

## 5. RI/FS TASKS

This section outlines the remedial investigation/feasibility study (RI/FS) tasks and procedures that will be followed at Fort McClellan, Alabama. The principal project tasks including planning, field investigation, hydrogeologic characterization, human health and ecological risk assessment, and feasibility study are described below. The techniques and procedures to be used during this effort are outlined and will utilize the *Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports* (USATHAMA 1987), the *Compendium of Superfund Field Operations Methods* (U.S. Environmental Protection Agency [USEPA] 1987), and *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA 1988). Specific feasibility study and risk assessment guidance is cited in the appropriate sections below. Detailed operating procedures, sample and survey locations, and quantitative data management information is provided in the project Sampling and Analysis Plan.

### 5.1 PROJECT PLANNING

In addition to this work plan, SAIC will prepare a Quality Assurance Project Plan, Project Management Plan, Sampling and Analysis Plan, and Health and Safety Plan for the Fort McClellan RI/FS. Each of these planning documents is described separately below.

#### 5.1.1 *Project Management Plan*

A Project Management Plan will be prepared to document the overall management approach for the development of the RI/FS and will include a discussion of the technical approach, project schedules, detailed costs, and personnel. A draft and final version of the plan will be prepared.

#### 5.1.2 *Quality Assurance Project Plan*

A Quality Assurance Project Plan (QAPP) will be prepared using the January 1990 USATHAMA Quality Assurance Program and the *Engineering Support Branch Standard*

*Operating Procedures and Quality Control Manual* (USEPA 1991). Three drafts of the document and a final version of the plan will be prepared.

### ***5.1.3 Sampling and Analysis Plan***

A Sampling and Analysis Plan (SAP) will be prepared to document all monitoring procedures, field sampling, sampling procedures, and sample analyses to be completed during the RI/FS. The SAP will include a Data Management Plan to provide details regarding the sample numbering system, data transfer from the field including hard copy and Installation Restoration Data Management Information System (IRDMIS) transmittals, chain-of-custody, and data validation. Three drafts and a final version of the SAP will be prepared.

### ***5.1.4 Health and Safety Plan***

A Health and Safety Plan (H&SP) will be developed concurrently with the Sampling and Analysis Plan. The plan will contain all elements required by 29 CFR 1910.120. The plan will incorporate SOPs developed by the U.S. Army Technical Escort Unit (USATEU) for sampling in areas where chemical or biological surety material is potentially present. Three drafts and a final H&SP are planned.

## **5.2 REMEDIAL INVESTIGATION TASKS**

Upon acceptance and approval of project plans by the U.S. Army Environmental Center (USAEC) and the Alabama Department of Environmental Management (ADEM), the USATEU and SAIC will commence field activities at Fort McClellan. Investigation activities will include aerial photography and field reconnaissance, screening level surveys, field sampling, monitoring well installation and sampling, and risk assessment. The locations of sampling points are shown in the Sampling and Analysis plan. A summary of the RI tasks to be conducted at each site is provided in Table 5-1.

### ***5.2.1 Aerial Photography and Field Reconnaissance***

Prior to the onset of field work at Fort McClellan, SAIC will evaluate low altitude aerial photographs to be provided by the USAEC for each of the RI/FS sites. The photographs will

**Table 5-1. Summary of Remedial Investigation Tasks  
Fort McClellan, Alabama**

Site No.	Site Name	SI Field and Laboratory Results	RI/FS Activities
1	Area T-4	<ul style="list-style-type: none"> <li>Unable to locate site</li> </ul>	<p>Research site location using historical coordinates and aerial photography. Conduct additional field reconnaissance of site. Collect soil samples for analysis for MINICAMS analysis for CWA and laboratory analysis for CWA breakdown products.</p> <p>Surface soil MINICAMS screening for CWA. Laboratory analysis for CWA breakdown products.</p>
2	Area T-5	<ul style="list-style-type: none"> <li>HD, GB, VX chemical agent, agent breakdown products not detected at 5 locations</li> </ul>	<p>Delineate pit boundaries and possible ordnance geophysically; Surface soil MINICAMS screening; possible excavation in pit area; laboratory analysis of soil for CWA breakdown products.</p>
3	Area T-24A	<ul style="list-style-type: none"> <li>HD, GB chemical agent, agent breakdown products not detected at 3 locations</li> </ul>	<p>Locate disposal sump possible buried drums; Surface soil MINICAMS screening for CWA; drill soil boring in pit area; install 4 groundwater monitoring wells.</p>
4	Area T-38	<ul style="list-style-type: none"> <li>HD, GB VX chemical agent, agent breakdown products not detected at 4 locations</li> </ul>	<p>Additional site reconnaissance for CWA ordnance; Surface soil MINICAMS screening for CWA; Laboratory analysis for CWA breakdown products.</p>
5	Range K	<ul style="list-style-type: none"> <li>HD, GB, VX chemical agent, agent breakdown products not detected at 1 location</li> </ul>	<p>Assess site geophysically for additional burials; MINICAMS screening for CWA; laboratory analysis for CWA breakdown products; test pit excavations; Install/sample 3 GW wells.</p>
6	Range J	<ul style="list-style-type: none"> <li>HD chemical agent, agent breakdown products not detected at 4 locations</li> </ul>	<p>Install 7 monitoring wells; investigate pond area geophysically; Surface soil and groundwater MINICAMS screening for CWA; Laboratory analysis for CWA breakdown products; topographic surveying.</p>
7	Range L	<ul style="list-style-type: none"> <li>Samples not collected; metal detection indicates possible munitions burials at site</li> </ul>	<p>Surface soil MINICAMS screening; Laboratory analysis for CWA breakdown products; possible excavation at site.</p>
8	Detection and Identification Area	<ul style="list-style-type: none"> <li>HD, GB chemical agent, agent breakdown products not detected at 2 locations</li> </ul>	<p>Additional geophysical surveying in southwestern portion of site; monitoring well installation (4), sampling, and analysis.</p>
9	Former Landfill 1	<ul style="list-style-type: none"> <li>Magnetometer survey indicates potential ground disturbance</li> </ul>	

