FINAL ALTERNATIVES ASSESSMENT
OF
INTERIM RESPONSE ACTIONS
FOR
OTHER CONTAMINATION SOURCES
MOTOR POOL AREA

NOVEMBER 1989

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Prepared by:

WOODWARD-CLYDE CONSULTANTS

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FOR ROCKY MOUNTAIN ARSENAL CONTAMINATION CLEANUP

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13. ABSTRACT *(Maximum 200 words)*

THIS DOCUMENT DESCRIBES THE PROCESS AND RESULTS OF THE ALTERNATIVES ASSESSMENT CONDUCTED FOR THE MOTOR POOL AREA WHICH APPEARS TO BE A POTENTIAL SOURCE OF TRCLE CONTAMINATION TO THE GROUND WATER. THE GOAL OF THIS ASSESSMENT IS TO EVALUATE ALTERNATIVES BASED UPON SUCH FACTORS AS 1) THE PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT, 2) MITIGATION OF THE THREAT TO HUMAN HEALTH, AND 3) COST.

THE ASSESSMENT IS DIVIDED INTO THE FOLLOWING SECTIONS:

1. INTRODUCTION
2. SITE BACKGROUND AND RESULTS OF CURRENT AND PREVIOUS INVESTIGATIONS
3. IDENTIFICATION AND EVALUATION OF INTERIM ACTION TECHNOLOGIES
4. DEVELOPMENT AND EVALUATION OF ALTERNATIVES
5. COST ESTIMATES
6. CONCLUSIONS.

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1.0 INTRODUCTION

1.1 PURPOSE OF THE INTERIM RESPONSE ACTION (IRA) ALTERNATIVE ASSESSMENT DOCUMENT

The Interim Response Action (IRA) Alternative Assessment Document describes the process and results of the alternative assessment conducted for the Motor Pool Area at the Rocky Mountain Arsenal (RMA). The Motor Pool Area is located in Section 4 of RMA (Figure 1-1). The Motor Pool Area appears to be a potential source of trichloroethylene (TCE) contamination to the groundwater. This evaluation is discussed in subsection 2.2.2.

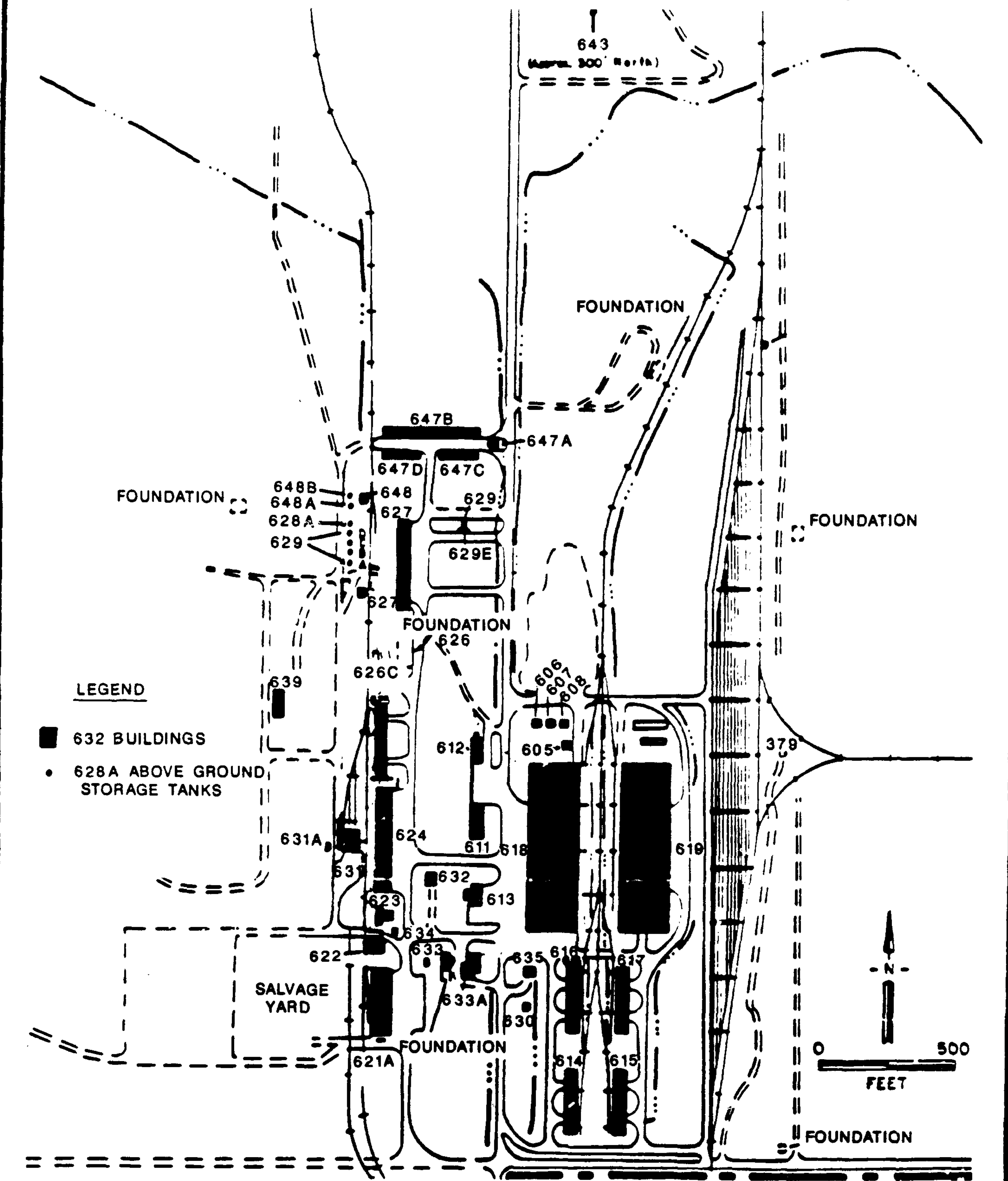
Technologies and alternatives have been developed that will remove or contain the potential source of groundwater contamination at this site. These alternatives will be evaluated to assess whether there is a clear and significant benefit in performing an interim response action now. The selection of the preferred interim action is presented in Section 6.0.

The interim response action referenced herein is identified in Section XXII of the Federal Facility Agreement, paragraph 22.1(l) and is governed by the process set forth in paragraphs 22.5 - 22.15 of that Agreement.

The goal of this assessment document is to evaluate alternatives based upon, but not limited to, factors such as the protection of human health and the environment, mitigation of the threat to human health, and the reasonableness of cost and timeliness. Consistent with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by SARA, 1986, and the National Contingency Plan (NCP), the assessment seeks to balance preferences for treatment on site and for responses that permanently reduce the mobility, toxicity, or volume of hazardous substances against the need, in the context of removal actions, for consistency with the final remedy and for responses that are practical, cost-efficient, and that reduce or control hazards posed by the site as early as possible.

1.2 IRA CANDIDATE SELECTION CRITERIA

To evaluate whether and what type of response action is necessary and appropriate, the following questions have been developed as part of a decision logic:



SOURCE: EBASCO, MOTOR POOL AREA CONTAMINATION ASSESSMENT REPORT, 1988

Job No.: 22238	Figure 1-1 MOTOR POOL AREA VICINITY MAP
Prepared by: D.C.C.	
Date: 10/23/89	

(1) Is the site an active primary source?

- Is it an active source of groundwater contamination?
- Is it a primary groundwater contamination source?

(2) Does the site pose a significant risk to human or biota receptors?

- Have potential receptors been identified?
- Have previous studies been confirmed by new data?
- Is there any conflicting evidence?

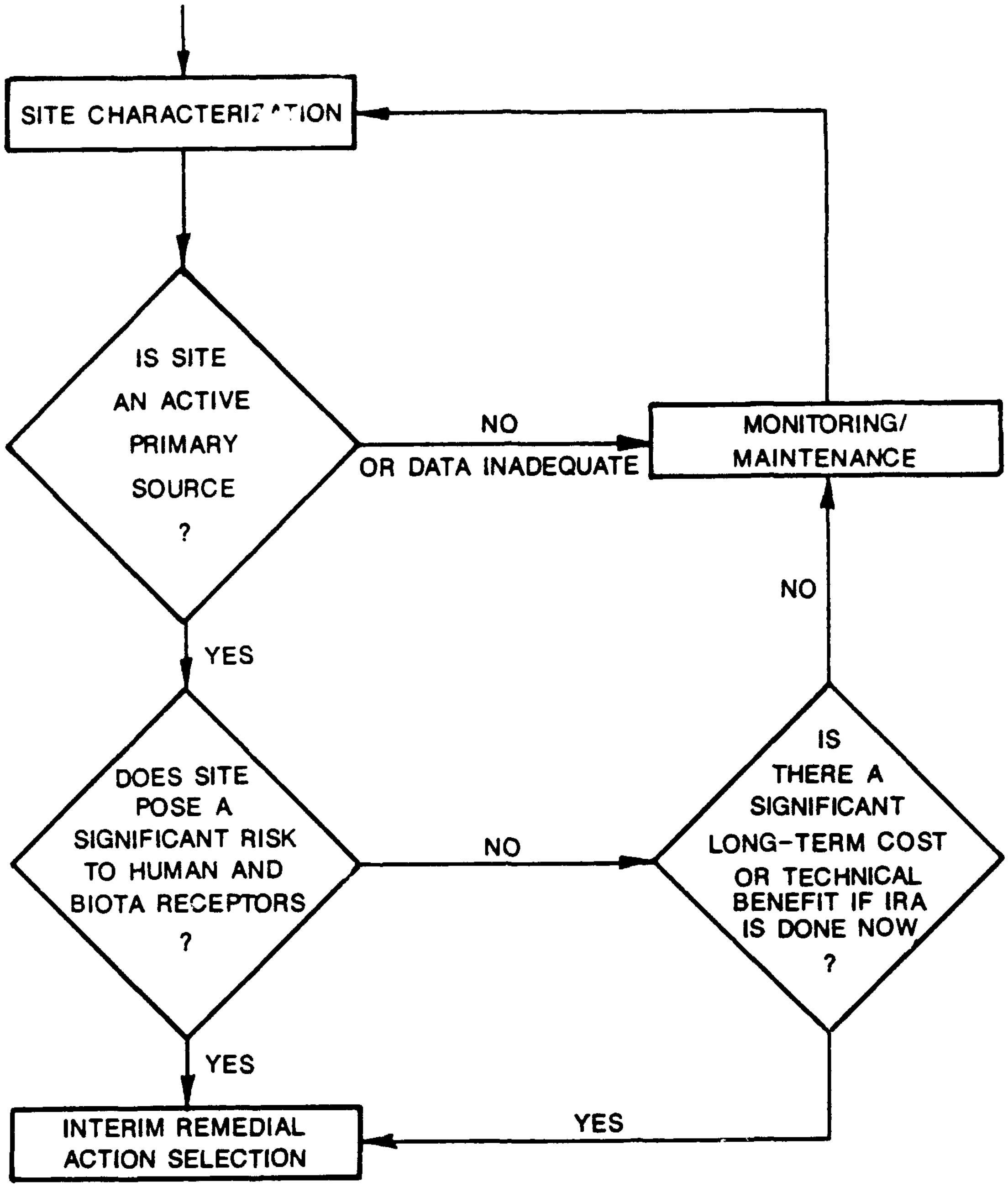
(3) Is there a significant long-term benefit if an IRA is done now?

- Will interim action result in an accelerated cleanup?
- Will interim action reduce long-term costs?

The type of action taken and the timing of the action will depend on the responses to the above questions. The decision logic is shown in Figure 1-2.

If the answers to the questions on the decision flow chart are inconclusive, then reasonable yet conservative assumptions favoring a protective response will be adopted.

At the Motor Pool Area, it appears that there is an active primary source of groundwater contamination. Although the TCE plume originating from the Motor Pool Area may be partially intercepted by either the South Adams County Water and Sanitation District (SACWSD) treatment system, or the Irondale Containment System, there appears to be both a long-term cost and technical benefit in performing an IRA now since treatment after the TCE has spread becomes both more costly and complex insofar as a larger area must be addressed. Alternative interim response actions are discussed in this document. The benefit in performing any of these actions is discussed in Section 6.0.



Job No: 22238	Figure 1-2 - DECISION FLOW CHART FOR INTERIM ACTION VERSUS MONITORING/MAINTENANCE ON HOT SPOT IRAs
Prepared by: D.C.C.	
Date: 6/15/89	

1.3 REPORT ORGANIZATION

This Alternative Assessment Document is divided into five additional text sections and a reference section.

Section 2.0 summarizes the information and results of the current and previous investigations, including a brief description of the site, extent of contamination, and a summary of the evaluation. Section 3.0 identifies and provides a preliminary evaluation of feasible interim action technologies. Section 4.0 presents the alternatives developed from the technologies, provides a detailed description of each site-specific alternative, and describes the criteria used to evaluate them. Section 5.0 presents a cost estimate of each alternative. Section 6.0 presents an evaluation of the alternatives. Section 7.0 lists references cited.

2.0 SITE BACKGROUND AND INTERIM ACTION INVESTIGATION

2.1 SITE DESCRIPTION

2.1.1 Location

The Motor Pool Area consists of the developed area in the southeastern corner of Section 4 on the Rocky Mountain Arsenal (RMA). The site is located near the rail yard on the west side of the boundary line between Sections 3 and 4 and is approximately 650 feet by 2,300 feet. Structures within the site include 7 tanks, 3 old foundations, and 26 buildings. The structures consist of administration buildings, motor vehicle storage and maintenance buildings, warehouses, railroad roundhouse and tracks, former agricultural research buildings, fuel storage tanks, fuel station, and a groundwater well pumphouse (Figure 1-1).

2.1.2 History

Prior to 1942, the Motor Pool Area consisted of farm land that was used to produce wheat and corn, or was used as grass land for hay and grazing of cattle. The Motor Pool Area was acquired by the U.S. Army in 1942 as part of RMA. Railroad spurs into the study area from the northwest and southern boundaries were built during the initial construction of RMA (Ebasco 1989a).

Most of the structures in the study area were built by the Army during the initial construction period of 1942 to 1943. During this period, a sanitary sewer system was constructed that extended north from the Motor Pool and rail yard areas. Portions of the sewer ended in septic tanks and drainage fields. In 1945, construction of the sewer was completed with the construction of two pump stations and a pressure sewer line that flowed eastward to outfall into the interceptor line north of the Administration area.

Since the 1940s, the Motor Pool Area has been used by RMA for servicing equipment, vehicles, and railroad cars, as well as for storing fuel, road oil, and flammable liquids.

The roundhouse (Building 631) has been in use since the beginning of operations at RMA in 1942. It has been used for the maintenance of locomotives, railcars, and other heavy equipment. Solvents used to clean parts and surfaces may have been discharged either to a ditch east of the roundhouse or to a septic tank. From 1968 to 1982, the building was used by the U.S. Army reserve units for vehicle maintenance. From 1975 to 1985, it was periodically used as a repair shop for earth-moving equipment. A small structure for storing cleaning solvents and paint thinners, which are used in Building 631, is attached to this building.

During the early 1950s, Buildings 627B and 646 in the northern part of the Motor Pool were used by the Army for pesticide and herbicide storage. Only the foundation of Building 646 remains and is shown as such in Figure 1-1. At approximately the same time, a set of laboratories for the study of insecticides and plant pathology was operated by Julius Hyman and Company in Building 633B. From 1953 to 1957, Shell Chemical Company maintained these facilities as an agricultural research and bioassay laboratory (Ebasco 1989a).

In 1954, three alluvial groundwater supply wells and pumphouses were constructed in the northwestern part of Section 4 to supply additional industrial water to the South Plants during dry periods when surface water was insufficient. The wells are still maintained to supply water to the lakes in dry years. A buried pipeline was built across the study area to carry the water.

Previous Motor Pool Area studies include: a May 1984 Resource Conservation and Recovery Act (RCRA) audit by the Colorado Department of Health (Ebasco 1989a) in the area outside the roundhouse, a 1986 study to identify possible trichloroethylene sources in the Motor Pool Area (Ebasco 1988), and a soil gas study conducted in February 1986 to aid in defining trichloroethylene plumes in the groundwater (Ebasco 1987). The most recent studies include the Contamination Assessment Report (Ebasco 1988), the Western Study Area Report (Ebasco 1989a), and a soil gas survey conducted in summer 1989 (WCC 1989).

2.1.3 Geology

This section describes the regional geologic setting at RMA and the site-specific geology at the Motor Pool Area.

2.1.3.1 Regional Geology

The RMA is located about 7 miles northeast of central Denver in western Adams County. It occupies approximately 27 square miles within the Colorado Piedmont section of the Great Plains physiographic province. The surficial deposits of this area are characterized primarily by a veneer of wind-deposited and alluvial materials. Most of the topography at the Arsenal is gently rolling; however, there are several prominent hills that contain outcrops of resistant bedrock (Costa 1982).

The geologic history of the RMA and surrounding area spans at least 1-3/4 billion years and is recorded by the rock units that underlie the RMA. The oldest rocks are Precambrian crystalline units that occur approximately 12,000 feet below the surface. The youngest units are the Quaternary age surficial deposits that blanket the RMA. Since the Precambrian, the area has experienced several advances and withdrawals of shallow marine seaways, three episodes of orogeny (mountain building), and three periods of relative crustal stability that preceded the orogenic episodes. The first orogenic period began in the Pennsylvanian period, the second in the

Cretaceous, and the third, the Laramide Orogeny, occurred during the late Cretaceous and early Tertiary periods. The Laramide Orogeny was responsible for uplifting the Front Range Mountains and down-warping the Denver Basin.

Following the Laramide Orogeny, relative crustal stability existed in the Eocene Epoch. Periods of extensive erosion and deposition in late Eocene were followed by extensive volcanic eruptions during the Oligocene. Then, during the Pleistocene, a cooler, wetter climate brought periods of glaciation to the mountains (Hansen 1982). Regional uplift, mountain glaciation, stream erosion, and subsequent deposition were responsible for the Quaternary deposits and shaping the present-day topography (Haun 1965).

The Rocky Mountain Arsenal lies within the Denver Basin, one of the largest structural basins in the Rocky Mountain region. It covers approximately 60,000 square miles in portions of Colorado, Nebraska, Wyoming, and Kansas. The Denver Basin is an asymmetrical north-south trending syncline with its structural axis close to and parallel to the Front Range. Rock units on the west flank of the basin dip gently to the east though the dip becomes progressively steeper near the boundary between the Front Range uplift and the Denver Basin (Hansen 1982). The east flank of the basin generally dips to the west at one degree or less (Sonneberg 1982).

The Denver Basin is filled with approximately 15,000 feet of sediments ranging in age from Cambrian to Quaternary. Several major transgressions followed by periods of emergence resulted in the deposition of both marine and continental sediments (Haun 1965) consisting of conglomerate, sandstone, siltstone, shale, limestone, dolomite, coal, lignite, and volcaniclastic sediments. The Laramide Orogeny marked the last retreat of the marine seaway and, thus, sediments from the upper Cretaceous and the lower Tertiary record the final regression of the inland sea (Weimer 1973).

2.1.3.2 Stratigraphy

The full stratigraphic section at the Arsenal was penetrated by a deep injection well drilled in Section 26 in 1961. The well, used for contaminated wastewater disposal, reached a total depth of 12,045 feet in Precambrian basement rock. Injection of wastewater continued from March 1962 until September 1965. The operation was abandoned in 1965 after the injection of wastewater was correlated to an abundance of earthquakes in the area (Evans 1966).

Lithologic information obtained from the well indicates that there are 11,950 feet of Cambrian to Tertiary sedimentary rocks beneath the Rocky Mountain Arsenal. Unconsolidated Quaternary deposits uncomformably overlie the bedrock formations. Within these sediments are several aquifers including the Fox Hills sandstone of late Cretaceous age, the Laramie and Arapahoe Formations of late Cretaceous age, portions of the Denver Formation of late Cretaceous and early Tertiary age, and the overlying Quaternary surficial deposits (May 1982).

The aquifers of greatest concern at the RMA include portions of the Denver Formation and the unconsolidated Quaternary surficial deposits.

2.1.3.3 Denver Formation

The Denver Formation, which subcrops and occasionally outcrops at the Rocky Mountain Arsenal, was originally as much as 900 feet thick, but due to subsequent erosion, it now ranges from 250 to 500 feet at the Arsenal (May 1982). It was derived predominately from the erosion of andesitic and basaltic rocks and was deposited in fluvial environments, and as lacustrine deposits on an extensive piedmont plain (Romero 1976).

Materials in the Denver Formation include olive-gray, brown, and green-gray interbedded claystone, siltstone, sandstone, conglomerate, carbonaceous clay shale, low-grade coal, and lignite. Volcaniclastic material is also present in the Denver Formation and consists of angular to subangular lithic fragments and minerals in a fine-grained clay matrix. The clay matrix is bentonitic and is probably the weathering product of volcanic ash (May 1982).

Individual aquifers within the Denver Formation range in thickness from several inches up to 60 feet. They are generally discontinuous, lenticular, and consist of poorly cemented, medium- to fine-grained sandstone, which grade vertically and laterally into siltstone and clay shale (May 1982).

2.1.3.4 Quaternary Deposits

Unconsolidated sediments of Quaternary age uncomformably overlie the Denver Formation at the Arsenal. There are, however, a few locations where bedrock is exposed at the surface near topographic highs. The upper surface of the Denver Formation is a paleotopographic or erosional surface that was incised by ancient stream channels. These paleochannels were filled by unconsolidated surficial deposits (Costa 1982). The surficial deposits previously referred to as Quaternary alluvium or the alluvial aquifer are up to 130 feet thick and consist of alluvium, loess, and eolian deposits. They have been subdivided into eight units ranging in age from Pleistocene to Holocene (Scott 1960). At the Rocky Mountain Arsenal six units have been mapped. They are the Verdos alluvium of Kansan age, Slocum alluvium of Illinoian age, Louviers and Broadway of Wisconsin age, Piney Creek alluvium, and Post-Piney Creek alluvium of Holocene age (DeVoto 1968).

2.1.3.5 Alluvium

The alluvial deposits are generally composed of yellowish-brown to very pale orange clays, silts, sands, gravels, and boulders. Coarser alluvial material is found in the paleochannels (May 1982). The alluvium is generally unconsolidated except where calcium carbonate has cemented sand and gravel into a conglomerate. The grain size of the alluvial material ranges from clay size to boulders. The sands are subangular to subrounded quartz with mica, heavy minerals, and chert. According to the Unified Soil Classification System, they are predominately SM (sand-silt mixtures) and SP (poorly graded sands) and often contain gravel. The sands are lenticular and grade laterally and vertically into clay, silt, and gravel (May 1982).

2.1.3.6 Loess/Eolian Deposits

Loess and other eolian deposits of Pleistocene and Holocene age are widely distributed at the RMA. The loess is generally less than 10 feet thick but may be up to 20 feet thick in the eastern part of the area. It consists of yellowish-brown to light grayish-brown sandy silt and may contain large amounts of clay. The other eolian deposits are generally 10 to 20 feet thick but may be as much as 40 to 50 feet thick. They consist of light-brown fine sand, sandy silt, and clay (Lindvall 1980).

2.1.3.7 Site Geology

The Motor Pool Area is in Section 4 on the western edge of the RMA. There are two stratigraphic units of interest beneath the Motor Pool Area: the Quaternary Alluvium and the Denver Formation. The alluvial material consists of discontinuous lenses of sand and gravel, interbedded with silt and clay. Gravels and gravelly sands are common at the base of the alluvial section, especially in paleochannels. The alluvial material ranges from about 70 feet to about 100 feet in thickness. The thickest alluvium occurs over bedrock lows, and the thinnest over bedrock highs.

The alluvial-bedrock contact is highly irregular due to the extensive erosion that was caused by ancient stream channels, which preceded the deposition of the alluvium. Generally, the bedrock surface slopes to the northwest in the Motor Pool Area; however, where the bedrock surface has been incised by an ancient stream channel, the slope becomes perpendicular to the trend of the paleochannel. A northwest trending paleochannel cuts across the northern boundary of the Motor Pool Area and has approximately 70 feet of relief.

The Denver Formation in the Motor Pool Area is predominantly composed of claystone with interbedded sandstone, siltstone, and lignite layers from 2 to approximately 20 feet thick. Layers of the volcaniclastic unit are also present (Ebasco 1989a).

2.1.4 Hydrology

This section describes the regional hydrologic setting at RMA and the site-specific hydrology at the Motor Pool Area.

2.1.4.1 Regional Hydrology

The Rocky Mountain Arsenal lies within the South Platte River drainage basin. The river is located several miles to the west and northwest of the Arsenal.

Several tributary drainages flow northwest across the Arsenal to the South Platte River. Groundwater at the Arsenal occurs in the Quaternary surficial deposits and in several bedrock aquifers. The aquifers of primary concern at the Rocky Mountain Arsenal, however, are the Quaternary deposits and portions of the underlying Denver Formation. The deeper bedrock aquifers are separated from the Denver Formation by 50 to 100 feet of shale called a "buffer zone," which acts as an aquitard (Romero 1976).

Groundwater at the Rocky Mountain Arsenal generally flows from the southeast to the northwest and eventually discharges into the South Platte River. There are local variations in flow direction (May 1982). One such variation is caused by local bedrock paleotopography and the groundwater mound that exists beneath the South Plants area (May 1982). Groundwater in the unconsolidated Quaternary alluvial aquifer is found under unconfined conditions. Groundwater in the Denver Formation is found under unconfined and confined flow conditions at the Arsenal. The nature of the contact between the alluvial aquifer and the upper Denver Formation influences whether the flow conditions are unconfined or confined. If the Denver Formation sandstones subcrop below the saturated alluvium, the base of the subcropping sandstone is considered the base of the unconfined flow system.

The hydraulic conductivity of the two aquifers varies considerably. The hydraulic conductivity of the alluvium has been measured at between 9.08×10^{-1} to 2.4×10^{-3} cm/sec. The lower hydraulic conductivity values were found in the Basin A area. Hydraulic conductivity measured in the Denver Formation yielded values ranging from 10^{-7} cm/sec for clay shales and 10^{-3} cm/sec to 10^{-4} cm/sec for sands (May 1982).

Due to the contrast in hydraulic conductivity between the Denver Formation and the alluvium, groundwater flow and contaminant transport through unfractured fine grained bedrock is assumed to be relatively slow compared to flow and transport in either saturated alluvium or in fractures or sandstones in the Denver Formation (Stollar 1988). Within the alluvial unit, the paleochannels generally have higher hydraulic conductivities than the surrounding alluvial materials due to the coarser materials in the paleochannels. These channels appear to serve as conduits that move alluvial groundwater at higher rates and volumes than in other parts of the unconfined system (May 1982). The primary groundwater flow components at the Arsenal generally follow the paleochannels in the alluvium; however, flow is not restricted to only the paleochannels. Groundwater flow does occur over channel divides and through the Denver Formation (May 1982).

2.1.4.2 Site Hydrology

Site 4-6 is situated in the Irondale Gulch drainage basin. It has an average elevation of 5,200 feet above mean sea level (MSL) and a local relief of 5 feet. In the northern portion of the area, surface water drains north and is controlled by railroad embankments and drainage ditches. The surface water from the southern portion of the area drains west into a drainage ditch and then continues northwest to a local topographic depression.

Groundwater within the alluvium is approximately 60 feet below the ground surface, and it flows to the northwest and north-northwest (Environmental Science and Engineering [ESE] 1986). The February 1987 water table and groundwater flow direction, as determined by Ebasco Services (1988), is shown in Figure 2-1.

The entire Denver Formation is saturated within the site and may contain some local confined aquifers. The more hydraulically conductive units in the formation are expected to be subhorizontal sandstone or siltstone bodies adjacent to less conductive claystone. The direction of groundwater flow is expected to be generally the same as that of the alluvial groundwater.

