumstances these analytes would be found in higher concentrations within the TCE plume. The lack of these contaminants in groundwater at the site is likely due to the somewhat sterile characteristics of the fractured basalt in which methanogenic anaerobic bacteria could not flourish.

At the CRL benzene was detected in one groundwater sample collected from a monitoring well installed approximately 4,800 feet southeast of the southeast corner of CRL, which appears to be installed in a southern arm of the alluvial channel that lies to the east of the CRL. Benzene is a LNAPL and migrates or disperses rapidly through an aquifer. Although benzene was detected at the landfill during the soil-gas survey, the CRL is an unlikely source of benzene in this well due to the relatively large distance between the well and the landfill. In addition, because benzene is a component of petroleum products, there are other possible benzene sources that exist closer to where it was detected.

The other fuel components detected during the soil-gas survey (toluene, ethylbenzene, and xylenes) were either absent or detected in very small quantities (Table 1) in groundwater samples collected from the Basalt A aquifer. Their high vapor pressure and relatively low water solubility accounts for this observation. It is unlikely that these analytes would migrate into the groundwater in high concentrations unless the soil pore spaces became saturated and their upward mobility became blocked.

Basalt B Aquifer

The six monitoring wells installed in the Basalt B aquifer were sampled during 1990 and 1991. Six samples (including one duplicate) were collected from MW-74, four during 1990 and two during 1991. Three groundwater samples (one during 1990 and two during 1991) were collected from MW-79. MW-101 was sampled on three occasions during 1991; MW-126 on two occasions. Both MW-135 and MW-136 were sampled during the final sampling round in 1991.

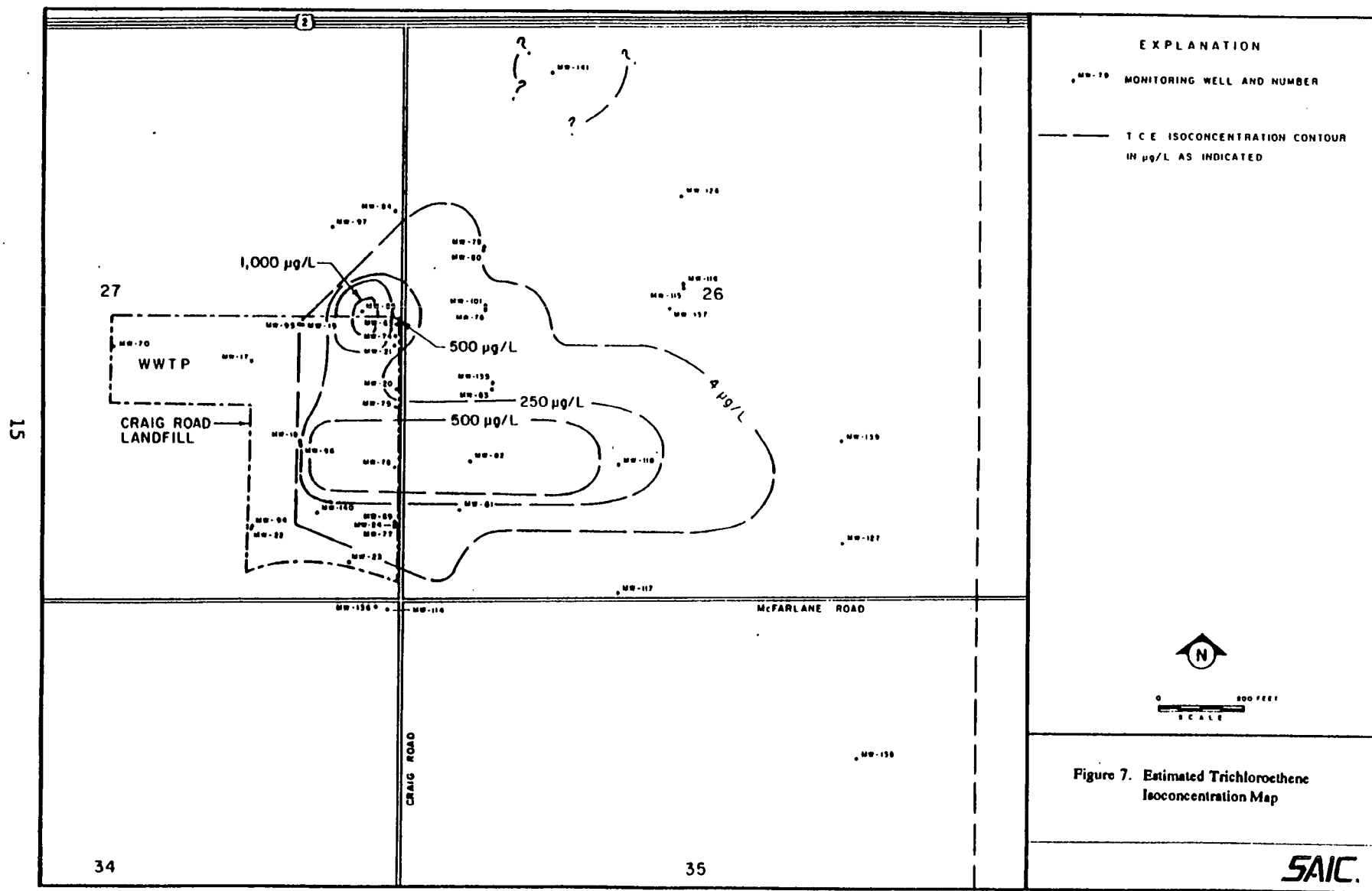


Table 2. Area/Volume Calculations
For Groundwater, CRL Fairchild AFB

Concentration Intervals ($\mu\text{g/L}$)	Average Concentration (mg/L)	Area (sq ft)	Total Volume(a) (cu ft)	Water Volume(b) (cu ft)	Water Volume(c) (liters)	Mass of TCE(d) (Kg)	TCE(e) (gal)
>1,000	1.500	70,000	7,000,000	700,000	19,821,900	2.97E+01	5
500 - 1,000	0.750	1,900,000,000	190,000,000	19,000,000	538,023,000	4.04E+02	73
250 - 500	0.375	1,700,000,000	170,000,000	17,000,000	481,389,000	1.81E+02	33
4 - 250	0.127	5,500,000	500,000,000	55,000,000	1,557,435,000	1.98E+02	36
1 - 4	0.003	12,000,000	1,200,000,000	120,000,000	3,567,942,000	1.07E+01	2

a) Area X 100 ft saturated thickness (average)

b) Total volume X 10% porosity

c) Conversion: 28.317 liter/cu ft

d) Water volume (L) X average concentration (mg/L) X $1\text{E}10^{-6}$ Kg/mg

e) Conversion to gallons: TCE density = 1.46; mass TCE(Kg)/1.460 Kg/L X 0.2642 gal/L

TCE was the only VOC detected in groundwater samples collected from the lower aquifer (see Table 1). This analyte was detected in six samples in concentrations ranging from 4 to 67 $\mu\text{g/L}$. The only Basalt B well found to contain TCE was MW-74, which is located in the northeast corner of the CRL (Figure 6). This is just downgradient of where the highest concentrations of TCE were detected in the upper aquifer (MW-85) and where known breaches between the upper and lower aquifers exist in the unused residential wells at the mobile home park.

The SVOC phenol (7 $\mu\text{g/L}$) was detected in one groundwater sample collected from MW-126, which appears to be located on the east side of the alluvial channel (see Figure 5). The presence of phenol in this well is not likely associated with contaminants derived from the CRL.

Residential and Municipal Wells

A total of 18 residential wells were sampled on an irregular basis between 1989 and 1991. Nine of these residential draw water from the upper aquifer, two from the lower aquifer, two from the channel, and the remainder from either an interbed or from an unknown depth. Groundwater collected from these wells was analyzed primarily for TCE. There are only two municipal water supply wells (city of Airway Heights wells RW-1 and RW-4, completed in the channel) and one private well (RW-7, completed in the upper aquifer), serving a light industrial site, currently in use that have been affected by TCE. The level of contamination in these wells is below the federal MCLs and is considered safe for drinking water use. These wells are currently sampled on a quarterly basis to monitor for contaminants. Users of these wells would be notified if TCE levels in their well rose above MCLs. TCE was detected in three water supply wells that served the mobile home park located just northeast of the northeast fill area in concentrations exceeding the MCL. These wells have since been closed for supply purposes and the residents from the mobile home park presently are supplied with water from the Base.

2. Soils

Historical aerial photographs indicate that landfilled materials were placed in trenches in the northeast and southwest corners of the CRL site and were subsequently covered with native soils. Test pits excavated as part of the remedial investigation indicate that an average of 3 feet of soil covers the two fill areas. Since native soils were placed over the refuse after landfill operations were terminated, surface soil contamination at the site is not suspected and this medium was not sampled during the remedial investigation.

Groundwater data indicate that contaminants leach from the buried landfilled material into the subsurface soil. An attempt was made to collect samples of contaminated subsurface soil located beneath the buried landfilled material during a soil boring program. In all instances, sampling attempts failed due to bit refusal within the landfill material. The base of the fill material is estimated to be at 20 to 25 feet below ground surface in the southwest area and at 30 to 35 feet in the northeast area.

A soil-gas survey performed at the site detected numerous volatile organic compounds (VOCs) believed to be buried within the landfill. Compounds typically associated with fuels and fuel products and components of cleaning solvents (i.e., benzene, toluene, ethylbenzene, xylenes and TCE) were detected. The results of the soil-gas survey, discussed under air results, are indicative (at least in part) of the subsurface soil contamination in these two areas.

The boundaries of the northeast and southwest source areas were determined by aerial photography, geophysical surveys, and borings. Average landfill and soil thicknesses from borings and planimeter measurements of landfill areas were used to estimate source volumes. The sizes of potentially contaminated areas within the fill boundaries were also estimated by the planimeter method using the contours from the soil-gas survey (Figure 8). Table 3 summarizes the area and volume calculations of the contaminant source areas.

3. Surface Water/Sediments

Perennial surface water found on site is associated with the WWTP and either evaporates or infiltrates into the ground, hydraulically upgradient of the landfilled areas. No surface water comes into contact with the waste, since once it infiltrates into the landfill it becomes groundwater. In addition, there is low annual precipitation, a high evapotranspiration rate, highly permeable surface soil, and no surface drainage leaving the site. Therefore, surface water and sediments were not considered affected media and did not undergo extensive environmental sampling.

4. Air

No formal ambient air monitoring was performed at the CRL due to the site's proximity to the flight path at the Base. However, the site was surveyed for VOCs using an HNu, and a soil-gas survey was conducted. Background levels from the breathing zone (2 meters above ground surface) ranged from 0 to 2 ppm VOCs. VOCs were detected at 44 of the 149 soil-gas sampling locations that covered the northeast and southwest fill areas.

In the northeast area, the maximum soil-gas concentrations detected were 380 parts per billion by volume (ppbv) for 1,1-DCA and 56,000 ppbv for TCE. One estimated value each was reported for toluene (31 ppbv) and methylene chloride (340 ppbv). In the southwest fill area three contaminant hot spots were identified, with the central hot spot containing the highest concentrations (TCE, 96,000 ppbv; 1,1-DCE, 17,000; 1,1-DCA, 15,000 ppbv; xylenes, 460,000 ppbv; ethylbenzene, 140,000; benzene, 18,000 ppbv; toluene, 53,000 ppbv; methylene chloride, 4,400 ppbv).