**Table 5-1. Summary of Remedial Investigation Tasks  
Fort McClellan, Alabama (continued)**

Site No.	Site Name	SI Field and Laboratory Results	RI/FS Activities
10	Former Landfill 2	<ul style="list-style-type: none"> <li>• Organics, inorganics, agent breakdown products not detected in groundwater</li> </ul>	Groundwater and surface water/sediment sampling and analysis. Survey 2 geophysical transects (EM, magnetometer).
11	Former Landfill 3 (OLF)	<ul style="list-style-type: none"> <li>• Organic and inorganic contamination detected in groundwater at site; explosive compounds detected in groundwater</li> </ul>	Install 9 additional wells; Delineate extent of groundwater contamination; hydrogeology; groundwater and surface water/sediment sampling; laboratory subsurface soil analysis for contaminants of concern.
12	Old Water Hole	<ul style="list-style-type: none"> <li>• Magnetometer survey indicates substantial quantities of buried material</li> </ul>	Investigate site using quantitative geophysics; install five perimeter groundwater monitoring wells; assess CWA surface soil contamination using MINICAMS screening and laboratory analyses; topographic mapping.

be used to document historical site usage and as a basis for confirming field reconnaissance. USEPA (1982, 1983) portfolios for areas T-24A, T-38, Range J, and for the northeastern corner of Pelham Range are currently available for the project. The aerial photography will be used to identify structures and areas for investigation in the field and will be used to guide the placement of sampling points and monitoring wells dependent on the available coverage. Global Positioning System (GPS) technology and land surveying will be used during field reconnaissance to verify field coordinates and to locate remote structures quantitatively.

### **5.2.2 Screening Surveys**

Screening-level surveys including MINICAMS analyses and geophysical surveys will be conducted at the RI/FS sites to provide broader-based areal coverage of the site areas and to provide non-intrusive investigation methods for areas containing uncontrolled munitions or chemical agents. MINICAMS surveys will be conducted to provide broader spatial analysis of the distribution of detected chemical agent in the surficial and shallow subsurface site soils. MINICAMS analyses will be used at all of the former Army training areas. MINICAMS sampling distribution will be determined using a systematic (triangular grid) sampling scheme combined with biased sampling of known training localities. USEPA (1989) guidance (*Methods for Evaluating the Attainment of Cleanup Standards, Volume 1: Soils and Solid Media*) will be used for selection of sampling locations. Geophysical surveys including magnetometry, electromagnetic conductivity, and ground penetrating radar will provide non-intrusive data regarding the distribution of subsurface anomalies particularly at Range L, Old Water Hole, Area T-38, and Former Landfill #2. Geophysical data will be collected along transects and grids.

### **5.2.3 Field Sampling**

In addition to the survey-level sampling and analysis to be conducted for the RI/FS, environmental samples will be collected and laboratory analyzed to quantitatively assess environmental contamination at the sites. Subsurface soil, surface water, sediment, and groundwater samples will be collected and analyzed according to the schedule outlined in Table 5-2. Groundwater samples will be collected from monitoring wells, on-Post potable water sources, and from the Town of Weaver water supply wells. Two rounds of groundwater

sampling will be conducted for existing wells and for the additional wells to be installed during the RI. Field sampling activities to be conducted by the USATEU will be under the oversight of SAIC QA/QC personnel.

#### ***5.2.4 Intrusive Sampling and Monitoring Wells***

The purpose of the soil drilling program is to obtain subsurface soil samples for lithologic and chemical analysis, stratigraphic information, and to install groundwater monitoring wells. Subsurface soil samples will be field-described to determine the sample lithology. Soil samples will be collected at 5-foot intervals and at distinct changes in lithology. These samples will be screened in the field using a photoionization detector (PID) to provide field information on potential contaminant distributions. The location of the soil borings will be based on the history of the site and the locations of existing monitoring points. Soil sample locations are provided in the SAP.

To provide additional information concerning the hydrogeology and hydrochemistry of the sites under investigation, the soil borings will be completed as monitoring wells after the soil samples have been collected and the total borehole depth is reached. The monitoring wells will provide necessary site-specific information on the groundwater quality and elevation. Subsequent to the completion and development, groundwater samples will be collected from the monitoring wells.

A minimum of 33, schedule 40 polyvinyl chloride (PVC) monitoring wells will be installed during the RI/FS. The distribution of existing wells and the planned additions of new wells are shown in Table 5-3. The wells are planned to provide groundwater sample locations for chemical analysis to determine the groundwater quality near the sites under investigation. Monitoring wells also will be used to obtain water level data for determining site-specific groundwater flow direction at the landfill and munitions burial sites. Monitoring well installations at Landfill #3 will include approximately 3 off-Post well placements west of the facility boundary.