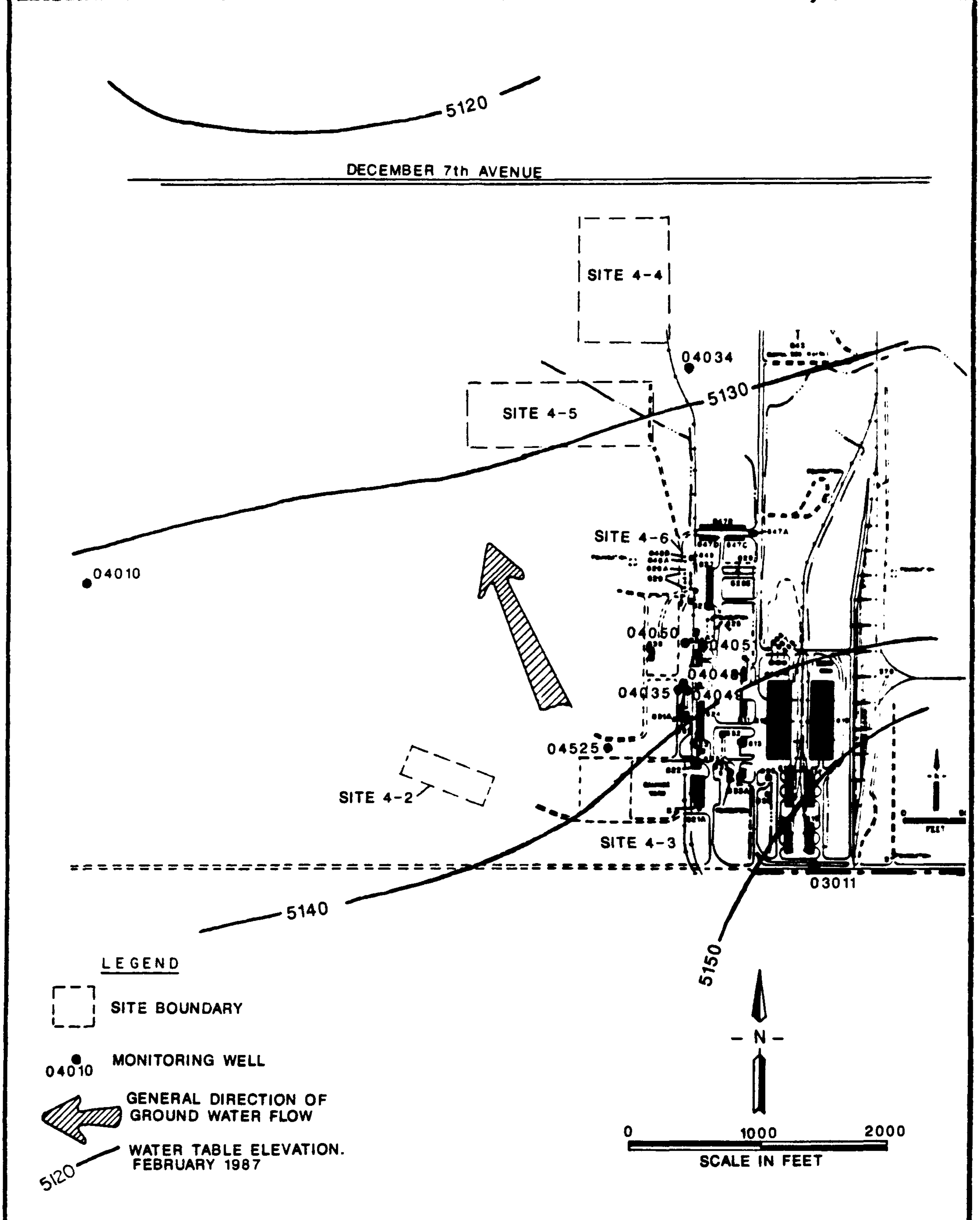
2.2 NATURE AND EXTENT OF CONTAMINATION

A summary of the nature and extent of contaminants found in the Motor Pool Area is discussed in this section. Information used in this summary was obtained from previous studies including a soil gas study conducted in February 1986 to aid in defining trichloroethylene plumes in the groundwater (Ebasco 1987), a Contamination Assessment Report (Ebasco 1988), the Western Study Area Report (Ebasco 1989a), and a soil gas survey conducted in summer 1989. These reports can be referenced for additional details.

2.2.1 Soils and Sediments

The soils investigation of the Motor Pool Area has been in three general areas:

- Repair, salvage, and surplus facility (Building 624) and railroad roundhouse (Building 631) areas
- Motor Pool and vehicle maintenance facility (Building 627) area
- Fuel tank storage area



FROM: EBASCO 1988

Job No: 22238	Figure 2-1 WATER TABLE ELEVATIONS, GENERALIZED GROUND WATER FLOW DIRECTION, AND WELL LOCATIONS
Prepared by: D.L.C.	
Date: 10/20/89	

The analytical data was collected from soil samples taken at various depths in the vadose zone. Sampling depths at the sites were generally 0 to 1, 4 to 5, 9 to 10, 14 to 15, and 19 to 20 feet. Borings greater than 20 feet in depth were sampled at 10-foot intervals beyond 20 feet. A summary of the analytical results is shown in Table 2-1.

Indicator levels and ranges were established to assess the significance of metal and organic analytical values. Organic compound indicator levels have been set at the certified reporting limit for each compound. Metal indicator ranges have been set within naturally occurring levels in the alluvial soils at RMA. These indicator ranges are shown in Table 2-1. A more detailed discussion of the selection of the indicator ranges can be found in the Introduction to the Contamination Assessment Reports (ESE 1987).

Trichloroethylene was detected in the area between the roundhouse and Building 624 in a near-surface soil sample taken beneath a man-made drainage ditch. This suggests that at some time in the past, chlorinated solvents used at these facilities were present in the north-trending ditch.

Concentrations of ICP metals (cadmium, chromium, copper, lead, and zinc) and arsenic above background were also found in near-surface soil samples taken from the ditch. This is attributed to the sanding and stripping operations performed during equipment maintenance and repair.

Methylene chloride, trichloropropene, and aldrin were present in soil samples taken near the roundhouse (Table 2-1).

At Building 627, tetrachloroethylene was detected between 18 and 30 feet below grade beneath the same north trending ditch that passes Building 624 and the roundhouse. These detections may suggest infiltration from the upgradient discharges at the roundhouse and Building 624.

DBCP, toluene, and benzothiazole were found in near-surface soil samples taken downgradient from a drainage pipe exiting the south side of Building 627. The drain pipe discharged hot water and detergent in the mid-1960s and diluted wastes from the wash bay since 1951 (Ebasco 1989a).

Methylnaphthalene, pyrene, and fluoranthene were detected in near-surface soil samples taken in the north trending ditch west of Buildings 624 and 627. These analytes are attributed to leaching from railroad ties treated with wood preservatives (Ebasco 1989a).

TABLE 2-1
SUMMARY OF SOIL SAMPLING ANALYSIS
MOTOR POOL AREA

Analytical Groups and Analytes Detected	Frequency of Detections[1]	Range (ug/g)	CRL Range (ug/g)[2]	Indicator Range (ug/l)
Organochlorine Pesticides				
Aldrin	2/163	0.9-3	0.3	
Arsenic	16/152	2.6-27	2.5-5	CRL-10
Mercury	14/152	0.057-0.38	0.050-0.060	CRL-0.1
ICP Metals				
Cadmium	13/152	1.4-30	0.66-0.74	1-2
Chromium	62/152	6.5-490	5.2-6.5	25-40
Copper	100/152	5.7-220	4.7-4.9	20-35
Lead	37/152	9.8-2000	8.4-13	25-40
Zinc	146/152	11-2300	8.7-9.5	60-80
DBCP	1/177	0.01	0.0050	
Polynuclear Aromatic Hydrocarbons				
Fluoranthene*	5/163	1-30	0.3*	
Pyrene*	6/163	0.5-20	0.3*	
Methyl naphthalene*	8/163	4-200	0.3*	
Volatile Halogenated Organics				
Tetrachloroethylene	3/135	0.4-1	0.3	
Trichloroethylene	1/135	2	0.3-0.5	
Trichloropropene*	1/135	0.2	0.3*	

(11111C02-3400) (11/19/89) (RMA)

TABLE 2-1
(continued)

Analytical Groups and Analytes Detected	Frequency of Detections[1]	Range (ug/g)	CRL Range (ug/g)[2]	Indicator Range (ug/l)
<u>Methylene Chloride</u>	1/135	3	0.7-2	
<u>Volatile Hydrocarbons</u>				
4-Hydroxy-4-methyl-2-pentanone*	1/135	4	0.3*	
Methylcyclohexane*	2/135	2-10	0.3*	
<u>Volatile Aromatic Organics</u>				
Ethylbenzene	1/135	4	0.3-0.4	
m-Xylene	1/135	2	0.7-0.8	
Toluene	2/135	2-4	0.3	
<u>Organosulfur Compounds</u>				
Benzothiozole	1/163	0.3	0.3*	

ug/g - Migrograms per gram
1 - Fraction represents the total number of samples with detections of an analyte in relation to the number of analyses conducted on all samples. This value does not include multiple detections of a specific analyte in the same sample, which occasionally has occurred when more than one analytical method has been used. Total number of borings, 36; total number of samples, 165.
2 - Certified Reporting Limit (CRL) or detection limit which varies among laboratories conducting analyses.
* - There is no CRL for tentatively identified compounds. The value shown is a detection unit based on 10% of the internal standard for the method used. The number of detections is given, but the number of samples is not.

SOURCE: Ebasco, May 1989

(11111C02-3400) (11/19/89) (RMA)

The fuel tank storage area is located west of Building 627 and consists of seven above-ground tanks. Soil samples from the area showed the following analytes to be in the near-surface soils (concentrations are summarized in Table 2-1):

- Methylcyclohexane
- Benzene
- Ethylbenzene
- m-Xylene
- Toluene
- Methylnaphthalene

Lead and zinc occurred in surface soils at concentrations slightly exceeding their indicator ranges.

2.2.2 Surface Water and Groundwater

Surface water does not occur in the Motor Pool Area except briefly following rainfall or snow melt events. There are no significant surface water features within the site except some drainage ditches from the roundhouse and Motor Pool facility wash bay that form an intermittent, poorly integrated surface drainage system.

Surface water and sludge samples taken in 1984 from the ditch leading from the Motor Pool facility wash bay in Building 627 contained several non-target solvent-emulsifier degreaser compounds (Ebasco 1989a).

Groundwater in the Motor Pool Area is 60 to 65 feet below the ground surface (Ebasco 1989a). Table 2-2 shows a summary of groundwater contaminants in the Motor Pool Area. During the soil gas survey conducted in 1986 at the Motor Pool Area, high trichloroethylene concentrations were detected near Buildings 624 and 631 (Ebasco 1987). Groundwater samples from the nearby alluvial Well Nos. 04035, 04048, 04049, 04050, and 04051 detected trichloroethylene (Figure 2-1). From these data, the trichloroethylene alluvial groundwater plume is interpreted to originate in the Motor Pool Area and extend to the north-northwest. None of the Denver Formation wells in the WSA detected trichloroethylene (TCE). This finding suggests that the plume is confined in the upper portion of the unconfined aquifer at this site.

Trichloroethane and chloroform were detected in the alluvial wells. These compounds were not detected in the upgradient Well No. 03011.

TABLE 2-2
SUMMARY OF CONTAMINANTS IN GROUNDWATER

Analyte	Frequency of Detection	Range[1] (ug/l)	CRL Range[2] (ug/l)
Volatile Organic Compounds			
1,1-Dichloroethylene	1/18	5.0	1.10-1.85
1,2-Dichloroethylene	3/13	0.89-6.0	---
1,1,1-Trichloroethane	3/23	1-12	0.80-1.70
1,1,2-Trichloroethane	2/23	1.5-2	0.78-1.63
Chloroform	14/27	0.54-6.0	0.50-1.88
T-1,2-Dichloroethylene	3/14	1.9-3.7	0.76-1.75
Trichloroethylene	24/27	1.7-260	1.0-1.1
Benzene	3/24	3.0-270	1.34-1.92
Toluene	1/25	1.5	1.21-2.80
Dibromochloropropane	1/22	0.67	0.13-0.19
ICP Metals			
Chromium	1/9	14	5.96
Lead	1/9	22	18.6
Zinc	6/9	34-100	20.1

[1]Source: Ebasco 1989a
[2]Source: Ebasco 1989b

Tetrachloroethylene was not detected in groundwater samples from the Motor Pool Area (Ebasco 1989a). DBCP was found in one out of three samples from Well No. 04031, but DBCP was not detected in 12 other samples from wells in the area.

Volatile halogenated organics (VHO) detected in samples from alluvial wells near the fuel storage tank area are:

- 1,2-Dichloroethylene
- Trichloroethylene
- 1,1,1-Trichloroethane
- 1,1,2-Trichloroethane
- Chloroform

Concentrations of these contaminants are summarized in Figure 2-2. The groundwater data suggest that the source of these compounds is probably in the vicinity of the roundhouse and Building 624 area (see Plate WSA 3.2-2 of Ebasco 1989a).

Benzene was detected in three of the four wells, and DBCP was found in one sample out of three samples from Well No. 04031. This site is not considered to be a source of DBCP or benzene in the groundwater (Ebasco 1989a).

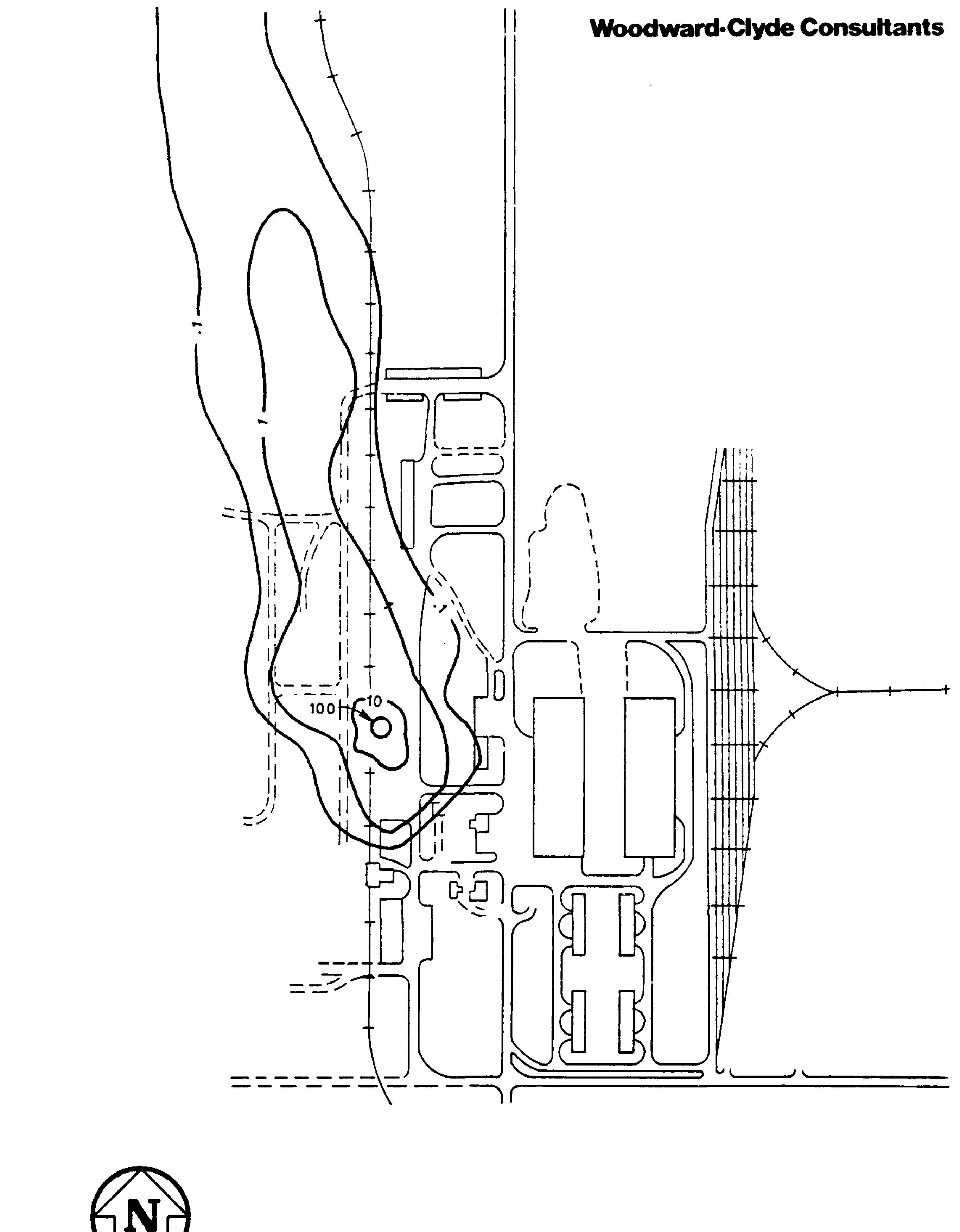
2.2.3 Soil Gas

Three soil gas programs have been conducted in the Motor Pool Area to locate organic contaminants. The first soil gas program was conducted in early 1986 (Ebasco 1987) when groundwater sampling had initially detected trichloroethylene near the roundhouse and Building 624. The trichloroethylene soil gas data showed a trichloroethylene soil vapor plume extending northwest from the Motor Pool Area. Another 1986 soil gas program used static samplers over a 1-month period. This study confirmed previous study results (Ebasco 1987).

The most recent soil gas investigation of the Motor Pool Area was conducted in July 1989. Eighty soil gas samples and 6 soil samples were collected on the investigation site. Sampling depths were 5, 10, 15, and 20 feet below grade, with a standard sampling depth of 15 feet. Sampling results are in Figure 2-2.

The volatile organic compounds that were analyzed for at each of the sampling locations included:

Woodward-Clyde Consultants



0 250 500 1000

SCALE IN FEET

Job No :	22238
Prepared by :	H.W.M./K.A.S
Date :	10/23/89

FIGURE 2-2 TCE SOIL GAS SURVEY MOTOR POOL AREA

- Trichloroethylene (TCE)
- Trans 1,2 Dichloroethylene
- Cis 1,2 Dichloroethylene
- 1,1 Dichloroethylene
- Benzene
- Toluene
- Ethyl benzene
- o, m, p-Xylene

Measured concentrations of TCE in soil gas ranged from the detection limit 0.01 ug/l to about 600 ug/l, with concentrations of TCE typically greater than 200 ug/l in the soil gas between Buildings 624 and 625. Selected soil samples taken at 15-foot depths confirmed these high soil gas values.

Evidence seems to indicate that the origin of this TCE contamination is a 3-inch floor drain shown on 1942 plumbing plans of Building 624 that leads to an outside ditch located between Buildings 624 and 625. TCE has been used as a degreasing agent in Building 624.

2.3 CONTAMINANT FATE AND TRANSPORT

Previous investigations at the site show TCE as being present both in soil vapor in the vadose zone and in groundwater sampling. Although there are several other areas that have surface and near-surface contamination, the TCE appears to have the greatest impact on groundwater quality degradation. Therefore, the potential fate and transport mechanisms of TCE will be the focus of this section.

Previous fate and transport summaries have addressed TCE (Ebasco 1987). Based on the site characteristics, the following observations have been made:

- TCE rapidly volatilizes to the atmosphere from near-surface soil deposits. This is an important fate mechanism for any remaining TCE near the surface. However, since most of the TCE appears to be at greater depths, loss by volatilization to the atmosphere appears to be minor.

- The sandy soils at the site lack the physical and chemical properties to strongly bind and attenuate chemicals, enhancing the potential for migration into the alluvial aquifer. Direct precipitation is generally evapotranspired but may infiltrate into the vadose zone under certain conditions and ultimately recharge the alluvial aquifer.

- TCE is easily mobilized and can readily infiltrate the sandy, permeable alluvium at the site.

- The presence of TCE in soils at depth and in the local groundwater suggests that surface water infiltration has provided a continuing pathway for downward migration though the vadose zone into the alluvial aquifer.

- The presence of oxidizing conditions in the alluvial aquifer suggests that dechlorination and eventual degradation to vinyl chloride is not a significant process. However, reducing conditions exist locally in the Denver Formation, suggesting that degradation is possible there. No vinyl chloride has been detected in either the Denver or alluvial aquifer.

- Alluvial groundwater flow rates are on the order of 2000 feet/year. Therefore, negligible transverse dispersion of TCE in the alluvial aquifer. Also, no apparent degradation has been observed.

In summary, it appears that the most likely fate of TCE in the Motor Pool Area is downward migration with surface water infiltration through the vadose zone into the alluvial aquifer, and subsequent transport with the alluvial aquifer with insignificant chemical or biological degradation.

2.4 APPLICABLE SITE STANDARDS

With the available knowledge of the nature and distribution of chemical contaminants at the site, as well as the fate and transport of these chemicals in the environment, a survey of Applicable or Relevant and Appropriate Requirements (ARARs) is necessary. These ARARs will identify any site-specific regulatory requirements that might limit the choice of alternatives. Action-specific and chemical-specific ARARs are considered to the extent that any alternative which cannot potentially meet those requirements will not be carried forward. Site-, action, and chemical-specific ARARs will be finalized and issued together with the decision document to identify those requirements which will guide the design and implementation of the selected alternative.

2.5 EVALUATION BASIS FOR INTERIM RESPONSE ACTIVITY

This section presents the assumptions to be used in the technology and alternative development for interim response action at the Motor Pool Area. These assumptions and the subsequent design basis are developed from the site history, soil and groundwater investigations, and contaminant fate and transport.

Although there may be several areas of contamination in the Motor Pool Area that may need to be addressed during the final remedy, only one source of TCE contamination has been identified for this IRA. Groundwater sampling, as well as two 1986 and a 1989 soil gas survey, identify what appears to be a subsurface plume of TCE. This TCE plume has its highest concentrations near a 3-inch diameter drain line between Buildings 624 and 625. One soil sample taken in the area detected 2 ppm TCE between 4 and 5 feet (Ebasco 1989a). Because TCE was the only contaminant found in soil vapor analyses, TCE contamination is the focus of this study.

The semi-quantitative nature of the summer 1989 soil vapor survey results indicates that TCE concentrations in the soil peak within the first 20 feet of the surface. Soil vapor concentrations appear to follow a surface depression to the west and subsequently to the north, along a drainage ditch that parallels the rail spur west of Buildings 624 and 625. Therefore, for the purposes of this study, the areal extent of the apparent source of contamination to be addressed is a region bound on the north and south by Buildings 624 and 625, on the east by the walkway between Buildings 624 and 625, and on the west by the rail spur. This region is approximately 60 feet by 100 feet. The vertical extent of contamination to be addressed is 20 feet. The evaluation is summarized in Table 2-3.

Since the evaluation basis volume has been selected based on a semi-quantitative method, either further characterization or confirmation sampling during an interim response action should be considered. However, this design volume will allow for the comparison of alternatives on a common basis.

TABLE 2-3
SOIL REMEDIATION DESIGN BASIS FOR MOTOR POOL AREA

Source Characteristics	Estimate	Minimum	Maximum
Perimeter (ft)	320		
Source surface area (ft^2)	6,000		
Depth of groundwater (ft)	60		
Depth of confining layer (ft)	100		
Depth of contamination (ft)	20	15	25
Volume of contaminated soil (yd^3)	4,500	3,400	5,630

Soil Characteristics

Interbedded silty sand, gravel, and clay partly covered by a thin layer of eolian sand and silt.

Assumed Parameters

Soil bulk density	1.25 tons/yd^3
Porosity	30%

3.0 IDENTIFICATION AND EVALUATION OF INTERIM ACTION TECHNOLOGIES

This section presents the interim action objective and identifies potential interim action technologies specific to the Motor Pool Area at the Rocky Mountain Arsenal (RMA). As the preliminary step to identifying interim response action (IRA) alternatives, potentially applicable technologies for the IRAs are identified, described, and evaluated in terms of their feasibility and general effectiveness. Acceptable technologies or combinations of technologies developed into the IRA alternatives are presented in Section 4.0.

3.1 INTERIM RESPONSE ACTION OBJECTIVES

The objective of this IRA is to mitigate the threat of releases from the Motor Pool Area. Alternatives to meet this objective are developed using technologies discussed in subsection 3.2 and evaluated in Sections 4.0 and 6.0. The evaluation is based on, but not limited to, such factors as protection of human health and the environment, mitigation of the threat to human health, and the reasonableness of cost and timeliness, per the Federal Facility Agreement (FFA), paragraph 22.6

3.2 IDENTIFICATION AND EVALUATION OF TECHNOLOGIES

This section identifies and evaluates IRA technologies applicable to the Motor Pool Area. Table 3-1 (located at the end of this section) lists general response actions and associated technologies typically applied to contaminated soil. Each technology is evaluated as being applicable or not applicable, based on the site-specific and contaminant-specific conditions at the Motor Pool Area.

The technologies remaining after this initial evaluation are then described in this section. This description focuses on the technical performance, operational reliability, and implementation of each technology. Several technologies are eliminated from further consideration at this point. Table 3-2 (located at the end of this section) summarizes this discussion.

Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), as amended by SARA, 1986, guidance (Environmental Protection Agency 1988) suggests the selection of no more than 10 or 11 alternatives. The alternatives should include a mix of institutional controls, containment, in-situ treatment, and onsite treatment technologies, as well as onsite storage and offsite disposal. This suggested mix of technologies was applied in selecting the alternative technologies carried forward to Section 4.0.

This section is organized by general response action. Technologies are introduced with respect to their applicability to address a particular general response. These general response actions include monitoring, institutional controls, containment, source collection, treatment, and storage/disposal.

3.2.1 Monitoring

Monitoring of the Motor Pool Area would consist of periodic sampling of existing upgradient and downgradient groundwater monitoring wells. Groundwater would be analyzed for the organic compounds that have been detected in the soil at the Motor Pool Area. The resulting historical data base, augmented by current and future monitoring, would provide an indication of whether the Motor Pool Area is a continuing source of groundwater degradation in the time between the implementation of an IRA and the overall site remediation. Monitoring is a feasible technology at the Motor Pool Area.

3.2.2 Institutional Controls

Although not a technology, institutional controls are incorporated into the assessment as a variation of the no action alternative. Institutional controls would be applicable in the case of no action, onsite storage or landfill, capping in place, or other interim alternatives, which result in leaving contaminated materials on site that could be compromised by future excavation or construction activities.

Since a fence and guard post are used to secure the arsenal, site access restrictions are already in place to some extent. Additional restrictions, such as fencing around the Motor Pool Area, would be feasible.

3.2.3 In-place Containment

Six technologies are identified as either source containment or associated with source containment measures:

- Capping
- Dikes and berms
- Slurry walls
- Grout curtain
- Sheet piling
- Groundwater interception and treatment

3.2.3.1 Capping

Capping is a process used to cover buried waste materials to prevent their contact with the land surface and surface water. Substantive performance standards for caps must conform with 40 CFR Part 264.310, which describes Resource Conservation and Recovery Act (RCRA) Landfill Closure Requirements. As described, a cap consists of a compacted clay layer, a synthetic geomembrane liner, a sand drainage layer, and a surface layer of vegetated topsoil, asphalt, or rock. For short-term implementation, non-conforming caps are sometimes applicable. These consist only of a compacted clay layer beneath a surface layer of either vegetated topsoil, asphalt, concrete, or rock.

Surface caps must be sloped to provide rapid surface drainage away from the contaminated areas. Collection systems may be incorporated into surface caps; however, this is generally not necessary if high concentrations of mobile contaminants are not present. The technology required to implement this alternative is commonly used for in-place closure of contaminated soils or in conjunction with confinement of contaminated groundwater.

Capping is effective in minimizing the leaching of contaminants from the soil profile above the groundwater table. However, waste materials below the water table will still be transported by groundwater migration. Supplementary groundwater control measures are generally required when soil contamination extends below the groundwater table.

Surface-capping technology is relatively economical to implement, is technically feasible and, when used in conjunction with other groundwater measures, can be effective in reducing contaminant leachate production from near-surface soils.

3.2.3.2 Dikes and Berms

Dikes and berms are well-compacted earthen ridges constructed immediately upslope from or along the perimeter of a disposal site. These structures are generally designed to provide short-term protection of critical areas by intercepting storm runoff and by diverting the flow to natural or man-made drainage ways.

This technology is a cost-effective, technically feasible method of preventing surface runoff from impacting remediation operations at the Motor Pool Area.

3.2.3.3 Slurry Walls

A slurry wall is a vertical, low-permeability wall, typically constructed of a soil/bentonite mixture, which is placed in a trench kept open by a slurry (bentonite/water mixture). The trench is typically 2 to 3 feet wide and is usually keyed into a low-permeability basal unit. A surface capping system is generally constructed in conjunction with the slurry wall.

At this site, the relatively extensive depth of the Denver Formation, which appears to be the first suitable stratum for effective containment of downward migration of contamination, is unfavorable for economical soil/bentonite slurry wall construction for surrounding and containing source containment. However, a slurry wall used in conjunction with a groundwater extraction and treatment system would be a feasible method of addressing groundwater contamination at this site.

3.2.3.4 Grout Curtain

Grout curtains are subsurface barriers created in unconsolidated materials by pressure injection. They are generally more expensive than slurry walls, and their ability to develop a continuous low-permeability barrier is questionable. Occasionally, as a result of grout shrinkage and erratic movement of the grout through the soil pores, large voids may remain. Sandy soils present at the site could require large volumes of grout, making this alternative potentially very expensive with less control of barrier wall continuity compared to a soil/bentonite slurry wall. For these reasons, this technology is eliminated from further consideration.

3.2.3.5 Sheet Piling

Sheet piling cut-off walls may serve as a groundwater barrier to redirect groundwater flow. Such cut-off walls may be used to redirect or contain groundwater to eliminate contact with contaminated materials and/or to prevent contaminated groundwater and waste material from migrating off site. Of the three available materials for sheet piling (wood, precast concrete, and steel), steel is the most efficient and cost-effective groundwater barrier.

The installation of a steel sheet piling cut-off wall requires that the pilings be assembled at their edge interlocks before being driven into the ground. The piles are then driven a few feet at a time over the entire length of the wall by using either a pneumatic or steam pile driver until the appropriate depth is obtained.

Initially, steel sheet piling cut-off walls are quite permeable; the edge interlocks must be loose to facilitate the driving process and to allow water to pass through them easily. Eventually, fine soil particles may adhere within the seams, and the wall becomes less permeable to groundwater flow. In very coarse, sandy soils, the wall may never seal unless the piling seams are first grouted, which adds to the overall cost. Corrosion of the steel from chemical exposure due to soil and groundwater contaminants can be reduced by the use of galvanized steel or other steel coatings at an increased cost; however, driving operations may damage the coating material. In general, steel sheet piling cut-off walls tend to be more expensive and probably less effective than slurry walls. Therefore, the use of sheet piling cut-off walls is not considered a feasible remedial action technology and is eliminated from further consideration.