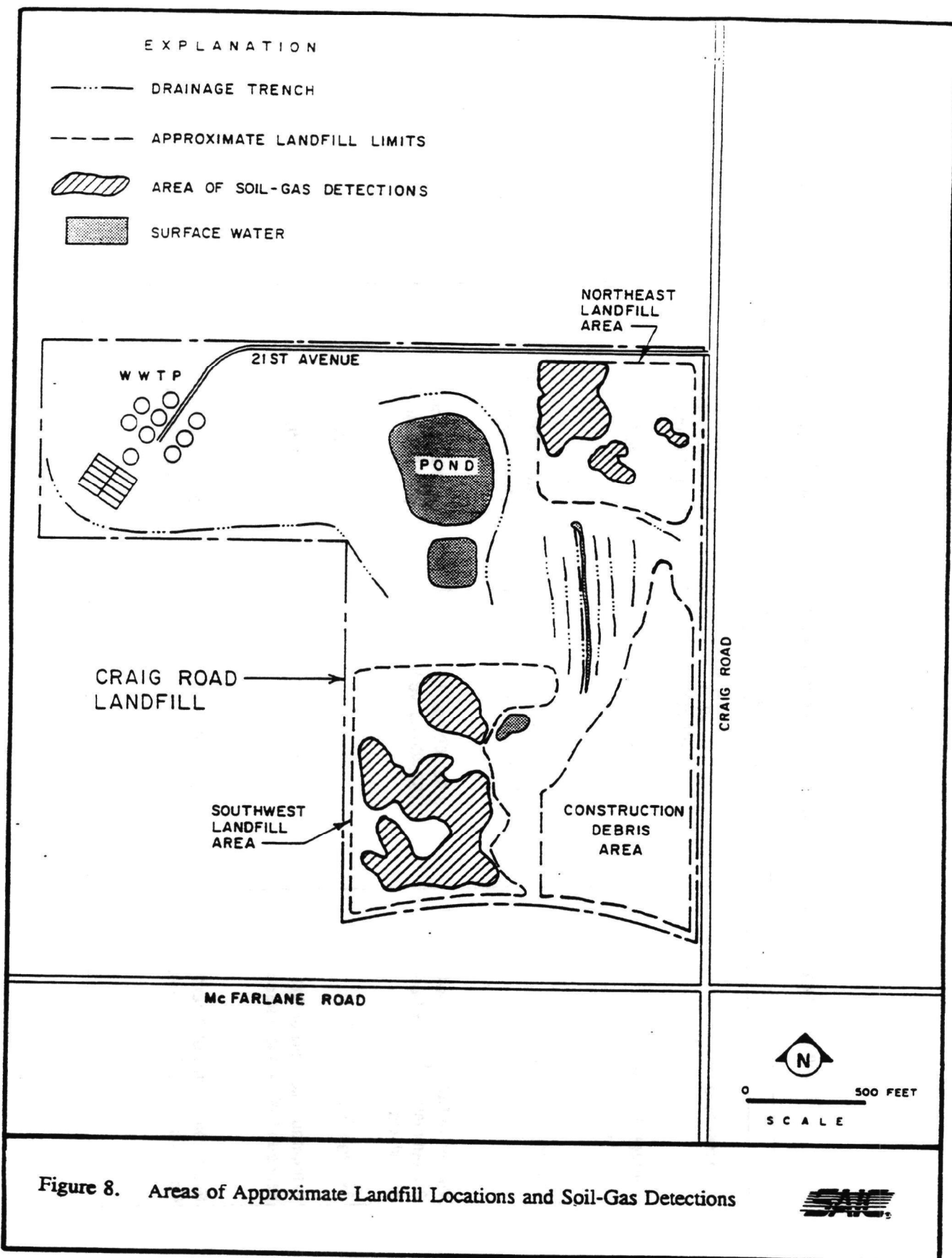


Table 3. Area and Volume Estimates Associated with Buried Landfill Sources

	NE AREA	SW AREA
Disposal Area	262,000 sq. ft. (6 acres)	549,900 sq. ft. (12.6 acres)
Average Thickness of Refuse	30 ft.	20 ft.
Refuse Volume	7,860,000 cu. ft. (291,000 cu. yd.)	10,998,000 cu. ft. (407,300 cu. yd.)
Volume of Refuse Potentially Contaminated by VOCs Based on Soil-Gas Contours	3,603,000 cu. ft. (133,400 cu. yd.)	4,779,000 cu. ft. (177,000 cu. yd.)
Average Depth to Bedrock	45 ft.	25-30 ft.
Estimated Thickness of Soil between Refuse and Bedrock	15 ft.	5 ft.
Estimated Volume of Potentially Contaminated Soil below Refuse	3,931,200 cu. ft. (145,600 cu. yd.)	2,748,600 cu. ft. (101,800 cu. yd.)

VI. SUMMARY OF SITE RISKS

CERCLA response actions at the CRL site as described in the ROD are intended to protect human health and the environment from risks related to current and potential exposure to hazardous substances at the site.

To assess the risk posed by site contamination, a Baseline Risk Assessment was completed as part of the Remedial Investigation. The human health risk assessment for the CRL considered potential effects of the site-related contaminants on human health and the ecological risk assessment evaluated potential risks to the environment. The risk assessments were conducted in accordance with EPA's Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (RAGS HHEM) and Volume II: Environmental Assessment Manual, other EPA national guidance, and EPA Region 10 Supplemental Risk Assessment Guidance for Superfund. This section of the ROD summarizes the results of the Baseline Risk Assessment for the CRL site.

A. Human Health Risks

The human health risk assessment considered potential risks associated with exposure to CRL site contaminants. The assessment involved a four-step process that included the identification of contaminants of concern, an assessment of contaminant toxicity, an exposure assessment of the population at risk, and a characterization of the magnitude of risk.

1. Identification of Chemicals of Potential Concern

Potential contaminants of concern for the CRL site were identified as chemicals detected in groundwater in the vicinity of the site and in soil-gas samples taken from the northeast and southwest fill areas.

a. Groundwater

Potential chemical of concern in groundwater were subjected to a risk-based screening process to identify chemicals to be included in the quantitative risk assessment. Risk-based concentrations (RBCs) were calculated according to Risk Assessment Guidance for Superfund, Part B. Table 4 lists the RBCs calculated for the organic contaminants that were detected in groundwater samples collected from monitoring wells associated with the CRL. The maximum concentrations of TCE, 1,1-DCE, vinyl chloride, and BEHP detected in groundwater exceeded their respective screening levels.

Rationale for the selection of specific contaminants of concern for groundwater are discussed below.

TABLE 4
SCREENING OF GROUNDWATER CONTAMINANTS
CRAIG ROAD LANDFILL, FAIRCHILD AFB

TCL No.	Chemical	Max. Conc.	Federal Regulations		Weight of Evidence(a)	DLs	Risk-Based Concentrations			Frequency of Detections All Wells (b)	Frequency of Detections Boundary Wells (c)	Include In RA	Rationale
			MCL	MCLG			Risk=10-6	Risk=10-4	HI=0.1				
Organic Compounds (Concentrations In ug/l):													
3	Vinyl chloride	2	2	0	A	0.18-5	0.03	3	NA	1/126 (0.8%)	(d)	yes	Exceeds 10-6 RBC (e)
8	1,1-Dichloroethene	0.8	7	7	C	0.13-2	0.07	7	30	1/126 (0.8%)	1/38 (2.6%)	yes	Exceeds 10-6 RBC (e)
9	1,1-Dichloroethane	0.3	NA	NA	C	0.07-2	NA	NA	80	1/126 (0.8%)	1/38 (2.6%)	no	Less than RBC
10	trans-1,2-Dichloroethene	54	100	100	no data	0.1-2	NA	NA	70	3/126 (2.4%)	3/38 (7.8%)	no	Less than RBC
14	1,1,1-Trichloroethane	0.4	200	200		D	0.03-3	NA	NA	200	1/126 (0.8%)	1/38 (2.6%)	no
20	Trichloroethene	2800	5	0	B2	0.12-2	3	300	NA	61/126 (48%)	35/38 (92%)	yes	Exceeds RBC
23	Benzene	0.6	5	0	A	0.2-1	0.6	60	1	1/126 (0.8%)	(d)	no	Equal to 10-6 RBC (f)
28	Tetrachloroethene	0.7	5	0	B2	0.03-2	1	100	40	2/126 (1.6%)	1/38 (2.6%)	no	Less than RBC
29	Toluene	0.2	1000	1000	D	0.2-2	NA	NA	300	3/126 (2.4%)	(d)	no	Less than RBC
31	Chlorobenzene	0.3	100	100	D	0.2-2	NA	NA	5	1/126 (0.8%)	(d)	no	Less than RBC
35	Phenol	7	NA	NA	D	2-10	NA	NA	2000	1/126 (0.8%)	(d)	no	Less than RBC
39	1,4-Dichlorobenzene	1	75	75	C	1-10	3	300	200	1/126 (0.8%)	(d)	no	Less than RBC
92	Bis(2-ethylhexyl)phthalate	53 J	4 (g)	0 (g)	B2	1-10	6	600	70	5/91 (5.5%)	4/29 (14%)	yes	Exceeds 10-6 RBC
	Acetophenone	22	NA	NA	NA	3	NA	NA	37037	2/91 (2.2%)	1/29 (3.4%)	no	Less than RBC

(a) = Weight of evidence is an EPA classification for characterizing the extent to which the available data indicate that an agent is a human carcinogen.

(b) = Duplicate samples are included in total.

(c) = Well selection based on location of well in Basalt Flow A at site boundary:
 MW-63, MW-69, MW-75, MW-76, MW-77, MW-85, MW-96, MW-140

(d) = Analyte not detected in any boundary well.

(e) = Detection limits were greater than RBCs.

(f) = Other evidence is available for excluding benzene from RA; see explanation in text.

(g) = Proposed MCL.

J = Concentration in duplicate sample is 20 ug/L; RPD = 90%.

DLs = Range of detection limits.

Trichloroethene

TCE was found to be the most predominant and wide-spread contaminant associated with the site. TCE concentrations exceeding the RBC of 3 ug/L were detected in many groundwater samples collected from wells installed to monitor groundwater quality in the Basalt A aquifer. The peak TCE concentration of 2,800 ug/L was detected in monitoring well MW-85, located off site, north of the northeast contaminant source area. The highest concentration found at a distance from the site was 490 ug/L, detected in the downgradient well MW-118, which is located approximately 2,000 feet due east of the landfill boundary. In addition, TCE concentrations from three downgradient, off-base residential water supply wells (RW-9, RW-10, and RW-11), all located within 700 feet to the northeast of the site, ranged from 57 to 79 ug/L.

1,1-Dichloroethene

1,1-DCE was detected at 0.8 ug/L in one groundwater sample collected from MW-69 during the last sampling round; this exceeds the RBC of 0.07 ug/L. The contaminant was not detected in groundwater from any monitoring wells during the four previous sampling rounds. The analytical detection limit for this analyte ranged from 0.2 to 5 ug/L, which exceed the RBC. 1,1-DCE is a breakdown product of TCE; therefore, TCE could act as a potential source of 1,1-DCE in groundwater over time. This chemical was included in the quantitative risk assessment.

Vinyl Chloride

Vinyl chloride was detected at 2 ug/L in groundwater collected from MW-18 during round 4. This well was not sampled during following sampling rounds due to mechanical difficulties in the well. Vinyl chloride was not detected in other monitoring wells over 10 rounds of groundwater sampling; however, the detection limit for vinyl chloride during most of these rounds exceeded the risk-based concentration and the federal MCL. Since vinyl chloride is a breakdown product of TCE, groundwater contaminated with TCE could act as a source of vinyl chloride in this medium over time. Therefore, this analyte was included in the quantitative risk assessment.

bis(2-Ethylhexyl)phthalate

BEHP was detected in five groundwater samples (including one field duplicate) during the remedial investigation. The maximum concentration of BEHP detected at the site was 53 ug/L in monitoring well MW-69. All four detections exceeded the RBC of 6 ug/L. BEHP is a common plasticizer; it is not clear whether BEHP is associated with waste disposal at the CRL site or with field and/or laboratory contamination. Due to the uncertainty of the source of BEHP, this analyte was carried through the risk assessment.

Benzene

Benzene was detected at the RBC level in one groundwater sample collected from monitoring well MW-138, located approximately 4,800 feet southeast of the southeast corner of the CRL.

Although benzene was detected at the landfill during the soil-gas survey, the CRL is an unlikely source of benzene in this well due to 1) the relatively large distance between the monitoring well and the site and 2) the lack of benzene detection in monitoring wells located in the immediate vicinity of the fill areas. Since benzene is a component of common petroleum products, there may be other possible benzene sources in the vicinity of monitoring well MW-138. Therefore, benzene was not carried through the risk assessment.