Table 5-2. Summary of RI/FS Sampling and Analysis

Site	Soil Analyses										Water Analyses																
	Field Screening Laboratory Sediment					Agent Breakdown Products					Groundwater					Agent Breakdown Products											
	Soil Samples (HD,VX,GB)	Soil Samples	Sediment Samples	Soil Samples	Soil Samples	HDGB	VX	VOC	SVOC	Metals	PCB's	Pesticides/	Explosives	TCLP	Groundwater Samples (2rounds)	Surface Water Samples	HDGB	VX	VOC	SVOC	Metals	PCB's	Pesticides/	BOD	TCLP	Explosives	
T-4	10	4	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
T-5	26	4	2	6	6	2	2	2	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2	2	2	0	2
T-24A	7	6	1	7	7	0	7	7	7	7	0	7	7	0	0	1	1	1	1	1	1	1	1	1	1	0	1
T-38	56	6	0	6	6	6	6	6	6	6	6	6	6	3	8	0	8	8	8	8	8	8	8	8	0	2	8
Range J	11	4	0	4	0	0	0	0	0	0	0	0	0	1	6	0	6	0	0	0	0	0	0	0	0	0	0
Range K	10	4	0	4	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Range L	50	8	2	10	10	10	10	10	10	10	10	10	10	3	14	4	18	18	18	18	18	18	18	18	4	2	18
Detection & Identification	13	4	0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Old Water Hole	50	8	0	8	8	8	8	8	8	8	8	8	8	2	10	0	10	10	10	10	10	10	10	10	0	2	10
Landfill #1	0	8	2	0	0	0	10	10	10	10	10	10	10	2	8	2	0	0	0	10	10	10	10	10	2	2	10
Landfill #2	0	0	2	0	0	0	2	2	2	2	2	2	2	0	6	2	0	0	0	8	8	8	8	8	2	2	8
Landfill #3	0	12	2	0	0	0	14	14	14	14	14	14	14	4	38	4	0	0	42	42	42	42	42	4	2	42	
Background	0	4	2	6	6	6	6	6	6	6	6	6	6	1	8	3	11	11	11	11	11	11	11	11	3	0	11
Town of Weaver	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	2	2	2	2	2	0	2	
Potable Water	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	4	4	4	4	4	4	4	4	0	4	
Quarterly LF-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	19	19	19	19	19	0	2	19	
<b>Total</b>	<b>293</b>	<b>72</b>	<b>13</b>	<b>59</b>	<b>47</b>	<b>36</b>	<b>65</b>	<b>65</b>	<b>65</b>	<b>65</b>	<b>58</b>	<b>67</b>	<b>16</b>	<b>123</b>	<b>18</b>	<b>60</b>	<b>54</b>	<b>54</b>	<b>135</b>	<b>135</b>	<b>135</b>	<b>135</b>	<b>18</b>	<b>18</b>	<b>14</b>	<b>135</b>	

**Table 5-3. Monitoring Well Placements**

Site	Existing Wells	Planned Wells
T-4	0	0
T-5	0	0
T-24A	0	0
T-38	0	4
D & I	0	0
Range J	0	3
Range L	0	7
Old Water hole	0	5
Former Landfill #1	0	4
Former Landfill #2	3	0
Former Landfill #3	10	9
Background	2	1
Total	15	33

Background samples will be obtained from three locations on the Main Post and from one location on Pelham Range. Background groundwater samples will be obtained from the existing well at Reilly Lake, from a proposed well east of the operating Landfill #4 (to be installed as part of a RCRA action at the landfill), and from a proposed well southeast of Range T-24A. A potable well at Rideout Hall on Pelham Range will also be sampled. Upgradient wells at individual sites may also be regarded as representative of background conditions if the well is determined to be consistently upgradient. Background soil samples will also be collected at these locations. Surface water and sediment samples collected upgradient of sites T-5, T-24A, Landfill #2, and Landfill #3 will be treated as background for the Main Post and Pelham Range.

**5.2.5 Surveying**

Accurate location of sampling points and monitoring wells is necessary for correctly interpreting analytical results and physical measurements, for data management within the computer-based IRDMIS, and for concise mapping of site features. At present, detailed

topographic maps are not available specifically for the all of the RI/FS sites. Topographic surveying will be conducted at Range L and Old Water Hole because detailed (1 to 2 foot contour intervals) mappings of these sites will be necessary for engineering purposes. Soil boring, monitoring well, and geophysical grid/transect locations at all sites will be surveyed by a registered surveyor. SAIC and USATEU may utilize GPS technology to locate unmapped, existing structures, monuments, markers, and screening-level sample locations. The accuracy for the GPS surveys will be quantified against known control points.

### ***5.2.6 Document and Data Management***

Document and data management for the Fort McClellan RI/FS will utilize SAIC's Central Record Facility (CRF) and USAEC's Installation Restoration Data Management Information System (IRDMIS) to archive reports, memoranda and other project correspondence and to manage geographic, analytical, and geotechnical results on USAEC's Unix-based Pyramid microcomputer system. These systems have been selected and designed such that access is limited and transactions are monitored to provide legally defensible and traceable data. Details of the document and data management are provided in the SAP. SAIC's CRF is a computer-based document archive system that incorporates scanned documents and library archives. The CRF is managed and operated by SAIC in Oak Ridge, Tennessee. The IRDMIS is USAEC's information repository for global data pertinent to U.S. Army posts around the world. The IRDMIS database is administered, maintained, and operated by Potomac Research Incorporated (PRI) and incorporates user-level personal computer access to the mainframe databases.