3.2.3.6 Groundwater Interception and Treatment

A successful containment technology that has been used at RMA is groundwater interception and treatment. Groundwater extraction wells are pumped to create a reverse hydraulic gradient, thereby limiting the migration of contaminants by reducing the movement of the groundwater. Extracted water is treated and reinjected.

Groundwater extraction and treatment as a containment technology can be performed using extraction wells alone or extraction wells in conjunction with a physical barrier.

Contaminated water can be intercepted using extraction wells to collect the water and also reverse the hydraulic gradient. Collected water is then treated and usually reinjected downgradient of the intercept system to reduce the overall hydrologic effects of the system. Using extraction wells alone is adequate for some purposes.

Extraction wells can also be used in conjunction with a physical barrier to improve the efficiency of the system. The physical barrier can be a slurry wall or sheet piling or grout curtain.

The barrier wall can either be constructed perpendicular to the groundwater gradient, downgradient of the contaminant source, or it can be constructed 360 degrees around the entire source area. When the barrier wall is constructed downgradient of the source, the groundwater is extracted upgradient of the well to maintain a reverse hydraulic gradient. When the 360-degree barrier is constructed, water is extracted from within. Creating a lower potentiometric surface inside the barrier prevents exfiltration of the groundwater through the barrier, which could result from possible construction imperfections.

This technology has been successfully implemented at several sites at RMA and is technically feasible for the TCE plume in the Motor Pool Area.

3.2.4 Source Collection

Excavation of contaminated soils is a standard approach to source collection at hazardous waste sites. Excavation is a prerequisite to disposal of soils in a landfill (on site or off site) or treatment in a land farm or by incineration, and is also required for some methods of soil washing or chemical fixation.

Temporary excavations will typically be performed with side slopes of 1 vertical to 1 horizontal (1:1) or as determined by a detailed stability analysis to protect workers and equipment within the excavation in accordance with the Occupational Safety and Health Administration (OSHA) requirements. This technology is feasible for use in the Motor Pool Area.

3.2.5 Treatment

The contaminated soils at the Motor Pool Area can be treated to reduced their mobility, toxicity, or volume. This treatment may be physical, chemical, biological, or a combination of these. Treatment can be accomplished with or without source collection methods described in the previous section. Treatment methods not requiring source collection are called in-situ methods and are described in subsection 3.2.5.1. Onsite treatment methods are described in subsection 3.2.5.2. Offsite treatment technologies are discussed in subsection 3.2.5.3.

3.2.5.1 In-situ Treatment Technologies

Five technologies are identified as in-situ treatment measures:

- In-situ bioremediation
- In-situ chemical fixation
- In-situ vapor extraction
- In-situ soil washing
- In-situ radio frequency soil heating

3.2.5.1.1 In-situ Bioremediation. In-situ bioremediation is based on enhancing those factors that enable naturally occurring soil and water bacteria to biologically decompose waste contaminants in place. Generally, oxygen content (via peroxide injection or aeration), nitrate and phosphate nutrient levels, and pH need to be augmented or adjusted. Injection of the methane or methanol necessary for TCE degradation could result in clogged injection wells due to excessive biomass growth along the slotted interval of the injection well.

This technology will degrade trichloroethylene (TCE) first to dichloroethylene (DCE) and subsequently, to vinyl chloride. There is some question of whether the degradation process proceeds any further (Kleopfer, et al. 1985). If this is the case, the end product of this process is a compound with a greater carcinogenic potency than the original TCE. Therefore, this process will not be considered further.

3.2.5.1.2 In-situ Chemical Fixation. Chemical fixation technology for organic contaminants is potentially available without excavation of soils. At least one supplier has demonstrated a pilot-scale system to drill and blend waste material in place with a fixative or bonding agent. The process consists of drilling into the waste or soil with a boring rod with two liquid channels. While the rod is being lifted, bonding agents supplied by grout pumps are injected through the channels and mixed, eventually setting into a vertical cylindrical column of impermeable inorganic crystalline or cemented material.

This technology can be very effective on metals and higher molecular weight semivolatile and nonvolatile organics. However, volatile organics have not been demonstrated to be fixed effectively into the solid matrix. Therefore, this technology will not be evaluated further.

3.2.5.1.3 In-situ Vapor Extraction. Vapor extraction is an in-situ technique for removing volatile organic chemicals (VOC) from soils above the water table. The process of vapor extraction consists of applying a vacuum to a well or trench screened above the water table, inducing a flow of air through adjacent soils, and progressively air-stripping the volatile contaminants contained in the soil matrix. Its most effective use to date has been in removing VOCs from soils where the contaminants are too deep or too dispersed for removal by excavation to be practical.

The principles underlying the soil gas vapor extraction process are straightforward. In the vadose zone of undisturbed, contaminated soils, equilibrium is maintained between the liquid and/or solid and vapor phases of the volatile contaminants. For soils that have even moderate permeability in the vadose zone, sufficient air can be drawn through the soil to remove the vapor phase contaminants at useful rates. The removal of contaminated vapors upsets the equilibrium between the liquid and/or solid and vapor phases, and causes further volatilization from the soil. Continued operation of the process results in an almost complete removal of the contaminants, except for the portion that is effectively bound to the soil.

Vapor removal from the vadose zone may be accomplished in one of several ways. One of the most common approaches is the application of a vacuum through a collection zone by either wells or perforated pipe in trenches. In tighter soils or for removal of somewhat less volatile species, an air sweep may be induced by injection of high pressure air, and may even be supplemented by pre-heating the injection air to improve volatility by elevating temperature. Exhaust air from the vacuum blower can be treated using either carbon adsorption, catalytic oxidation, or thermal oxidation. Spent carbon can be thermally reactivated either onsite of offsite and reused.

The information available regarding the soil contamination indicates that vacuum extraction would be a suitable remedial activity to consider. To date, however, it has not been documented that the soil structure, permeability, and stratification are suited to inducing air movement. Pilot testing would be required to establish potential air flow rates and contaminant removal capabilities. This technology is feasible for soils in the Motor Pool Area.

3.2.5.1.4 In-situ Soil Washing. In-situ soil washing has been applied at the test or pilot level for both organic and metal contaminated soils. The process consists of saturating the contaminated zones via injection wells with chelate, solvent, or diluent, and collecting the introduced fluid and entrained contaminant via a second series of wells, thus producing a washing circuit.

Several potential problems may be encountered with this approach. First, the chelate or solvent, by rendering the contaminants soluble, may spread the contamination if the collection system is not completely effective. Second, because of the uncertainties of distribution patterns, large quantities of solutions must be applied. Third, contact patterns and residence time are less certain than in an above-ground system. For these reasons, in-situ soil washing will not be applied at the site.

3.2.5.1.5 In-situ Radio Frequency Soil Heating. Radio frequency (RF) soil heating is an in-situ soil treatment that relies on the ability of electromagnetic waves in the RF range to heat contaminated soil to the 500 to 600 °F range. At this temperature, volatile organic compounds are driven off of the soil matrix to the surface where they are collected in an offgas treatment system.

The RF energy is introduced into the soil through an array of tubular hollow-pipe electrodes. While there are no reported limitations with respect to such concerns as depth of contamination, soil type, underground utilities or buried objects, the presence of free water presents a grounding problem.

The offgas is collected under a hood in an induced draft system through a cooling step and an offgas treatment. This offgas treatment can be either condensation/collection, catalytic oxidation, or carbon adsorption. The selection of treatment technologies is usually based on economic and permitting considerations.

The technology is still in the developmental stage, with a full-scale design currently progressing. Therefore, a full-scale application for the Motor Pool Area as an IRA may not be possible. This process will not be retained for further consideration at this time; however, the technology is promising and its progress should be monitored for future application.

3.2.5.2 Onsite Soil Treatment Methods

Six technologies are identified as onsite treatment measures for contaminated soil:

- Landfarming
- Soil/slurry bioreactor
- Chemical fixation/stabilization
- Soil washing
- Thermal desorption
- Onsite incineration

3.2.5.2.1 Landfarming. Land treatment of contaminated soils is essentially a variation of the land treatment of oily wastes that is a common practice in the petroleum industry. For contaminated soil, the contamination is already contained in the soil matrix. Surficially contaminated soils can be treated in-situ by irrigation, nutrient addition, and rototilling. This technique is generally limited to the upper 1 foot of soil. Soils that contain contamination deeper than 1 foot, as exists at the Motor Pool Area, must be excavated prior to landfarming.

A landfarming operation usually consists of the construction of a bermed containment area. This area will be sloped to a sump for collection and subsequent recirculation of nutrients and water. The contaminated soil is usually placed over the containment area in 6- to 12-inch lifts. The soil is occasionally rototilled to enhance aerobic biodegradation. This process of nutrient addition, moisture maintenance, and rototilling continues until microbial degradation has reduced organic concentrations to acceptable levels. This rate of degradation needs to be determined in a treatability study. However, the only demonstrated degradation of chlorinated hydrocarbons involves the use of a co-carbon substrate such as methane. Due to the difficulties and safety considerations associated with the introduction of methane into a land treatment unit, this technology will not be retained for further consideration.

3.2.5.2.2 Soil/Slurry Bioreactor. Another innovative variation on the soil biotreatment technology involves transferring the majority of the contaminants from soil to a water stream and performing biodegradation in the liquid phase. The process is based on the use of conventional concrete mixing and washing equipment to maintain a continuous flow of mechanically prepared soil and a recycle loop of surfactant and microorganisms.

Soils are excavated and size-classified through vibrating screens for removal of oversized clods, rocks, rubble, and debris. Classified soil is either milled or directly fed to a mixing step where it is sprayed and agitated with a concentrated solution of microbes and surfactants. The wet slurry passes through a spray washer where large particles are mechanically washed and ejected, and fine slurry proceeds to a series of open or closed liquid/solid contact bioreactors. The reactors are aerated by high-power mixers or bottom-air spargers to enhance aerobic biodegradation. The resulting treated slurry is dewatered, with solids removed to land disposal or replacement, and liquids are recycled to the mixing truck. Offgases can be collected for recycling, adsorption, or incineration. As treatment progresses, microorganisms are expected to generate sufficient surfactant enzymes of their own, whereupon the addition of synthetic surfactants would be stopped.

Dewatered solids produced by this process may, in some cases, contain a low enough concentration of contaminants to require no further treatment prior to final placement or disposal. The presence of relatively recalcitrant compounds may require that soils so treated be subsequently landfarmed to achieve regulatory limits. Oversized soils ejected from the washer may be further milled or ground and reintroduced upstream of the process train. Rocks, segregated from the soil during screening, may be separately fed into the slurry bioreactor for treatment. When soil treatment is complete and the process shut down, the remaining water must be collected and further treated prior to disposal.

The primary advantage of the soil/slurry bioreactor in comparison to surface land treatment appears to be the reduction of treatment time and the improvement in control over emissions and reaction rates. Therefore, this technology will be considered further.

3.2.5.2.3 Chemical Fixation/Stabilization. Chemical fixation/stabilization refers to treatment methods that surround or encapsulate waste components in a stable inorganic matrix. The treatment additives are selected to:

- Minimize contaminant spread by agglomerating the wastes and reducing the transfer surface area
- Reduce the solubility, toxicity, or mobility of hazardous components
- Solidify or otherwise improve the handling or structural characteristics of the waste

Stabilization generally refers to those processes that add materials to change the pH, limit the solubility or mobility, or otherwise chemically alter the environment around the contaminant molecule. This process may not solidify the waste or contaminated soil, leaving it either friable or close to its original consistency after treatment.

Chemical fixation involves applying additives of the type and quantity that will produce a monolithic block of high structural integrity. This process mechanically locks the contaminants inside a structural matrix but does not necessarily chemically react with or alter them.

Chemical fixation/stabilization can be accomplished by various means; most are referred to in terms of the additives used to treat the waste. The two approaches discussed herein are the cement process, which is a chemical process, and the pozzolanic silicate process, which is a physical process. Both processes will require a solids-handling operation consisting of the following basic steps:

1. Excavation of contaminated soils
2. Temporary storage on a pad on site
3. Blending with additives in a high shear mixer or pug-type mill
4. Reaction time in a solidification cell
5. Replacement into either the excavation pit or a landfill

3.2.5.2.3.1 Cement Process. The cement process is based on the addition of primarily portland cement or other cement materials and water, which will mechanically incorporate waste components into a rigid matrix when it cures. However, many wastes, especially organic contaminants, remain leachable from the cured cement since they are not chemically bound. This process elevates the bulk pH to a level at which most metal ions are in the insoluble hydroxide or carbonate form. The actual cement matrix is a calcium-silicate hydrate.

The metal salts are not stable over a wide pH range, and potentially, even precipitation is acidic enough to initiate leaching. This process, when used alone, is generally not effective on some metal salts such as salts of lead, copper, and zinc. Hence, the cement process is usually used in conjunction with other processes as a final hardening agent.

3.2.5.2.3.2 Pozzolanic Silicate Process. The pozzolanic process forms a matrix from fine ground siliceous materials such as fly ash, blast furnace slag, or kiln dust with calcium oxide or gypsum and water. Silicate content is often augmented by addition of solutions of sodium or potassium silicate. As with the cement process, this process increases the weight and volume of the waste. However, depending on additive ratios, the product consistency may remain clay-like to friable rather than a cemented solid.

This system has been applied to both divalent metal contaminants and organic contaminants in field-scale remediations. This system is effective in binding heavy metals because they chemically react with the silicate materials as the initiators of the gel or setting process. The presence of oil and grease may interfere with the reaction, as do some sulfates, dichromates, and carbohydrates. Oil and grease are not expected to be factors in the treatment at the Motor Pool Area.

Since volatile organic compounds are not effectively fixed into a stable matrix, this technology may not meet treatability standards and will not be considered further.

3.2.5.2.4 Soil Washing. Soil washing consists of mixing contaminated soil with a solvent to dissolve and remove the entrapped organics. In the batch process, a tank or plastic-lined pit is filled with excavated soils in a working pile. The pile is sprayed and flooded with the treatment solvent, and the leachate is collected and recycled. The solution is recycled until the contaminant concentrations in both the soil and the treatment solution are in equilibrium, and no further extraction from the soil will occur. The solution is then diverted and solids extracted via vacuum filtration or another dewatering process. The remaining liquids are either processed for reuse or chemically or thermally destroyed. The sludge generated in the filtration process is suitable for treatment by thermal processes for the destruction of any organic content. The solution process significantly reduces the volume of solids to a smaller amount that can be safely transported more economically to an offsite recovery treatment/disposal facility.

Soil washing can also be conducted as a continuous process by utilizing a froth flotation. In this application, the soils are screened prior to the addition of cleansing agents and water to form a slurry. This slurry is routed to parallel flotation cells. The contaminated froth is drawn off the top, and the slurry is pumped to wet-scouring tanks for a final water rinse. The cleaned slurry is then dewatered by filtration, leaving a soil that can be returned to the site or disposed of as clean fill. The contamination is collected in the form of a concentrated sludge, which can be incinerated or landfilled. This process has been conducted on a bench- and pilot-scale in Europe with excellent removal efficiencies reported on soils with concentrations of contaminates in the range of those at the Motor Pool Area (Brochine, undated). However, due to the testing required prior to implementation, this technology is considered inapplicable for this site.

3.2.5.2.5 Low-temperature Thermal Desorption. Low-temperature thermal desorption is a two-step process for the destruction of volatile organic compounds. Contaminated soil is first fed into a rotary drum system equipped with heat transfer surfaces. The soil is heated to approximately 500 to 800° F. This serves to volatilize any water and organics that are drawn off into a carrier gas stream and then into an afterburner for subsequent destruction. The majority of the carrier gas is recycled, while a slip stream is drawn off through an activated carbon system prior to discharge to the atmosphere. The heat source for the rotary drum can be an indirect fired recirculating glycol system with propane as fuel, indirect propane, or a direct fuel-fired system. The afterburner fuel supply is usually natural gas.

These systems are generally effective for removal of volatile organic compounds with Henry's constants greater than 3.0×10^{-3} atm-m^3/mole from contaminated soils and sludges. The process is limited to soil and sludges containing no more than 10 percent total organics or 60 percent moisture. Neither of these constraints poses a problem at the Motor Pool Area. Solid feeds must be screened, if necessary, to less than 1.25 inches.

This technology is feasible for the destruction of volatile organic compounds.

3.2.5.2.6 Onsite Incineration. Incineration is a thermal technology in which the soils are combusted at high temperature under turbulent conditions. Specific design and operating conditions typical for hazardous waste processing include combustion temperatures in excess of 1200° C, and 99.99 percent destruction and removal efficiencies (DRE) for hazardous organic compounds, with the exception of the highly toxic and stable polychlorinated triphenyls and dioxins where a 99.9999 percent DRE is to be achieved. The residence time is generally about 2 seconds for gases and vaporized liquids, and minutes or fractions of an hour for soils and solids. Operators of incinerators and thermal treatment devices must demonstrate that they can meet these performance requirements. Other considerations include emission control equipment and backup procedures and controls for waste shutoff and/or incinerator shutdown should equipment malfunction or wastes vary beyond the intended feed composition. Test burns of the waste may be desirable to initially develop the necessary air pollution control devices.

Incineration of chlorinated organic compounds produces hydrogen chloride (and free chlorine, if there is an inadequate supply of hydrogen). Either a wet or a dry scrubber is used to remove this acid gas. For heating values less than 5000 Btu/lb, combustion of the waste is generally not self-sustaining, and a significant proportion of auxiliary fuel is required in the primary chamber. In most cases, secondary combustion in an afterburner is required to ensure high destruction and removal efficiency and adherence to the regulations regarding residence time and temperature.

There are several potential, proven incinerator designs, including rotary kiln, fluidized bed, and infrared moving bed. Each has characteristic solids handling and combustion configurations. Each process has been demonstrated to varying degrees; however, the rotary kiln process is the most widely used. This technology is feasible for the Motor Pool Area.

3.2.5.3 Offsite Treatment

The technology identified as an offsite treatment measure is incineration.

Incineration is a thermal treatment technology in which the contaminated soils and sludges are combusted at high temperature (usually 1800° to 2000°F), under turbulent conditions. The residence time is generally about 2 seconds for gases and vaporized liquids, and minutes or fractions of an hour for soils and solids. This process results in the oxidation of all organic material to carbon dioxide and water. Other elements in the soil (e.g., chlorine) or elements in the contaminant molecules will produce acid gases.

Offsite incineration involves combusting wastes at an existing permitted facility located outside the property boundary. The potential for offsite incineration relative to other options depends on a number of factors, including:

- The availability of an incineration facility within economic hauling distance from the site
- The facility's possession of permits appropriate for the type of contaminants to be treated
- The suitability of the incinerator type and configuration for processing soils

Since soil incineration will completely destroy volatile organic compounds, offsite incineration is feasible for soils at the Motor Pool Area.

3.2.6 Temporary Storage/Disposal

Soil and other solid wastes may require disposal before or after treatment. This disposal can be either onsite temporary storage or offsite disposal at a properly permitted facility. This section evaluates technologies for the temporary storage/disposal of soils, sludges, and other solid waste.

3.2.6.1 Onsite Temporary Storage

Two technologies have been identified for onsite temporary storage of solid wastes:

- Temporary waste pile
- Solid waste landfill

3.2.6.1.1 Temporary Waste Pile. Solid wastes that have been classified as hazardous under 40 CFR Part 261 would be stored in a temporary waste pile that substantively complies with the requirements of 40 CFR 264, Subparts L and N. Design requirements currently include double liners, leachate collection and treatment, capping, surface water control, and a groundwater monitoring system. This technology is feasible for the temporary storage of contaminated soils at the Motor Pool Area.

3.2.6.1.2 Solid Waste Landfill. A selected soil treatment technology may be effective in declassifying the material as hazardous as defined in 40 CFR Part 261. Therefore, hazardous waste storage requirements would be unnecessary. Onsite solid waste disposal in a facility designed to meet EPA's solid waste landfill requirements may be feasible for temporary storage.

3.2.6.2 Offsite Disposal

Two alternative methods are available for offsite disposal of soils/sludges:

- Disposal in a hazardous waste landfill
- Disposal in a solid waste landfill

3.2.6.2.1 Disposal in a Hazardous Waste Landfill. Contaminated soils and sludges or treated solid waste streams from treatment processes can be disposed of off site in a commercial hazardous waste landfill. The nearest, fully permitted hazardous waste facility to RMA is the USPCI Grassy Mountain landfill near Clive, Utah. Offsite disposal will require excavation and management of groundwater by using one or more of the treatment technologies described previously. This technology is feasible for the Motor Pool Area.

3.2.6.2.2 Disposal in a Nonhazardous Waste Landfill. Nonhazardous solid wastes from soil/sludge treatment processes can be disposed of in a nonhazardous waste landfill. Several of these landfills exist in the area. Disposal at a facility with less stringent controls than a hazardous waste facility will require that the waste transported off site be delisted and considered nonhazardous. Since there will be some nonhazardous debris generated in these operations, this will be considered a feasible technology.

3.3 SUMMARY OF RETAINED TECHNOLOGIES

Table 3-2 summarizes this section. Several identified technologies were evaluated as not being applicable based on technical implementability. The remaining technologies were used to formulate the alternative remediation scenarios of Section 4.0.

TABLE 3-1
IDENTIFICATION OF POTENTIAL TECHNOLOGIES
FOR MOTOR POOL AREA
SOILS

Response Action	Interim Action Technology	Process Description	Site Rating	Comments	Unit Cost
Monitoring					
	Additional Sampling	Sampling/ Analysis	A	Sampling of existing site groundwater monitoring wells	$5,000
	Installation of Wells	Sampling/ Analysis	A	Monitoring wells exist on site	$3,000-7,000/well
Institutional Controls					
	Access Restrictions	Fencing	A	Will limit site access	$10/LF
In-place Containment					
	Surface Capping	Clay Cap	A	Requires grading and surface cover; uncovered cap may crack due to exposure	$5-15/yd2
		Multilayered Cap	A	Typically consists of clay, synthetic, and drainage layers	$30-50/yd2
		Synthetic Liner	NA	Highly susceptible to deterioration if not protected	$4-10/yd2
		Asphalt	A	Effective as erosion protection; imperviousness, may degrade as a result of weathering and cracking	$4-8/yd2

A = Applicable NA = Not Applicable

TABLE 3-1 (Continued)

Response Action	Interim Action Technology	Process Description	Site Rating	Comments	Unit Cost
		Concrete	NA	Excessively rigid, may crack, expensive	$20-50/yd2
	Surface Control	Soil Stabilization	A	Improves erosion resistance, may decrease infiltration	$3-5/yd2
		Grading	A	Controls runoff and runon; inexpensive, reduces erosion	$0.5-1.0/yd2
		Dikes/Berms	A	Controls runoff and runon; inexpensive	$2-5/yd3
	Vertical Barriers	Slurry Wall	A	Demonstrated technology at several hazardous waste sites	$5-15/ft2
		Grout Curtains	A	Low quality control for field implementation	$6-10/ft2
		Sheet Piling	A	More pervious than slurry wall, installation difficult in dense or cobbly soils	$10-20/ft2
	Groundwater Interception	Extraction Well	A	Effective for groundwater containment	$15,000/well
		Extraction Well with Physical Barrier	A	Effective for groundwater containment	$15,000/well + $5-15/ft2 + $6,000/yr O&M

A = Applicable NA = Not Applicable

TABLE 3-1 (Continued)

Response Action	Interim Action Technology	Process Description	Site Rating	Comments	Unit Cost
Source Collection					
	Excavation	Backhoe	A	Hazardous soils excavation has occurred at the Arsenal	\$1-3/yd3
In-situ Treatment					
	Biological	Oxygen/Nutrient Injection	A	Potentially effective on TCE-contaminated soil	Low <\$100/yd3
	Chemical	Fixation	A	Effective on some organics, bench testing is recommended	\$45-65/yd3
	Physical	Vitrification	NA	Most applicable on mixed waste; more effective technologies for volatile organics	\$400-700/yd3
		Vapor Extraction	A	Effective on volatile organics	Cap=\$1.5-2M O&M=\$2/yd3
		Soil Washing	A	Potentially effective on TCE-contaminated soils	\$150-200/yd3
		Radio Frequency Soil Heating	A	Potentially effective for volatile organics in soil	\$50-90/Ton

A = Applicable NA = Not Applicable

TABLE 3-1 (Continued)

Response Action	Interim Action Technology	Process Description	Site Rating	Comments	Unit Cost
Onsite Treatment					
	Biological	Landfarming	A	Potentially effective on TCE-contaminated soil	$25-40/yd3
		Bioreactor	A	Potentially effective on TCE-contaminated soil	$25-45/yd3
	Chemical	Fixation	A	More effective on metals than organics; quality control fairly high for small soil sizes	$35-100/yd3
		Soil Washing	A	Proven effective on organics in soil	$60-80/yd3
		Solution Mining (Chelation)	NA	Typically used for metal extraction in mining	$60-80/yd3
		Oxidation	NA	Effective in lab studies for organics; difficult to duplicate in field	$100-125/yd3
		Dechlorination	NA	Effective only on cyclic chlorinated hydrocarbons	$100-150/yd3
	Physical	Thermal Desorption	A	Effective for volatiles and some semivolatiles	$150-200/yd3

A = Applicable NA = Not Applicable

TABLE 3-1 (Continued)

Response Action	Interim Action Technology	Process Description	Site Rating	Comments	Unit Cost
Onsite Treatment		Pozzolonic Fixation	A	Will reduce contaminant mobility by reducing soil surface area	$50-100/yd3
		Vitrification	NA	Most applicable for mixed waste; more effective technologies for volatile organics	$300-500/yd3
	Incineration	Rotary Kiln	A	Effective on volatile organics	$400-800/yd3
		Fluidized Bed	A	Effective on volatile organics	$400-800/yd3
		Infrared Moving Bed	A	Effective on volatile organics	$400-800/yd3
Offsite Treatment	Incineration	Rotary Kiln	A	Effective on volatile organics	$1,800/yd3
Onsite Temporary Storage		Waste Pile	A	Will provide maximum practical onsite containment	$50-60/yd3
		Solid Waste Landfill	A	Appropriate for nonhazardous materials	$40-60/yd3

A = Applicable NA = Not Applicable

TABLE 3-1 (Continued)

Response Action	Interim Action Technology	Process Description	Site Rating	Comments	Unit Cost
Offsite Disposal					
	Landfill	Hazardous Waste	A	Appropriate for smaller volumes and residual sludges from treatments	$100-500+/yd3
		Nonhazardous Waste	A	Applicable for nonhazardous or delisted waste	$1-15/yd3

A = Applicable NA = Not Applicable

TABLE 3-2
TECHNOLOGY SCREENING FOR
MOTOR POOL AREA
SOILS

Response Action	Interim Action Technology	Process Description	Potentially Applicable (yes/no)	Screening Comments
Monitoring	Additional Sampling	Sampling/ Analysis	YES	Groundwater monitoring will continue
	Installation of Wells	Sampling/ Analysis	NO	Sufficient wells exist
Institutional Controls				
	Access Restrictions	Fencing	YES	Perimeter fencing can be constructed around the affected area
In-place Containment				
	Surface Capping	Clay Cap	NO	Unprotected clay may crack upon extended exposure; poor drainage
		Multilayered Cap	YES	A multilayered cap can be constructed
		Asphalt	NO	Asphalt alone will not be a sufficient cap; however, could be used as a protective liner for the designed cap

TABLE 3-2 (Continued)

Response Action	Interim Action Technology	Process Description	Potentially Applicable (yes/no)	Screening Comments
In-place Containment (continued)	Surface Control	Soil Stabilization	YES	Soil stabilization techniques may be incorporated for erosion control to cement existing soil enhancing runoff
		Grading	YES	Site grading will be incorporated to control surface drainage and divert runoff/runon to the source areas
		Dikes/Berms	YES	Will be incorporated for designs of temporary storage pads of soils as well as containment of site process treatment areas
	Vertical Barriers	Slurry Wall	NO	Confining layer too deep for conventional excavation equipment
		Grout Curtains	NO	Less effective than a slurry wall
		Sheet Piling	NO	Ineffective for gravelly, sandy soil; potential for migration through joints
	Groundwater Interception	Extraction Well	YES	Effective for an IRA
		Extraction Well with Physical Barrier	NO	Not cost-effective for IRA

TABLE 3-2 (Continued)

Response Action	Interim Action Technology	Process Description	Potentially Applicable (yes/no)	Screening Comments
Onsite Treatment (continued)		Soil Washing	NO	Removal efficiencies less than other potential technologies
	Physical	Thermal Desorption	YES	Potentially effective
		Pozzolonic Fixation	NO	Volatile organics difficult to fix
	Incineration	Rotary Kiln	YES	Demonstrated technology
		Fluidized Bed	NO	Only one incinerator type carried forward to Alternative 6
		Infrared Moving Bed	NO	Only one incinerator type carried forward to Alternative 6
Onsite Temporary Storage		Waste Pile	YES	Appropriate for temporary storage of hazardous materials
		Solid Waste Landfill	YES	Landfill only used for nonhazardous treatment process residues
Offsite Disposal	Landfill	Hazardous Waste	YES	Appropriate for hazardous materials
		Nonhazardous Waste	YES	Appropriate for nonhazardous materials (i.e., site debris)

TABLE 3-2 (Continued)

Response Action	Interim Action Technology	Process Description	Potentially Applicable (yes/no)	Screening Comments
Source Collection Soils	Excavation	Backhoe	YES	Excavation is considered in some alternatives
In-Situ Treatment				
	Biological	Oxygen/Nutrient Injection	NO	Potential implementation problems due to injection well clogging
	Chemical	Fixation	NO	Quality assurance questionable for fixation of VOCs with low TCLP levels
	Physical	Vapor Extraction	YES	VES will address volatile organics; offgas treatment required
		Soil Washing	NO	Potentially inefficient surfactant collection system could lead to further contaminant migration
		Radio-Frequency Soil Heating	NO	Technology has not yet been demonstrated on a full scale
Onsite Treatment	Biological	Landfarming	NO	Inefficient configuration for introduction of required methane co-carbon substrate
		Bioreactor	YES	More efficient than landfarming for controlled emissions and reactor rates
	Chemical	Fixation	NO	Volatile organics difficult to chemically fix

4.0 DEVELOPMENT AND EVALUATION OF ALTERNATIVES

This section evaluates interim response alternatives (IRA) that have been developed for the Motor Pool Area. The alternatives are designed from one or more feasible technologies introduced in Section 3.0. The alternatives address the onsite contamination and any waste streams that are generated as part of treatment. These alternatives are then evaluated with respect to:

- Overall protectiveness of human health and the environment
- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)
- Reduction in mobility, toxicity, and volume
- Short- and long-term effectiveness
- Implementability

Costs associated with the alternatives will be addressed in Section 5.0.