Inorganics

Inorganic background levels for the Basalt A aquifer were statistically determined for aluminum, barium, iron and manganese. Groundwater metal concentrations in wells located at the site boundary and downgradient of the CRL were screened against the calculated background levels. Background levels could not be calculated for the remaining metals; therefore, statistical comparisons were made to determine whether groundwater metal concentrations downgradient of the site were different from levels found upgradient of the site. Based on these screening processes, metals were not identified as contaminants of concern for the risk assessment.

b. Air

Data collected from soil-gas measurements from the northeast and southwest fill areas were used to model contaminant emissions from these areas. The following maximum soil-gas concentrations detected during the soil-gas survey (measured in $\mu\text{g}/\text{cm}^3$) were used as input parameters for the model:

<u>Location</u>	<u>Compound</u>	<u>Concentration</u>
NE	Benzene	1.0×10^{-4}
NE	Methylene chloride	1.3×10^{-3}
NE	TCE	3.0×10^{-1}
SW	Benzene	1.9
SW	Methylene chloride	5.2×10^{-2}
SW	TCE	5.2×10^{-1}

2. Exposure Assessment

The exposure assessment identified potential pathways for contaminants of concern to reach the exposed population. The conceptual site model shown in Figure 9 identifies contaminant sources, release/transport mechanisms, affected media, exposure points, exposure routes, and potential receptors for the site. The conceptual site model was used as the basis for identifying the potential exposure pathways addressed in the Baseline Risk Assessment.

a. Exposure Pathways

Groundwater

Contaminants that leach from the two fill areas have affected the groundwater quality beneath and downgradient of the landfill. Ingestion of groundwater is the primary exposure pathway for

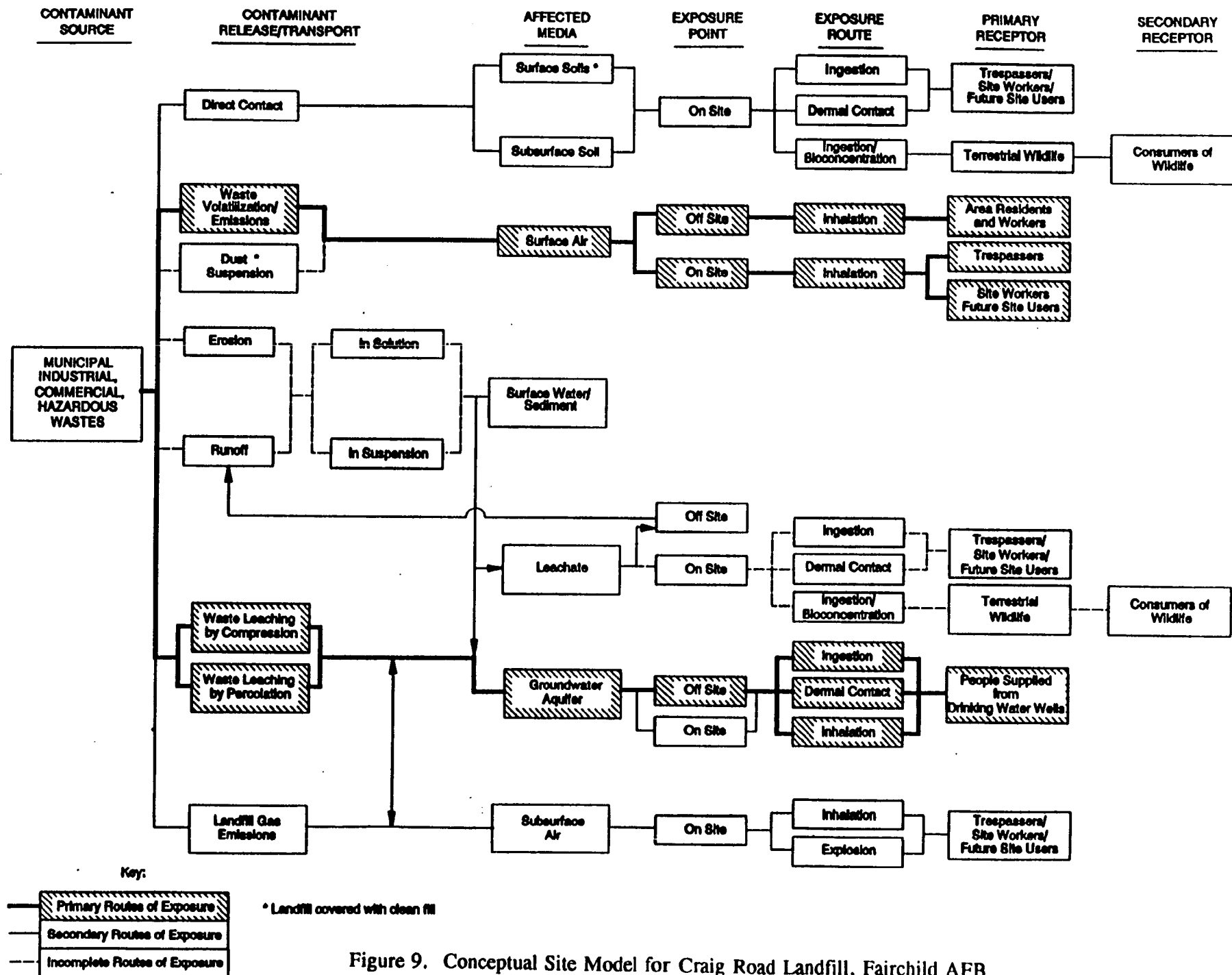


Figure 9. Conceptual Site Model for Craig Road Landfill, Fairchild AFB.

the CRL site. Exposure routes associated with groundwater include ingestion, inhalation, and dermal contact with groundwater contaminants. Risks associated with a residential groundwater exposure scenario were estimated in the Baseline Risk Assessment. The groundwater exposure scenarios are summarized in Table 5.

The current and expected future groundwater use in the immediate vicinity of the site is residential and light industrial. There are currently four residential drinking water supply wells located within one-half mile of the site. Three of these wells are not currently used for residential use because levels of TCE in these wells exceed federal drinking water standards. Residential groundwater use is considered the most conservative groundwater exposure scenario for the site.

The risk estimates provided in the risk assessment are for exposure to contaminants found in the Basalt A aquifer. TCE was detected at a level below the federal MCL in the Basalt B aquifer during the most recent groundwater sampling round. Figure 6 shows the general relationship between the Basalt A and Basalt B aquifers.

Surface and Subsurface Soil

Excavation within the fill areas could result in direct contact with contaminated subsurface soil and fill material. Several volatile organic chemicals were detected in soil-gas measurements taken from these areas. Subsurface soil samples were not collected during the remedial investigation and therefore, risks associated with this exposure pathway have not been quantified. Soil-gas measurements are indicative of soil contamination; exposure to subsurface soils could result in unacceptable risks to human health.

Historical aerial photographs and field test pits indicate that a native soil cover was placed over the subsurface disposal areas. Therefore, surface soil contamination is not suspected at the site and is not considered a complete contaminant exposure pathway.

Surface Water/Sediments

Surface water associated with the wastewater treatment plant and surface runoff due to precipitation infiltrates to groundwater on site. Surface water and sediments associated with the WWTP pond do not contact contaminated fill materials. Therefore, contamination of surface water and sediments is not suspected at the site and is not considered a complete contaminant exposure pathway.

Air/Landfill Gases

Emissions of volatile organic contaminants from the fill areas to the atmosphere is a potential route of contaminant migration. Methane gas, generated under anaerobic conditions within the landfill, can act to enhance migration of volatile contaminants through the air pathway. Inhalation of air contaminants by nearby residents and workers is a potential exposure pathway. An air pathway analysis was performed by EPA Region 10 to estimate risks associated with this

Table 5

Human Exposure Scenarios for Risk Assessment

a) Ingestion of drinking water:

Utilization of Landfill Site/ Source Area	Utilization of Adjoining Area/ Off-Site Receptors	Routes of Exposure	Environmental Media of Concern	Example of Exposure	Exposure Model Assumptions (Residential Scenario)		
					Exposure Factor	RME	Average Case
<p>PAST: Two areas of landfill, including sanitary/industrial waste, construction debris, cleaners and solvents, paints and thinners, waste oils.</p> <p>CURRENT: Discharge and infiltration/evaporation of effluent from Base wastewater treatment plant. Area is fenced and posted Government Property/No Trespassing. However, infrequent access required by workers for pond and ditch maintenance and weed control.</p>	<p>CURRENT: Within half-mile radius of landfill, land use is low-density rural residential, medium-density housing (mobile home park), light industrial, and mining (gravel). Within one-mile radius of landfill, land uses include agriculture, recreation, rural residences, commerce and industry. Agriculture includes irrigated crops and cattle.</p>	<p>Ingestion of drinking water from local off-site wells.</p>	<p>Groundwater: local alluvial and bedrock aquifers.</p>	<p>Use of groundwater as a drinking water supply.</p> <p>Currently, four drinking water supply wells exist within one-half mile of site. Only one in current use. Estimated that 15-20 exist within one mile of site.</p>	Chemical Concentration in Groundwater ($\mu\text{g/L}$)	95% UCL of mean	Mean Value
					Ingestion of Water (L/day)	2	1.4
					Exposure Frequency (days/yr)	350	274
					Exposure Duration (years)	30	9
					Adult Body Weight (kg)	70	70

RME = Reasonable Maximum Exposure.
 UCL = Upper Confidence Limit.

Table 5 (Continued)

Human Exposure Scenarios for Risk Assessment

b) Inhalation of organic vapors from drinking water:

Utilization of Landfill Site/ Source Area	Utilization of Adjoining Area/ Off-Site Receptors	Routes of Exposure	Environmental Media of Concern	Example of Exposure	Exposure Model Assumptions (Residential Scenario)		
					Exposure Factor	RME	Average Case
					Chemical Concentration in Groundwater ($\mu\text{g/L}$)	95% UCL of mean	Mean Value
					Contact Rate for Inhalation (m^3/day)	15	15
					Exposure Frequency (days/yr)	350	274
					Exposure Duration (years)	30	9
					Adult Body Weight (kg)	70	70
					Air Concentration Factor from Domestic Water Use (L/m^3)	0.5	0.5
<p>PAST: Two areas of landfill, including sanitary/industrial waste, construction debris, cleaners and solvents, paints and thinners, waste oils.</p> <p>CURRENT: Discharge and infiltration/evaporation of effluent from Base wastewater treatment plant. Area is fenced and posted Government Property/No Trespassing. However, infrequent access required by workers for pond and ditch maintenance and weed control.</p>	<p>CURRENT: Within half-mile radius of landfill, land use is low-density rural residential, medium-density housing (mobile home park), light industrial, and mining (gravel). Within one-mile radius of landfill, land uses include agriculture, recreation, rural residences, commerce and industry. Agriculture includes irrigated crops and cattle.</p>	Inhalation of organic vapors in well water.	Atmosphere: breathing zone in bath or shower.	Breathing vapors emanating from drinking water during shower or bath.			

Table 5 (Continued)

Human Exposure Scenarios for Risk Assessment

c) Dermal contact with drinking water:

Utilization of Landfill Site/ Source Area	Utilization of Adjoining Area/ Off-Site Receptors	Routes of Exposure	Environmental Media of Concern	Example of Exposure	Exposure Model Assumptions (Residential Scenario)		
					Exposure Factor	RME	Average Case
<p>PAST: Two areas of landfill, including sanitary/industrial waste, construction debris, cleaners and solvents, paints and thinners, waste oils.</p> <p>CURRENT: Discharge and infiltration/evaporation of effluent from Base wastewater treatment plant. Area is fenced and posted Government Property/No Trespassing. However, infrequent access required by workers for pond and ditch maintenance and weed control.</p>	<p>CURRENT: Within half-mile radius of landfill, land use is low-density rural residential, medium-density housing (mobile home park), light industrial, and mining (gravel). Within one-mile radius of landfill, land uses include agriculture, recreation, rural residences, commerce and industry. Agriculture includes irrigated crops and cattle.</p>	<p>Dermal contact with well water.</p>	<p>Groundwater: Basalt Flow A Aquifer.</p>	<p>Use of groundwater for showering/bathing.</p>	Chemical Concentration in Groundwater ($\mu\text{g/L}$)	95% UCL of mean	Mean Value
					Skin Surface Area for Adult (cm^2)	20000	20000
					Exposure Time (hours/day)	0.17	0.12
					Exposure Frequency (days/yr)	350	274
					Exposure Duration (years)	30	9
					Adult Body Weight (kg)	70	70

pathway. EPA's SCREEN air dispersion model and soil-gas measurements from the two fill areas at the site were used to support the risk calculations.