#### **5.2.6.1 Document Control System**

The CRF was designed to secure and archive information, usually reports, documents or memoranda, generated during activities on SAIC contracts. The CRF will be used to provide legal traceability (i.e., during external audits) to any project related transactions between regulatory agencies, USAEC, and SAIC. Historical information and documents for the Fort McClellan RI/FS will be maintained at SAIC's regional office in McLean, Virginia. A document control number (DCN) will be assigned to all project documents to facilitate access and retrieval.

### **5.2.6.2 IRDMIS**

SAIC and analytical laboratory personnel have been trained in using the IRDMIS Data Entry and Validation Subsystem (PC Tool, Version 5.0). SAIC staff will be responsible for entering, correcting, and updating map and geotechnical data. Laboratory data management personnel will be responsible (under SAIC oversight) for entering and correcting chemical data and for submitting control charts to the USAEC Chemistry Division for review. The following sections summarize the procedures SAIC will use to enter data into IRDMIS and ensure that the laboratories are submitting error-free chemical transfer files.

USAEC's data entry and storage system recognizes three levels of data, Level 1 through Level 3, with increasing levels of security. Level 1 data reside on computers at SAIC and the laboratories. Level 1 chemical data have not been corrected for moisture content. After SAIC and the laboratories have submitted transfer files to PRI, the data are elevated to Level 2 (i.e., property of the Army). After passing record and group check at PRI, level 2 data are elevated to level 3, which are the responsibility of the AEC. Direct access to level 3 data within IRDMIS is only available to authorized U.S. Army personnel and contractors (Figure 5-1).

### **5.2.6.3 Sample Tracking and Chain-of-Custody**

USAEC's Pyramid system provides a secure archive location for electronic data, however, in order to ensure that only legally defensible data are submitted to the Pyramid, rigorous chain-of-custody (COC) and quality control (QC) processes are required. COC procedures will be implemented as an adjunct to SAIC's sample tracking system (STS).

SAIC will use USAEC's IRDMIS PCTool Data Entry and Validation Subsystem (Version 5.0), prepared by PRI to enter map and geotechnical data. The laboratories, Data Chem (DCL) and Environmental Science and Engineering (ES&E), have developed software for entering chemical data. After entry, SAIC and the laboratories will transmit transfer files to USAEC's electronic bulletin board system (BBS) for processing.

During the field investigation, SAIC's field sampling team will enter data and update the STS on notebook computers. The field sampling teams will use notebook computers and dot-