4.1 INTERIM ACTION ALTERNATIVES

Nine alternatives have been developed as IRAs according to Comprehensive Environmental Resource, Compensation and Liability Act of 1980 (CERCLA) guidance. The suite of alternatives includes administrative, containment, treatment, and disposal options. The alternatives are:

Alternative	Description
1	No action
2	Monitoring
3	Institutional controls
4	Multilayered cap*
5	In-situ vapor extraction*
6	Onsite incineration*
7	Bioremediation*
8	Thermal desorption*
9	Offsite incineration*

*These alternatives include groundwater interception and treatment.

The first three alternatives do not involve containment or treatment but are included per EPA guidance document, "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA," Interim Final, October 1988.

The next alternative represents in-place containment with no treatment. This is considered appropriate since this is an IRA. The contamination would remain in place until the overall site remediation addressed this area.

The next four alternatives represent feasible onsite treatment scenarios. One is an in-situ alternative not requiring excavation, while the other three require excavation and soil/sludge treatment on site. Each requires some form of auxiliary treatment or disposal of offgas, wastewater, or solids streams.

The final alternative consists of excavation and offsite treatment at a fully permitted commercial incinerator.

Alternatives 4 through 9 include a groundwater interception and treatment system. This has been included as a backup to source mitigation. The source being addressed has been defined for this IRA. However, there may be other sources of groundwater contamination in the Motor Pool Area that have not yet been identified. The groundwater interception and treatment system would provide for containment of unidentified sources.

Each alternative is described in the following subsections. These designs are conceptual in nature. The details of the selected alternative will be determined during final design.

4.1.1 Alternative 1 - No Action

This alternative assumes that no action will be taken to contain or treat contaminated soils at the Motor Pool Area. Additional groundwater monitoring would not be required if this alternative is selected.

4.1.2 Alternative 2 - Monitoring

Alternative 2 assumes that the only action taken at the Motor Pool Area is additional groundwater monitoring. In addition, groundwater monitoring will be part of Alternatives 3 through 9.

The monitoring consists of quarterly sampling and analysis of groundwater from existing groundwater Well Nos. 04030, 04035, 04036, 04048, 04050, and 04051 (see Figure 2-1 for well locations). The water will be analyzed for volatile halogenated organics.

This information will be included as part of the comprehensive monitoring program at the Rocky Mountain Arsenal (RMA). Analyses of these data will help to evaluate how much the Motor Pool Area is actively degrading groundwater quality in the area and will provide information necessary to develop a final response action. Groundwater sampling will be conducted on a quarterly basis for this alternative and alternatives 3 through 9.

In addition to groundwater monitoring, an air monitoring program will be designed. The program will monitor ambient air for fugitive dust and organic volatilization. It is assumed that four monitoring stations will be set up on all sides of the site.

The sampling effort will include:

- Dust PM 10, for metals and fugitive particulates
- Tenax/activated carbon, for volatile organic compounds

Air sampling will be performed during the construction operations period of Alternatives 4 through 9.

4.1.3 Alternative 3 - Institutional Controls

Alternative 3 consists of constructing a fence around the site. This would entail the construction of approximately 320 lineal feet of chainlink fence with controlled access points (i.e., locked gates).

4.1.4 Alternative 4 - Multilayered Cap

Alternative 4 would consist of covering the contaminated soil in the Motor Pool Area with a cap to reduce infiltration of surface water. The cap would consist of, from the base upwards, an 18-inch-thick compacted clayey soil layer, a 60-mil-thick high density polyethylene (HDPE) flexible membrane liner, a synthetic drainage net, a geotextile filter fabric, and a 1-foot protective soil layer. The cap would be sloped from the center to the edge at 2 or 3 percent to facilitate runoff of surface water from the cap. This cover design would reduce infiltration of surface water into the area. Water infiltrating the cover would collect onto the clayey soil/flexible membrane composite layer and would be drained to the outside of the cap by gravity through the synthetic drainage net. The geotextile filter fabric would reduce the risk of the synthetic drainage net clogged by soil particles from the overlying soil layer. Treatment of the protective soil layer, such as cement or asphalt addition, may reduce erosion potential and maintenance of the cover.

Any near-surface contaminated soils in the vicinity of the Motor Pool Area would be excavated, placed beneath the cap, and graded to help provide the slope needed for the cap.

4.1.4.1 Groundwater Interception and Treatment

A trichloroethylene plume has been identified to be originating from the Motor Pool Area (Ebasco 1989a). Alternatives 4 through 9 have been developed to address the soil contamination identified near Buildings 624 and 625 (see subsection 2.2.3). However, there may be other sources of groundwater contamination in the Motor Pool Area that have not been clearly defined in time for this IRA.

In order to address these other potential sources, a groundwater interception and treatment system would be implemented in conjunction with Alternatives 4 through 9. The groundwater would be intercepted by extraction wells that would collect the contaminated groundwater and retard the progress of the plume. The extraction wells would be located north-northwest of the Motor Pool Area and would be designed to extract approximately 100 to 150 GPM. The exact location and extraction rate would be determined during the implementation phase.

Extraction water would be treated in conjunction with the Rail Classification Yard IRA. Water would be sent through conveyance piping to the Irondale Containment System, which would be expanded, if necessary, to deal with the increased flow. If the Irondale Containment System cannot be adapted to deal with the increased flow, a treatment system would be built in the vicinity of the Motor Pool Area IRA and Rail Classification Yard IRA extraction systems.

4.1.5 Alternative 5 - In-Situ Vapor Extraction

Vapor extraction would be an in-situ technique for removing TCE from soils above the water table. The process of vapor extraction consists of applying a vacuum to a well or trench screened above the water table, inducing a flow of air through adjacent soils, and progressively air-stripping the volatile contaminants contained in the soil matrix. Its most effective use to date has been removing volatile organic chemicals (VOC) from soils where the contaminants are too deep or too dispersed for removal by excavation to be practical. The actual design for the vapor extraction system is dependent upon information gained from a pilot test.

A vapor collection system consisting of either trenches or wells would be installed within a 60-foot by 100-foot contaminated area of the Motor Pool Area. A pilot test would determine trench size or well location necessary to capture contaminants throughout the areal extent of the plume. It is estimated that three wells, each at a depth of approximately 20 feet, would be required. Extraction wells would have a 15-foot screened interval with a clearance of approximately 5 feet from the top of screen to ground surface. Well boring diameters should be at least 10 inches and filled with a coarse sand or pea gravel packing in the annular space. The well should be grouted above the gravel pack for a tight seal. To improve the efficiency of the vapor extraction process, the site would be capped with a layer of asphalt. Pressurized and possibly pre-heated air would be injected into the soil. Soil vapors would be drawn by a positive displacement vacuum blower at 2- to 6-inch Hg vacuum through an inlet liquid separator/silencer, which would be insulated to muffle expanding gas noise. Stack discharges would be monitored and regulated to maintain a VOC emissions rate below the standards.

Stack treatment may be necessary depending on startup and pilot test results. Either a vapor phase carbon system or catalytic destruction would be considered as an effective stack control measure. Stack piping would be routed through a vapor phase carbon filter or catalytic oxidizer to adsorb or oxidize volatile emissions from the exhaust prior to discharge to the atmosphere.

Any liquid collected or condensed from the inlet/silencer would consist predominantly of condensed water vapor from the soil gas. This water would require treatment prior to disposal. An applicable treatment would be granular activated carbon. The spent carbon would require subsequent reactivation. The volume of water is expected to be very low.

After the collection system is complete, soil gas monitoring wells would be installed throughout the contaminated soils area. Essentially, soil gas monitoring wells are similar to water monitoring wells but are screened only above the water table.

4.1.5.1 Groundwater Interception and Treatment

A groundwater interception and treatment system would be implemented as part of this alternative. The system is described in subsection 4.1.4.1.

4.1.6 Alternative 6 - Onsite Incineration

This alternative would include excavation, incineration of the contaminated soils, and backfilling and regrading the excavated area with clean soils. The contaminated soils would be excavated to a depth of approximately 20 feet.

It is assumed that approximately 4,500 yd^3 plus a 20 percent bulking factor (total approximately 5,400 yd^3) of contaminated soil would be removed from a 60-foot by 100-foot area. It is assumed that groundwater would not be extracted during excavation since the soil is above the aquifer. Since the excavation is to be conducted close to Buildings 624 and 625, plate and pile shoring would be installed on the north, east, and south sides of the excavation. A section of the rail spur may require removal if a ramp becomes necessary for excavation equipment access.

The soils would be screened and sized if necessary. The prepared soils would be fed via a completely sealed conveyor chute or feeder to the primary rotary kiln incinerator. The rotary kiln incinerator would be a refractory lined cylindrical shell operated in the temperature range of 1400° to 2600°F. The supplementary fuel source would be natural gas. Residence time for solids here can range from 20 minutes to 2 hours. The flue gas would be sent to an afterburner to assure complete oxidation of the contaminants prior to entering the air pollution control equipment and discharge from the stack. The afterburner would be operated in the temperature range of 1600° to 2600°F. The air pollution control equipment would consist of acid gas and particulate removal via a wet scrubber and a baghouse.

A solid residuals handling system would remove inert solids to a storage bin prior to being returned to the excavation. A 99.99 percent destruction and removal efficiency (DRE) on contaminated soils can be achieved.

After the incineration process is complete, imported fill would be brought in from nearby, as needed, to grade the site.

4.1.6.1 Groundwater Interception and Treatment

A groundwater interception and treatment system would be implemented as part of this alternative. The system is described in subsection 4.1.4.1.

4.1.7 Alternative 7 - Bioremediation

This alternative would include excavation of 4,500 yd^3 plus 20 percent bulking factor (total approximately 5,400 yd^3) of contaminated soils and biotreatment in a soil/slurry bioreactor. The sequence of activities that would be performed in this alternative consists of the following:

- Construction of a containment area for soil-treating equipment and soil storage
- Excavation of contaminated soils
- Size-classification using vibrating screens
- Biodegradation in soil/slurry bioreactor
- Backfill and compaction of excavation with treated soil
- Regrade site

Since the excavation is to be conducted close to Buildings 624 and 625, plate and pile shoring would be installed on the north, east, and south sides of the excavation. A section of the rail spur may require removal if a ramp becomes necessary for excavation equipment access.

The excavated soils would be staged on a containment pad prior to transfer to vibrating screens for classification. This classification step removes any oversized rocks, rubble, etc. This material may either be milled prior to recycling into the system or fed directly into the reactor. The soil is then fed by conveyor to an agitation vessel, where it is mixed with water and a concentrated slurry of microbes.

This slurry is then transferred to a series of liquid/solid contact bioreactors where spargers introduce air and sufficient methane to maintain the aerobic degradation of TCE. The number of reactors, the resident time and other parameters, and the amount of methane and oxygen required would need to be determined during lab-scale tests.

The treated slurry is drawn off the reactors and dewatered by a hydrocyclone. The filtrate is recycled to the agitator while the cleaned and dried soils are returned to the excavation for recompaction. Imported fill material is added as necessary to ensure proper compaction and drainage.

4.1.7.1 Groundwater Interception and Treatment

A groundwater interception and treatment system would be implemented as part of this alternative. The system is described in subsection 4.1.4.1.

4.1.8 Alternative 8 - Low-temperature Thermal Desorption

Alternative 8 would include excavation, low-temperature thermal desorption of the excavated soils, and backfill/regrading of the excavated area. The low-temperature thermal desorption would be performed on a semicontinuous basis. The treatment equipment would consist of a solids handling system, hot oil system, gas handling system, and a water system.

Contaminated soils would be excavated to a depth of approximately 20 feet. It is assumed that approximately 4,500 yd^3 plus a 20 percent bulking factor (total approximately 5,400 yd^3) of contaminated soil shall be removed from a 60-foot by 100-foot area. Since the excavation is to be conducted close to Buildings 624 and 625, plate and pile shoring would be installed on the north, east, and south sides of the excavation. A section of the rail spur may require removal if a ramp becomes necessary for excavation equipment access.

The excavated soil would be stockpiled on a storage pad prior to treatment. The storage pad would have a clay liner to minimize contact between contaminated and uncontaminated soil. A second pad of similar size would be constructed nearby for temporary storage of treated soils. Each pad would be surrounded on the perimeter with a containment berm. Contaminated soils would be screened to 2 inches. Fragments larger than 2 inches will be sent to a shredder. The screened and shredded material would then be sent to the low-temperature thermal stripping processor or rotary drum system. The processor heats up to approximately 400 °F and would vaporize water and contaminants. The contaminated vapors would have particulates removed and then be condensed. The condensate would be sent to a solvent/water separator and onto carbon filters. The clean water would be used for dust control. The gases would be sent to an afterburner. Approximately 99.9 percent or greater of the contaminants would be removed. The treated soil would be temporarily stockpiled on a lined pad and used as backfill for the excavated areas.

During operations, confirmation samples from the treated soil and recirculated water would be collected for testing for comparison to clean-up criteria.

Site operations for the low-temperature thermal stripping process are as follows:

- Excavate contaminated soil and transport to storage pad
- Screen all material greater than 2 inches in diameter from soils
- Shred material larger than 2 inches
- Convey soils to processing system
- Transfer treated soil to storage pad for temporary storage
- Backfill excavated area with treated soil

After the thermal stripping process is complete, the treated soil would be used to fill the excavated area, and the site would be regraded.

4.1.8.1 Groundwater Interception and Treatment

A groundwater interception and treatment system would be implemented as part of this alternative. The system is described in subsection 4.1.4.1.

4.1.9 Alternative 9 - Offsite Incineration

This alternative would include excavation of contaminated soils and offsite transport to an existing permitted facility.

The contaminated soils would be excavated to a depth of approximately 20 feet. It is assumed that approximately 4,500 yd^3 plus a 20 percent bulking factor (total approximately 5,400 yd^3) of soil would be removed from a 60-foot by 100-foot area.

The soil would be transported via truck or rail. The trucks or rail cars would be decontaminated and secured prior to hauling. It is assumed that with an excavation rate of 1,000 yd^3 per day, this operation would require approximately sixty-five to seventy 15 yd^3 dump trucks daily, for approximately six days.

The contaminated soil would be sent to an offsite fully permitted hazardous waste incinerator. The incinerator would be a rotary kiln type designed specifically to incinerate soil. The facility would have capacity to store and/or treat the volume of contaminated soil. The facility would have the necessary air pollution control equipment and other required environmental protection. Any residual would be handled by the offsite facility contractor and would probably be landfilled.

After excavation of the contaminated site, the area will be backfilled with clean soil and regraded.

4.1.9.1 Groundwater Interception and Treatment

A groundwater interception and treatment system would be implemented as part of this alternative. The system is described in subsection 4.1.4.1.

4.2 INTERIM ACTION ALTERNATIVE EVALUATION CRITERIA

The interim action alternative will be evaluated based on the following criteria:

- Overall protection of human health and the environment
- Compliance with ARARs
- Reduction of mobility, toxicity, or volume
- Short- and long-term effectiveness
- Implementability
- Cost

The IRA objectives identified in paragraphs 22.5 through 22.7 of the Federal Facility Agreement are included in these criteria. The definition and interpretation of these criteria are outlined in this section. Costs are discussed in Section 5.0.

How each alternative addresses each of the evaluation criteria will be presented in greater detail in Section 6.0. However, a summary of alternative evaluation criteria is presented in matrix form in Tables 4-1 and 4-2. (Tables 4-1 and 4-2 are located at the end of this section.)

4.2.1 Overall Protection of Human Health and the Environment

This criterion assesses whether each alternative provides for adequate protection of human health and the environment. Assessment of protection draws upon other evaluation criteria, especially short-term effectiveness and compliance with ARARs and considers whether each alternative poses unacceptable short-term or cross-media impacts.

4.2.2 Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

One criterion used to evaluate each of the interim alternatives is in compliance with ARARs. Alternatives that meet all ARARs will be preferred because they ensure that interim action will be conducted in a manner that protects human health and the environment.

4.2.3 Reduction of Mobility, Toxicity, or Volume

Reduction of waste mobility, toxicity, or volume reduces the potential of that waste to harm humans or the environment. This evaluation criterion evaluates the process effectiveness to reduce organic and metals concentrations or to reduce waste quantity. Specific issues addressed in the evaluation of this criterion include the following questions:

- Does the process completely destroy organics?
- Does the process permanently immobilize organics?
- Does the process reduce the mobility of organics?
- Does the process significantly reduce the toxicity of organics?
- Does the treatment produce a reduction in hazardous waste volume?
- Does the process result in an increase in hazardous waste volume?

4.2.4 Short- and Long-term Effectiveness

The effectiveness of an interim action alternative will be considered in terms of its short- and long-term effectiveness in meeting the interim action objectives.

Short-term effectiveness examines the effectiveness of alternatives in protecting human health and the environment during the construction and implementation period until objectives have been met. Short-term effectiveness has two elements: community protection and worker protection.

Community protection considers any risk that results from implementation of the proposed interim action. Some of the questions that identify potential community risks from an interim action include the following questions:

- If a process failed, what would be the effect on the community?
- Are effective mitigation measures available to reduce community risk if the process fails?
- How will the effects on the community be addressed and mitigated?

Worker protection during interim response activities evaluates the potential threats that may be posed to workers and the effectiveness and reliability of protective measures that could be taken. Among the issues, worker protection considerations are:

- What are the risks to workers that must be addressed?
- How will the risks to the workers be addressed and mitigated?
- What risks remain to the workers that cannot be readily controlled?

Long-term effectiveness addresses the results of the interim action in terms of residual risk. After response objectives have been met, the primary focus is the extent and effectiveness of the controls that may be required to manage the risk posed by either treatment residuals or untreated waste. The following questions need to be addressed to assess long-term effectiveness:

- What risk remains, relative to a no-action alternative?
- What type of long-term monitoring is required?
- What difficulties or uncertainties may be associated with long-term operation and maintenance?
- Is there a clear and significant long-term benefit in implementing this alternative now?

4.2.5 Implementability

The implementability criterion addresses the technical and administrative feasibility of an alternative and the availability of various services and materials required for its implementation. Specific issues to be evaluated include the following questions:

- Is the technology generally available and sufficiently demonstrated on a full scale?
- What difficulties or uncertainties are related to implementation; could these lead to schedule delays?
- Are the necessary equipment and specialists available?
- Will more than one vendor be available to provide a competitive bid?
- Are adequate treatment, storage capacity, and disposal services available; can additional capacity/services be developed if necessary?

- What are the monitoring requirements during implementation?
- What effect would this alternative have on implementing a final remedy?

TABLE 4-1
TECHNICAL EVALUATION OF ALTERNATIVES
MOTOR POOL AREA
THRESHOLD CRITERIA

Alternative	Interim Response Action	Overall Protectiveness of Human Health and the Environment	Compliance with ARARs
1. No Action		Not protective	There are no location-specific or action-specific ARARs for this alternative, nor would it meet ambient or chemical-specific ARARs.
2. Monitoring	-Groundwater and air sampling	Not protective	This alternative will comply with location-specific or action-specific ARARs related to monitoring. Ambient or chemical-specific ARARs would not be met.
3. Institutional Controls	-Install fencing	Not protective	The insitutional controls will comply with location-specific or action-specific ARARs, related to access and construction. Ambient or chemical-specific ARARs would not be met.
4. Multilayered Cap*	-Site preparation -Construct cap	Somewhat protective; reduces risk by isolating material from surface; infiltration barrier limits vertical migration; groundwater intercept system provides protection from other possible sources.	This alternative will be designed to comply with ARARs to the maximum extent practicable.
5. In-situ Vapor Extraction*	-Site preparation -Install vapor extraction system -Site restoration	Protective; reduces risk by removing contaminants; groundwater intercept system provides protection from other possible sources.	This alternative will be designed to comply with ARARs to the maximum extent practicable.

(11111CO2-3400) (11/19/89) (RMA)

TABLE 4-1
(Continued)

Alternative	Interim Response Action	Overall Protectiveness of Human Health and the Environment	Compliance with ARARs
6. Onsite Incineration*	-Site preparation -Excavate -Incinerate soils -Return treated soil to excavation -Regrade Site	Protective; reduces risk by destroying organics; groundwater intercept system provides protection from other possible sources.	This alternative will be designed to comply with ARARS to the maximum extent practicable.
7. Bioremediation*	-Site preparation -Excavate -Operation of soil/slurry bioreactor -Return treated soil to excavation -Regrade site	Protective; reduces risk by biodegrading TCE; groundwater intercept system provides protection from other possible sources.	This alternative will be designed to comply with ARARs to to the maximum extent practicable.
8. *Thermal* Desorption*	-*Site preparation* -Excavate -Thermal desportion of organics -Return treated soil to excavation -Regrade site	*Protective; reduces* risk by destroying organics; groundwater intercept system provides protection from other possible sources.	This alternative will be designed to comply with ARARs to to the maximum extent practicable.
9. Offsite Incineration*	-Excavate -Transport to offsite incinerator -Regrade site	Protective; reduces risk by destroying organics; potential risk from material transport; groundwater intercept system provides protection from other possible sources.	Transporation and offsite disposal will be designed to comply with ARARs to the maximum extent practicable.

*These alternatives include groundwater interception and treatment.

(11111CO2-3400) (11/19/89) (RMA)

TABLE 4-2
TECHNICAL EVALUATION OF ALTERNATIVES
MOTOR POOL AREA
EVALUATION CRITERIA

Alternative	Reduction of Toxicity, Mobility, or Volume	Short-Term Effectiveness	Long-Term Effectiveness	Implementability	Cost
1. No Action	None	None	None	Easily implemented	Low
2. Monitoring	None	Monitoring can begin immediately; no additional impact on community or environment; sampling personnel may require personal protective equipment	Limited long-term effectiveness; potential indicator of future impact on sensitive receptors; re-evaluation necessary	Easily implemented as part of existing monitoring program	Low
3. Institutional Controls	None	Fence construction can begin immediately; no additional impacts on community or environment; construction personnel may require personal protective equipment	Long-term effectiveness limited; access control must be monitored; re-evaluation necessary	Easily implemented	Low

(11111C02-3400) (11/19/89) (RMA)

TABLE 4-2
(Continued)

Alternative	Reduction of Toxicity, Mobility, or Volume	Short-Term Effectiveness	Long-Term Effectiveness	Implementability	Cost
4. Multilayered Cap*	Reduces mobility of contaminants to groundwater by reducing infiltration	Less than one year implementation; no additional impacts on community or environment; construction personnel may require personal protective equipment; dust control measures may be necessary	Long-term effectiveness limited; cap inspection required; re-evaluation necessary; groundwater intercept system requires operation and maintenance	Straightforward construction; destruction of cap necessary for further remedial action; groundwater intercept system easily implemented	Low
5. In-Situ Vapor Extraction System*	Mobility of contaminants is greatly reduced; toxicity is reduced by onsite or offsite thermal oxidation; volume of contaminated material is reduced	Approximately one year implementation; offgassing must be controlled to minimize risk to workers and community	Expected good long-term effectiveness; groundwater intercept system requires operation and maintenance	Technology has gone through significant testing and is currently available; off-gas treatment must be monitored and vapor extraction must be field tested; easily adapted if contamination exends deeper than assumed; groundwater intercept system easily implemented	Low

(11111C02-3400) (11/19/89) (RMA)

TABLE 4-2
(Continued)

Alternative	Reduction of Toxicity, Mobility, or Volume	Short-Term Effectiveness	Long-Term Effectiveness	Implementability	Cost
6. Onsite Incineration*	Mobility and toxicity greatly reduced; volume of soil essentially unchanged; offgas treatment residuals require handling	Less than one year implementation; air emissions and dust control measures will be necessary; workers may require personal protective equipment	Expected good long-term effectiveness; groundwater intercept system requires operation and maintenance	Difficult to implement due to complex mechanical operation and stringent destruction and removal efficiency requirements; excavation and shoring required; groundwater intercept system easily implemented	High
7. Bioremediation*	Mobility and toxicity of contaminants is greatly reduced; volume of soil essentially unchanged	Less than one year implementation; air emission and dust control measures may be necessary; workers may require personal protective equipment	Expected good long-term effectiveness; groundwater intercept system requires operation and maintenance	Treatability testing is required; turnkey contractors available; excavation shoring required; groundwater intercept system easily implemented	Medium

(11111C02-3400) (11/19/89) (RMA)

TABLE 4-2
(Continued)

Alternative	Reduction of Toxicity, Mobility, or Volume	Short-Term Effectiveness	Long-Term Effectiveness	Implementability	Cost
8. Thermal Desorption*	Mobility and toxicity of contaminants greatly reduced; volume of soil essentially unchanged; offgas treatment residuals require handling	Less than one year implementation; air emission and dust control measures will be necessary; workers may require personal protective equipment	Expected good long-term effectiveness; groundwater intercept system requires operation and maintenance	Thermal desorption proven feasible for volatile organics; treatability testing required; turnkey contractors available; excavation shoring required; ground-water intercept system easily implemented	Medium
9. Offsite Incineration*	Mobility and toxicity of contaminants greatly reduced; volume of soil essentially unchanged	Less than one year implementation; dust control measures may be necessary; workers may require personal protective equipment; possible community impact associated with transportation	Expected good long-term effectiveness; groundwater intercept system requires operation and maintenance	Easily implemented; excavation shoring required; many contractors available; ground-water intercept system easily implemented	High

*These alternatives include groundwater interception and treatment.

(11111C02-3400) (11/19/89) (RMA)

5.0 ECONOMIC EVALUATION OF ALTERNATIVES

The alternatives developed in Section 4.0 have been evaluated with respect to the threshold criteria of protection of human health and the environment and compliance with Applicable or Relavant and Appropriate Requirements (ARARs). They have also been evaluated with respect to:

- Reduction of mobility, toxicity, or volume
- Short- and long-term effectiveness
- Implementability

This section addresses the costs involved with implementing each alternative. Since the Federal Facility Agreement states that the Interim Response Action (IRA) Decision Document should select the most cost-effective alternative for obtaining the objective of this IRA, these estimated costs will be a fundamental tool in the decision-making process.

5.1 ECONOMIC ASSUMPTIONS

The cost estimates developed for the evaluated alternatives are intended to be used as comparative tools. These study estimates can be considered to have an accuracy of +50 to -30 percent. These estimates are divided into capital costs and operation and maintenance (O&M) costs. A present worth analysis is also presented to compare alternatives with different expenditure patterns.

Whenever possible, vendor quotes for capital and O&M costs are used. However, several other sources of costs have been utilized. These include generic unit costs, previous similar estimates (modified by site-specific information) and conventional cost estimating guides. All costs that are obtained from these materials will be escalated to third quarter 1989 by using the Chemical Engineering plant cost index.

The following engineering assumptions have been used.

- For the purpose of cost comparisons, a 5-year operating life has been assumed for the IRA. This assumption may be altered by the final Record of Decision (ROD).

- Connections to electricity, natural gas, water, and sewer will be provided by Rocky Mountain Arsenal (RMA) at no additional cost to the remediation project.

- An operating rate of 7,000 hours/year will be used for continuous processes utilizing mechanical equipment. This allows for approximately 20 percent downtime for maintenance and repair.

- Engineering, design, construction management, and startup are assumed to be 20 to 50 percent of major purchased equipment (MPE) costs to $5,000,000; 15 to 20 percent of MPE for equipment costs in the range of $5,000,000 to $10,000,000; and 5 to 10 percent of MPE for equipment costs in excess of $10,000,000.

- A contingency of 20 percent has been applied to all capital and O&M cost estimates.

- Utility costs have been estimated by using the following rates:

Electricity	$0.085/kwh
Water	$3.76/1,000 gallons
Natural gas	$3.359/1,000 ft^3
Sewer	$1.50/1,000 gallons

- Offsite disposal costs have been estimated by using the following rates:

Transportation	$120/ton
Disposal	$140/ton

- O&M costs incurred after the first year have been discounted at 5 percent.

- Treatment operations conducted by a turnkey vendor are considered under O&M costs, regardless of treatment duration.