An additional hazard posed by migrating methane gas is the potential for explosion due to gaseous buildup in confined spaces. Such buildup normally occurs through penetrations and cracks in the foundation. The nearest buildings in the vicinity of the site are located approximately 650 feet from the site boundary. These buildings are mobile homes and do not have basements; the likelihood that methane will accumulate under these well ventilated circumstances is small. Even with skirting, unless the skirting intercepts the gas flow and traps the gas, the hazard should be low. Since the quantity of methane generation at the landfill is uncertain, the remedial actions developed for the site have been developed to address landfill gas generation.

b. Exposure Point Concentrations

Groundwater Contaminants. Average and reasonable maximum exposure (RME) point concentrations were developed for TCE, 1,1-DCE, vinyl chloride, and BEHP based on actual measurements made during the RI investigation. Analytical data used for determining the exposure point concentrations were obtained from monitoring wells containing the peak concentrations of each of the contaminants. For example, MW-85 contained the peak concentrations of TCE; therefore, temporal data from this well was used to calculate the exposure point concentration for TCE. The 95 percent upper confidence limit on the mean was used to calculate RME exposure point concentrations. One-half of the detection limit was used to calculate the exposure point concentrations in the case where a contaminant was not detected in a sample. Exposure point concentrations for vinyl chloride, 1,1-DCE, TCE, and BEHP were derived from data collected from monitoring wells MW-18, MW-69, MW-85, and MW-69, respectively.

The calculated 95 percent upper confidence limit was higher than the peak concentration for all of the contaminants evaluated in the risk assessment; therefore, in accordance with RAGS HHM, the maximum concentration was used in computing the risk estimates.

Air Contaminants. The following worst-case emissions rates (measure in ug/s) were estimated using EPA's Farmer model, Air/Superfund National Technical Guidance Study Series, Volume 2, Estimates of Baseline Air Emissions at Superfund Sites (1990).

<u>Area</u>	<u>Benzene</u>	<u>Methylene Chloride</u>	<u>TCE</u>
NE	0.109	2.60	448
SW	1630	11500	870

The worst-case emission rates were used in conjunction with EPA's SCREEN air quality dispersion model to estimate the ambient concentrations of air pollutants at various off-site locations surrounding the landfill, including at a mobile home park located approximately 650 feet from the CRL site boundary. The worst-case, 1-hour concentrations for benzene, methylene chloride, and TCE at the mobile home park were 0.98, 1.97, and 1.94 ug/m³, respectively.

c. Exposure Factors

Exposure factors used to derive chemical uptake for the groundwater and air exposure pathways were obtained from EPA's Standard Default Exposure Factors document (OSWER Directive No. 9285.6-03). For each contaminant, the average case (using mean concentration) and RME (95 % UCL) risks were calculated using the exposure model assumptions presented in Table 5. The exposure factors used to derive contaminant uptake from groundwater through dermal contact during showering and bathing were obtained from EPA's "Interim Guidance for Dermal Exposure Assessment" and the Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (RAGS HHEM).

3. Toxicity Assessment

Toxicity information was provided in the Baseline Risk Assessment for the chemicals of concern. Generally, cancer risks are calculated using toxicity factors known as slope factors, while noncancer effects rely on reference doses.

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

Reference doses (RfDs) have been developed by EPA for indicating the potential for adverse health effects from exposure to chemicals exhibiting noncarcinogenic effects. RfDs, which are expressed in units of mg/kg-day, are estimates of lifetime daily exposure for humans including sensitive subpopulations, that are likely to be without risk of adverse effect. Estimated intakes of contaminants of concern from environmental media (e.g., the amount of a contaminant of concern ingested from contaminated drinking water) can be compared to the RfD. RfDs are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied.

The Baseline Risk Assessment relied on oral and inhalation Sfs and RfDs. Because dermal toxicity factors have not been developed for the chemicals evaluated, oral toxicity factors were used in estimating risks from dermal exposure. The toxicity factors shown in Table 6 were drawn from the Integrated Risk Information System (IRIS) or, if not IRIS values were available, from the Health Effects Summary Tables (HEAST).

Trichloroethene

According to the most recent assessment of TCE on the IRIS database, the chronic oral and inhalation RfD assessments are under review by an EPA work group. The most recent annual

Table 6. Toxicity Factors for Chemicals of Concern

Analyte	Chronic Reference Dose (mg/kg-day)			Slope Factor 1/(mg/kg-day)			Weight of Evidence Class
	Inhalation	Oral	Dermal	Inhalation	Oral	Dermal	
Trichloroethene				1.7E-02 (a)	1.1E-02 (a)	1.0E-02 (b)	B2
1,1-Dichloroethene		9.0E-03 (c)	9.0E-03 (b)	1.2 (a)	6.0E-01 (c)	6.0E-1 (b)	C
Vinyl chloride				2.9E-01 (a)	1.9 (a)		A
bis(2-ethylhexyl)- phthalate		2.0E-02 (c)	1.0E-03 (b)		1.4E-02 (c)	2.8E-01 (b)	B2

Sources:

- (a) EPA Health Effects Assessment Summary Tables (HEAST), 1991.
- (b) EPA Interim Guidance for Dermal Exposure Assessment, 1991.
- (c) EPA Integrated Risk Information System (IRIS), on-line database.

summary (FY-1991) of HEAST reports TCE as a Group B2 carcinogen (probable human carcinogen). An inhalation slope factor of 1.7×10^{-2} (mg/kg/day)⁻¹ was reported based on two inhalation studies using mice. An oral slope factor of 1.1×10^{-2} (mg/kg/day)⁻¹ was reported based on two studies on mice where tumors developed on livers. Although both slope factors had been removed from IRIS pending further review, the slope factors for inhalation and oral ingestion presented in HEAST were used in this risk assessment.

4. Risk Characterization

For carcinogens, risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated by multiplying the SF (see toxicity assessment above) by the "chronic daily intake" developed using the exposure assumptions. These risk are probabilities generally expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer of 1×10^{-6} indicates that an individual has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure to a carcinogen under the specific exposure conditions assumed.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a reference dose (see toxicity assessment above) derived for a similar exposure period. The ratio of exposure to toxicity is called a hazard quotient. Hazard quotients are calculated by dividing the chronic daily intake (CDI) by the specific RfD. By adding the hazard quotients for all contaminants of concern that affect the same target organ (e.g., liver), the hazard index (HI) can be generated.

Groundwater Pathway

The cancer risk estimates associated with groundwater exposure are summarized in Table 7. The total excess cancer risk for reasonable maximum exposures to groundwater is 1×10^{-3} . This risk level exceeds the EPA Superfund acceptable risk range of 1×10^{-4} to 1×10^{-6} (1 in 10,000 to 1 in 1,000,000).

Comparing the risk contribution from each contaminant shown in Table 7, the total excess cancer risk associated with TCE is two orders of magnitude higher than the risk associated with the other individual contaminants. The summary of carcinogenic risks in Table 7 indicates that the inhalation exposure route creates a greater risk to human health than the ingestion exposure route. This is due to the relatively higher inhalation slope factor for 1,1-DCE and TCE when compared to their oral slope factor.

Table 8 presents the estimates of noncarcinogenic toxic effects (RME) calculated for chronic exposure to 1,1-DCE and BEHP in groundwater. For the ingestion of drinking water route of exposure, the hazard quotient for 1,1-DCE is 0.002; for BEHP, 0.07. For dermal contact with groundwater during showering and bathing, the hazard quotient for 1,1-DCE is 0.00004; for BEHP, 0.00001. The total sum of chronic noncarcinogenic estimates via the groundwater pathway is 0.07, which is the same approximate magnitude as associated with the ingestion of BEHP in drinking water. The estimates for noncarcinogenic health effects are below unity, indicating that adverse health effects would not be expected under the defined exposure scenario.

Table 7. RME Cancer Risk Estimates
CRL, Fairchild AFB, WA

Exposure Route: Ingestion of Drinking Water and Inhalation of Vapors During Household Use (VOCs only)

$$\text{Risk}_{\text{RME}} = C \times \left[\frac{((\text{CR}_o \times \text{EF} \times \text{D}) \times \text{SF}_o)}{\text{BW} \times \text{AT}} + \frac{((\text{AC} \times \text{CR}_i \times \text{EF} \times \text{D}) \times \text{SF}_i)}{\text{BW} \times \text{AT}} \right]$$

where: C = Concentration; peak value used, 95 % UCL exceeds peak; (ug/Lx0.001 mg/ug)
 CR_o = Contact rate for ingestion (L/day)
 CR_i = Contact rate for inhalation (m₃/day)
 EF = Exposure frequency (days/year)
 D = Duration (years)
 BW = Body weight (kg)
 AT = Averaging time (years x days/yr)
 AC = Air concentration factors resulting from domestic water use (L/m₃)
 SF_o = Oral slope factor (mg/kg-day)⁻¹ (HEAST)
 SF_i = Inhalation slope factor (mg/kg-day)⁻¹ (HEAST)

Chemical	Group	C	CR _o	CR _i	EF	D	BW	AT	AC	SF _o	SF _i	Risk
Vinyl chloride	A	2	2	15	350	30	70	70x365	0.5	1.9	2.9x10 ⁻¹ (a)	7x10 ⁻⁵
1,1-DCE	C	0.8	2	15	350	30	70	70x365	0.5	6x10 ⁻¹	1.2	4x10 ⁻⁵
TCE	B2	2800	2	15	350	30	70	70x365	0.5	1.1x10 ⁻²	1.7x10 ⁻² x0.35 (b)	1x10 ⁻³
BEHP	B2	53	2	NA	350	30	70	70x365	NA	1.4x10 ⁻²	NA	9x10 ⁻⁶

(a) SF_i not available in HEAST value derived using unit risk. See calculations in Appendix B for conversion calculations.

(b) The inhalation slope factor for TCE is for absorbed or metabolized dose; therefore, calculations or risk include an absorption correction of 0.35 for the inhalation slope factor.

NA Not applicable; semivolatile chemical, does not affect inhalation exposure route.

Table 7. RME Cancer Risk Estimates
CRL, Fairchild AFB, WA (cont.)

Exposure Route: Dermal Contact with Groundwater During Showering/Bathing

$$\text{Risk}_{\text{RME}} = \frac{(\text{CW} \times \text{SA} \times \text{K}_p \times \text{ET} \times \text{ED} \times \text{CF})}{\text{BW} \times \text{AT}} \times \text{SF}_d$$

where: CW = Chemical concentration in groundwater; peak value used, 95% UCL exceeds peak; (ug/Lx0.001 mg/ug)
SA = Skin surface area available for contact (cm²)
K_p = Chemical-specific dermal permeability constant (cm/hr)
ET = Exposure time (hrs/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
CF = Volumetric conversion factor for water (1 L/1000 cm³)
BW = Body weight (kg)
AT = Averaging time (years x days/yr)
SF_d = Calculated chemical-specific dermal slope factor (mg/kg-day)⁻¹

Chemical	Group	CW	SA	K _p	ET	EF	ED	CF	BW	AT	SF _d	Risk
Vinyl chloride	A	2	20000	7.24x10 ⁻³ (a)	0.17	350	30	0.001	70	70x365	(c)	(c)
1,1-DCE	C	0.8	20000	9.55x10 ⁻³ (a)	0.17	350	30	0.001	70	70x365	0.60(d)	9x10 ⁻⁸
TCE	B2	2800	20000	8.32x10 ⁻² (a)	0.17	350	30	0.001	70	70x365	0.01(e)	5x10 ⁻⁵
BEHP	B2	53	20000	5.70x10 ⁻⁶ (b)	0.17	350	30	0.001	70	70x365	0.28(f)	2x10 ⁻⁹

- (a) Source of constant: Flynn, 1990; EPA, 1991e.
(b) Source of constant: Scott et al., 1987; recommended.
(c) Toxicokinetic study reports minimal dermal absorption (0.031%) value considered too insignificant for computing a dermal slope factor.
(d) DCE is small organic molecule with properties similar to lipid-soluble anesthetics; thus, it is expected to readily penetrate skin, which is lipid-rich tissue (ATSDF, 1989b) (similar to TCE). Calculation of dermal slope factor assumes complete absorption.
(e) Oral toxicity value already expressed as absorbed dose, therefore no adjustment to toxicity value required.
(f) Toxicokinetic study reports absorption rate for BEHP of 5%.