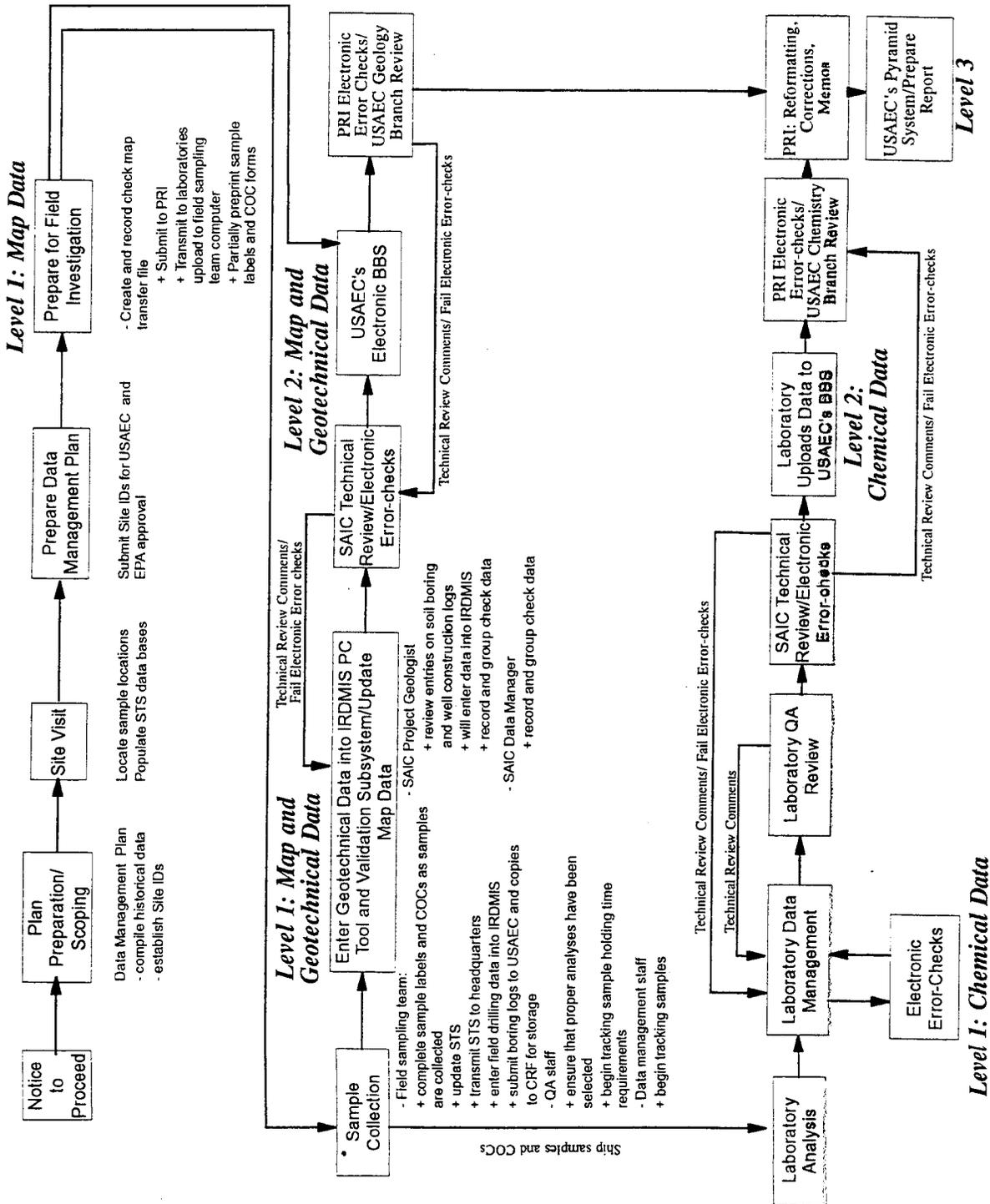


Figure 5-1. Data Management Flow Diagram for Fort McClellan RI/FS

matrix printers. Fax/modem boards with communication software are installed on the computers for transmitting information to SAIC-McLean and the analytical laboratories.

### **5.2.7 Reporting**

The RI report will incorporate data and information from all phases and tasks of the RI into a comprehensive document. The report format will closely follow the suggested USEPA format and will include all historical and background information, field measurements, analytical results, field protocols, identified nature and extent of contamination, contaminant fate and transport, hydrogeologic data interpretations, ecological and baseline risk assessment results, and raw data tabulations. A preliminary RI report outline is shown in Table 5-4. SAIC will prepare three drafts and a final report documenting the results and findings of the remedial investigation.

## **5.3 BASELINE RISK ASSESSMENT**

A human health risk assessment and ecological evaluation will be conducted for the 12 sites comprising the Fort McClellan RI/FS. The baseline risk assessment considers site conditions in the absence of remedial actions. The risk assessment examines the presence and release of chemical contaminants from the sites under investigation, the observed levels of the substances in the environment, the potential routes of exposure to human and ecological receptors, and the likelihood of adverse effects following contact with contaminated environmental media.

A detailed assessment of the exposure settings, exposure pathways, exposure routes, and receptor populations at each site is not included in this document. This work plan is intended to provide an overview of the anticipated approach to the risk assessment based on a preliminary review of conditions and previous site information.

Methods to characterize risk in the RI/FS will be consistent with those specified by USEPA for remedial investigations (RIs). USEPA guidance documents will be used to complete the assessment including *Risk Assessment Guidance for Superfund Volume I, Human Health Evaluation Manual* (USEPA 1989a), and *Risk Assessment Guidance for Superfund Volume II,*

*Environmental Evaluation Manual* (USEPA 1989c). An overview of risk assessment for the RI is presented in the National Contingency Plan (NCP) and in the USEPA manual *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA 1988b).

The baseline risk assessment does not state actual risks, rather it is an assessment of hypothetical health problems associated with exposure to chemicals detected at each site. The intent is to support site management practices by determining if there is a theoretically significant threat to human health and the ecosystem.

### **5.3.1 Human Health Evaluation**

The general approach to risk assessment of exposure to contaminated environmental media is well established. The National Research Council (NRC) prepared a comprehensive overview of the structure of this assessment (NRC 1983) that has become the foundation for subsequent USEPA guidance. The *Human Health Evaluation Manual* and the *Environmental Evaluation Manual* (USEPA 1989a,b) provide a detailed presentation of the risk assessment process. As specified by USEPA, the human health and ecological evaluation process may be divided into four fundamental analytical components:

- Data evaluation and hazard identification
- Exposure assessment
- Toxicity or hazard assessment
- Risk characterization.

A fifth component of the baseline risk assessment is the uncertainty analysis, which helps put into perspective the confidence underlying the health risk estimates. The uncertainty analysis is an important site management tool, in as much as it helps to put the results of the risk assessment into perspective. The risk assessment analyzes chemical exposures related to each site by considering the significance of the following endpoints:

**Table 5-4. RI Report Format**

Executive Summary
1. Introduction
1.1 Purpose of Report
1.2 Site Background
1.3 Report Organization
2. Study Area Investigation
2.1 Field Investigations
3. Physical Characteristics of Study Areas
3.1 Results of Field Activities
4. Nature and Extent of Contamination
4.1 Results of Chemical Analyses
5. Contaminant Fate and Transport
5.1 Potential Routes of Migration
5.2 Contaminant Persistence
5.3 Contaminant Migration
6. Baseline Risk Assessment
6.1 Human Health Evaluation
6.2 Environmental Evaluation
7. Summary and Conclusions
7.1 Summary
7.2 Conclusions
8. References
Appendices

- Chronic or subchronic noncancer effects
- Cancer effects
- Decreased ability of the ecosystem to function,
- Decreased reproduction by threatened or endangered species (if any)
- Threats to critical habitats (if any) defined under the Endangered Species Act.

These analyses relate to both human and ecological effects as analytical endpoints. The evaluation of human health effects will be based on estimates of exposure and risk. The evaluation of ecological effects will be based on comparison of the ecological surveys from the sites with those of uncontaminated reference areas.