5.2 ALTERNATIVE COSTING

5.2.1 Alternative 1 - No Action

This alternative assumes that no action will be taken to contain or treat contaminated soil at the Motor Pool Area. This alternative results in no capital or O&M costs; therefore, present worth costs are not included in Table 5-1. (Tables 5-1 through 5-10 are located at the end of this section.)

5.2.2 Alternative 2 - Monitoring

Costs for monitoring include groundwater sampling. Only an O&M cost is included because only existing monitoring wells will be sampled, so no capital cost is required. Monitoring costs are shown in Table 5-2.

Table 5-2 also shows the capital and O&M costs for air monitoring, which is included for the construction operations period of Alternatives 4 though 9.

5.2.2.1 Capital Cost

No capital cost is involved for this alternative because only existing monitoring wells will be sampled.

5.2.2.2 Operations and Maintenance

Groundwater O&M costs of $124,800 include quarterly sampling, analysis, and reporting.

5.2.2.3 Present Worth Value

The total present worth value of $541,000 is the present worth value for the O&M cost of $124,800 over 5 years (Table 5-1).

5.2.3 Alternative 3 - Institutional Controls

Cost details for Alternative 3 are presented in Table 5-3. The major cost item for institutional controls is fencing around the central area.

The total capital required for this alternative is $9,800. Besides the 20 percent contingency, the only major cost items are fencing at $3,200 and site preparation at $5,000.

5.2.3.1 Operations and Maintenance

No additional operations and maintenance costs have been assumed for Alternative 3. Only the O&M cost from Alternative 2, Monitoring, is included at $124,800.

5.2.3.2 Present Worth Value

The total present worth value for Alternative 3 is $551,000, which is a total of the capital and the present worth value of the O&M cost over 5 years (Table 5-1).

5.2.4 Alternative 4 - Multilayered Cap

Cost details for Alternative 4 are presented in Table 5-4 and the capital, O&M, and present worth value are summarized in Table 5-1.

5.2.4.1 Capital Cost

Some of the major cost items for the cap construction are: site preparation, $50,000; cap construction, $11,800; air monitoring capital, $37,200; groundwater extraction and well installation, $15,000; and engineering design and supervision, $22,800. Including the 20 percent contingency, the total capital requirement is $164,100. Construction activities are assumed to be completed within 1 year.

5.2.4.2 Operations and Maintenance

In the summary table, the O&M cost of $299,800 from Table 5-2 has been included for the operations period (year 1). During the operations period, O&M costs include groundwater monitoring, and groundwater extraction and treatment. During the post interim action period, the cost items are groundwater monitoring at $124,800, groundwater extraction and treatment at $6,000, and cap maintenance at $8,000 for a total closure period O&M cost of $138,800.

5.2.4.2 Present Worth Value

The present worth value for this alternative is $919,000, which is the total of the capital and the present worth value of the operations and post interim action O&M costs.

5.2.5 Alternative 5 - In-situ Vapor Extraction

Cost details are presented in Table 5-5, and the present worth value summary is presented in Table 5-1.

5.2.5.1 Capital Cost

Major cost items for the total capital requirement are as follows: extraction/injection, well installation, $16,000; air monitoring capital, $37,200; the VES system and activated carbon, $7,500 and $9,000, respectively; groundwater extraction well installation, $15,000; and engineering and supervision, $43,900. The total capital requirement for this alternative is $157,900, including a 20 percent contingency. The construction period is anticipated to be within 1 year.

5.2.5.2 Operations and Maintenance Cost

The operation period cost is $326,500 and includes construction operations period groundwater and air monitoring, vapor extraction system operation, and groundwater extraction and treatment. The post interim action O&M cost is $130,800.

5.2.5.3 Present Worth Value

The total present worth value for this alternative is $911,000, which is a total of the capital and the present worth value of the two O&M costs over the 5-year period.

5.2.6 Alternative 6 - Onsite Incineration

Cost details for this alternative are presented in Table 5-6 and summarized in the present worth value in Table 5-1.

5.2.6.1 Capital Costs

The total capital requirement is $183,200. Major elements of this estimate are: site preparation, $50,000; temporary storage pad construction, $25,000; air monitoring capital, $37,200; groundwater extraction well installation, $15,000; and engineering and supervision, $25,400.

5.2.6.2 Operations and Maintenance

Annual O&M costs for onsite incineration are based on $18 per yd^3 for soils handling, which includes excavation, shoring, and backfilling, and $700 per ton for incineration.

The operations period costs occur in year 1 and come to $7,731,200. From years 2 through 5, post interim action monitoring costs of $130,800 occur, which include groundwater monitoring and reporting, and groundwater extraction and treatment.

5.2.6.3 Present Worth Value

The total present worth value of the alternative, combining the capital and present worth O&M cost, is $7,988,000.

5.2.7 Alternative 7 - Bioremediation

Cost details for Alternative 7 are presented in Table 5-7.

5.2.7.1 Capital Cost

A total capital requirement of $147,200 is based on site preparation, air monitoring capital, and engineering and supervision.

5.2.7.2 Operations and Maintenance

Major O&M costs include mobilization and demobilization of soil/slurry bioreactor and bioremediation costs, as well as soils handling. O&M costs also include construction, operations, and groundwater and air monitoring at $293,800. Total O&M costs during the construction operations period are $1,005,100, and during the post-interim action period (years 2 to 5) are $130,800.

5.2.7.3 Present Worth Value

A total present worth value of $1,547,000 is the sum of the capital and the present worth of the operations and post interim action O&M costs.

5.2.8 Alternative 8 - Thermal Desorption

Cost details for Alternative 8 are presented in Table 5-8.

5.2.8.1 Capital Cost

The total capital requirement for Alternative 8 is $183,200 and assumes a cost for construction of a liner and additional costs such as engineering and supervision.

5.2.8.2 Operations and Maintenance

A total annual O&M cost of $1,850,300 *will occur within the first year.* Thermal desorption of organics is based on $150/yd^3. Additional major cost items are monitoring and soils handling. Post interim action costs will occur from years 2 through 5 and include groundwater monitoring and groundwater extraction and treatment.

5.2.8.3 Present Worth Value

The total present worth is $2,387,000.

5.2.9 Alternative 9 - Offsite Incineration

Cost details for Alternative 9 are presented in Table 5-9.

5.2.9.1 Capital Cost

The total capital requirement of $13,160,700 is based on transporting 6,750 tons to a hazardous waste incinerator in Fort Arthur, Texas. Incineration and transportation costs are based on $1,200/ton and $120/ton, respectively. Some of the other major costs include soils handling, sampling and analysis, and engineering and supervision. Offsite disposal is assumed to occur within 1 year.

5.2.9.2 Operations and Maintenance

Groundwater monitoring and groundwater extraction and treatment will occur from years 1 through 5 at $130,800.

5.2.9.3 Present Worth Value

A total present worth value of $13,728,000 is the sum of the capital and the operations and post interim action present worth O&M costs.

5.3 SENSITIVITY ANALYSIS

A sensitivity analysis has been performed to determine which alternative will be affected by changes in the design basis presented in Section 2.5. Table 5-10 summarizes this analysis and presents the total present worth value for each alternative per sensitivity parameter. A discussion of each parameter follows:

- Volume of Contaminated Soil Reduced by 50 Percent. The design basis of 4,500 yd^3 was reduced to 2,250 yd^3. The incineration alternatives were the most sensitive to this parameter, resulting in reductions of 42 percent and 53 percent for onsite and offsite, respectively, while the other onsite treatment alternatives, thermal desorption and bioremediation, were only slightly sensitive (10 percent and 26 percent reductions, respectively). The in-situ and containment alternatives were essentially insensitive to this parameter.

- Volume of Contaminanted Soil Increased by 100 Percent. The design basis of 4,500 yd^3 was increased to 9,000 yd^3. Again, the same patterns were observed. Incineration was most sensitive; other onsite treatment alternatives were slightly sensitive, and in-situ and containment alternatives were essentially insensitive.

- Double Unit Cost. Because of the uncertainties associated with treatment technology unit costs, the cost sensitivity of each alternative to this parameter was evaluated. The same general observations of which alternatives are most sensitive to variations in unit cost estimates can be made for the sensitivity to volume estimates.

Since the volume of material expected to require treatment is in question, the alternatives that are less sensitive to this estimate may be preferred in a cost evaluation.

TABLE 5-1
PRESENT WORTH SUMMARY
MOTOR POOL AREA

Design Basis

Soil Volume = 4,500 (yd3)
Discount Factor = 5%

ALTERNATIVE	CAPITAL COSTS	ANNUAL O & M OPERATIONS	ANNUAL O & M POST-IRA	PRESENT WORTH ANNUAL O&M Opn & Post-IRA	TOTAL PRESENT WORTH VALUE (O&M + Cap.)
ALT 2 - Monitoring	$0	Yrs. 1 - 5 $125,000	NA	$541,000	$541,000
ALT 3 - Institutional Controls	$10,000	Yrs. 1 - 5 $125,000	NA	$541,000	$551,000
ALT 4 - Multilayered Cap*	$164,000	Yr. 1 $300,000	Yrs. 2 - 5 $139,000	$755,000	$919,000
ALT 5 - In-situ Vapor Extraction*	$158,000	Yr. 1 $325,000	Yrs. 2 - 5 $131,000	$752,000	$910,000
ALT 6 - Onsite Incineration*	$183,000	Yr. 1 $7,731,000	Yrs. 2 - 5 $131,000	$7,805,000	$7,988,000
ALT 7 - Bioremediation*	$147,000	Yr. 1 $1,005,000	Yrs. 2 - 5 $131,000	$1,400,000	$1,547,000

TABLE 5-1 (Continued)

ALTERNATIVE	CAPITAL COSTS	ANNUAL O & M OPERATIONS	ANNUAL O & M POST-IRA	PRESENT WORTH ANNUAL O&M Opn & Post-IRA	TOTAL PRESENT WORTH VALUE (O&M + Cap.)
ALT 8 - Thermal Desorption*	$183,000	Yr. 1 $1,850,000	Yrs. 2-5 $131,000	$2,204,000	$2,387,000
ALT 9 - Offsite Incineration*	$13,161,000	Yrs. 1 - 5 $131,000	NA	$567,000	$13,728,000

*These alternatives include groundwater interception and treatment

TABLE 5-2

ALTERNATIVE 2 - GROUNDWATER AND AIR MONITORING: COST ESTIMATE

MOTOR POOL AREA

ASSUMPTIONS:

(1) Groundwater samples at $3500/sample (includes labor, health and safety, and analytical).
(2) Quarterly groundwater sampling of 6 wells (24 samples/year).
(3) For air monitoring, assume quarterly sampling of four stations on each side of the site only during excavation of soils.
(4) Air monitoring samples include dust/metals and volatile organics.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMOUNT	COST
(A)	GROUNDWATER MONITORING:				
	CAPITAL COST (none)				
	ANNUAL OPERATIONS AND MAINTENANCE				
(1)	Sampling of Existing Monitoring Wells	ea.	$3,500	24	$84,000
(2)	Reporting/Data Interpretation	ea.	$5,000	4	$20,000
		Subtotal			$104,000
(3)	Contingency at 20%				$20,800
	ANNUAL O&M COST				$124,800
(B)	AIR MONITORING:				
	CAPITAL COST				
(1)	DUST PM 10	ea.	$3,000	4	$12,000
(2)	Sampling Pumps	ea.	$1,000	4	$4,000
(3)	Technical Support and Program Design	ea.	$15,000	1	$15,000
		Subtotal			$31,000
(4)	Contingency at 20%				$6,200
	TOTAL CAPITAL COST				$37,200

TABLE 5-2 (Continued)

ITEM	DESCRIPTION	UNIT	UNIT COST	AMOUNT	COST
ANNUAL OPERATIONS AND MAINTENANCE					
(1)	DUST/metals sampling	ea.	$1,000	16	$16,000
(2)	Volatiles	ea.	$300	16	$4,800
(3)	Labor	ea.	$20,000	4	$80,000
(4)	Interpretation & Reporting	ea.	$10,000	4	$40,000
		Subtotal			$140,800
(5)	Contingency at 20%				$28,160
	ANNUAL O&M COST				$168,960

TABLE 5-3
ALTERNATIVE 3 - INSTITUTIONAL CONTROLS: COST ESTIMATE
MOTOR POOL AREA

ASSUMPTIONS:

(1) Institutional costs include groundwater monitoring.
(2) Institutional controls consist of perimeter fencing (320 ft).

ITEM	DESCRIPTION	UNIT	UNIT COST	AMOUNT	COST
CAPITAL COST					
(1)	Site Preparation				$5,000
(2)	Fencing	L.F.	$10	320	$3,200
		Subtotal			$8,200
(3)	Contingency (20%)				$1,640
	TOTAL CAPITAL COST				$9,840
ANNUAL OPERATIONS AND MAINTENANCE (years 1-5)					
(1)	Groundwater Monitoring (Item A, Table 5-2)				$124,800

TABLE 5-4
ALTERNATIVE 4 - MULTILAYERED CAP: COST ESTIMATE
MOTOR POOL AREA

ASSUMPTIONS:

(1) Site preparation will consist of grading and filling of low-lying areas to control runoff, and removal and replacement of railroad lines.

(2) Monitoring costs are detailed in Table 5-2.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMOUNT	COST
CAPITAL COST					
(1)	Air Monitoring Capital (Item B, Table 5-2)				$37,200
(2)	Site Preparation				$50,000
(3)	Groundwater Extraction Well				$15,000
(4)	Construct Cap:				
	Clay	yd3	$8	335	$2,680
	Flexible Membrane	yd2	$5	670	$3,618
	Synthetic Drainage Net	yd2	$3	670	$2,211
	Geotextile	yd2	$2	670	$1,474
	Protective Soil Layer	yd3	$8	225	$1,800
	Cap Cost				$11,783
		Subtotal			$113,983
(5)	Engineering and Supervision at 20%				$22,797
		Subtotal			$136,780
(6)	Contingency at 20%				$27,356
	TOTAL CAPITAL COST				$164,136

TABLE 5-4 (Continued)

ITEM	DESCRIPTION	UNIT	UNIT COST	AMOUNT	COST
ANNUAL OPERATIONS AND MAINTENANCE					
(1)	Construction Operations Monitoring (year 1) (Items A and B, Table 5-1)				$293,760
(2)	Groundwater Extraction and Treatment				$6,000
	ANNUAL O&M COST				$299,760
ANNUAL POST-INTERIM ACTION MONITORING (year 2-5)					
(1)	Groundwater Monitoring (Item A, Table 5-2)				$124,800
(2)	Groundwater Extraction				$6,000
(3)	Cap Maintenance				$8,000
	ANNUAL POST-INTERIM ACTION O&M COST				$138,800

TABLE 5-5
ALTERNATIVE 5 - IN-SITU VAPOR EXTRACTION: COST ESTIMATE
MOTOR POOL AREA

ASSUMPTIONS:

(1) Three vacuum extraction wells (above the water table) and one air injection well will be installed. Assume maximum depth 20 feet. Cost includes installation, and health and safety.
(2) A surface seal will be necessary, assume 3-inch asphalt paving.
(3) Assume a one year project life.
(4) Exhaust soil gas will be treated using vapor phase granular activated carbon (GAC). Assume 4 GAC vapor phase bins containing 1800 lbs of carbon will last for the duration of the project. Costs include shipping, setup, and regeneration based on a lease agreement with carbon supplier.
(5) Vacuum extraction costs include piping, blower, and installation, and assumes the use of an existing building.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMOUNT	COST
CAPITAL COST					
(1)	Air Monitoring Capital (Item B, Table 5-2)				$37,200
(2)	Vapor Extraction/Injection Wells	ea.	$4,000	4	$16,000
(3)	Vacuum Extraction System				$7,500
(4)	Granular Activated Carbon Bins	ea.	$4,500	2	$9,000
(5)	Paving	yd2	$4.50	670	$3,015
(6)	Groundwater Extraction Well				$15,000
		Subtotal			$87,715
(7)	Engineering and Supervision at 50%				$43,858
		Subtotal			$131,573
(8)	Contingency at 20%				$26,315
	TOTAL CAPITAL COST				$157,887

TABLE 5-5 (Continued)

ITEM	DESCRIPTION	UNIT	UNIT COST	AMOUNT	COST
ANNUAL OPERATIONS AND MAINTENANCE (year 1)					
(1)	Construction Operations Monitoring (Items A and B, Table 5-1)				$293,760
(2)	Vapor Extraction System Operations				
	A. System Operations				
	1. Labor (8hr/wk)	hr	$22	416	$9,152
	2. Supervision (40hrs/yr)	hr	$65	40	$2,600
	3. General Operations & Maintanence				$500
	Subtotal				$12,252
	B. Replacement & Regeneration of Carbon bins	ea.	$4,500	2	$9,000
	VES Subtotal				$21,252
(3)	Groundwater Extraction and Treatment				$6,000
(4)	Contingency at 20%				$5,450
	ANNUAL O&M COSTS				$326,462
ANNUAL POST-INTERIM ACTION O&M COSTS (years 2-5)					
(1)	Groundwater Monitoring (Item A, Table 5-2)				$124,800
(2)	Groundwater Extraction and Treatment				$6,000
	ANNUAL POST-INTERIM ACTION O&M COST				$130,800

TABLE 5-6
ALTERNATIVE 6 - ONSITE INCINERATION: COST ESTIMATE
MOTOR POOL AREA

ASSUMPTIONS:

(1) Soils will be excavated and stored on a temporary pad prior to incineration.
(2) Incineration to be completed in one month by an onsite, turn-key operator. Costs include performance monitoring for soils.
(3) Soil volume = 4,500 yd3 plus 20 percent excavation bulking at 1.25 ton/yd3.
(4) Frequency of air samples is double the estimate for other construction monitoring.
(5) The north, east, and south sides of the excavation will be shored using plates and beams; assume a lease rate of $8.55/ft2 for plates and $780/ton for beams.
(6) Soils handling included excavation, shoring, and backfilling at site, and placement of treated soils in the onsite temporary waste pile.
(7) Stack sampling assumes operation period of 25 days at two samples per day.
(8) Confirmation samples will be taken at the bottom of the excavation to ensure adequate contaminant removal.
(9) Treated soils will be returned to the excavated area.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMOUNT	COST
CAPITAL COST					
(1)	Air Monitoring Capital (Item B, Table 5-2)				$37,200
(2)	Site Preparation (includes removal and replacement of rail lines)				$50,000
(3)	Liner Construction				$25,000
(4)	Groundwater Extraction Well				$15,000
		Subtotal			$127,200
(5)	Engineering and Supervision at 20%				$25,440
		Subtotal			$152,640
(6)	Contingency at 20%				$30,528
	TOTAL CAPITAL COST				$183,168

TABLE 5-6 (continued)

ITEM	DESCRIPTION	UNIT	UNIT COST	AMOUNT	COST
ANNUAL OPERATIONS AND MAINTENANCE (year 1)					
(1)	Construction Operations Monitoring				$462,720
(2)	Mobilization/Set up/Demobilization				$50,000
(3)	Soils Handling	yd3	$18	5,400	$97,200
(4)	Rotary Kiln Incineration	ton	$700	6,750	$4,725,000
(5)	Stack Sampling	ea.	$500	50	$25,000
(6)	Confirmation Sampling	ea.	$500	6	$3,000
(7)	Groundwater Extraction and Treatment				$6,000
		Subtotal			$5,368,920
(8)	Engineering and Supervision at 20%				$1,073,784
		Subtotal			$6,442,704
(9)	Contingency at 20%				$1,288,541
	ANNUAL O&M COST				$7,731,245
ANNUAL POST-INTERIM ACTION O&M COST (years 2-5)					
(1)	Groundwater Monitoring (Item A, Table 5-2)				$124,800
(2)	Groundwater Extraction and Treatment				$6,000
	ANNUAL POST-INTERIM ACTION O&M COST				$130,800

TABLE 5-7
ALTERNATIVE 7 - BIOREMEDIATION: COST ESTIMATE
MOTOR POOL AREA

ASSUMPTIONS:

(1) Bioremediation will be performed by a turn-key contractor using a soils/slurry bioreactor.
(2) Soil volume = 4,500 yd3 plus 20 percent excavation bulking.
(3) The north, east, and south sides of the excavation will be shored using plates and beams; assume a lease rate of $8.55/ft2 for plates and $780/ton for beams.
(4) Soils handling includes excavation, shoring, and backfilling.
(5) Confirmation samples will be taken at the bottom of the excavation to ensure adequate contaminant removal.
(6) Treated soils will be returned to the excavated area.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMOUNT	COST
CAPITAL COST					
(1)	Air Monitoring Capital (Item B, Table 5-2)				$37,200
(2)	Site Preparation (includes removal and replacement of rail lines)				$50,000
(3)	Groundwater Extraction Well				$15,000
		Subtotal			$102,200
(4)	Engineering and Supervision at 20%				$20,440
		Subtotal			$122,640
(5)	Contingency at 20%				$24,528
	TOTAL CAPITAL COST				$147,168
ANNUAL OPERATIONS AND MAINTENANCE (year 1)					
(1)	Construction Operations Monitoring (Items A and B, Table 5-2)				$293,760
(2)	Mobilization/Demobilization				$70,000
(3)	Equipment				$120,000

TABLE 5-7 (Continued)

ITEM	DESCRIPTION	UNIT	UNIT COST	AMOUNT	COST
(4)	Biotreatment	yd3	$20	5,400	$108,000
(5)	Soils Handling	yd3	$18	5,400	$97,200
(6)	Confirmation Sampling	ea.	$500	6	$3,000
(7)	Groundwater Extraction and Treatment				$6,000
		Subtotal			$697,960
(8)	Engineering and Supervision at 20%				$139,592
		Subtotal			$837,552
(9)	Contingency at 20%				$167,510
	ANNUAL O&M COST				$1,005,062
ANNUAL POST-INTERIM ACTION O&M COSTS (year 2-5)					
(1)	Groundwater Monitoring (Item A, Table 5-2)				$124,800
(2)	Groundwater Extraction and Treatment				$6,000
	ANNUAL POST-INTERIM ACTION O&M COST				$130,800

TABLE 5-8
ALTERNATIVE 8 - THERMAL DESORPTION: COST ESTIMATE
MOTOR POOL AREA

ASSUMPTIONS:

(1) Soil treatment can operate at 200 yd3/day by a turn-key contractor. Includes performance sampling of soils.
(2) Soil will be excavated and stored on a temporary pad.
(3) Soil volume = 4,500 yd3 plus 20 percent for excavation bulking.
(4) The north, east, and south sides of the excavation will be shored using plates and beams; assume a lease rate of $8.55/ft2 for plates and $780/ton for beams.
(5) Soils handling includes excavation, shoring, and backfilling.
(6) Stack sampling assumes 25 day operation period at 2 samples per day.
(7) Confirmation samples will be taken at the bottom of the excavation to ensure adequate contaminant removal.
(8) Treated soils will be returned to the excavated area.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMOUNT	COST
CAPITAL COST					
(1)	Air Monitoring Capital (Item B, Table 5-2)				$37,200
(2)	Site Preparation (includes removal and replacement of rail lines)				$50,000
(3)	Liner Construction				$25,000
(4)	Groundwater Extraction Well				$15,000
		Subtotal			$127,200
(5)	Engineering and Supervision at 20%				$25,440
		Subtotal			$152,640
(6)	Contingency at 20%				$30,528
	TOTAL CAPITAL COST				$183,168
ANNUAL OPERATIONS AND MAINTENANCE (year 1)					
(1)	Construction Operations Monitoring (Items A and B, Table 5-2)				$293,760
(2)	Mobilization/Set up/Demobilization				$50,000

TABLE 5-8 (Continued)

ITEM	DESCRIPTION	UNIT	UNIT COST	AMOUNT	COST
(3)	Soils Handling	yd3	$18	5,400	$97,200
(4)	Thermal Desorption	yd3	$150	5,400	$810,000
(5)	Stack Sampling	ea.	$500	50	$25,000
(6)	Confirmation Sampling	ea.	$500	6	$3,000
(7)	Groundwater Extraction and Treatment				$6,000
		Subtotal			$1,284.960
(8)	Engineering and Supervision at 20%				$256,992
		Subtotal			$1,541,952
(9)	Contingency at 20%				$308,390
	ANNUAL O&M COST				$1,850,342
ANNUAL POST-INTERIM ACTION O&M COST (year 2-5)					
(1)	Groundwater Monitoring (Item A, Table 5-2)				$124,800
(2)	Groundwater Extraction and Treatment				$6,000
	ANNUAL POST-INTERIM ACTION O&M COST				$130,800

TABLE 5-9
ALTERNATIVE 9 - OFFSITE INCINERATION: COST ESTIMATE
MOTOR POOL AREA

ASSUMPTIONS:

(1) Soils will be transported to a Chemical Waste Management facility in Port Arthur, Texas for incineration at a transport cost of $120/ton.
(2) Soil amount = 4,500 yd3 plus 20 percent excavation bulking at 1.25 tons/yd3, assume one year remedial life.
(3) Incineration costs assumed at $0.60/lb ($1200/ton).
(4) The north, east, and south sides of the excavation will be shored using plates and beams; assume a lease rate of $8.55/ft2 for plates and $780/ton for beams.
(5) Soils handling includes excavation, shoring, and backfilling.
(6) Confirmation samples will be taken at the bottom of the excavation to ensure adequate contaminant removal.

ITEM	DESCRIPTION	UNIT	UNIT COST	AMOUNT	COST
CAPITAL COST					
(1)	Air Monitoring Capital (Item B, Table 5-2)				$37,200
(2)	Site Preparation (includes rail line removal and replacement)				$50,000
(3)	Soils Handling	yd3	$23	5,400	$124,200
(4)	Transport to Offsite Facility	ton	$120	6,750	$810,000
(5)	Offsite Incineration	ton	$1,200	6,750	$8,100,000
(6)	Confirmation Sampling	ea.	$500	6	$3,000
(7)	Groundwater Extraction Well				$15,000
		Subtotal			$9,139,400
(8)	Engineering and Supervision at 20%				$1,827,880
		Subtotal			$10,967,280
(9)	Contingency at 20%				$2,193,456
	TOTAL CAPITAL COST				$13,160,736

TABLE 5-9 (Continued)

ITEM	DESCRIPTION	UNIT	UNIT COST	AMOUNT	COST
ANNUAL POST-INTERIM ACTION O&M COST (year 1-5)					
(1)	Groundwater Monitoring (Item A, Table 5-2)				$124,800
(2)	Groundwater Extraction and Treatment				$6,000
	ANNUAL POST-INTERIM ACTION O&M COST				$130,800

TABLE 5-10
SENSITIVITY ANALYSIS
MOTOR POOL AREA

Sensitivity Parameter	Alt 4 Multilayered Cap	Alt 5 In-situ Vapor Extraction	Alt 6 Onsite Incineration	Alt 7 Bioremediation	Alt 8 Thermal Desorption	Alt 9 Offsite Incineration
Design Basis	$919,000	$910,000	$7,988,000	$1,547,000	$2,387,000	$13,728,000
Half Volume Excavated and Treated	$911,000	$907,000	$4,682,000	$1,406,000	$1,765,000	$7,223,000
Double Volume Excavated and Treated	$936,000	$915,000	$14,602,000	$1,828,000	$3,632,000	$26,737,000
Double Unit Treatment Cost	$945,000	$936,000	$14,497,000	$1,723,000	$3,527,000	$25,418,000

Note: Alternatives 2 and 3 are not included in the sensitivity analysis because changes in the volume or unit treatment costs do not affect the cost of these alternatives.

6.0
CONCLUSIONS

This alternative assessment document has summarized the history and extent of contamination at the Motor Pool Area. This information was used to develop a basis by which technologies could be evaluated. Both demonstrated and promising technologies were formulated into nine alternatives to address the contaminated soil at the site.

This section initiates the process by ranking the alternatives and classifying them as preferred, marginally preferred, or not preferred. Preferred and marginally preferred alternatives are then evaluated further based on the evaluation criteria described in Section 4.2.