Table 7. RME Cancer Risk Estimates
CRL, Fairchild AFB, WA (cont.)

Summary of Carcinogenic Risk (RME):

<u>Exposure Route</u>	<u>Chemical of Concern</u>				<u>Total Risk via Route</u>
	<u>Vinyl chloride</u>	<u>1,1-DCE</u>	<u>TCE</u>	<u>BEHP</u>	
Ingestion of groundwater	4×10^{-5}	6×10^{-7}	4×10^{-4}	9×10^{-6}	4×10^{-4}
Inhalation of VOCs	3×10^{-5}	4×10^{-5}	7×10^{-4}	NA	8×10^{-4}
Dermal contact	NA	9×10^{-8}	5×10^{-5}	2×10^{-9}	5×10^{-5}
Total risk via groundwater pathway	7×10^{-5}	4×10^{-5}	1×10^{-3}	9×10^{-6}	1×10^{-3}

Table 8. RME Chronic Noncarcinogenic Effects Estimates,
CRL, Fairchild AFB, WA

Exposure Route: Ingestion of Drinking Water

$$HI_{RME} = C \times \frac{(CR \times EF \times D)}{BW \times AT} / RfD_o$$

where: C = Concentration; peak value used, 95 % UCL exceeds peak; (ug/Lx0.001 mg/ug)
 CR = Contact rate for ingestion (L/day)
 EF = Exposure frequency (days/yr)
 D = Duration (years)
 BW = Body weight (kg)
 AT = Averaging time (yrs x days/yr)
 RfD_o = Oral reference dose (mg/kg-day) (HEAST)

<u>Chemical</u>	<u>C</u>	<u>CR</u>	<u>EF</u>	<u>D</u>	<u>BW</u>	<u>AT</u>	<u>RfD_o</u>	<u>HI</u>
1,1-DCE	0.8	2	350	30	70	30x365	9x10 ⁻³	2x10 ⁻³
BEHP	53	2	350	30	70	30x365	2x10 ⁻²	7x10 ⁻²

NOTE: No inhalation RfD available for 1,1-DCE, presently under review by CRAVE Workgroup (HEAST).

Table 8. RME Chronic Noncarcinogenic Effects Estimates,
CRL, Fairchild AFB, WA (cont.)

Exposure Route: Dermal Contact with Groundwater During Showering/Bathing

$$HQ_{RME} = \frac{CW \times SA \times K_p \times ET \times EF \times ED \times CF}{BW \times AT \times RfD_d}$$

where: CW = Chemical concentration in groundwater (ug/Lx0.001 mg/ug)
 SA = Skin surface area available for contact (cm²)
 K_p = Chemical-specific dermal permeability constant (cm/hr)
 ET = Exposure time (hours/day)
 EF = Exposure frequency (days/yr)
 ED = Exposure duration (years)
 CF = Volumetric conversion factor for water (1 L/1000 cm³)
 BW = Body weight (kg)
 AT = Averaging time (yrs x days/yr)
 RfD_d = Estimated dermal reference dose (mg/kg-day)

<u>Chemical</u>	<u>CW</u>	<u>SA</u>	<u>K_p</u>	<u>ET</u>	<u>EF</u>	<u>ED</u>	<u>CF</u>	<u>BW</u>	<u>AT</u>	<u>RfD_d</u>	<u>HQ</u>
1,1-DCE	0.8	20000	9.55x10 ⁻³	0.17	350	30	0.001	70	30x365	9x10 ⁻³ (a)	4x10 ⁻⁵
BEHP	53	20000	5.70x10 ⁻⁶	0.17	350	30	0.001	70	30x365	1x10 ⁻³ (b)	1x10 ⁻⁵

- (a) DCE is small organic molecule with properties similar to lipid-soluble anesthetics; thus, it is expected to readily penetrate skin, which is lipid-rich tissue (similar to TCE). Calculation of dermal slope factor assumes complete absorption.
- (b) Toxicokinetic study reports absorption rate for BEHP of 5%.

Table 8. RME Chronic Noncarcinogenic Effects Estimates,
CRL, Fairchild AFB, WA (cont.)

Summary of RME Chronic Noncarcinogenic Effects:

Exposure Route	Chemical of Concern		Total Risk via Route
	<u>1,1-DCE</u>	<u>BEHP</u>	
Ingestion of Groundwater	2×10^{-3}	7×10^{-2}	7×10^{-2}
Dermal Contact w/Groundwater	4×10^{-5}	1×10^{-5}	5×10^{-5}
Total Chronic Effects via Groundwater Pathway - HI	2×10^{-3}	7×10^{-2}	7×10^{-2}

Air Pathway

Cancer risk estimates for the air exposure pathway are shown in Table 9. Risk estimates associated with the three contaminants of concern under a residential exposure scenario for five off-site locations are shown. Total risk is the sum of the risks from exposure to all three contaminants from both landfill areas.

Factors that may underestimate risks to future residents are: (1) gas-generation within the landfill was not considered; (2) air-filled porosity was not directly measured but was estimated based on the soil's water capacity; and (3) soil-gas samples were not analyzed for vinyl chloride, a common landfill constituent. The presence of vinyl chloride could increase risks associated with this pathway. In addition, many factors will change over time, such as soil-gas concentrations. Any increase or decrease in soil-gas concentrations will be reflected as increases or decreases in risk rates.

The risks from exposure to annual air concentrations, which are more appropriately used for risk assessment calculations, are expected to be at least an order of magnitude less than the risks from the 1-hour, worst-case concentrations presented here. The following factors lead to overestimation of actual risk: (1) the highest values of soil-gas concentrations were used, (2) the area over which flux occurs was conservatively estimated, (3) the worst possible atmospheric conditions were used in the air model, and (4) worst-case, 1-hour concentration was assumed, rather than one-tenth the worst-case, 1-hour concentrations, which is more commonly used.

These calculations lead to worst-case estimates of emissions, ambient concentrations, and carcinogenic risks.

Table 9. Estimated Maximum Carcinogenic Risks at Given Locations

Compound	Mobile Home Park	Boundary Location			
		North	West	South	East
Benzene	7×10^{-6}	2×10^{-5}	1×10^{-4}	9×10^{-5}	4×10^{-5}
Methylene Chloride	4×10^{-7}	1×10^{-6}	5×10^{-6}	4×10^{-6}	3×10^{-6}
Trichloroethene	5×10^{-6}	2×10^{-5}	3×10^{-5}	3×10^{-5}	2×10^{-5}
Total risk	1×10^{-5}	4×10^{-5}	2×10^{-4}	1×10^{-4}	7×10^{-5}

5. Uncertainty in the Risk Assessment

The accuracy of the risk characterization depends in large part on the accuracy and representativeness of the sampling, exposure, and toxicological data. Most assumptions are intentionally conservative so the risk assessment will be more likely to overestimate risk than to underestimate it.

Uncertainty in the toxicity evaluation may overestimate risk by relying on slope factors that describe the upper confidence limit on cancer risk for carcinogens. Some under estimation of risk may occur due to lack of quantitative toxicity information for some contaminants detected at the site. Qualitative uncertainty exists in evaluating carcinogenicity of chemicals that have no human evidence of carcinogenicity. Evidence for carcinogenicity of TCE is based on animal studies, and weight of the evidence for TCE is under review by EPA to determine status as either B2, probable human carcinogen, or C, possible human carcinogen.

Another uncertainty arises as to whether groundwater detections of vinyl chloride, 1,1-DCE and BEHP are actually associated with the site. Each of these contaminants has a very low frequency of detection. Since vinyl chloride and 1,1-DCE were infrequently detected, RAOs were not set for these compounds. However, because they are breakdown products of TCE, they should be included as part of the long-term monitoring. Since BEHP was detected in groundwater at a low frequency and since the detections may be associated with field or laboratory contamination, BEHP is not considered in the Remedial Action Objectives for remediation.

B. Ecological Risk Assessment

To assess the environmental effects of the contaminants present at the CRL site, an evaluation of potentially affected terrestrial species was conducted. Three state-designated species (burrowing owl, great blue heron, and Swainson's hawk) have been observed on the Base and may inhabit or frequent the CRL. No federal or state threatened or endangered species are known to occur at the CRL. A site-specific survey of the number and species of animals inhabiting the landfill area was not conducted as part of the remedial investigation.

The primary exposure routes available to wildlife at the CRL site are inhalation of volatile organics associated with soil-gas and ambient air at the site and dermal contact with contaminated subsurface soils and fill material, particularly for burrowing and underground dwelling wildlife. Contaminants detected in soil-gas measurements were selected as the contaminants of concern for ecological exposure through the air pathway. Ecological exposure to subsurface soil contamination was not evaluated since the level of soil contamination was not quantified during the investigation.

Exposure to surface water and sediments associated with the wastewater treatment plant infiltration pond were not considered a complete contaminant pathway since surface water and sediment contamination are not suspected at the site. Contaminated groundwater is not in contact with surface water and therefore was not considered a complete exposure pathway.

Due to the lack of actual ecological site data and toxicological data on wildlife, toxicity thresholds developed for laboratory animals were in the ecological assessment. Table 10 provides a comparison of mean and maximum subsurface soil-gas concentrations of TCE, benzene, toluene, total xylenes, and methylene chloride detected during the remedial investigation with the toxicity thresholds developed for mice. The comparisons shown in Table 10 indicate that burrowing animals inhabiting the landfill could potentially be impacted by the contaminant vapors present in the soil pore spaces.

Table 10
RISK CHARACTERIZATION FOR THREE CONTAMINANTS OF ECOLOGICAL CONCERN
FOR FAIRCHILD AFB

	<u>TOXIC THRESHOLD (1) CONCENTRATIONS (ppm)</u>		<u>MEAN SUBSURFACE SOIL-GAS (3) CONCENTRATIONS (ppm)</u>	<u>MAXIMUM SUBSURFACE SOIL-GAS (3) CONCENTRATIONS (ppm)</u>
TCE	8450	(2)	1500	96000
Benzene	100		240	18000
Toluene	1200		1300	130000
Total Xylenes	5300		3200	460000
Methylene Chloride	100		460	4700

(1) U.S. Department of Health ATSDR (Chronic toxicity threshold inhalation values for mice).

(2) U.S. Department of Health ATSDR (Acute toxicity threshold inhalation values for mice).

(3) Soil-Gas Survey by SAIC - Values represent the worst-case concentrations sampled at a 3-foot depth on the average.

Uncertainties in evaluating the effects of ecological exposure to chemical contaminants at the CRL include: (1) lack of site-specific ecological survey for the CRL site, (2) limited toxicological data, and (3) uncertainties in ecological exposure factors.

VII. REMEDIAL ACTION OBJECTIVES

Remedial action at this site is required to protect human health and the environment. The following findings of the remedial investigation and baseline risk assessment support the need for cleanup action at the site:

- TCE have been detected in groundwater samples from residential wells and on-site and off-site monitoring wells at concentrations exceeding federal maximum contaminant levels. The affected aquifer serves as a water source for both residential and municipal water supplies.
- The excess cancer risk associated with the reasonable maximum groundwater exposure is estimated to be 1 in 1000. This exceeds the EPA acceptable risk range of 1 in 10,000 to 1 in 1,000,000.
- Two fill areas at the landfill continue to be a source of a groundwater contamination plume.
- Soil-gas measurements indicate that volatile contaminants are present within the fill material. Although the risks have not been quantified, direct exposure to subsurface soil and debris may result in unacceptable risks.