#### **5.3.1.1 Data Collection, Evaluation, and Hazard Identification**

The first step in the risk assessment process will be to obtain and evaluate all available data on contaminants present within the sites under investigation. The objective is to collect and organize the data into a form that may be used in the baseline risk assessment, as follows:

- Collect and analyze samples and sort the preliminary analytical data set by environmental medium.
- Examine the extent to which environmental monitoring data are aggregated to represent exposures likely to occur at the site (e.g., or alternately represent areas of elevated contamination or hotspots within a site)
- Summarize information on background concentrations of chemicals and compare those with observed levels of site-related contamination
- Identify chemicals of potential concern: develop an initial data set that may be appropriately used in the risk assessment process
- Limit the number of chemicals to be used as the subject of the risk assessment, if appropriate.

Existing and newly collected sample data will be of sufficient quality for human health assessment and for comparing background levels to concentrations at each site. Sample sets will be large enough to avoid anomalous results where, for example, one sample with an extreme

concentration (high or low) might bias the exposure estimates. Background samples will represent conditions that would exist in the absence of the disposal practices.

From the full listing of all chemicals identified at each site, a subset will be identified that is of sufficient quality to be used in risk assessment. It may or may not be practical to evaluate all chemicals that have passed through data quality review. Representative "highest risk" compounds may be selected on the basis of:

- Quantities present at the site
- Extent of environmental contamination, toxicity, or hazard
- Mobility and persistence of the chemical in the environment.

This final screening step for reducing the number of substances is specified as optional by USEPA, since it does not improve the quality or accuracy of the risk assessment. This option can help facilitate the risk assessment process when and if time and resources prohibit the evaluation of the full and complex data set. In order to prevent inappropriate screening of substances, the decision to eliminate any substance from further consideration will be based only on data that has passed data quality review.

#### **5.3.1.2 Exposure Assessment**

The objectives of the exposure assessment will be to:

- define the exposure setting, which describes the source of chemical release to the environment for each site
- delineate exposure pathways, exposure points (where receptors may contact contaminated media), and exposed receptors
- measure or estimate the chemical uptake from the exposure for the receptor in contact with the contaminated media.

The environmental data are used to represent the magnitude and extent of contamination within each environmental medium, and may include an assessment of the transport and trans-

formation of the subject compounds. Exposure profiles are descriptions of each receptor, and these will be developed to define receptors and their exposure to site contaminants.

*Sources of Chemical Release*—Environmental contamination related to past site activities has been identified from earlier investigations and is likely to be confirmed at some sites during the RI. In particular, soil will likely be a media of concern, with a particular focus on soil exposures to humans and terrestrial biota (e.g., small mammals, birds, and vegetation).

*Exposure Pathways, Points, and Receptors*—Human exposure pathways will include ingestion and dermal contact with contaminated soils, inhalation of soil (dust), and ingestion of groundwater and surface water usage. There are residential areas within one mile of Fort McClellan, and future residential receptors will be considered for exposures via ingestion, inhalation, and dermal contact. Conceptual site models will be developed, which are written and graphical depictions of each pathway, receptor and exposure route of concern.

Table 5-5 indicates the receptors for inclusion in the baseline risk assessment, as based on existing information. The receptors are individuals who come into contact with site media as follows:

- Workers or personnel contacting soil while engaged in work activities (occupational or commercial)
- Trespassers (or personnel) contacting soil while engaged in recreational activities such as hunting and hiking
- Future residents contacting soil at home after land use conversion project
- Residential and occupational groundwater consumers
- Persons or animals contacting or ingesting affected surface water or sediments.

Although there are no residential settings at any of the sites, residential land use is considered for each of the site at some time in the future. Whether or not an installation is on a closure list is not usually considered sufficient justification for eliminating the future resident scenario.

*Quantifying Exposure Through Chemical Uptake*—USEPA specifies that actions at hazardous waste sites should be based on an estimate of the reasonable maximum exposure (RME) expected to occur under both current and future land-use conditions (USEPA 1989a). USEPA defines the reasonable maximum exposure as the highest exposure that is reasonably expected to occur at a site. RMEs are estimated for individual pathways, and combined across exposure routes if appropriate.

In addition to RME estimates, the baseline risk assessment will provide analogous most likely exposures (MLE), which are intended to represent more average exposures. MLE and RME exposures thus provide a range of estimates that may be useful in interpreting the significance of the results of the baseline risk assessment.

Once receptors at risk are identified, environmental concentrations at points of exposure will be determined or projected. Exposure concentrations will be based on the results of site monitoring. Transport modeling is not required other than the in the use of factors to estimate respirable soil particulate emissions. Representative concentrations for use in risk assessment will be taken as the arithmetic mean (for MLEs) and upper 95 percentile confidence limit on the arithmetic mean (UCL, for RMEs) of the sampling results. "Not detected" results will be incorporated into the calculations as one half the limit of detection.