6.1 ALTERNATIVE SCREENING

The nine alternatives were ranked using the decision logic shown in Figure 6-1. The alternatives have been classified as one of the following:

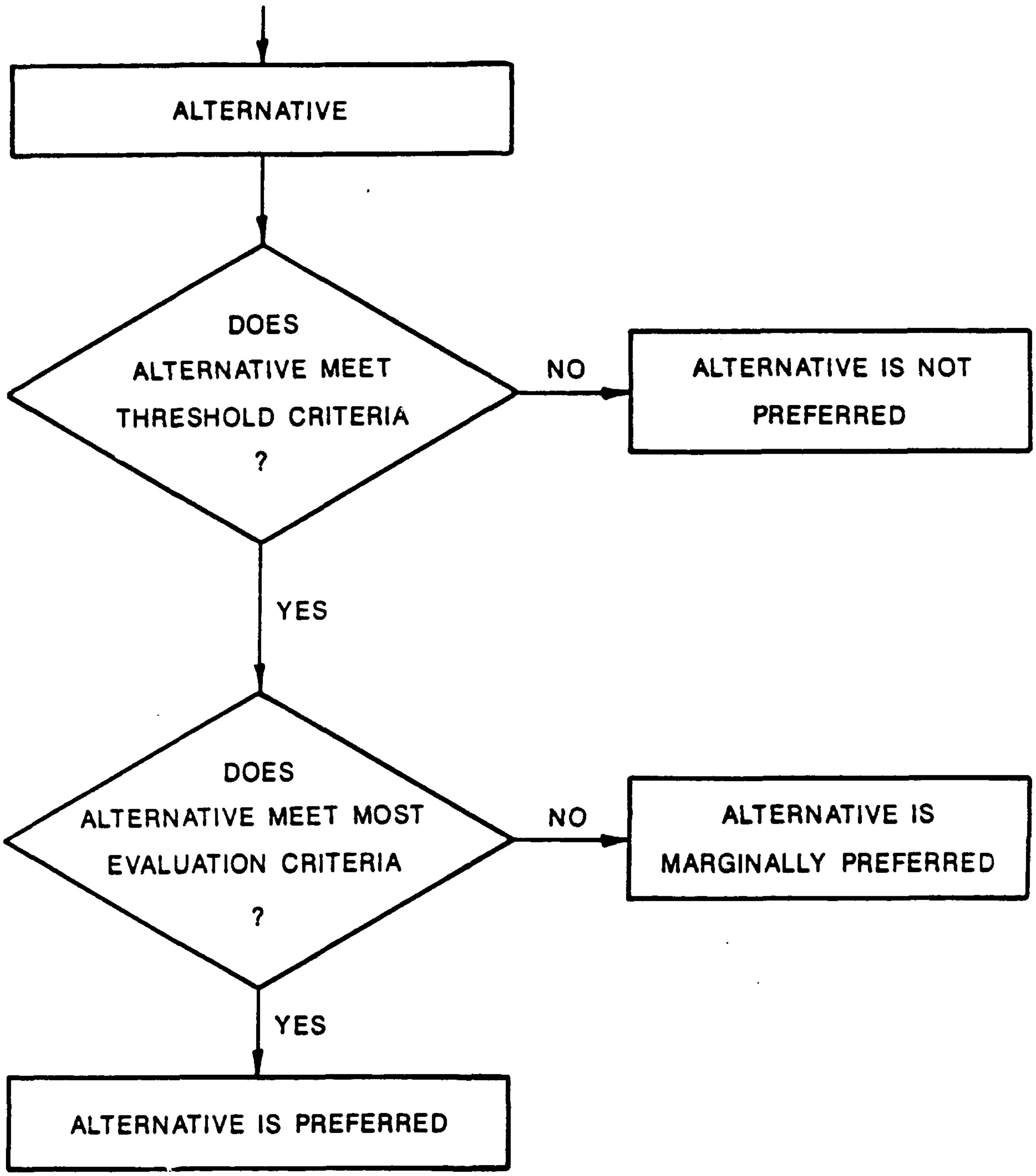
- Preferred: Preferred alternatives meet the threshold criteria listed in Table 4-1 and meet most of the evaluation criteria listed in Table 4-2. Preferred alternatives will be considered further.

- Marginally Preferred: Marginally preferred alternatives meet the threshold criteria listed in Table 4-1 to some degree and meet some of the evaluation criteria listed in Table 4-2. Marginally preferred alternatives will be considered further.

- Not Preferred: Alternatives that are not preferred either do not meet the threshold criteria of Table 4-1, or meet few of the evaluation criteria of Table 4-2. These alternatives will not be considered further.

The nine alternatives are classified in Table 6-1. There are three preferred alternatives:

- Alternative 5 - In-situ vapor extraction
- Alternative 7 - Bioremediation
- Alternative 8 - Thermal desorption



THRESHOLD CRITERIA: OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

COMPLIANCE WITH ARARS

EVALUATION CRITERIA: REDUCTION OF TOXICITY, MOBILITY AND VOLUME

SHORT-TERM EFFECTIVENESS

LONG-TERM EFFECTIVENESS

IMPLEMENTABILITY

COST

Job No. : 22238	Figure 6-1 IRA ALTERNATIVE RANKING
Prepared by : K.A.S.	
Date : 9/4/89	

TABLE 6-1
ALTERNATIVE CLASSIFICATION

Alternative	Classification	Comments
1. No Action	Not preferred	Not protective; no reduction in mobility, toxicity, and volume; no short- or long-term effectiveness
2. Monitoring	Marginally preferred	Somewhat protective; no reduction in mobility, toxicity and volume; groundwater contamination can be tracked for evidence of ongoing degradation; easily implemented
3. Institutional Controls	Marginally preferred	Somewhat protective; no reduction in mobility, toxicity, or volume; poor short-term effectiveness; no long-term effectiveness; groundwater contamination can be tracked for evidence of ongoing degradation; easily implemented
4. Multilayered Cap*	Marginally preferred	Somewhat protective; reduces mobility, does not reduce contaminant toxicity and volume; moderate short-term effectiveness; poor long-term effectiveness; easily implemented

TABLE 6-1
(Continued)

5.	In-situ Vapor Extraction*	Preferred	Protective; reduces mobility, toxicity and volume; good long-term effectiveness; exhaust air controls may require continual monitoring; easily implemented
6.	Onsite Incineration*	Not preferred	Protective; mobility and toxicity greatly reduced; air emission controls necessary; good long-term effectiveness; difficult to implement; high cost
7.	Bioremediation*	Preferred	Protective; mobility and toxicity greatly reduced; good short- and long-term effectiveness; lab-scale testing required
8.	Thermal Desorption*	Preferred	Protective; mobility and toxicity greatly reduced; air emission controls necessary; good long-term effectiveness; lab-scale testing required
9.	Offsite Incineration*	Marginally preferred	Protective; mobility and toxicity greatly reduced; good short- and long-term effectiveness; easily implemented; high cost

*These alternatives include groundwater interception and treatment

These alternatives are all protective of human health and the environment and can be designed to meet Applicable or Relevant and Appropriate Requirements (ARARs).

There are four marginally preferred alternatives:

- Alternative 2 - Monitoring
- Alternative 3 - Institutional controls
- Alternative 4 - Multilayered cap
- Alternative 9 - Offsite incineration

Alternative 4 is somewhat protective of human health and the environment. Alternatives 2 and 3, although not protective, are capable of tracking contamination for evidence of ongoing degradation. Alternative 9 is somewhat protective of human health and the environment and provides a proven, feasible offsite alternative.

There are two alternatives that are not preferred:

- Alternative 1 - No action
- Alternative 6 - Onsite incineration

Alternative 1 is not protective of human health and the environment. Alternative 6 is difficult to implement and is not cost-effective for this volume of soil, relative to other onsite alternatives.

The preferred and marginally preferred alternatives will be evaluated in greater detail in the following section.

6.2 ALTERNATIVE EVALUATION

Alternatives have been evaluated against the following criteria:

- Reduction of contaminant mobility, toxicity, or volume
- Short-term effectiveness, including community protection and worker protection
- Long-term effectiveness
- Implementability
- Cost

Tables 6-2 through 6-7 (located at the end of this section) provide details of the evaluation. All of the alternatives can be implemented in less than 1 year. A summary of the evaluation for each alternative follows.

6.2.1 Alternative 2 - Monitoring

This alternative does not reduce the mobility, toxicity, or volume of the contaminated material. When evaluating the short-term effectiveness of monitoring, with respect to its impact on the community and workers at the site, it is shown to have good short-term effectiveness. The long-term effectiveness of this alternative relies on the effectiveness of the current downgradient extraction and treatment systems to protect drinking water supplies. Any difficulties in implementing a monitoring program would be minimal.

6.2.2 Alternative 3 - Institutional Controls

This alternative does not reduce the mobility, toxicity, or volume of the contaminated material. When evaluating the short-term effectiveness of implementing institutional controls, with respect to its impact on the community and workers at the site, it is shown to have good short-term effectiveness. The long-term effectiveness of this alternative relies on the effectiveness of the current downgradient extraction and treatment systems to protect drinking water supplies. Any difficulties in implementing this alternative would be minimal.

6.2.3 Alternative 4 - Multilayered Cap

This alternative reduces the vertical migration of contaminants, although the toxicity and volume of contaminants are not reduced.

This alternative has fairly good short-term effectiveness. Short-term effectiveness is evaluated based on the effects of the alternatives on the community as well as workers at the site during implementation. Impacts on the community during implementation are minimal. There is some risk to the community if the cap fails because the contaminants are located above a public drinking water supply aquifer. However, the groundwater intercept system provides a safeguard against cap failure as well as a safeguard against other possible contamination sources. Risk to workers during construction can be addressed using common personal protective equipment and site safety hazard prevention techniques. Long-term effectiveness of this alternative is somewhat limited by the fact that the alternative is based on a containment technology. Containment does reduce the effects of the source of groundwater contamination, but it does not actually remediate the source. The effectiveness of this alternative as a source mitigation measure would need to be re-evaluated periodically.

This alternative is also based on demonstrated technology that can be easily implemented by a number of contractors.

6.2.4 Alternative 5 - In-situ Vapor Extraction

An in-situ vapor extraction system (VES) will completely destroy the organics, provided that the carbon is thermally reactivated.

This alternative has good short-term effectiveness. Short-term effectiveness is evaluated based on the effect of the alternative on the community as well as workers at the site during implementation. Possible emissions releases from the process to the atmosphere can be controlled by designing redundancy and shutdown capabilities into the system. Risks to workers are fewer than those for other alternatives because VES does not require the deep excavation involved with the other treatment alternatives.

VES has excellent long-term effectiveness. The risk from the contaminants is eliminated because the contaminants would be completely destroyed if the carbon were to be thermally reactivated. In addition, the groundwater intercept system provides a safeguard against other possible sources of groundwater contamination.

This is a demonstrated technology that has been widely used. Uncertainties in the depth of contamination and the lithology of the area could require the installation of additional extraction wells. However, one of the major advantages of this alternative is that such changes can be easily adapted and implemented in a very flexible operation.

6.2.5 Alternative 7 - Bioremediation

This alternative completely destroys the organic contaminants.

This alternative has fairly good short-term effectiveness. Short-term effectiveness is evaluated based on the effect of the alternatives on the community as well as workers at the site during implementation. Possible emission releases to the atmosphere during excavation can be monitored, and the excavation can be temporarily shut down if necessary. Possible emission releases from the process to the atmosphere can be controlled by designing redundancy and shutdown capabilities into the system. Risks to workers during excavation and operation can be addressed using common personal protective equipment and site safety hazard prevention techniques.

This alternative has good long-term effectiveness because the contaminants are completely destroyed. In addition, the groundwater intercept system provides a safeguard against other possible sources of groundwater contamination.

Soil/slurry bioreactor technology has been demonstrated on a pilot scale for TCE-contaminated soils. Scale-up problems should be minimal due to the small volume of soil at the Motor Pool Area. Uncertainties in soil contamination volumes could require modified excavation techniques, which could affect costs. Uncertainties in bioreaction rates and retention times could affect the schedule. Finally, there is some potential for the generation of partial degradation products such as dichloroethylene and vinyl chloride.

6.2.6 Alternative 8 - Thermal Desorption

This alternative completely destroys the organic contaminants.

This alternative has fairly good short-term effectiveness. Short-term effectiveness evaluation is based on the effect of the alternative on the community as well as workers at the site during implementation. Possible emission releases to the atmosphere during excavation can be monitored and the excavation temporarily shut down if necessary. Possible emission releases from the process to the atmosphere can be controlled by designing redundancy and shutdown capabilities into the system. Risks to workers during excavation and operation can be addressed by using common personal protective equipment and site safety hazard prevention techniques.

This alternative has good long-term effectiveness because the organic contaminants are completely destroyed. In addition, the groundwater intercept system provides a safeguard against other possible sources of groundwater contamination.

Uncertainties in soil contamination volumes could require modified excavation techniques, which could affect costs.

6.2.7 Alternative 9 - Offsite Incineration

This alternative completely destroys the organic contaminants.

This alternative has fairly good short-term effectiveness. Short-term effectiveness is evaluated based on the effect of the alternative on the community as well as workers at the site during excavation. Possible emission releases to the atmosphere during excavation can be monitored, and the excavation can be temporarily shut down if necessary. There is some risk to the community in the vicinity of the offsite incinerator. Risks to workers during excavation can be addressed by using common personal protective equipment and site safety hazard prevention techniques. There is some risk associated with the transportation of the contaminated soils to the offsite incinerator.

This alternative has good long-term effectiveness because the organic contaminants are completely destroyed. In addition, the groundwater intercept system provides a safeguard against other possible sources of groundwater contamination.

Uncertainties in soil contamination volume could require modified excavation techniques, which could affect costs.

6.3 CONCLUSIONS

Alternative 5, In-situ Vapor Extraction, is the preferred alternative. This alternative completely destroys the contaminants of concern in the Motor Pool Area. The technology has been clearly demonstrated and is widely used. The process can be easily adapted and implemented to address the uncertainties associated with the volume and depth of contaminated soil in this area. Impacts on the community and the workers are greatly reduced because no excavation is required. The groundwater intercept system provides a safeguard against other possible sources of contamination.

TABLE 6-2
REDUCTION OF MOBILITY, TOXICITY, OR VOLUME EVALUATION

Subcriteria	Alternative 2- Monitoring	Alternative 3- Institutional Controls	Alternative 4- Multilayered Cap	Alternative 5- In-situ VES	Alternative 7- Bioremediation	Alternative 8- Thermal Desorption	Alternative 9- Offsite Incineration
Does the process completely destroy organics?	No	No	No	Yes, if carbon is sent to a thermal reactivation step	Yes	Yes	Yes
Does the process permanently immobilize organics?	No	No	No	No, if carbon is landfilled; not applicable if carbon is thermally reactivated	N/A	N/A	N/A
Does the process reduce mobility of organics?	No	No	Yes	Yes	N/A	N/A	N/A
Does the process significantly reduce the toxicity of organics?	No	No	No	Yes, if carbon is thermally reactivated	Yes	Yes	Yes
Does treatment produce a reduction in hazardous waste volume?	No	No	No	Yes	Yes	Yes	Yes

(11111C02-3400) (11/19/89) (RMA)

TABLE 6-2 (Continued)

Subcriteria	Alternative 2- Monitoring	Alternative 3- Institutional Controls	Alternative 4- Multilayered Cap	Alternative 5- In-situ VES	Alternative 7- Bioremediation	Alternative 8- Thermal Desorption	Alternative 9- Offsite Incineration
Does the process result in an increase in hazardous waste volume?	No	No	Possibly, the cap construction materials may require subsequent remediation	No	No	No	No

N/A: Not Applicable

(11111C02-3400) (11/19/89) (RMA)

TABLE 6-3
SHORT-TERM EFFECTIVENESS EVALUATION: COMMUNITY PROTECTION

Subcriteria	Alternative 2- Monitoring	Alternative 3- Institutional Controls	Alternative 4- Multilayered Cap	Alternative 5- In-situ VES	Alternative 7- Bioremediation	Alternative 8- Thermal Desorption	Alternative 9- Offsite Incineration
If the process failed, what would be the effect on the community?	Possible contamination of public drinking water supply	Possible contamination of public drinking water supply if monitoring aspect fails	Groundwater intercept system provides safeguard against possible contamination of public drinking water supply	If carbon system failed, TCE could be exhausted to atmosphere; Groundwater intercept system provides safeguard against possible contamination of public drinking water supply	If emission control system failed, volatile organics could be exhausted to atmosphere; excavation process may result in volatile organic emissions. Groundwater intercept system provides safeguard against possible contamination of public drinking water supply	If emission control system failed, volatile organics could be exhausted to atmosphere; excavation process may result in volatile organics emissions. Groundwater intercept system provides safeguard against possible contamination of public drinking water	If emission control system failed, community in vicinity of incineration could be exposed to incineration exhaust; excavation process may result in volatile organic emissions; some risks associated with transportation. Groundwater intercept system provides safeguard against possible contamination of public drinking water supply

(11111C02-3400) (11/19/89) (RMA)

TABLE 6-3 (Continued)

Subcriteria	Alternative 2- Monitoring	Alternative 3- Institutional Controls	Alternative 4- Multilayered Cap	Alternative 5- In-situ VES	Alternative 7- Bioremediation	Alternative 8- Thermal Desorption	Alternative 9- Offsite Incineration
Are effective mitigation measures available to reduce community risk if the process fails?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
How will the effects on the community be addressed and mitigated?	An additional downgradient monitoring program is already in place	An additional down-gradient monitoring program is already in place	An additional down-gradient monitoring program is already in place	System can be designed with continuous offgas monitoring with shut down capabilities in case of break-through	System can be designed with continuous offgas monitoring with shut down capabilities in case of break-through; ambient air and wind monitoring results may temporarily shut down excavation operations	System can be designed with continuous off-gas monitoring with shut down capabilities in case of break-through; ambient air and wind monitoring results may temporarily shut down excavation operations	System can be designed with continuous off-gas monitoring with shut down capabilities in case of break-through; ambient air and wind monitoring results may temporarily shut down excavation operations

(11111C02-3400) (11/19/89) (RMA)

TABLE 6-4
SHORT-TERM EFFECTIVENESS EVALUATION: WORKER PROTECTION

Subcriteria	Alternative 2- Monitoring	Alternative 3- Institutional Controls	Alternative 4- Multilayered Cap	Alternative 5- In-situ VES	Alternative 7- Bioremediation	Alternative 8- Thermal Desorption	Alternative 9- Offsite Incineration
What are the risks to the workers that must be addressed?	Volatile organics inhalation	Volatile organics inhalation	Volatile organics inhalation	Volatile organics inhalation	Volatile organics inhalation; excavation safety hazards	Volatile organics inhalation; excavation safety hazards	Volatile organics inhalation; excavation safety hazards
How will the risks to the workers be addressed and mitigated?	Proper personal protective equipment	Proper personal protective equipment	Proper personal protective equipment	Proper personal protective equipment	Proper personal protective equipment; shoring and sloping of excavation sidewalls	Proper personal protective equipment; shoring and sloping of excavation sidewalls	Proper personal protective equipment; shoring and sloping of excavation sidewalls
What risks remain to the workers that cannot be readily controlled?	None	None	General construction site safety hazards	General construction site safety hazards	General construction site safety hazards	General construction site safety hazards	General construction site safety hazards

(11111C02-3400) (11/19/89) (RMA)

TABLE 6-5
LONG-TERM EFFECTIVENESS EVALUATION

Subcriteria	Alternative 2-Monitoring	Alternative 3-Institutional Controls	Alternative 4-Multilayered Cap	Alternative 5-In-situ VES	Alternative 7-Bioremediation	Alternative 8-Thermal Desorption	Alternative 9-Offsite Incineration
What risk remains, relative to a no-action alternative?	No reduction in risk.	No reduction in risk	Risk is somewhat reduced by creation of a physical barrier, and by reduction of infiltration and therefore, contaminant migration to the ground-water	Risk is greatly reduced by removing con-taminants and destroying them if carbon is thermally reactivated	Risk is greatly reduced by destroying contaminants	Risk is greatly reduced by destroying contaminants	Risk is greatly reduced by destroying contaminants; possible transportation risks
What type of long-term monitoring is required?	Goundwater monitoring	Groundwater monitoring	Groundwater monitoring; cap inspection	Ground-water monitoring	Groundwater monitoring	Groundwater monitoring	Groundwater monitoring
What difficulties and uncertainties may be associated with long-term operation and maintenance?	Some uncertainty as to adequate amount of data collection	Some uncer-tainty as to adequate amount of data collection	Some uncer-tainty as to adequate amount of data collection	Some un-certainty as to adequate amount of data collection	Some uncer-tainty as to adequate amount of data collection	Some uncer-tainty as to adequate amount of data collection	Some uncer-tainty as to adequate amount of data collection

(11111C02-3400) (11/19/89)

TABLE 6-5 (Continued)

Subcriteria	Alternative 2- Monitoring	Alternative 3- Institutional Controls	Alternative 4- Multilayered Cap	Alternative 5- In-situ VES	Alternative 7- Bioremediation	Alternative 8- Thermal Desorption	Alternative 9- Offsite Incineration
Is there a clear and significant long-term benefit in implementing this alternative now?	This alternative already exists, to some extent	This alternative already exists, to some extent	Yes, vertical migration of contaminants would be reduced; contaminants from other potential sources would be contained	Yes, contaminants at identified source would be destroyed; contaminants from other potential sources would be contained	Yes, contaminants at identified source would be destroyed; contaminants from other potential sources would be contained	Yes, contaminants at identified source would be destroyed; contaminants from other potential sources would be contained	Yes, contaminants at identified source would be destroyed; contaminants from other potential sources would be contained

(11111C02-3400) (11/19/89)

TABLE 6-6
IMPLEMENTABILITY EVALUATION

Subcriteria	Alternative 2- Monitoring	Alternative 3- Institutional Controls	Alternative 4- Multilayered Cap	Alternative 5- In-situ VES	Alternative 7- Bioremediation	Alternative 8- Thermal Desorption	Alternative 9- Offsite Incineration
Is the technology generally available and sufficiently demonstrated on a full scale?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
What difficulties or uncertainties are related to implementation; could these lead to schedule delays?	None	None	None	Some uncertainty about extent of contamination; process can be easily adapted to address additional contamination with minor schedule delays	Some uncertainty about extent of contamination; depth of contamination may require specialized excavation techniques	Some uncertainty about extent of contamination; depth of contamination may require specialized excavation techniques	Some uncertainty about extent of contamination; depth of contamination may require specialized excavation techniques

(11111C02-3400) (11/19/89)

TABLE 6-6 (Continued)

Subcriteria	Alternative 2- Monitoring	Alternative 3- Institutional Controls	Alternative 4- Multilayered Cap	Alternative 5- In-situ VES	Alternative 7- Bioremediation	Alternative 8- Thermal Desorption	Alternative 9- Offsite Incineration
Are the necessary equipment and specialists available?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Will more than one vendor be available to provide a competitive bid?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Are adequate treatment, storage capacity, and disposal services available; can additional capacity/services be developed if necessary?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
What are the monitoring requirements during implementation?	Groundwater monitoring	Groundwater monitoring	Ambient air and groundwater monitoring	Ambient air and groundwater monitoring; offgas monitoring	Ambient air and groundwater monitoring; offgas monitoring	Ambient air and groundwater monitoring; offgas monitoring	Ambient air and groundwater monitoring; offgas monitoring

(11111C02-3400) (11/19/89)

TABLE 6-6 (Continued)

Subcriteria	Alternative 2- Monitoring	Alternative 3- Institutional Controls	Alternative 4- Multilayered Cap	Alternative 5- In-situ VES	Alternative 7- Bioremediation	Alternative 8- Thermal Desorption	Alternative 9- Offsite Incineration
What affect would this alternative have on implementing a final remedy?	None	None	Cap construction materials may need subsequent remediation	None	None	None	None
How long would it take to implement this alternative?	Less than one year	Less than one year	Less than one year	Less than one year; however, increased volumes may result in increased treatment times	Less than one year; however, increased volumes may result in increased treatment times	Less than one year; however, increased volumes may result in increased treatment times	Less than one year

(11111C02-3400) (11/19/89)

TABLE 6-7
COST EVALUATION

Subcriteria	Alternative 2- Monitoring	Alternative 3- Institutional Controls	Alternative 4- Multilayered Cap	Alternative 5- In-situ VES	Alternative 7- Bioremediation	Alternative 8- Thermal Desorption	Alternative 9- Offsite Incineration
What is the estimated present worth capital and maintenance cost for this alternative?	$541,000	$551,000	$919,000	$911,000	$1,547,000	$2,387,000	$13,728,000

(11111C02-3400) (11/19/89)

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APPENDIX A
COMMENTS AND RESPONSES

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII
999 18th STREET - SUITE 500
DENVER, COLORADO 80202-2405

OCT 11 1989

Ref: 8HWM-SR

Mr. Donald L. Campbell
Office of the Program Manager
Rocky Mountain Arsenal
ATTN: AMXRM-PM
Commerce City, Colorado 80022-2180

Re: Rocky Mountain Arsenal (RMA) Alternative Assessment of Interim Response Actions for Other Contamination Sources: Motor Pool Area, September 1989.

Dear Mr. Campbell:

We have reviewed the above referenced document and have the enclosed comments. We wish to emphasize our concern that the document does not assess groundwater contamination and does not consider remediating or containing the groundwater near the source. Further, the document states that the contaminated groundwater would be intercepted offsite by the South Adams County Water and Sanitation District (SACWSD) Treatment Facility, which is at best incomplete, infeasible, and unacceptable.

The document does not adequately assess the Motor Pool Area as a source of groundwater contamination nor does it consider interception and treatment of the groundwater near the source as a remedial alternative for this IRA. We do not agree with the limitation of no groundwater remediation as part of this IRA, and note that several IRAs are devoted partially or completely to the interception and treatment of groundwater.

Our concerns on associated ARARs issues are addressed in a separate letter. Please contact Linda Grimes at (303) 293-1262, if you have questions on this matter.

Sincerely,

Connally Mears

Connally Mears
EPA Coordinator for RMA Cleanup

cc: Jeff Edson, CDH
David Shelton, CDH
Vicky Peters, CAGO
Lt. Col. Scott Isaacson
Chris Hahn, Shell
R. D. Lundahl, Shell
John Moscato, DOJ
Robert Foster, DOJ

RESPONSES TO THE U.S. ENVIRONMENTAL PROTECTION AGENCY'S COMMENTS ON THE ALTERNATIVES ASSESSMENT FOR THE OTHER CONTAMINATION SOURCES MOTOR POOL AREA NOVEMBER 1989

Comment 1: Page 1-4, third paragraph, the text states that "...the TCE plume originating from the Motor Pool area is intercepted by the South Adams County Water and Sanitation District (SACWSD) treatment system...". The SACWSD facility treats groundwater collected at several municipal well sites, all of which are a considerable distance from the source. Further, the municipal production well locations and operations are not designed to comprehensively intercept the subject plume. The plume could bypass the municipal wells and affect off-post private wells or future SACWSD production wells that are still used for drinking and irrigation. Groundwater contamination should be assessed in this document.

Response: The text has been changed. A groundwater interception and treatment system is being considered as part of the Motor Pool Area IRA in the Final Alternatives Assessment.

Comment 2: Page 2-2, fourth paragraph, the text identifies three alluvial ground water supply wells in Section 4. Please identify the well numbers.

Response: The reference listed in the WSAR (AML, 1973/RIC 81339R20) did not identify these three supply wells by well number.

Comment 3: Page 2-6, please state whether the wash bay has been a source of discharged "diluted wastes", as indicated by the text. If so, please present an indication of the contents of the wastes.

Response: The WSAR lists the following analytes as being detected in a shallow soil boring in the vicinity of the drain pipe; methyl napthalene at 30 ug/g at 0.1 feet and benzothiozole at 0.3 ug/g at 4 to 5 feet.

Comment 4: Page 2-6, third paragraph, the text describes isolated detections of methylene chloride, trichloropropene and aldrin. Please define "isolated" in this context.

Response: The text has been changed to state that these analytes were present in soil samples taken near the Roundhouse.

Comment 5: Page 2-8, fifth paragraph, the statement is made that even though benzene was detected in three of the four wells that the site is not considered to be a source of benzene in the groundwater. Considering the high concentration of benzene found in the groundwater, is there some better indication of the source of the benzene plume? Since fuel was stored on the site, a source of benzene contamination at the site could be expected.

Response: The WSAR discusses incorporating benzene concentrations with depth in the well cluster 04030, 04031, 04032, and 04033 and concluded that the source "may be located upgradient" and that "the soil in this area is not considered a source of benzene in the alluvial groundwater."

Comment 6: Page 2-18, second paragraph, the statement is made that synergism between metals could reduce toxicity. This statement is inappropriate in this text and cannot be substantiated for this site. The metals would be taken up by the plants and could be toxic in herbivores.

Response: The text has been changed.

Comment 7: Page 2-18, fourth paragraph, the text indicates that metal organic chelates are a nonsoluble metal form. It is expected that metal organics chelates would be soluble. The text should be amended.

Response: The text has been changed.

Comment 8: Page 2-20, first paragraph, the text makes the following statement: "because TCE was the only contaminant found in the soil vapor analyses, it is assumed TCE is the only contaminant in the area." Soil gas testing is not a quantitative analyses method; it would be considered a qualitative or semi-quantitative method at best. Other contaminants which may not be as volatile as TCE would not be detected in the soil gas surveys. The prior soil sampling and groundwater sampling and analyses indicate the presence of other contaminants in the area (refer to Tables 2-1 and 2-2). The text should be amended.

Response: The text has been changed.

Comment 9: Page 3-9, last paragraph, the text indicates that vacuum extraction would decrease the concentration of the compound at least in the top one foot of groundwater. Please reference the basis for that comment.

Response: The text has been changed.

Comment 10: Page 3-16, first paragraph, the fourth sentence states that "...the solution is recycled until the contaminant concentration in both the soil and treatment solution are equal." The text should be corrected to say "are in equilibrium".

Response: The text has been changed.

Comment 11: Page 3-17, last paragraph, the dechlorination process identified was used on a liquid, and it is not known that this process is applicable to soils. Please amend the text to reflect this.

Response: The text has been changed.

Comment 12: Page 3-18, third paragraph, please check the accuracy of the Henry's Law Constant, indicated in the text.

Response: The Henry's Law Constant has been corrected.

Comment 13: Page 3-21, second paragraph, the text eliminates a hazardous waste landfill based on a CERCLA preference for treatment to reduce volume, toxicity, and mobility of the contaminants. This preference alone is not a basis to eliminate an alternative, as other factors should be weighed, also.

Response: The text has been changed.

Comment 14: Page 3-21, last paragraph, disposal in a Class I landfill is eliminated because of CERCLA preference. This preference alone is not a basis to eliminate an alternative, as other factors should be weighed, also.