Remedial Action Objectives (RAOs) for the CRL were developed to address the requirements of CERCLA, as amended by SARA, and the state of Washington's Model Toxics Control Act (MTCA). The RAOs for the CRL were developed in accordance with the National Contingency Plan (NCP) to protect human health, public welfare, and the environment from potential threats due to contaminants associated with the site. The specific goals and objectives of the remedial action at the CRL are:

1. To prevent consumption by area residents of groundwater exceeding federal MCLs
2. To restore contaminated groundwater in the upper aquifer to levels that are safe for drinking
3. To prevent further migration of contaminated groundwater across the site boundary and to the lower aquifer
4. To minimize the migration of contaminants from the fill material to the groundwater
5. To prevent exposure to contaminants within subsurface soil and debris.

Groundwater cleanup levels have been established to meet the requirements of CERCLA, and MTCA as an applicable requirement. MTCA Method B, which is the standard method for complex sites such as the CRL, was used to establish cleanup levels. The Method B cleanup levels are based on MTCA as promulgated on January 28, 1991. The cleanup level for TCE is 5 ug/L. In addition, the cumulative excess cancer risk associated with the site will be reduced to at most 10^{-5} , consistent with MTCA.

VIII. DESCRIPTION OF ALTERNATIVES

The cleanup alternatives which were evaluated in the FS include elements from two different categories of actions. The first category is source controls, which are intended to minimize migration of contaminants from the fill material to the groundwater and to prevent direct exposure to contaminated subsurface soil and debris. The second action category is groundwater controls. These controls are intended to prevent further migration of contaminated groundwater across the site boundary and to prevent consumption by area residents of groundwater exceeding MCLs. The combination of both source control and groundwater control actions is necessary to achieve the broader objective of restoring contaminated groundwater in the aquifer to levels that are safe for drinking.

As part of the Base's operational plans, the wastewater treatment plant has undergone closure. This action was taken independently of site remediation efforts; however, several aspects of this action are expected to facilitate the groundwater cleanup. The closure should reduce the migration of contaminants from the fill material to groundwater. In addition, the loss of recharge will lower the gradient of groundwater and reduce the velocity of contaminant migration.

A. Source Controls

Source control alternatives were developed to address RAOs 2, 4, and 5. All of the source control alternatives, except the no-action alternative (SC-1), include institutional controls. Restricted access to the site (e.g., fences) and posted warnings around the perimeter of the site would decrease inadvertent contact with contaminated soil and debris. Public meetings and prepared news releases would allow a wider dissemination and understanding of information on the health risks of contact with the contaminated soils and debris. Finally, deed restrictions would be used to preclude future residential, industrial, commercial, or agricultural use of the area.

1. Alternative SC-1

The first alternative is no action. Evaluation of this alternative is required under CERCLA; it serves as a reference against which other alternatives can be compared. Under this alternative, no action would be taken to control migration of contaminants from the fill material to groundwater and no institutional controls would be established to prevent exposure to contaminated subsurface soils and debris. The northeast and southwest disposal areas would continue to act as a source of contamination to groundwater and groundwater levels would

continue to exceed MCLs. Modeling predicts that groundwater contaminant concentrations would decrease through natural dilution, degradation, and dispersion, and would attain the cleanup levels in approximately 77 years. There is no cost associated with this alternative.

2. Alternative SC-2

Alternative SC-2 involves containment of contaminants within the landfill. The CRL would be graded to improve drainage and decrease erosion. A low-permeability cap would be constructed over the northeast and southwest areas of the CRL. A passive gas management system would be installed to reduce methane buildup and pressure under the cap. The cap would decrease infiltration of precipitation through, and contaminant migration out of, the fill areas.

The design, construction, and maintenance of the cap would meet the closure requirements of Washington State's Minimum Functional Standards for Solid Waste Handling and of federal RCRA Subtitle D. Emissions from the passive gas management system would be treated as necessary to ensure compliance with air quality standards set by the state of Washington and the Spokane County Air Pollution Control Authority, and the Clean Air Act.

Estimated capital cost for this alternative range from \$3,772,325 to \$4,222,325. Operating and maintenance costs for the alternative range from \$34,184 to \$37,000 per year. The estimated present net worth ranges from \$4,297,817 to \$4,791,106, assuming a 5 percent discount rate and 30 years of O&M costs.

3. Alternative SC-3

This alternative would include all of the actions described in Alternative SC-2 (a cap and passive gas management system) with the addition of hot spot removal prior to the construction of the landfill cap. The goal of hot spot removal is to remove highly contaminated material from the landfill to reduce the potential for continued groundwater contamination. Hot spots would be identified based on the results of soil-gas measurements taken during the remedial investigation. Intact containers of contaminants and contaminated material surrounding ruptured containers would be removed, placed in sealed containers, and shipped for proper off-site treatment/disposal. Figure 6 shows the hot spots identified in the RI Report. An estimated total of 300 cubic yards of material would need to be removed at the CRL, assuming there are only five hot spots in the landfill and that 60 cubic yards of material would need to be removed per hot spot. Excavation, transport, and treatment/disposal of the contaminated material would comply with the RCRA Subtitle C regulations.

The costs for this alternative are estimated at \$4,237,525 to \$4,687,525 (capital cost); \$34,184 to \$37,000 (O&M costs); and \$4,297,817 to \$4,791,106 (present net worth), assuming a 5 percent discount rate and 30 years O&M costs.

4. Alternative SC-4

Alternative SC-4 includes the landfill capping component from Alternative SC-2 with the addition of an active soil vapor extraction system. The extraction system would include the use

of vacuum blowers, air infiltration and vapor extraction wells, collection headers, and treatment systems. A treatability study would be performed to determine the optimum gas extraction and treatment system design. The emissions from the vapor treatment system would comply with the Spokane County Air Pollution Control Authority and state of Washington air quality standards, and the Clean Air Act.

Estimated costs for the alternative are \$4,581,875 to \$5,031,875 (capital costs), \$45,684 to \$48,500 (O&M costs), and \$5,284,150 to \$5,777,439 (present net worth), assuming a 5 percent discount rate and 30 year O&M.

B. Groundwater Extraction and Treatment

Groundwater alternatives were developed to address RAOs 1, 2, and 3. All of the alternatives include monitoring the groundwater near the CRL. Institutional controls and public education and notification would be included as part of all of the alternatives except for the no-action alternative (GW-1). Institutional controls can be implemented to discourage access to contaminated groundwater. Deep wells that are located within the contaminant plume may provide a conduit for contaminant migration to lower aquifers. These wells would be inspected and reconstructed or abandoned as necessary. Public education and notification would include public meetings, prepared news releases, and information provided to groundwater users as a method for disseminating information about the contamination and associated risks.

1. Alternative GW-1

The first alternative is no action. Evaluation of this alternative is required under CERCLA; it serves as a reference against which other alternatives can be compared. Under this alternative, no action would be taken to treat or contain contaminated groundwater and no institutional controls would be imposed to prevent use of contaminated groundwater. Contaminants at levels exceeding MCLs would continue to migrate toward residential and municipal drinking water supply wells. Modeling predicts that groundwater contaminant concentrations would decrease through natural dilution, degradation, and dispersion, and would attain the cleanup levels in approximately 77 years. Groundwater monitoring would allow a periodic assessment of the migration of the contaminant plume. The public would be informed of the results of the monitoring program.

Although there would be no capital cost, periodic monitoring over a 30-year period would incur annual O&M costs of \$40,000. The present net worth of this alternative would be \$614,898.

2. Alternative GW-2

This alternative involves the installation of a groundwater extraction and treatment system on the CRL property. The objective of this alternative is to prevent continued migration of contaminated groundwater from the CRL site. To accomplish this, a total of approximately 20 extraction wells would be installed along the north and east boundaries of the northeast disposal area and along the east boundary of the southwest disposal area. Groundwater would be extracted from the upper aquifer and treated using an air stripping unit. Air stripping would

reduce the concentrations of contaminants in the extracted water to the groundwater cleanup levels established for the site. The treated water would be reintroduced into the upper aquifer at an off-site location downgradient of the CRL. Groundwater monitoring wells would be installed to monitor effectiveness of the extraction system.

The air emissions from the air stripper would be treated using activated carbon. Used carbon would be recycled off site at an EPA-approved facility. Air emissions from the air stripper system would be treated as necessary to ensure protection of human health and the environment and compliance with air quality standards set by the state of Washington and the Spokane County Air Pollution Control Authority.

Preliminary calculations indicate that the extraction system would capture groundwater within approximately 40 feet of the disposal area boundaries. The timeframe required to achieve the groundwater cleanup levels in the upper aquifer within the landfill boundaries ranges from less than 10 years to more than 75 years, depending on the source control alternative selected. Contaminated water in the upper aquifer outside of this area would remain untreated, and would reach the cleanup levels through natural dispersion and dilution. Modeling of the upper aquifer's characteristics indicates that the groundwater cleanup levels would be achieved outside of the site boundaries in approximately 6 years. Residential and municipal water supply wells would be monitored, and water users notified if their water supply contained contaminants in excess of the MCLs.

The groundwater cleanup levels established for the site would be attained throughout the contaminated plume beyond the point of compliance, which is defined as the CRL property boundary.

Residual risk associated with the groundwater cleanup levels is 6×10^{-6} . This is considered protective of human health and the environment. Residual risk associated with the air emissions following contaminant removal from the GAC is estimated at 5×10^{-6} , which is also considered to be protective of human health and the environment.

Approximate costs of the alternative are \$1,447,500 (capital costs), \$337,000 (O&M costs), and \$3,138,008 to \$6,628,016 (present net worth), assuming a 5 percent discount rate and 6 and 30 years O&M costs.

3. Alternative GW-3

This alternative would include the groundwater extraction system described in Alternative GW-2, with the addition of providing point-of-use treatment and/or an alternative water supply to users of wells which are constructed in compliance with state and local regulations, and which are contaminated above MCLs by the off-site portion of the groundwater plume. The objectives of this alternative are to prevent continued migration of contaminated groundwater from the CRL site, and to prevent consumption by area residents of groundwater contaminated above MCLs.

Point-of-use treatment systems are typically installed at the wellhead for wells serving multiple users, or near the point where piping from an individual user's well enters the user's building.

Some routine maintenance and periodic replacement of system components would be necessary. The selection of point-of-use treatment or provision of an alternative water supply would be made based on several factors, such as distance to an existing water system, or the amount of water demand. Once the cleanup levels are achieved outside of the site boundaries, point-of-use treatment and/or an alternative water supply would no longer be necessary. Residual risks associated with this alternative are the same as for GW-2.

Costs for this alternative are estimated at \$1,522,500 (capital costs), \$347,000 (O&M costs), \$3,283,765 to \$6,856,741 (present net worth), assuming a 5 percent discount rate and 6 and 30 years O&M costs.

IX. SUMMARY OF THE COMPARATIVE ANALYSIS OF ALTERNATIVES

This section and Table 11 summarize the relative performance of each of the alternatives with respect to the nine criteria identified in the NCP. These criteria are categorized into three groups:

Threshold Criteria

1. Overall protection of human health and the environment
2. Compliance with applicable or relevant and appropriate requirements

Primary Balancing Criteria

3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility, or volume through treatment
5. Short-term effectiveness
6. Implementability
7. Cost

Modifying Criteria

8. State/support agency acceptance
9. Community acceptance.

A. Threshold Criteria

The remedial alternatives were first evaluated in relation to the threshold criteria. The threshold criteria must be met by each alternative in order to be selected.