In the *Supplemental Guidance to Risk Assessment Guidance: Calculating the Concentration Term* (USEPA 1992), USEPA states "The 95 percent UCL of a mean is defined as a value that, when calculated repeatedly for randomly drawn subsets of site data, equals or exceeds the true mean 95 percent of the time. Although the 95 percent UCL of the mean provides a conservative estimate of the average (or mean) concentration, it should not be confused with a 95th percentile of site concentration data." The 95 percentile UCL estimates are statistically conservative, protective of health, and are recommended by USEPA (USEPA 1989c). USEPA guidance also notes that environmental concentrations are "best expressed as an estimate of the arithmetic mean regardless of the distribution of the data" (USEPA 1992b). This point applies to the calculation of exposure point concentrations (EPC). Although the distribution of sample data is an important consideration when performing statistics on sample

**Table 5-5. Potential Exposure Pathways under Current and Future Land Use at Fort McClellan**

Potentially Exposed Individual	When Exposed	Exposure Pathway	Pathway Included in Evaluation?	Exposure Route	Comment
Resident adult and child	Future (no residents currently at sites).	Soil around home	Yes	Ingestion, Dermal, Inhalation	Although unlikely land use at these SWMUs, this is included in evaluation of future land use as a conservative measure.
		Groundwater used in home	Yes	Ingestion, Dermal, Inhalation	Included in evaluation of future land use as a conservative measure.
		Surface water	No		Surface water exposure considered under trespasser scenario.
		Sediment	No		Sediment exposure considered under trespasser scenario.
		Air (vapors, not dust)	No		Very low potential for vapor release from these SWMUs. Open spaces; Minimal potential for exposure.
		Food Chain	No		Significant effort required to convert to residential, garden prospects poor; soils very salty. Grazing unlikely in contaminated areas.
Workers	Current or Future	Soil around workplace	Yes	Ingestion, Dermal, Inhalation	Could occur at work and during projects that disturb pavement and soil.
		Groundwater used at work	Yes	Ingestion	Groundwater exposure for water consumed at work.
		Surface water	No		Surface water exposure considered under trespasser scenario.
		Sediment	No		Sediment exposure considered under trespasser scenario.
		Air (vapors, not dust)	No		Very low potential for vapor release from these SWMUs. Open spaces; Minimal potential for exposure.
		Food Chain	No		Unlikely in workplace setting.
Trespasser, adult and child	Current	Soil	Yes	Ingestion, Dermal, Inhalation	This is the only remote SWMU, trespassing at other SWMUs very unlikely.
		Groundwater used in home	No		Excluded from task scope; evaluated separately.
		Surface water	Yes	Ingestion, Dermal	Included in evaluation of future land use as a conservative measure.
		Sediment	Yes	Ingestion, Dermal	Included in evaluation of future land use as a conservative measure.
		Air (vapors, not dust)	No		Very low potential for vapor release from this SWMU. Open spaces; Minimal potential for exposure.
		Food Chain	No		Impractical correlation of tissue concentrations to specific sites.

data, when used for EPCs the sample data are always treated as a normal distribution. This is because EPCs are used to assess multiple exposures occurring over time. The distribution of these multiple average exposures is always normal regardless of the sample data distribution.

The 95 percent UCL will be calculated using the following formula:

$$UCL = \bar{x} + t \left( \frac{s}{\sqrt{n}} \right)$$

where:

- $\bar{x}$  = mean or average concentration
- s = standard deviation (for the sample)
- t = statistical value from the t-distribution (one-tailed test)
- n = number of samples.

Intake and dose estimates (in (mg/kg)/day) will be developed for each substance of potential concern using the representative environmental concentrations (i.e., mean and UCL values). Estimates of dose are needed in the risk characterization and will be generally determined as follows:

**Intake Equations.** Chemical intakes are estimated by means of the following general equation:

$$Intake (mg/kg-day) = \frac{C \times IR \times EF \times ED \times CF}{BW \times AT}$$

where:

- C = Chemical Concentration (Exposure Point Concentration)
- IR = Intake Rate
- EF = Exposure Frequency
- ED = Exposure Duration
- BW = Average Body Weight
- AT = Averaging Time
- CF = Dimensional Conversion Factors to attain units of mg/kg-day.

The above expression is the general form of the equation that will be used to derive estimates of subchronic or chronic intake or dose (lifetime assumed to be 70 years). The chronic dose estimate based on mean and UCL concentrations in environmental samples will be used as the basis of the risk characterization.

#### **5.3.1.3 Toxicity Assessment**

The objectives of the toxicity or hazard assessment will be to evaluate the inherent toxicity of the substances under investigation, and to identify and select toxicological values for use in evaluating the significance of exposure. The following are several toxicity values of importance that are typically used to evaluate human health risk:

- Reference doses (RfDs) for oral and inhalation exposure - acceptable intake values for chronic chemical exposure (noncarcinogenic effects)
- Carcinogenic slope factors for oral and inhalation exposure to chemical contaminants;
- A benchmark blood lead level for uptake of lead into children.

The primary source of information for these data is the Integrated Risk Information System (IRIS) data base, an USEPA computer database. Data in the IRIS system is regularly updated and represents the most current source of this information. In some cases toxicity that is unavailable on IRIS may be found in the USEPA Office of Research and Development (ORD) Health Effects Assessment Summary Tables (HEAST: FY 1993). SAIC has on-line access to the IRIS Data Base and receives the quarterly HEAST publications from USEPA ORD. If toxicity values are not available from these sources, and if specific guidance is unavailable from USEPA, the substance will be included but will not be quantitatively evaluated in the baseline risk assessment.

#### **5.3.1.4 Risk Characterization**

The last step, risk characterization, is the process of integrating the results of the exposure and toxicity assessment. It is common practice to consider risk characterization separately for carcinogenic and noncarcinogenic effects because of differences in the way

organisms respond to carcinogenic or noncarcinogenic agents. The evaluation of noncarcinogenic effects assumes a threshold of exposure below which adverse health impacts are unlikely. There is no such assumption for carcinogenic compounds, however, and all such exposures are assumed to carry some cumulative cancer risk.