Response: The text has been changed.

Comment 15: Page 4-6, Section 4.1.6, please specify the method of determination of the excavation boundaries of a "60 foot by a 100 foot area". Please state what contamination levels were used to delineate the site boundaries.

Response: Excavation boundaries were chosen to provide a common basis for the comparison of alternatives. Some additional investigation to define exact depth of contamination may need to be performed during the design phase of this IRA. The 60-foot long by 100-foot area used for the evaluation is bounded on the north and south by Buildings 624 and 625 respectively, on the east by the walkway between Building 624 and 625, and on the west by the rail spur, as discussed in Section 2.5.

Comment 16: Page 4-7, Section 4.1.7, please define "contaminated soils" which determine the excavation depth.

Response: The "contaminated soils" are the TCE source area identified in the 1989 soil gas survey. A contamination depth of 20 feet was used for alternative evaluation purposes based on the results of the 1989 soil gas survey, as discussed in Section 2.5.

Comment 17: Table 4-1a, for three alternatives (no action, monitoring, and institutional controls), the table indicates compliance with ARARs. The table should indicate that there are no ARARs for these alternatives. In order to determine the acceptability of these actions, a risk analysis would have to be done.

Response: The table has been revised. Monitoring and institutional controls can be designed and implemented so that location-specific or action-specific ARARs (to the extent they exist) are met. Since no treatment is involved, ambient or chemical-specific ARARs will not be met. The no action alternative would not trigger location or action-specific ARARs, nor would it meet ambient or chemical-specific ARARs.

Comment 18: Page 6-1, first paragraph, Conclusions, the document does not assess the groundwater contamination from the motor pool area, presenting a data gap which should be reflected in the conclusions.

Response: Groundwater contamination is being addressed by including a groundwater interception/treatment system as part of the Motor Pool Area IRA. Conducting a groundwater assessment is outside the scope of the IRA. The CMP-water and water RI generally provide the necessary data to characterize the groundwater in this area. Any additional assessment would be conducted, as necessary, during the planning and design phase of the project.

STATE OF COLORADO

COLORADO DEPARTMENT OF HEALTH
4210 East 11th Avenue
Denver, Colorado 80220
Phone (303) 320-8333

Roy Romer
Governor

Thomas M. Vernon, M.
Executive Director

October 11, 1989

Mr. Donald Campbell
Deputy Program Manager
Rocky Mountain Arsenal
AMXRM-PM, Building 111
Commerce City, CO 80022-2180

Re: State Comments on Draft Final Alternative Assessment of the Final Response Action for Other Contaminated Sources - Motor Pool Area

Dear Mr. Campbell:

The State submits the following comments regarding the Draft Final Alternative Assessment of the Final Response Actions for Other Contaminated Sources - Motor Pool Area.

As you are aware, the State has claimed in the past, and continues to claim, that the motor pool area is a RCRA-regulated hazardous waste management unit. This area, therefore, must be closed in accordance with the Colorado Hazardous Waste Management Act.

If you have any questions, please feel free to call.

Sincerely,

Jeff Edson
RMA Program Manager
Hazardous Materials and
Waste Management Division

JE/cf

Enclosure

cc: Michael Hope, AGO
Chris Hahn
Edward McGrath
John Moscato
Connally Mears
Bruce Ray
Tony Truschel
LTC Scott P. Isaacson

11/17/89 11:21 ☎5562230 P M-R M A ☑002

15 Nov 89
12:30

STATE OF COLORADO

COLORADO DEPARTMENT OF HEALTH
4210 East 11th Avenue
Denver, Colorado 80220
Phone (303) 320-8333

Roy Romer
Governor

Thomas M. Vernon, M.D.
Executive Director

November 9, 1989

Mr. Donald Campbell
Deputy Program Manager
Rocky Mountain Arsenal
AMXRM-PM, Bldg. 111
Commerce City, Colorado 80022-2180

Re: State Comments on Draft Alternative Assessment, Interim Response Action, Other Contamination Sources, Motor Pool - Rocky Mountain Arsenal

Dear Mr. Campbell:

On October 11, 1989 the State submitted its comments on the above-referenced document. Unfortunately, those comments contained some errors which I would like to correct. General Comment number 2 and Specific Comment 1 were drafted without consideration of the July 1989 soil gas survey data and, therefore, are no longer appropriate. Accordingly, the State is hereby withdrawing subparagraph B. of specific comment #1, and that portion of General Comment #2 that refers to insuffient soil gas exploration. Please accept my apologies for any inconvenience this oversight may have caused.

If you have any questions, please give me a call.

Sincerely,

Jeff Edson
Hazardous Materials and
Waste Management Division

JE:jmb
C:\WS2000\RMA\CAMPBEL6.LTR

cc: Michael R. Hope
John Moscato
Chris Hahn
Edward J. McGrath
Connally Mears
Bruce Ray
Lt. Col. Scott Isaacson
Tony Truschel

RESPONSES TO THE STATE OF COLORADO'S COMMENTS ON ALTERNATIVE ASSESSMENT OF INTERIM RESPONSE ACTIONS FOR OTHER CONTAMINATION SOURCES MOTOR POOL AREA NOVEMBER 1989

GENERAL COMMENTS

Comment 1: In the Motor Pool Alternative Assessment, the Army contemplates a myriad of response actions that apparently provide for ultimate remediation of a particular section of the Motor Pool area. Such activities are beyond the scope of the "other sources IRA" as discussed in 1987, when the State concurred in the designation of this IRA. The original objective envisioned by the State was to expeditiously contain or remove source material and thereby halt further migration of highly concentrated waste into ground water or soils. The alternatives presented by this report include several relatively innovative technologies which are currently in various experimental stages but remain basically unproven. Although this document does acknowledge that some field or bench testing will be required, it does not discuss how these additional activities will affect scheduling of the response action. It would seem that the conducting of testing sufficient to ensure the effectiveness of implementation would cause undue delay. In addition, adoption of such treatment alternatives on a source by source basis may prove to be inconsistent with the final remedy selected at the Arsenal, or result in costly and duplicative efforts.

The most obvious and appropriate interim response alternatives, excavation and temporary storage of contaminated soils, and interception of the contaminated groundwater plume, were not even considered. The report should therefore be revised to include these alternatives.

Response: The Army disagrees with the State of Colorado's opinion that treatment alternatives are beyond the scope of the "other sources IRA." Paragraph 22.6 of the Federal Facility Agreement states that "The goal of the assessment shall be to evaluate appropriate alternatives and to select the most cost-effective alternative for attaining the objective of the IRA." The objective of the IRA is "to mitigate the threat of releases from the Motor Pool Area." The Army has evaluated a broad range of alternatives including, but not limited to, containment and treatment. The Army has evaluated these alternatives based on criteria recommended in the CERCLA guidance with emphasis on implementability and consistency with a final response action. Therefore, technically immature treatment alternatives or alternatives with excessive implementation periods would be discounted in the evaluation process. If a treatment alternative is selected, it would necessarily be one which could be implemented with minimal field testing and be completed in a time frame consistent with the overall IRA implementation schedule.

The treatment alternatives evaluated for application at the Motor Pool Area are generally well proven on TCE-contaminated soils. If field testing cannot be completed during the design phase without undue delay, or if the alternative cannot be considered consistent with a final remedy, the alternative is dropped from further consideration.

Groundwater interception and treatment has been added as part of the Motor Pool Area IRA in the final assessment. Excavation and temporary storage was considered and discounted early in the selection process because it was not cost-effective when compared to in-situ treatment technologies, such as vapor extraction, which provide a cost-effective response for the type of contaminants at this site.

Comment 2: The Army appears prepared to engage in extensive and costly remedial activities before it has adequately defined the nature and extent of contamination in the Motor Pool area. Although the report contains conjecture regarding the source of the TCE plume, this supposition is apparently based upon one boring and limited soil gas analysis. The State recommends that the Army immediately commence a remedial investigation data collection program in an effort to identify the source(s) of the TCE and other contamination in the Motor Pool Area. The State's specific recommendations for such additional work are included in its specific comments.

Response: The Army believes sufficient data are available to support an assessment of alternatives. Thirty-six soil borings were drilled during previous site investigations, and three soil gas surveys have been performed. Additional site characterization may need to be performed at the Motor Pool Area as part of the Feasibility Study (FS) before implementation of a final remedy. Additional site characterization now would not permit timely implementation of this IRA. However, it is clear that TCE contamination exists in the soil in the vicinity of the Building 624 floor drain. Remediating this contamination may unmask or allow better definition of other sources or plumes and lead to a better understanding of the Motor Pool Area. Thus, performing an IRA on the TCE contamination currently and clearly identified in the Motor Pool Area not only mitigates the threat of release from the site, but also is consistent with the final remedy by facilitating additional site characterization.

SPECIFIC COMMENTS

Comment 1: The State recommends that the Army conduct additional remedial investigative work as soon as possible to identify the source(s) of contamination in the Motor Pool Area. This work should include at a minimum:

A. Re-analysis of historical documents and aerial photographs and reinspection of the facility. This second effort may be revealing based on the knowledge of the site gained in preparing the Contamination Assessment Report and Study Area Report.

B. Previous soil gas surveys provided only regional definition of contaminant groundwater plumes. The Army should now implement a finer grid soil gas survey to attempt to locate specific sources of that contamination. Soil gas analysis should include TCE, PCE, and chloroform at a minimum.

C. It is possible that observed groundwater contamination is from adjacent ground disturbances that have not been investigated to date, or from historical spills. Therefore, soil investigations should be completed in the following areas identified in the Site 4 - 6 Contamination Assessment Report:

Page	Location	Potential Contaminants
12	parallel to and just east of railroad tracks west of building 627 and (foundation) 6	TCE and other solvents including trimethyl benzene, napthalenes, trimethyl and nonyl phenols, butoxyl ethanol, tridecane, tetrachloroethylene
12	pit east of Building 627	same (not yet sampled)
12	southeastern corner of Building 625	paints, solvents, acids, thinners
12	west and south of Building 631	TCE, chloroform, tetrachloroethylene (not yet sampled)
14	ditch east of Building 631	same (not yet sampled)
12	south of Building 621	known or suspected spill site, unknown contaminants

12	southeast of Building 624	caustics (oakite, zurco), TCE and other chlorinated organic solvents. HCs, tetrachloroethane
12	underground gasoline lines from storage tanks to Building 629	TCE and other non-target aromatic, cyclic, and chlorinated HCs, alkanes
	major drainage ditch west of Building 627 to northern boundary of WSA-6	known or suspected spill site, unknown contaminants

(of the 6 borings placed in the ditch adjacent to 627 during Phase I study, Boring 4 is too far upgradient of 627 to be affected by Motor Pool discharges. Only Borings 5 and 9 were completed to depths greater than 20 feet, and both of these borings - separated by over 300 feet - had tetrachloroethylene detects at 20 feet).

adjacent to railroad tracks by Phase I Boring 38	aldrin (49 to 50 ft, 62 to 63 ft)
adjacent to railroad tracks north of Building 624	high metal concentrations (Cd, Cr, As, Hg)

D. Finally, based on information acquired from the above-stated investigations, an additional series of monitoring wells should be installed to more precisely locate sources. The State cannot recommend well locations until this information is collected, but is willing to work with the Army on well locations upon review of these data.

Response: Refer to the response to the State's General Comment No. 2.

Comment 2: Figure 1-1 - The legend for this figure is not clear and should therefore be corrected.

Response: The figure has been revised.

Comment 3: Page 1-3 & 1-4 - The candidate selection criteria discussed on pages 1-3 and 1-4 do not accord with the flow chart presented as Figure 1-2. Specifically, the flow chart's initial diamond which presents the threshold question of whether the site is an active, primary source of contamination does not limit that question to an assessment of the site's effect on ground water. Such a limitation was expressly disapproved by State representatives at the June 7, 1989 subcommittee meeting which was held to discuss screening criteria for the "other sources" IRA.

Secondly, the first bullet under the third criteria, which is suppose to accord with the third diamond on the chart should be changed to address the question of accelerated clean-up. The question currently posed: "Will interim action reduce risks?" is vague and undefined and should more appropriately be applied as an evaluation criteria by which to judge proposed remedial alternatives.

Response: The Army's major concern and the emphasis of this assessment is the threat of release of TCE contamination to the groundwater from the Motor Pool Area.

Secondly, the Army agrees that adding a statement on accelerated cleanup would clarify the discussion on Page 1-4 and the text has been changed.

Comment 4: Page 1-4 - The benefit in performing an interim action to remediate a source under the "Other Sources" IRA should be analyzed in the Alternative Assessment Document, not in the Decision Document as proposed by the Army. Unless such a benefit is recognized, the Army should not be expending time and resources evaluating alternatives.

Response: The benefit of performing an IRA at the Motor Pool Area is discussed in more detail in Section 6.2 of the final alternatives assessment document.

Comment 5: Page 2-6 - The statement regarding "metal indicator ranges" is very confusing, especially when one examines the referenced Table 2-1 which does not contain "metal indicator ranges". The State has previously commented that the term "indicator range" appropriately refers to concentrations that indicate that contamination is present. The Army appears to be using it to refer to supposed background levels. The text must be corrected.

Response: The table has been revised for clarity. Indicator ranges do refer to supposed background levels, as discussed in the Introduction to the Contamination Assessment Reports (ESE 1987).

Comment 6: Page 3-6 - It is not clear from the text whether the Army is comparing the performance of grout curtains and sheet piling to the performance of a slurry wall under ideal conditions or under the conditions present at the site. On page 3-5, the slurry wall alternative was dismissed because it would not be efficacious at the site. Would grout curtains and sheet piling work better than a slurry wall given the depth to low permeability material in the Motor Pool Area?

Response: The alluvial soils in the vicinity of the Motor Pool Area consist of discontinuous lenses of sand and gravel, interbedded with silt and clay. The highly permeable sands and gravels make slurry walls, sheet piles, and grout curtains all inapplicable for this site for the reasons stated in the text.

Comment 7: It is not clear why the Army has limited offsite alternatives to incineration. This choice must be explained and justified.

Response: Incineration is the only demonstrated offsite treatment alternative for TCE-contaminated soil.

Comment 8: Although on Page 3-16 the Army states that soil washing would be retained for further consideration, it is rejected in Table 3-2 and is not discussed in Chapters 4 and 5. Given the Army's conclusions regarding this technology's removal efficiencies, it should retain soil washing for further evaluation.

Response: The text has been changed.

Comment 9: Since alternatives 2 and 3 (monitoring and institutional controls) are not protective of human health and the environment, which is a threshold criteria, they should be eliminated from further consideration.

Response: Monitoring, as well as the monitoring program associated with the institutional controls alternative, are considered somewhat protective. Continued tracking of groundwater quality provides additional information, which may be used, if necessary, to implement some future treatment or containment action. These alternatives do not survive the screening process of Section 6.0 and therefore are eliminated from further consideration.

Comment 10: The Army should seriously consider alternatives for the interception of contaminated ground water near the sources(s) of TCE contamination. This option is similar in general scope to soil remedial alternatives contemplated in this alternative assessment document. Its neglect is inconsistent with the Railyard Hot Spot IRA Alternative Assessment which proposes groundwater interception. It may be feasible to construct one intercept system to contain both the TCE and the DBCP plume. As noted in general comment 1 above, the Army should also include excavation and temporary storage in a sufficiently protective waste pile as an alternative.

Response: A groundwater interception and treatment system, similar to and coordinated with the system proposed for the Rail Classification Yard IRA, is included as part of the Motor Pool Area IRA in the final alternatives assessment.

Excavation and temporary storage was considered and discounted early in the alternative selection process it was not cost-effective when compared to in-situ treatment technologies, such as vapor extraction (see response to the State's General Comment No. 1).

Comment 11: Disposal of treated residual soils in an offsite Class I landfill should be retained for further evaluation, especially since the information contained in the Alternatives Assessment does not indicate whether the treatment technologies will be successful at treating the soil to a nonhazardous solid waste.

The Alternative Assessment document states that the ability of the remedial alternative to satisfy ARARs will be assessed; however, this evaluation is not done in this report. Nor does this report propose remedial objectives or set forth the degree of cleanup each technology is expected to achieve. Without such information, protectiveness and conformance with ARARs cannot truly be incorporated into the ranking process contained in section 6. Therefore, before the Army chooses any of the enumerated treatment technologies, it must establish the degree of cleanup that each could be expected to accomplish.

Response: Any treatment alternative which has not already demonstrated its ability to effectively remove TCE from a soil matrix would not be performed in favor of demonstrated treatment alternatives which could be implemented within the time frame of an IRA. Therefore, treatment alternatives which have not shown the ability to produce a nonhazardous residual would not be performed.

A detailed discussion of ARAPs associated with the selected alternative will be presented in the IRA Decision Document. During the design phase, work will be done to ensure that the design, as implemented, will meet all ARARs identified.

Shell Oil Company

c/o Holme Roberts & Owen
Suite 4100
1700 Lincoln
Denver, CO 80203

October 11, 1989

Mr. Donald L. Campbell
Office of the Program Manager
Rocky Mountain Arsenal, Bldg. 111
ATTN: AMXRM-PM
Commerce City, CO 80022-2180

Re: SHELL'S COMMENTS ON ALTERNATIVE ASSESSMENT FOR
MOTOR POOL AREA

Dear Mr. Campbell:

Enclosed are Shell Oil Company's comments on the Draft Final Alternative Assessment of Response Actions, Motor Pool Area, September 1989, Version 2.0. Shell's ARAR comments are being sent under separate cover.

Sincerely,

R. D. Lundahl
Manager Technical
Denver Site Project

RDL/jy

Enc.

cc: (w/enclosure)
Colonel Daniel R. Voss
Office of the Program Manager
for Rocky Mountain Arsenal
ATTN: AMXRM-PM
Commerce City, CO 80022-2180

Dr. William L. Trautmann
Interim Response Division
Office of the Program Manager for Rocky Mountain Arsenal
ATTN: AMXRM-IA
Commerce City, CO 80022-2180

Mr. David L. Anderson
U.S. Department of Justice
999 18th Street
Suite 501 North Tower
Denver, CO 80202

Lt. Col. Scott P. Isaacson
Department of the Army
Office of the Judge Advocate General
ATTN: DAJA-ELL
Pentagon, Room 1C480
Washington, D.C. 20310-2210

Victoria L. Peters, Esq.
Office of Attorney General
CERCLA Litigation Section
1560 Broadway, Suite 250
Denver, CO 80202

Mr. Jeff Edson
Hazardous Materials and Waste Management Division
Colorado Department of Health
4210 East 11th Ave.
Denver, CO 80020

Mr. Robert L. Duprey
Director, Air and Waste Management Division
U.S. Environmental Protection Agency, Region VIII
One Denver Place
999 18th Street, Suite 1300
Denver, CO 80202-2413

Mr. Connally Mears
Director, Air and Waste Management Division
U.S. Environmental Protection Agency, Region VIII
999 18th Street, Suite 500
Denver, CO 80202-2405

Mr. Jeff Edson
Colorado Department of Health
4210 East 11th Ave.
Denver, CO 80020

Mr. Mike Gaydosh
Air and Waste Management Division
U.S. Environmental Protection Agency, Region VIII
One Denver Place
999 18th Street, Suite 500
Denver, CO 80202-2405

Mr. Bruce M. Huenefeld
Interim Response Division
Office of the Program Manager for Rocky Mountain Arsenal
ATTN: AMXRM-IA
Commerce City, CO 80022-2180

RESPONSES TO SHELL OIL COMPANY'S COMMENTS ON DRAFT FINAL ALTERNATIVE ASSESSMENT OF INTERIM RESPONSE ACTIONS
MOTOR Pool Area
NOVEMBER 1989

General Comments

Shell Oil's major concerns with this Draft Final Alternative Assessment are as follows and are discussed in further detail under Specific Comments.

Comment 1: Results of investigations at this site do not provide a coherent picture of the source(s) of groundwater contamination. Therefore further site investigations should be performed. It may not be possible to define the source(s) with any exactitude on a timely basis. In this case, response actions which are less dependent for effectiveness on such definition, e.g., groundwater interception/treatment and vapor extraction should be preferred.

Response: The Army believes sufficient data are available to support an assessment of alternatives. The Army agrees that definitive relationships between soil and groundwater contamination in the Motor Pool Area have not been established by previous or current investigations. However, it is clear that TCE contaminated soil is present in the vicinity of the Building 624 floor drain. Remediating this contamination may unmask or allow better definition of other sources or plumes and lead to a better understanding of the Motor Pool Area. Shell's comment that, given the complex nature of this site, a groundwater interception/treatment alternative may be applicable is acknowledged and has been developed for this final assessment.

Comment 2: This assessment gives insufficient weight to objectives and guidelines set forth in the Federal Facility Agreement and the Technical Program Plan (FY88-FY92) for IRA's, emphasizing instead the guidelines of CERCLA Section 120. Consequently, the assessment is biased toward treatment alternatives which are better suited for consideration in the Final Remedy rather than as interim response actions. The intention that IRA's provide early response actions utilizing cost-effective, proven technologies to mitigate the threat of releases is subordinated to the longer term remediation goals of CERCLA. Many of the treatment alternatives which survived screening in this assessment would require considerable time for either or both development and demonstrating effectiveness on the RMA or implementing the treatment technology. They also pose the risk of not being consistent with the Final Remedy.

Response: The Army agrees that it may be desirable to give increased weight to the Federal Facility Agreement and Technical Program Plan guidance. The effects of this change in emphasis will be most evident in Section 6.0, which presents a preliminary evaluation of alternatives. It is emphasized that this is an Alternatives Assessment, not a Decision Document, and it is necessary and appropriate to assess all options, including no action, institutional controls, containment, and treatment in order to evaluate which alterative best meets the objectives of the IRA. An expanded evaluation is presented in the final assessment, which includes consideration of effectiveness, implementability, and consistency with the Final Remedy.

Comment 3: The Decision Flow Chart presented in this assessment (Figure 1-2) is an altered version of the Flow Chart actually agreed to by the Organizations and the State at the June 7, 1989 Other Contamination Sources Subcommittee meeting. Specifically, Data Inadequate should be on the NO leg of the first decision node, not on the YES node. The version agreed to is shown in Figure 1-1 of the final Technical Plan.

Response: The Decision Flow Chart was modified to provide for a slightly more conservative path through the decision process in recognition of the fact that not all data were validated at the time of publication. The point is now moot, however, since the validated data provide a "Yes" answer to the "active primary source" questions. The flow chart agreed to in the Final Task Plan has been included in the Final Alternatives Assessment.

Comment 4: Groundwater treatment is not considered in this assessment except as it may be used in groundwatering operations. Rejection of groundwater treatment as a technology option ignores the fact that groundwater interception and treatment is an effective containment strategy with favorable aspects with respect to the IRA objective and guidelines as set forth in the FFA and TPP. In fact, this strategy is widely employed on the RMA. All existing and pending groundwater intercept/treatment systems on the RMA are justifiable on the basis of containment, not remediation of groundwater.

Response: Groundwater interception and treatment is being considered as part of the Motor Pool Area IRA in the Final Alternatives Assessment and Decision Document.

Comment 5: The focus of this assessment is blurred because the text confuses objectives with remedial action strategies and CERCLA guidelines and criteria (Section 3.1). Consequently, in Shell's opinion, a large amount of the work performed in this assessment is misguided and unnecessary. The single objective of this IRA is provided in the Technical Program Plan, Section 3.3.2.7, to wit: Mitigate the threat of releases from selected "hot spot" (Motor Pool) contamination sources. This objective, which was agreed to by the Organizations, should be the focus of both alternative development and evaluation.

Response: The text has been changed to be consistent with the wording of the Technical Program Plan, Section 3.3.2.7. However this does not affect the subsequent technology screening and alternative evaluation, since the major objective of the proposed interim action has always been to mitigate the threat of release from the source.

Comment 6: Because of the foregoing, the screened list of alternatives in Section 6.0 Conclusions includes treatment alternatives, specifically 6, 7, 8 and 9 which seem inappropriate for an interim response action at this site and excludes two containment strategies which seem appropriate, specifically groundwater interception/treatment and source collection with temporary storage in a waste pile.

Response: The major contaminant in the Motor Pool Area is trichloroethylene (TCE). A number of well-proven treatment technologies are available for TCE-contaminated soils, including those presented as Alternatives 6, 7, 8, and 9. The objective of this IRA assessment is to mitigate the threat of release from the contamination source in a cost-effective, timely manner, consistent with the final remedy to the maximum extent possible. Nothing precludes the use of well-proven technologies to meet this objective. Groundwater interception/treatment is part of the Motor Pool Area IRA in the Final Alternatives Assessment. The use of a temporary waste pile appears to have fewer advantages than the alternatives developed, so is not considered.

Specific Comments

Comment 1: Page 1-1, first paragraph.

"The Motor Pool Area appears to be a potential source of Trichloroethylene (TCE) contamination to the groundwater."

Although the Motor Pool Area seems suspect as a potential source of a TCE groundwater plume, the data presented are inadequate to characterize either the origin of the plume or the soil contamination in the potential source area. The upgradient limit of the groundwater plume is not defined in the vicinity of the potential source. Also, TCE detections in soil gas extend well outside of the small area used as the design basis for a possible interim response action, indicating additional potential sources may exist. Until the potential source(s) is more clearly defined, assessing IRA alternatives is premature.

Response: See response to Shell's General Comment No. 1.

Comment 2: Page 1-1, last paragraph.

"An interim response action, as defined in this document, refers to any possible interim action..."

The scope and objectives of Interim Response Actions implemented for remediation of the RMA are defined in the Federal Facility Agreement (FFA) and the Technical Program Plan (TPP) and are the result of considerable discussions between the Organizations and the State and have been agreed to by the Organizations. It is therefore improper to conduct this Alternative Assessment on the basis of how an Interim Response Action is "defined in this (Alternative Assessment) document", unless the definition agreed to by the Organizations and the State is used. As discussed in General Comments, this assessment is misdirected due to a failure in recognizing the objectives and purposes of IRA's as set forth in the FFA and the TPP.

Response: The IRA Alternative Assessment has been conducted in accordance with the Federal Facility Agreement and the Technical Program Plan. The text has been changed to reflect this.

Comment 3: Page 1-1, last paragraph, first sentence.

The phrase "as amended by the Superfund Amendments and Reauthorization Act of 1986" should be added before "(CERCLA)."

Response: The text has been changed.

Comment 4: Page 1-4, first paragraph.

A benefit to cost or acceleration of cleanup are to be addressed under this criterion. Risk reduction is not.

Response: The text has been changed.

Comment 5: Page 1-4, second paragraph.

"The type of action taken, either long-term monitoring or interim treatment..."

The choices are not limited to monitoring or treatment. The objective of the Remediation of Other Contamination Source IRA is stated clearly in the Army's Technical Program Plan at 3.3.2.7: "Mitigate the threat of releases from selected "hot spot" contamination sources." Consistent with this objective, the intent of RMA IRA's is to prevent the worsening of problems. It is not to remediate sites, although remediation to acceptable levels may result. Considering emphasis on timely implementation of IRA's, this objective will usually be best met by a containment or isolation action. In some cases, treatment may facilitate containment or isolation. The focus however should be on preventing the spread of contamination, not on remediation.

Response: It is agreed that the objective of the IRA is to prevent the spread of contamination. However, it is appropriate to evaluate a range of alternatives in order to meet this objective, not excluding treatment alternatives, which may provide a greater benefit than containment, depending on the site.

Comment 6: Page 1-4, third paragraph.

"If the answers to the question on the decision flow chart are inconclusive, a conservative approach will be taken. For example, if a clear risk to human or biota receptions has not been shown, it will be assumed that some risk exists."

There are several serious misrepresentations in this statement which in part cause this assessment to be misdirected.

First, the issue involved here is not one of conservatism of approach to an interim response action, but is simply a matter of the data being inadequate to perform an assessment. To proceed with a specific action with inadequate data risks wasting valuable resources on work which may not protect the environment or human health, even in fact do harm, and may not be consistent with the Final Remedy.

Second, it was not agreed that if data are inconclusive or inadequate, a conservative approach would be taken. The agreement reached by the Organizations and the State in the June 7, 1989 Subcommittee meeting was that inadequate data would trigger the monitoring/maintenance action. Monitoring/maintenance may include further site investigation. The Decision Flow Chart in this assessment (Figure 1-2) is an altered version of the flow chart agreed to and which appears as Figure 1-1 in the Final Task Plan for Remediation of Other Contaminant Sources Interim Response Action. Specifically, the Data Inadequate decision path has been moved from the NO to the YES pathway. Figure 1-1 of this assessment document should be replaced by the agreed to version. Data on this site are inadequate to conclusively state that only one site of soil contamination in the Motor Pool is an active primary source of groundwater contamination. Accordingly, before proceeding with screening and evaluation of technology alternatives, further site investigation should be conducted.

Response: See response to Shell's General Comment No. 3.

Comment 7: Page 1-4, fourth paragraph.

"...there may be some benefit in performing an IRA now. ...The benefit in performing any of these actions will be discussed in the IRA Decision Document."

If the reason for considering an interim response action for this site is a possible long term benefit to cost or timing of RMA remediation, how can a meaningful discussion of alternatives be achieved if these possible benefits are not addressed? Clearly, achievement of a long term benefit in cost or timing should be a primary consideration and criterion in the development and evaluation of alternatives.

Response: Long-term benefit is discussed in the expanded alternatives evaluation in Section 6.2 of the final Alternatives Assessment.