Table 11. Comparison of Alternatives

Criteria/Alternatives	SC-1	SC-2	SC-3	SC-4	GW-1	GW-2	GW-3
1. Overall protection of human health and the environment.	Would not attain RAOs or be protective of human health and the environment.	Would minimize migration and prevent exposure to contaminants.	Would minimize migration and prevent exposure to contaminants. Would provide long-term protection. Possible short-term exposure during excavation.	Would minimize migration and prevent exposure to contaminants. Vapor extraction would provide protection during grading.	Does not attain RAOs. Is not protective of human health or the environment.	Protective of human health and the environment.	Immediate protection of human health and the environment.
2. Compliance with ARARs.	Would not meet State of Washington requirements.	Would meet landfill closure requirements and air emission standards.	Would meet landfill closure requirements, air emission standards, and would comply with RCRA Subtitle C for treatment of excavated material.	Would meet landfill closure requirements and air emission standards.	Would not attain cleanup standards.	Would meet groundwater cleanup standards.	Would meet groundwater cleanup standards.
3. Long-term effectiveness and permanence.	Would result in no reduction of risk.	Would provide long-term effectiveness and protection and would require long-term maintenance of the landfill cap.	Would provide high level of long-term effectiveness and permanence, and would require long-term maintenance of the landfill cap.	Would provide high level of long-term effectiveness and permanence, and would require long-term maintenance of the landfill cap.	Not protective of human health.	Would rely heavily on institutional controls.	Would provide highest degree of long-term effectiveness and protection.
4. Reduction of treatment, mobility and volume (TMV) through treatment.	Would not decrease the TMV.	Would not decrease toxicity and volume. Would reduce mobility.	Would decrease the TMV.	Would decrease the TMV of the contaminants.	Would not provide treatment, therefore there is no reduction of TMV.	Would provide effective reduction of TMV of the contaminants.	Would provide effective reduction of TMV of the contaminants.
5. Short-term effectiveness.	Would be ineffective in the short term.	Would provide high level of protection in a short period of time, and would rely heavily on restricted access to CRL.	Would provide a lower level of protection in the short term, and would rely heavily on restricted access to the CRL.	Would provide a high level of protection in a short period of time, and would rely heavily on restricted access to the CRL.	Would not provide protection in the short term.	Would provide a high level of protection in the short term, but relies heavily on institutional controls.	Would provide the greatest protection in the shortest timeframe.
6. Implementability	Easily implemented.	Can be implemented using existing technologies.	Difficult to implement.	Can be implemented using existing technologies.	Easily implemented.	Can be implemented using existing technologies.	Can be implemented using existing technologies.
7. Cost	There is no cost for this alternative.	\$4,297,817 to \$4,791,106.	\$4,763,017 to \$5,256,306	\$5,284,150 to \$5,777,439	\$614,898	\$3,138,008 to \$6,628,016	\$3,283,765 to \$6,856,741
8. State/support agency acceptance.	State does not accept this alternative as a viable option.	State does not accept this alternative as the preferred remedial action.	State does not accept this alternative as the preferred remedial action.	State accepts this alternative as the preferred remedial action.	State does not accept this alternative as a viable option.	State does not accept this alternative as the preferred remedial action.	State accepts this alternative as the preferred remedial action.
9. Community acceptance.	Community does not accept this alternative as a viable option.	Community accepts the preferred remedial action.	Community accepts the preferred remedial action.	Community accepts this alternative as the preferred remedial action.	Community does not accept this alternative as a viable option.	Community accepts the preferred remedial action.	Community accepts the preferred remedial action.

1. Overall Protection of Human Health and the Environment

This criterion addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering controls, and/or institutional controls.

All of the source control alternatives, except Alternative SC-1 (no action), would provide protection of human health and the environment by minimizing migration of contaminants from the fill material to groundwater, and by preventing exposure to contaminants in subsurface soils and debris within a relatively short period of time (1 to 3 years). Alternatives SC-3 and SC-4 would provide a high degree of long-term protection because they actively remove the contaminants. Alternative SC-1 would not be protective of human health and the environment since contaminants would continue to migrate to groundwater in concentrations above groundwater cleanup standards.

Alternatives GW-2 and GW-3 would be protective of human health and the environment, since active measures are taken to prevent migration of groundwater contaminants from the landfill area. The point-of-use treatment and alternative water supply elements in Alternative GW-3 would provide a high degree of protection, since they can deliver immediate reduction of risk to human health. Alternative GW-1 would not be protective of human health or the environment, since contaminated groundwater from the landfill area would continue to contribute to the off-site plume.

2. Compliance with ARARs

This criterion addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of other federal and state environmental statutes or provides a basis for an invoking waiver.

Compliance with ARARs will be achieved when a source control and groundwater extraction and treatment technology are used together. Alternatives SC-2, SC-3, and SC-4 will meet the closure requirements of Washington's Minimum Functional Standards for Solid Waste Handling, and RCRA Subtitle D, and air emission standards of both the Spokane County Air Pollution Control Authority and Washington State. Alternative SC-3 would need to comply with regulations in RCRA Subtitle C regarding shipment and disposal of hazardous wastes.

Both alternatives GW-2 and GW-3 would meet the state of Washington Model Toxics Control Act groundwater cleanup levels. Air emissions from the groundwater treatment unit will meet both the Spokane County Air Pollution Control Authority and Washington State air regulations. GW-1 will not attain MTCA groundwater cleanup levels.

B. Primary Balancing Criteria

Once an alternative satisfies the threshold criteria, it is evaluated against five primary balancing criteria.

3. Long-term Effectiveness and Permanence

This criterion refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk and the adequacy and reliability of controls.

Alternatives SC-3 and SC-4 would provide the highest level of long-term effectiveness and permanence because they provide contaminant removal and ultimate destruction. Long-term effectiveness of alternatives SC-2, SC-3, and SC-4 would be dependent upon long-term maintenance of the landfill cap. Alternative SC-1 would not provide any risk reduction since contaminants would continue to migrate from the fill material to groundwater.

Alternative GW-3 would provide the highest degree of long-term effectiveness and protection. Alternative GW-2 would rely more heavily on institutional controls and therefore is less effective than GW-3. Alternative GW-1 is not protective of human health because groundwater cleanup levels would not be attained.

4. Reduction of Toxicity, Mobility, or Volume Through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies a remedy may employ.

Alternatives SC-3 and SC-4 would decrease the toxicity, mobility, and volume of the contaminants because of the physical removal of the contaminants through hot spot removal and vapor extraction, with ultimate destruction provided at a RCRA Subtitle C disposal facility. The active vapor extraction in Alternative SC-4 would require a longer timeframe to achieve the same results as the hot spot removal in Alternative SC-3. Alternatives SC-1 and SC-2 would not decrease the toxicity, mobility, or volume of the contaminants through treatment.

Groundwater extraction and treatment in alternatives GW-2 and GW-3 would provide equally effective reduction of toxicity, mobility, and volume of the contaminants. Alternative GW-1 would not provide treatment, and so cannot provide reduction of toxicity, mobility, or volume.

5. Short-term Effectiveness

Short-term effectiveness refers to the period of time needed to complete the remedy and any adverse impacts on human health and the environment that may be posed during the construction and implementation of the remedy until cleanup levels are achieved.

Alternatives SC-2 and SC-4 would provide protection within the shortest period of time. Alternative SC-3 would provide a lower level of protection in the short term because of contaminant volatilization during the excavation process. Alternatives SC-2, SC-3, and SC-4 would rely heavily on restricted access to the CRL and strict site health and safety plans to protect workers during the construction period. Alternative SC-1 would be ineffective in the short term since contaminants would continue to migrate to the groundwater.

Alternative GW-3 would provide the greatest protection in the shortest timeframe because of the point-of-use treatment and alternative water supply elements. Alternative GW-2 would provide a high level of protection in the short term, but relies more heavily on institutional controls to attain this protection. Alternative GW-1 would not provide protection in the short term.

6. Implementability

Implementability is the technical and administrative feasibility of the alternative. All source control and groundwater alternatives can be implemented using existing technologies.

Alternatives SC-2, SC-3, and SC-4 would require that the cap be installed by experienced installers, but both the materials and required personnel are available from a variety of vendors. The active vapor extraction system would require more extensive construction, operation, and maintenance than the passive system in the other two alternatives.

No unusual obstacles are expected in the installation of extraction wells required for the implementation of Alternatives GW-2 and GW-3. Numerous wells have been installed to the base of the upper aquifer without difficulty. Basalt outcrops near the east end of the southwest landfill area that could limit the eastern extent on the vapor extraction system in that area. Access/easements would be required for monitoring wells installed on adjacent lands, and groundwater containment wells would be installed on the CRL property. Waste manifesting would be needed to transport waste (GAC filters) for off-site treatment.

7. Cost

Costs include estimated capital, operation, and maintenance costs, and net present worth costs. Table 11 shows a comparison of total estimated costs for each of the alternative.

For source controls Alternative SC-4 would be the most expensive source control, followed by Alternatives SC-3 and SC-2. Alternative SC-1 would have no initial costs.

Alternative GW-3 costs are slightly more expensive than Alternative GW-2. Alternative GW-1 would have minimal costs.

C. Modifying Criteria

Modifying criteria are used in the final evaluation of the remedial alternatives.

8. State Acceptance

This criterion refers to the whether the state accepts the preferred remedial alternative.

The Washington Department of Ecology concurs with the selection of the preferred remedial alternative. Ecology has been involved with the development and review of the Remedial Investigation, Feasibility Study, Proposed Plan, and Record of Decision. Ecology comments have resulted in substantive changes to these documents and has been integrally involved in determining which cleanup standards apply to contaminated groundwater under MTCA.

9. Community Acceptance

This criterion refers to the public's support for the preferred remedial alternative.

On August 25, 1992, Fairchild AFB held a public meeting to discuss the Proposed Plan for the CRL. Prior to this meeting copies of the Proposed Plan were sent to over 200 local residents and other interested parties. The results of the public meeting indicate that the residents of the surrounding communities accept the preferred remedial alternative. Community response to the remedial alternative is presented in the responsiveness summary, which addresses questions and comments received during the public comment period.

X. THE SELECTED REMEDY

A combination of both source control and groundwater control actions is necessary to achieve the broader objective of restoring contaminated groundwater in the upper aquifer to levels that are protective of human health and the environment. The Air Force's selected remedy to meet this objective at the CRL includes Containment with Active Vapor Extraction (Alternative SC-4) and On-site Groundwater Extraction/ Treatment with Off-site Point-of-Use Treatment and/or Alternative Water Supply (Alternative GW-3). The major components include:

- Capping the northeast and southwest disposal areas at the landfill
- Installing an active soil vapor extraction/treatment system in both capped areas
- Extracting contaminated groundwater from the upper aquifer at the landfill boundary and treating by air stripping and granular activated carbon; treated groundwater will be disposed of at an off-site location downgradient of the CRL property
- Monitoring off-site water supply wells within the off-site portion of the plume and providing point-of-use treatment and/or alternative water supply if needed in the future
- Monitoring groundwater in upper and lower aquifers

- Implementing institutional controls.

These components will restore groundwater to the groundwater cleanup level of 5 ug/L for TCE.

The active groundwater extraction/treatment system is intended to contain the contaminant plume at the CRL property boundary. That portion of the plume beyond the property boundary will be allowed to reach cleanup levels through natural dilution, degradation, and dispersion. The groundwater cleanup levels will be attained throughout the contaminated plume at and beyond the edge of the waste management unit, which is defined as the CRL property boundary. The remedy can be implemented within 1 to 3 years and, when complete, would reduce the estimated carcinogenic risk from the site to less than 1 in 100,000.

The total estimated costs associated with the selected remedy are \$6,253,675 for capital costs, \$46,000 to \$393,000 for O&M costs and a present net worth of \$8,722,073. The present net worth assumes a 5 percent discount rate and O&M costs for 30 years. The preliminary design considerations described in this ROD are for cost estimating and are subject to change based on the final remedial design and construction practices.

A. Landfill Cap

A low permeability cap will be placed over the northeast and southwest disposal areas. The purpose of the cap is to minimize the migration of contaminants to groundwater by reducing the infiltration of precipitation through the fill areas. The cap will be designed, constructed and maintained to meet the closure requirements of the state of Washington Minimum Functional Standards for Solid Waste Handling and of federal RCRA subtitle D.