Comment 8: Page 2-2, third paragraph.

Pesticides and herbicides were stored in Buildings 627B and 646 for on-post use by the Army. Please clarify that these buildings were not used by Shell for storage.

Response: The text has been changed.

Comment 9: Page 2-4, fourth paragraph.

From a hydrologic standpoint, it is doubtful that the entire Denver Formation is saturated since relatively dry claystone and shale layers are probably present. This statement should be revised.

Response: Previous studies (May 1982) have indicated an apparent hydrogeologic connection between the alluvial groundwater and the groundwater in the upper, weathered portion of Denver Formation. The Army is not aware of a documented perched aquifer in the Denver Formation below the Motor Pool Area, and believes that the Denver Formation is saturated in this area.

Comment 10: Page 2-7, last paragraph.

Should the reference (Table 2-2) be (Figure 2-1) instead? Table 2-2 does not identify water quality by wells, but Figure 2-1 shows well locations but no water quality data. It would be helpful if a TCE plume map were provided in this Section.

The data presented in this assessment and in referenced reports conflict with the statement that "...the trichloroethylene alluvial groundwater plume is interpreted to originate near Building 624 and extended to the north-northwest." TCE soil gas detections occurred approximately 500 feet south (upgradient) and 500 feet east of the potential source area shown in the inset maps on Figure 2-2. It is doubtful that diffusion of TCE from the groundwater under the suspected source would extend this far south and east. In addition, one TCE detection in a soil sample north of Building 623 was mentioned in a discussion of previous investigations in the Site 4-6 Contamination Assessment Report (Ebasco 1988). The detection is approximately 400 feet south of the interpreted source area. The 1986 soil gas survey from the Contamination Assessment Report showed a distribution of TCE similar to that in the recent soil gas survey, extending as far south as Building 623.

The groundwater quality data are inconclusive for locating the origin of the plume. Individual monitoring well data were not tabulated or illustrated; instead, the Western Study Area Report is referenced. The highest TCE concentration (260 ug/L) shown on Figure WSA 3.2-6 was from Well 04030, located 1,000 feet north of the interpreted source. TCE was detected in Well 04051, which is located 300 feet north-northeast of the source, yet the groundwater flow direction is north-northwest. Finally, there are no upgradient monitoring wells in the vicinity of the potential source to define the southern limit of the plume. Well 03011 is located in an upgradient direction from the source but is approximately 1,700 feet away and is useless for this purpose.

Response: Table 2-2 is the correct reference. A TCE plume map has been included in this section.

The text has been changed to indicate the probable TCE source as being in the Motor Pool Area rather than in the specific location of "near Building 624." However, this JRA would be performed on the source identified near Building 624. As for the more general comments regarding adequacy of data, please see response to Shell General Comment No. 1.

Comment 11: Page 2-8, third paragraph.

Well 04031 is one of four alluvial monitoring wells in a cluster. The fact that DBCP was detected near the CRL once in Well 04031 and not in the other three wells in the cluster, and not repeated nor detected in any other wells, suggest that this may be a false positive.

Response: Agreed.

Comment 12: Page 2-9, second paragraph.

The standard soil gas sampling depth is stated as 15 feet in the text but appears to be 5 feet on Figure 2-2. Which is correct? Figure 2-2 is very difficult to read and the locations of the buildings should be made clear. Also, soil gas concentrations are not shown for many of the 5-foot sample locations.

Response: Figure 2-2 has been revised to provide a better summary of results for the purposes of this document. The standard sampling depth was 15 feet -- the figure was incorrect. Details of the investigation and results can be found in the Field and Laboratory Investigation Report (WCC 1989).

Comment 13: Page 2-9, fourth paragraph.

High TCE concentrations in the soil gas near the potential source area could be caused by volatilization of TCE from either the groundwater or the surface soil contamination. Was an attempt made to distinguish between the two media in interpreting the soil gas data in the source area or through the study area?

Response: No attempt was made to distinguish between the two media. However, the 1989 soil gas survey clearly indicates high TCE soil vapor contaminants in the vicinity of a floor drain outfall, as discussed in Section 2.2.3 of this report, and in the Field and Laboratory Investigation Report (WCC 1989).

Comment 14: Page 2-10, 2.3 Contaminant Fate and Transport

This Section is very general and theoretical (with respect to this specific site). The brevity and simplicity of this discussion on fate and transport raise questions as to its value to this assessment.

The last sentence of the first paragraph states: "This section presents the fate and transport of both the organics and metals detected in these field investigations." This should be revised to state that possible mechanisms for fate and transport at this site are discussed.

The discussion in this section should be divided into two sections: (1) a discussion of the fate and transport of the contaminants in soils, and (2) a discussion of the fate and transport of the contaminants in groundwater. A treatment of the relevant information in the described fashion would avoid the confusion at paragraph 2.3.1.1.3 where data for the volatilization of compounds from water is used to explain the fate of aromatic organics via volatilization in soils.

Response: The text has been changed.

Comment 15: Page 2-10, Section 2.3.1.1 - Volatilization.

The volatilization of organic compounds from solids is dependent on several factors including soil temperature and moisture content, vapor pressure, solubility of the compound in water, compound concentration, the ability of two or more contaminants to form azeotropic mixtures, air flow over the soil surface, humidity, sorptive and diffusion characteristics of the soil, and bulk properties of the soil such as organic matter content, porosity, density, clay content, and clay mineralogy. All of these factors affect the distribution of a compound between soil, soil water, soil air, and the atmosphere.

Response: The text has been changed.

Comment 16: Page 2-10, last paragraph.

The volatilization of organochlorine pesticides is a function of several factors such as soil temperature, soil type, soil moisture, etc. Therefore, the statement that organochlorine pesticides slowly volatilize into the atmosphere due to their low vapor pressures is inaccurate. See W. A. Jury, et. al., "Behavior Assessment Model for Trace Organics in Soil: I. Model Description," J. Environ, Qual., Vol. 12, no. 4, 1983.

Response: The text has been changed.

Comment 17: Page 2-11, Section 2.3.1.1.2.

In addition to being relatively volatile, the chlorinated hydrocarbons listed in this section are also relatively mobile in soils. This information should be considered in the evaluation of landfarming as a treatment alternative. See Edward J. Shields, "Pollution Control Engineer's Handbook", at page 31. Moveover, the loss via volatilization of compounds to the atmosphere is a function of several factors including soil temperature and moisture content, soil porosity, humidity, and atmospheric stability. A suggested reference for this information is "Review of In-Place Treatment Techniques for Contaminated Surface Soils, Vol. I", (September 1984), EPA-540/2-84-003a.

Response: The text has been changed. Landfarming is not considered as a feasible alternative for the Motor Pool Area.

Comment 18: Page 2-11, Section 2.3.1.1.3.

The comments regarding Section 2.3.1.1.2 are also applicable to this paragraph. Also, the cited information is inappropriate here since this discussion refers to the volatilization of aromatic hydrocarbons from soils.

Response: The text has been changed.

Comment 19: Page 2-11, Section 2.3.1.2 - Hydrolysis.

Contrary to the claim that hydrolysis is unimportant to the fate of organic compounds, hydrolysis is very important to the fate of DBCP, tetrachloroethylene, trichloroethylene, and other organic compounds.

Response: The text has been changed.

Comment 20: Page 2-12, Section 2.3.1.2.2.

A reference should be provided for the statement that chloroform has a half-life of 3,500 years.

Response: The text has been changed.

Comment 21: Page 2-15, Section 2.3.2.1.

Precipitation runoff is more related to soil type and condition, vegetative cover, and precipitation intensity than it is to the amount of annual precipitation. The fact that precipitation averages only 15 inches pe1 year has very little to do with the fact that erosion is limited on the Arsenal. Most precipitation is lost through evapotranspiration, and only very little reaches the groundwater table. The last sentence in 2.3.2.1 incorrectly implies that most precipitation reaches the groundwater through infiltration. Infiltration can be enhanced locally, however, by features such as drainage ditches and topographic depressions.

Response: The text has been changed.

Comment 22: Page 2-15, first paragraph.

Although no Denver Formation monitoring wells are located in the vicinity of the Motor Pool, it was stated on page 2-8 that no TCE has been detected in Denver wells in the WSA. Why discuss the possibility of transport in the lignite seams? Are there data to support the fact that organics due to contamination have been detected in the lignite seams?

"Absorption" should be "adsorption".

Response: The text has been changed.

Comment 23: Page 2-16, first paragraph.

Same as comment 21. Infiltration of soluble organics was probably enhanced by the practice of discharging wastewater to drainage ditches.

Response: The text has been changed.

Comment 24: Page 2-17, first paragraph.

Soluble organics can migrate with the groundwater, but it should be pointed out that each compound has different retardation factors and migration will vary widely for this list of compounds.

Response: The text has been changed.

Comment 25: Page 2-17, third paragraph.

See comment 19 above.

Response: The text has been changed.

Comment 26: Page 2-17, last sentence of Section 2.3.2.3.4.

"...groundwater gradient" should be "groundwater migration rate."

Response: The text has been changed.

Comment 27: Page 2-18, Section 2.3.4.

The term "nonsoluble" should be replaced with "insoluble." This paragraph is over generalized to the point of being erroneous. For example, some metal oxides, such as chromium (VI) oxide, mercuric oxide, and arsenic pentoxide, are soluble in water. Humic metal complexes have conditional stability constants that vary with pH, and follow the Irving-Williams series. In general, the stabilities of aquatic humic complexes follow this order for the metals present at this site:

$$Hg > Cu > Cd$$

See E. M. Thurman, "Organic Geochemistry of Natural Waters," at 415. Given the conditions at this site, some of the metals may not be sorbed on the surface of humic material (if humic material is present).

Response: The text has been changed.

Comment 28: Page 2-18, last partial sentence continuing onto page 2-19.

Migration of metals associated with soil movement due to surface runoff in ephemeral streams is not limited because the annual precipitation is 15 inches per year. It is because erosion is minimal. Erosion and annual precipitation can even show an inverse relationship. Erosion is more related to soil type and condition, vegetative cover, and precipitation intensity.

Response: The text has been changed.

Comment 29: Page 2-19, second paragraph.

Total Threshold Limit Concentration (TTLC) is a criterion used only in California and is therefore not appropriate for use at RMA.

Response: Agreed. The text has been changed.

Comment 30: Page 2-19, third paragraph.

Infiltration/percolation to groundwater is not a very likely fate of precipitation at RMA without some mechanism of enhanced recharge.

Response: Intermittent infiltration is a possible pathway at Rocky Mountain Arsenal.

Comment 31: Page 2-19, 2.5 - Design Basis for Remedial Activity.

This section states that only one area of contamination appears to be actively degrading groundwater quality, implying that the site has been adequately characterized. As stated in previous comments, this is not the case and additional site investigation should be performed.

Response: The text has been changed.

Comment 32: Page 2-20, second paragraph.

"...TCE concentrations in the soil peak within the first twenty feet of the surface."

No data are presented to substantiate this statement. Maximum sampling depth in the 1989 soil gas sampling program was described as 15 feet, although Figure 2-2 shows one sample point at 20 feet at location G5. No significant attenuation of the TCE concentration occurred at this depth.

The vertical distribution of TCE in the vadose zone has not been determined in the recent soil study nor in previous soil sampling programs. Since the groundwater is at a depth of 60 to 65 feet below the ground surface, soil contamination is likely below the depth of 20 feet. Clay zones are present in the alluvium in the WSA that could affect migration pathways or act as collection points for TCE either as dissolved or separate phases. The lithology has been ignored and it is unlikely that the soil contamination in the upper 20 feet for the vertical extent of contamination for the design basis for remedial activity is unwarranted and further site characterization is necessary to ascertain the vertical distribution of TCE in the potential source.

Response: Although the vertical extent of contamination is somewhat unclear, the source of contamination has been identified to be within the upper 20 feet of soil. Investigation of depth of contamination could be performed during the design phase of the IRA.

Comment 33: Table 2-3.

The aqueous solubility of DBCP is approximately 1,200 mg/1, not 11,000 mg/1.

Response: Agreed. The text has been changed.

Comment 34: Table 2-5.

The stated maximum depth of contamination and maximum volume of contaminated soil are not backed up by any data. It seems that contamination likely does extend deeper than 25 feet or it would not have reached the water table.

Process Water Characteristics

Groundwater interception/treatment is an effective containment strategy. See comment 38. It should be considered in this assessment.

Contaminant Characteristics

What are the statistics under this heading?

Response: The stated maximum depth of contamination and maximum volume of contaminated soil are used as a common basis by which to evaluate alternatives. See Section 2.5.

Groundwater interception/treatment is being considered as part of the Motor Pool Area IRA in the final Alternatives Assessment.

The table has been revised.

Comment 35: Page 3-1, Section 3.0 Identification and Evaluation of Interim Action Technologies.

This assessment is biased toward a final remedy solution because it fails to recognize guidelines and objectives set forth by the Organizations in the FAA and TPP concerning conduct of IRA's on the RMA. Specifically,

- TPP, Section 3.3.2.7

  Remediation of Other Contamination Sources.

  Objective: Mitigate the threat of releases from selected "hot spot" contamination sources.

- TPP, Section 3.1

  IRA's are "removal" actions.

- FFA, Section 22.5

  All IRA's shall....to the maximum extent practicable, be consistent with and contribute to the efficient performance of Final Response Actions.

- FAA, Section 22.6

  The goal of the (IRA Alternative) assessment shall be to....select the most cost-effective alternative for attaining the objective of the IRA.

- FFA 2.3(a)

  Provide for IRA's which are appropriate for the Site prior to implementation of final remedial action(s) for the Site.

IRA's are intended to be implemented on a timely basis, otherwise the benefit of taking an action prior to implementing the Final Remedy is diminished or lost. Proven, off-the shelf technologies facilitate this intent. The goal is to quickly implement the most cost effective response that will mitigate a threat of release of contaminants. The objective is clearly not remediation, although a remediation alternative is not excluded if it best meets IRA and CERCLA guidelines.

There is almost no prominence given in this assessment to these IRA objectives and guidelines. Rather, the assessment has been incorrectly conducted using CERCLA guidelines for a final remedy.

Response: See response to Shell's General Comment No. 2.

Comment 36: <u>Page 3-1</u>, first paragraph.

The second sentence of this paragraph causes this Section and Sections 4.0, 5.0 and 6.0 to be misdirected.

> "The interim response action objectives are site-specific goals for treating soil to protect human health and the environment."

The objective of this IRA is to mitigate the threat of releases from the Motor Pool are a (TPP, Section 3.3.2.7). The assessment in Section 1-2, developed the goal of creating a long-term benefit in cost or timing for RMA final remediation of this site. Accordingly, alternates should be developed and evaluated with this site-specific goal uppermost in mind. Treating the soil may be a strategy to achieve this goal, but it is not the objective of the IRA. Protection of human health and environment is one of the criteria against which the expected performance of an alternative is evaluated.

Response: The wording of the objective has been changed to more clearly adhere to the Technical Program Plan.

Comment 37: <u>Page 3-1</u>, third paragraph.

The first bullet is the objective. The other bullets are evaluation criteria. The goal of reducing the cost of the Final Remedy should play a prominent role in the identification and evaluation of alternatives.

Response: The wording of the objective has been changed to more clearly adhere to the Technical Program Plan.

Comment 38: <u>Page 3-2</u>, second paragraph.

> "Table 3-1 lists General Response Actions and associated technologies typically applied to contaminated soil and associated groundwater."

Rather than starting with a universe of General Response Actions, this assessment could be better focused by considering possible strategies for meeting the specific IRA objectives for this specific site and then developing alternatives based on technologies appropriate for these strategies.

Response: A range of general response actions were considered (e.g., containment, treatment, etc.). Several alternatives were developed and evaluated for each of these general response actions.

The alternatives consist of one or more technologies considered applicable for this site. This approach provided the flexibility to consider a wide range of general response actions.

Comment 39: Page 3-3, last paragraph.

To the list of containment technologies should be added groundwater interception, treatment and reinjection. This is a practical containment strategy as is demonstrated by control systems presently in operation on the RMA.

Response: See response to Shell's General Comment No. 4.

Comment 40: Page 3-5, Section 3.2.3.3.

It seems appropriate to retain at least one impermeable wall technology for further consideration. Even though the great depths make construction of a wall expensive, the relative costs and benefits should be weighed against the alternatives.

Response: Impermeable wall technologies were eliminated from consideration early in the assessment process as not being cost-effective relative to other technologies due to the excessive depth of the nearest low permeability formation.

Comment 41: Page 3-9, 3.2.5.1.3.

Vapor extraction and in-situ soil washing (3.2.5.1.4) transfer contaminants from the soil to other media. The disposition of contaminants collected by these processes should be discussed.

Response: In the alternative development of vapor extraction, the adsorption of TCE onto activated carbon is considered. This carbon is then thermally reactivated off site to destroy adsorbed material. The text of subsection 3.2.5.1.3 has been changed to include this description.

Comment 42: Page 3-11, 3.2.5.2 On-Site Soil Treatment Methods.

The text should discuss the role of treatment technologies (other than in-situ treatment) in the context of interim response action objectives and guidelines as set forth in the FFA and TPP. For example, source collection may be an appropriate interim response strategy for a site but further disposition of the source material is required. Temporary storage in a waste pile, e.g., as with Basin F solids, for further handling in the Final Remedy is one possibility. Treatment and disposal of residues is another. However, in most cases it would not be cost-effective, and may not be consistent with the final remedy, to construct separate treatment facilities for individual, particularly small, sites. Thus, only special circumstances would seem to favor treatment as an interim response strategy. In addition, most treatment technologies will require time consuming demonstration of applicability to a specific site and thus may not provide the timely response intended for IRA's.

Response: Treatment as a general response action is compared on an equal basis with other general response actions (e.g., containment) during the IRA alternative evaluation in Section 6.0. Any alternatives that are not cost-effective or cannot be easily implemented in a reasonable time-frame are eliminated from consideration at that point.

Comment 43: Page 3-12, 3.2.5.2.1 Landfarming.

Landfarming, involving soil handling and tilling, would not seem applicable to a contaminant as volatile as TCE. Would not the problem of vinyl chlorine formation (See 3.5.5.1.1) also exist with landfarming? Contaminant concentrations are probably too low to warrant consideration of biotreatment technologies. These comments apply as well to 3.2.5.2.2 Soil/Slurry Bioreactor.

Response: Landfarming is not considered for further evaluation. Soils contaminated with TCE have been successfully treated on a pilot-scale with a soil/slurry bioreactor.

Comment 44: Page 3-16, first paragraph.

In the third sentence, delete the contaminant concentrations in both the soil and the treatment solution are equal , and. Equilibrium relationship is not likely to be equal concentrations in soil and solvent.

This technology seems ill-suited for an interim response action because of the complexities of the process, e.g., it requires further treatment of large volumes of solid and liquid residue streams.

Response: The text has been changed from "equal" to "in equilibrium." The technology is not carried further in the alternative assessment due to testing required prior to implementation which makes it inapplicable as an IRA. The text has been changed.

Comment 45: Page 3-18, first sentence.

If this technology is not applicable to contaminants present in the Motor Pool Area, why was it even included for discussion?

Response: This was included for the benefit of the reader who may have been familiar with the technology and may have considered it applicable. The text has been changed to delete the discussion.

Comment 46: Page 3-18, second paragraph.

Low temperature thermal stripping can use other forms of heating besides the indirect fired recirculating glycol system mentioned here. Both indirect propane and direct fuel fired systems can be used.

Response: The text has been changed.

Comment 47: Page 3-18, last paragraph.

The two second residence time only applies to gases and vaporized liquids; soils and solids will require minutes or fractions of an hour to be decontaminated.

Response: The text has been changed.

Comment 48: Page 3-19, last paragraph.

See comment 47.

Elements in the contaminant molecules will also produce acid gases.

Response: The text has been changed.

Comment 49: Page 4-1, 4.1 Development of Soil Remediation Alternatives.

The containment strategy of intercepting groundwater, treating and reinjection should be an alternative considered. Also, removal and placement in a temporary waste pile, e.g., as with Basin F solids, would appear to be a logical strategy and should be considered.

The title of this Section reflects the absence of focus in this assessment on the objective of this IRA, i.e., to mitigate the threat of releases of contaminants from Motor Pool Area source(s).

Response: See response to Shell's General Comment No. 4.

Placement in a temporary waste pile is not considered because it is not cost-effective when compared to an in-situ technology such as vapor extraction that could be a cost-effective response for the type of contaminants in the Motor Pool Area.

The section title has been changed.

Comment 50: Page 4-3, second paragraph.

Details of a monitoring program should be tailored to the specific interim response action implemented. Thus it is premature to specify the details here, for example, sample frequency, sample location and analyte suite. It should be stated that the plan details are for purposes of cost estimating only.

Response: Only conceptual alternative designs are presented in the IRA Alternatives Assessment. The monitoring program outlined is appropriate for the location and types of contaminants in this area. As with any alternatives, changes to the conceptual design may be made during final design.

Comment 51: Page 4-3, fourth paragraph.

Why is air monitoring required for non-invasive strategies? Isn't the CMP sufficient?

Response: Air monitoring has been removed from the alternatives, except during invasive activities.

Comment 52: Page 4-4, Section 4.1.4.

As discussed in detail in Shell's Comments on the Landfill Feasibility Study, water balance calculations performed using the EPA HELP (Hydrologic Evaluation of Landfill Performance) MODEL indicate that evapotranspiration is the predominant mechanism. A multi-layered cap is not cost-effective when one considers that only the top layer provides any significant benefit. A single vegetated layer would suffice for this IRA.

Response: The multilayered cap alternative is eliminated from consideration in Section 6.2. Its main advantage is its ability to inhibit vertical contaminate migration. Other alternatives met the overall objective of the IRA to a greater degree.

Comment 53: Page 4-5, last paragraph.

Nevertheless, treatment of this stream would probably be necessary. For example, activated carbon will be necessary to treat wastewater from this process, however, the disposal or recycling of the spent activated carbon is not addressed.

Response: The text has been changed.

Comment 54: Page 4-10, 4.2 Remedial Alternative Evaluation Criteria.

The preeminent criterion is the effectiveness of an alternative in achieving the objective of this interim response action, i.e., to mitigate the threat of releases of contaminants from the Motor Pool Area with the goal of providing a benefit to cost or timing of RMA remediation (Section 1.2). This criterion is not addressed in this Section or anywhere else in this assessment.

This Section only defines CERCLA evaluation criteria for remedial actions. An alternative Assessment should relate these criteria to specific site conditions and the specific alternative being evaluated. There should be more focus in this Section 4.0 on this site and on the interim response objective and guidelines. The questions listed under the evaluation criteria sections may be generally applicable to Superfund sites but many of them do not seem applicable to an interim response action at this specific site.

Response: Only alternatives which meet the objective to mitigate the source of contamination are developed and evaluated.

An expanded alternative evaluation is presented in Section 6.2 of the final document.

Comment 55: Page 4-11, second paragraph.

> "How each alternative addresses each of the evaluation criteria will be presented in greater detail in the IRA Decision Document. However, a summary of alternative evaluation criteria is presented in Tables 4-1a and 4-1b."

Discussion of how the alternatives address evaluation criteria (and most importantly the objective of the IRA) is the whole point of an Alternatives Assessment document and should be included. The summaries in Tables 4-1a and 4-1b are too brief to be of value. The ability of the other Organizations and the State to comment meaningfully on the ranking of alternatives in Section 6.0 is limited if there is no such discussion.

Response: The Alternatives Assessment has been expanded in Section 6.2 of the final document.

Comment 56: Page 4-11, 4.2.1 Effectiveness.

> "The following questions need to be addressed to assess long-term effectiveness."

None of these questions appears to be addressed in this assessment except in very general terms in Tables 4.1a and -1b. For example, what risks are mitigated by the alternatives described? Section 1.2 states that this site does not appear to pose a significant risk to human or biota receptors at this time. Achievement of the objective of this interim response action should be the preeminent criterion considered in this Section.

Response: Section 6.2 provides a more detailed assessment.

Comment 57: Page 4-13, 4.2.2 Reduction in Mobility, Toxicity and Volume.

CERCLA expresses a preference for remedies that reduce mobility, toxicity, or volume. None of the issues listed are discussed with specificity to the respective alternative interim response action at this site.

Response: Section 6.2 provides a more detailed assessment.

Comment 58: Page 4-14, 4.2.3 Implementability.

None of the issues listed are discussed with specificity to the respective alternative response action at this site.

Based on the intent of IRA's, timing to completion is of the essence and should be an important criteria. However, it is not directly considered.

Response: Section 6.2 provides a more detailed assessment.

Comment 59: Page 4-15, 4.2.4 Overall Protection of Human Health and the Environment.

The presence of a threat from this site to human health or the environment is not discussed. What is the basis for evaluation of alternatives against this criterion at this site?

Response: The Federal Facility Agreement lists the Motor Pool Area as a "hot spot" for which an IRA Alternative Assessment is required. The objective of this IRA is to mitigate the threat of releases from the Motor Pool Area. Existing groundwater data presented in the WSAR shows the presence of a TCE plume emanating from the Motor Pool Area. The implementation schedule for both the Decision Document and the Response Action itself makes it difficult to collect a sufficient amount of data for the comprehensive risk assessment required to determine whether a significant risk to human health or the environment exists.

Alternatives were evaluated based on their ability to mitigate the threat of releases at the site.

Comment 60: Table 4-1a, Table 6-1.

What justifies the conclusion that the No Action and Monitoring alternatives are not protective of Human Health and the Environment?

Response: The objective of this IRA is to mitigate the threat of releases from the Motor Pool Area. Implied in this objective is that a threat actually exists. If a threat actually exists, then both no action and monitoring do little or nothing to respond to this threat.

Comment 61: Table 4-1a.

Under Overall Protectiveness, what specifically is "the risk" against which this criterion is applied?

Under Compliance with ARAR's, at this point in the IRA process ARAR's are identified only preliminarily. Statements under this column should be qualified accordingly. Also, the ability of the respective alternative to meet an ARAR may not be known prior to testing or design.

Response: The risks referred to here are any health risks to the community and the environment resulting from the presence of TCE contamination at the site.

ARARs for the selected alternative will be presented in the IRA Decision Document. It is assumed that any alternative selected would be designed and implemented to meet, to the maximum extent practicable, ARARs for that alternative.

Comment 62: Page 5-1, second paragraph.

> "Since the Federal Facility Agreement states that the IRA Decision Document should select the most cost effective alternative which meets the threshold criteria, ..."

More accurately, the FFA (Section 22.6) states: "The goal of the assessment shall be to ...select the most cost-effective alternative for attaining the objective of the IRA" (emphasis added). The objective of the IRA should not be confused with CERCLA evaluation criteria.

Response: The text has been changed.

Comment 63: Page 5-1, third paragraph.

> "A present worth analysis is also presented to compare alternatives with different project durations."

Since project life is the same (5 yrs) for all alternatives, the present worth analysis is used here to facilitate comparison of alternatives with different expenditure patterns during the five year period.

Response: The text has been changed.

Comment 64: Tables 5-2 through -8.

Costs for air monitoring will be substantially greater for alternatives involving excavation and/or treatment than for alternatives that do not.

Response: Typical air monitoring program costs have been developed in an attempt to address the impact of monitoring on the overall project costs. The purpose of air monitoring is to determine project impacts during implementation and to provide necessary information to inhibit operations if community impacts are suspected. The details of a monitoring program will be developed during implementation.

Comment 65: Page 6-1, 6.0 Conclusions.

The preeminent criterion as developed in Section 1.2, i.e., to affect the cost or timing of the Final Remedy, is not addressed in this classification. (Neither is it addressed under the CERCLA criterion of Effectiveness in Section 4.0). This classification is essentially a ranking by ability to meet CERCLA criteria.

Response: Section 6.2 provides a more detailed evaluation.

Comment 66: Page 6-2, last paragraph.

If on-site incineration at $8.5MM is "not preferred" because it is not cost-effective, how can off-site incineration at $14.4MM be "marginally preferred"?

Response: Offsite incineration is included as marginally preferred in order to maintain a range of alternative strategies for further evaluation (i.e. an offsite treatment/disposal option). This alternative is eliminated from further consideration in the more detailed alternative presented in Section 6.2.

Comment 67: Table 6-1.

The Institutional Controls alternative is listed here as not protective but in Table 4-1a as marginally protective.

Response: The text has been changed.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
COLORADO FIELD OFFICE
730 SIMMS STREET
ROOM 292
GOLDEN, COLORADO 80401

IN REPLY REFER TO:

11 1989

FWE/CO

Mr. Donald L. Campbell
Office of Program Manager
Building 111
Rocky Mountain Arsenal
Commerce City, CO 80022

Dear Mr. Campbell:

We have reviewed the following documents and have no comments on them at this time: (1) Rocky Mountain Arsenal Offpost Private Well Inventory and Information Survey; (2) the Draft Final Assessment Reports for the M-1 Basins Section one and the Motor Pool area in Section 4 of the Rocky Mountain Arsenal; (3) and, the Applicable, Relevant and Appropriate Regulations (ARAR's) pertaining to these sites .

We appreciate the opportunity to review and comment on the documents.

Sincerely,

Wm. R. Noonan

for LeRoy W. Carlson
Colorado State Supervisor

cc: Pete Gober, FWS
Tom Jackson, FWS
Bob Stewart, DOI
David Anderson, DOJ
Connally Mears, EPA