B. Installing an Active Soil Vapor Extraction/Treatment System in Both Capped Areas

Vapor extraction wells will be installed to actively remove volatile contaminants contained within the landfill. This will reduce the volume of contaminants and satisfy the statutory preference for treatment. The soil vapor extraction network will consist of vacuum blowers, air infiltration and vapor extraction wells, collection headers, and an emissions control system. A treatability study will be performed to determine the optimum gas extraction and treatment system. Emissions from the active soil vapor extraction system will be treated as necessary to ensure compliance with air quality standards set by the state of Washington, Spokane County Air Pollution Control Authority, and the Clean Air Act. An annual evaluation will be performed by the Air Force to determine the effectiveness and benefit of the system. The vapor extraction system will be operated until the Air Force, EPA, and Ecology determine that the system is no longer effective and beneficial.

C. Extracting Groundwater at the Landfill Boundary and Treating by Air Stripping and Granular Activated Carbon

The objective of the groundwater extraction system is to prevent further migration of contaminated groundwater from the source areas. To accomplish this, approximately 15 extraction wells 150 feet deep will be installed in the upper aquifer along the north and east boundaries of the northeast fill area and the east boundary of the southwest fill area. The radial capture zone for each extraction well is projected to be 40 feet. Preliminary calculations indicate that an extraction rate of 200 gpm will be necessary to fully contain that portion of the plume within the CRL property boundaries.

Extracted groundwater will be treated using an air stripping unit. Air emissions from the air stripper will be treated using granular activated carbon. The Spokane County Air Pollution Control Authority has approved activated carbon as best available control technology for toxics (T-BACT) for this site under Chapter 173-460 WAC. The design specifications for the air stripping unit will be reviewed by the Spokane County Air Pollution Control Authority to assure that the emissions will comply with the substantive requirements of the regulations. Washington State air quality regulations (Chapter 173-460 WAC) state that the ambient source impact level (ASIL) of TCE cannot exceed 0.8 ug/m^3 .

An estimated 0.13 pounds of GAC will be needed per 1,000 gallons of water. Spent carbon will be managed in accordance with the EPA OSWER Directive 9834.11 which establishes policies for off-site disposal of CERCLA wastes.

Extracted groundwater will be treated to meet the groundwater cleanup levels since the treated effluent will be reintroduced into the upper aquifer. This will be accomplished using infiltration trenches or reinjection wells at an off-site location downgradient of the CRL property. The specific location and type of reintroduction will be chosen during the remedial design. The estimated volume of groundwater requiring treatment is 1.6 billion gallons. The off-site discharge will require a State Waste Discharge Permit (Chapter 173-216 WAC).

D. Monitoring Off-site Water Supply Wells and Providing Point-of-Use Treatment and/or Alternative Water Supply if Needed in the Future

In the portion of the plume beyond the capture zone of the groundwater extraction system, point-of-use treatment and/or alternative water supply will be provided to users of wells which are constructed in compliance with state and local regulations as necessary to prevent consumption by area residents of groundwater exceeding MCLs. Point-of-use treatment systems typically consist of a filtration system installed at the well head for wells serving multiple users, or near the point where piping from an individual user's well enters the user's building. Routine maintenance and periodic replacement of system components will be necessary. Provision of an alternate water supply will be considered based on factors such as the distance to an existing water system or the amount of water delivered.

E. Monitoring Groundwater in Upper and Lower Aquifers

Continued groundwater monitoring is necessary to evaluate the effectiveness of the remedial action, to verify modeled predictions of contaminant attenuation, and to evaluate the need for remedial actions in the lower aquifer. Known and suspected conduits for cross contamination between the upper and lower aquifer were identified during the Remedial Investigation.

Groundwater monitoring will be performed in the off-site portion of the plume to verify the decrease of contaminant levels as estimated in the FS. If monitoring does not confirm the predicted decrease of contaminant level, the Air Force will evaluate the need to perform additional response actions in accordance with all ARARs.

Approximately ten groundwater monitoring wells will be used to assess the effectiveness of the remedial actions, determine when the Remedial Action Objectives have been attained, and to evaluate the need for remedial actions in the lower aquifer. The wells will be sampled periodically. In addition to TCE, the monitoring program will at a minimum analyze for vinyl chloride and 1,1-DCE, since these analytes are breakdown products of TCE. Specific criteria for compliance monitoring and decision-making will be developed in the Remedial Action Management Plan, or an equivalent document.

F. Implementing Institutional Controls

Institutional controls will also be included as part of the selected remedy. These would include controls on access and use of the site for the life of the cleanup, and a restriction attached to the property deed. These controls will minimize human exposure to the contaminants that will remain beneath the cap. The CRL will be fenced with warnings posted around the perimeter to decrease contact with the contaminated soil and debris by the uninformed public. Contaminated water supply wells within the contaminant plume will be inspected and reconstructed or abandoned in accordance with Washington State regulation (173-160 WAC) if necessary. Periodic meetings and media releases will be prepared to inform the public about any issues or concerns regarding the CRL.

XI. STATUTORY DETERMINATIONS

Under CERCLA section 121, selected remedies must be protective of human health and the environment, comply with ARARs, be cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practical. In addition, CERCLA includes a preference for remedies that employ treatment that significantly and permanently reduces the volume, toxicity or mobility of hazardous wastes as their principal element. The following sections discuss how the selected remedy meets these statutory requirements.

A. Protection of Human Health and the Environment

The selected remedy protects human health and the environment through source and groundwater controls. Implementation of this remedial action will not pose unacceptable short-term risks toward site workers or nearby residents. Installation of the landfill caps will prevent direct exposure to contaminants within the landfill and will minimize the migration of contaminants to the groundwater. Soil vapor extraction will permanently remove contaminants from the fill material, thereby providing long-term effectiveness of the containment system.

The groundwater extraction and treatment system will prevent migration of the contaminant plume and permanently remove contaminants from the groundwater. Contaminants will be transferred from groundwater to the GAC and will ultimately be destroyed. The baseline risk for a residential scenario associated with the groundwater exposure pathway is estimated at 7×10^{-3} . The residual risks for this scenario at the end of the remedial action is estimated to be 6×10^{-6} .

Point-of-use treatment and/or provision of alternative water supply will provide protection to users of groundwater in the off-site portion of the contaminant plume if it becomes necessary during the remedial action.

Residual risks associated with the various vapor emission systems are estimated at 1×10^{-5} . The total residual excess cancer risk for the selected remedy is estimated at 2×10^{-5} , which is considered to be protective of human health and the environment.

B. Compliance with ARARs

The selected remedy will comply with the following federal and state ARARs that have been identified. No waiver of any ARAR is being sought or invoked for any component of the selected remedy. The ARARs identified for the CRL site include, but are not limited to, the following:

Chemical-Specific ARARs

- * Safe Drinking Water Act (SDWA), 40 USC Section 300, Maximum contaminant levels (MCLs) for public drinking water supplies established for the SDWA are relevant and appropriate for setting groundwater cleanup levels.
- * Title V of Clean Air Act, Amendment of 1990, Section 112(b) of the Act lists sources covered by the New Source Performance Standards and requires major emission sources to obtain permits from federally approved state permitting agencies. This section defines major sources as those with the potential to emit 10 tons per year of a hazardous air pollutant. This Act would be applicable in determining if Fairchild AFB could qualify for exemption for emissions from the air stripper and active soil vapor system as non major sources under section 502(a) of the Act.

- * Resource Conservation and Recovery Act (RCRA), Subtitle C (40 CFR 261), Applicable in identifying if the spent GAC filters from the air stripping system at the CRL are considered a hazardous waste for purposes of transporting them off site for treatment.
- * Emission Standards and Controls for Emitting Volatile Organic Compounds (VOCs), (Chapter 173-400 WAC), Establishes standards in the state of Washington for specific VOC source emissions; applicable in establishing emission standards for the active soil vapor treatment/extraction system and from the GAC unit.
- * Controls for New Sources of Toxic Air Pollutants (Chapter 173-460 WAC), WAC 173-460-150 list TCE as a Class A toxic air pollutant with an acceptable source impact level of 0.8 ug/m³. Section 030(c) states that contaminants with ASILs between 0.1 to 0.99 ug/m³ would require a maximum emission rate of 50 pounds per year to qualify for a small quantity exemption. Sections 040 and 050 provide procedures that must be followed to satisfy permitting authorities that the emissions would meet small quantity exemption status. This regulation would be applicable in determining if the emissions from the active soil vapor extraction system or the treated emissions from the GAC unit would qualify for small quantity exemption.
- * Model Toxics Control Act Cleanup Regulations (MTCA), (Chapter 173-340 WAC), Method B risk-based cleanup levels are applicable for establishing groundwater cleanup levels.

Action-Specific ARARs

- * RCRA Subtitle C (40 CFR 262)
Establishes standards for generators of hazardous wastes for the treating, storage and shipping of wastes. Applicable to the storage, packaging, labeling, and manifesting of the spent GAC filters off site for treatment.
- * RCRA, Subtitle D (40 CFR 258 Subpart F)
Establishes federal standards for the management of nonhazardous solid waste; relevant and appropriate for the design, construction and maintenance of landfill containment system.
- * Hazardous Materials Transportation Act (49 USC 1801-1813)
Applicable for transportation of potentially hazardous materials, including samples and wastes.
- * Noise Control Act (42 USC 4910)
Applicable for the design of air stripper system.

- * **Dangerous Waste Regulations (Chapter 173-303 WAC)**
Applicable for on-site treatment, storage, or disposal of dangerous waste of hazardous wastes generated during the remedial action.
- * **Minimum Standards for Construction and Maintenance of Wells (Chapter 173-160 WAC)**
Applicable regulations for the location, design, construction and abandonment of water supply and resource protection wells.
- * **State Waste Discharge Permit Program (Chapter 173-216 WAC)**
Applicable regulations governing off-site discharges to groundwater. Applicable to the extent that there is an on-site discharge to groundwater.
- * **Minimum Functional Standards for Solid Waste Handling (Chapter 173-304-407 WAC)**
Relevant and appropriate regulation for closure and post-closure care standards for municipal solid waste landfills; specifies the design, construction and maintenance of landfill containment system.

Location Specific ARARs

- * No location-specific ARARs

Other Criteria, Advisories, or Guidance to be Considered for this Remedial Action (TBCs)

- * EPA OSWER 9834.11, Revised Procedures for Planning and Implementing Off-site Response Actions, November 13, 1987. This directive provides procedures for off-site disposal of CERCLA wastes.
- * EPA/540-SW-89-047, Technical Guidance Document: Final Covers on Hazardous Waste Landfills and Surface Impoundments, July 1989. Provides general guidance for landfill cover design.

C. Cost Effectiveness

The selected remedy provides overall effectiveness proportionate to its cost. The capital and O&M costs for Containment with Active Vapor Extraction are slightly higher than for the other source control alternatives. However, this alternative will provide the highest degree of long-term effectiveness because contaminants which would otherwise remain contained in the fill material would be removed and treated. This will reduce the potential for continued groundwater contamination.

D. Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Possible

The selected remedy utilizes permanent solutions and alternative treatment technologies practicable for this site. The remedy utilizes treatment of the contaminant source and of affected groundwater within the CRL property boundaries. Soil vapor extraction provides a permanent solution by removing contaminants which would otherwise remain contained within the landfill material. Soil vapor extraction is considered an alternative treatment technology.

The risk from the groundwater contamination is permanently reduced through treatment without transferring the risk to other media. The selected remedy provides the best balance of long-term effectiveness and permanence; reduction in toxicity, mobility, and volume achieved through treatment; short-term effectiveness; implementability; and cost.

E. Preference for Treatment as a Principal Element

The selected remedy satisfies the statutory preference for treatment by utilizing treatment as a primary method to permanently reduce the toxicity, mobility, and volume of groundwater contaminants and of volatile contaminants contained within the landfill. Treatment may also be used at individual user well locations in the event of off-site contamination of drinking water above MCLs.

XII. DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan for the CRL was released for public comment in August 1992. The Proposed Plan identified Containment with Active Vapor Extraction and On-site Groundwater Extraction/Treatment with Off-site Point-of-Use Treatment and/or Alternative Water Supply as the preferred alternatives for source control and groundwater treatment, respectively. The Air Force reviewed all written and verbal comments submitted during the public comment period. Upon review of these comments, it was determined that no significant changes to the selected remedy, as originally identified in the Proposed Plan, were necessary.