*Noncancer Effects*—Traditionally, exposure to noncarcinogenic compounds has been evaluated by determining an experimentally-derived no observable adverse effect level (NOAEL) which is further reduced with safety factors in order to estimate an acceptable human dose such as an acceptable daily intake or RfD (NRC 1983). The RfD is then compared to the average daily dose experienced by the exposed, an individual (or population), to obtain a measure of concern for adverse noncarcinogenic effects:

$$HQ = \frac{\text{Dose}}{\text{RfD}}$$

where:

- HQ = Hazard Quotient: potential for adverse noncarcinogenic effects
- Dose = average daily dose for subchronic or chronic exposure (mg/kg body weight/day)
- RfD = acceptable intake for subchronic or chronic exposure (mg/kg body weight/day).

A HQ greater than 1 indicates a potential for adverse noncancer effects at the given exposure/dose level. Under current guidance (USEPA 1986b, USEPA 1989a), exposure to mixtures of noncarcinogens involves summing the HQs for all chemicals evaluated. If the sum of these ratios (the Hazard Index or HI) is less than 1, then the potential exists for adverse noncancer effects due to the combined effect of multiple chemicals. In this case USEPA recommends segregating the chemicals into groups of like or common toxicological effects, and again evaluating the potential health effects.

**Cancer Effects**—Procedures developed for evaluation of carcinogens (USEPA 1986b,c; USEPA 1989a) use a nonthreshold dose-response model to calculate a cancer slope factor (CSF). The CSF assumes linearity in the lowest portions of the toxicologic dose-response curve for each chemical, which means that at very low levels of exposure there is a linear relationship between dose and effect. To estimate the cancer risk related to a particular substance, the cancer slope factor is multiplied by an estimate of the chronic daily dose experienced by the exposed individual:

$$\text{Risk} = \text{CDI} \times \text{CSF}$$

where:

Risk = Upper bound estimate of the excess lifetime cancer risk to an individual (unitless probability)

CDI = Chronic daily dose averaged over a 70-year period (mg/kg body weight/day)

CSF = 95 percent upper-bound estimate of the slope of the dose-response curve (mg/kg body weight/day)<sup>-1</sup>.

The product of the CSF and the daily intake or dose (averaged over a lifetime) is the excess (or incremental) lifetime risk of an individual developing cancer. USEPA notes that the equation assumes that the dose-response relationship is linear, meaning the slope factor is constant and thus risk is directly proportional to intake. In evaluating risk of exposure to more than one carcinogen, the cancer risk for each substance is summed to provide an overall estimate of total carcinogenic risk (USEPA 1989a).

$$\text{Risk}_T = \sum_{i=1}^n \text{Risk}_i$$

where:

Risk<sub>T</sub> = The combined excess lifetime cancer risk across chemical carcinogens

Risk<sub>i</sub> = The risk estimate for the i<sup>th</sup> chemical of n chemicals under evaluation

This step sums the cancer risks for each source of environmental release, associated exposure pathway, and receptor group at risk of exposure.

*Lead*—The method for characterizing risk from exposures to lead differs from that of other chemicals. USEPA currently provides no toxicity values for lead, and considerable uncertainty exists regarding the selection of a single point estimate for acceptable or unacceptable health effects due to lead. Recent toxicologic developments indicate that health effects attributable to lead may be much more prevalent than previously thought and may or may not be associated with threshold effects. In particular, neurological effects and learning disabilities in children may occur at relatively low exposure levels, and this has prompted a reduction in the latest Center for Disease Control guideline for blood lead levels in children, from 25  $\mu\text{g}/\text{dL}$  to 10  $\mu\text{g}/\text{dL}$  lead.

USEPA has developed a computer program, LEAD 0.6 (USEPA 1993d) that estimates blood lead uptake from various environmental sources. Blood lead levels are considered a more appropriate indicator of low-level lead exposures than are the classic symptoms associated with much higher lead exposures. For the purpose of risk assessment, blood lead levels are estimated and compared to a benchmark target blood lead level. The RI/FS risk characterization for lead will be based on this alternative approach, in which blood lead uptake in children are estimated.

LEAD 0.6 analyzes blood lead uptake in children, the most sensitive receptors of lead exposures, and is not currently applicable to adults. Analysis using LEAD 0.6 will be limited, therefore, to children as potential receptors. Because the LEAD 0.6 model is not designed for analysis of exposure to adults, the soil lead EPCs will also be compared to recently published soil lead guidelines (USEPA 1991f). These guidelines establish a range of values for total lead in soil as interim cleanup levels. Although the guidelines are also largely based on effects in children, the comparison will provide additional information that may be used for evaluating the significance of lead exposures at Fort McClellan.

### **5.3.2 Baseline Ecological Risk Assessment**

The regulatory and scientific frameworks that guide the baseline ecological risk assessment (ERA) at the 12 sites at Ft. McClellan are contained in the *Risk Assessment Guidance for Superfund, Vol. II, Environmental Evaluation Manual, Interim Final* (USEPA 1989b), *Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document* (USEPA 1989d). The baseline ERA, comprising four interrelated activities (problem formulation, exposure assessment, effects assessment, and risk characterization), is structured according to a proposed general framework for ecological assessments (USEPA 1991d, 1992d).

#### **5.3.2.1 Objective and Scope of the ERA**

The objective of the baseline ERA is to define and evaluate the risk of adverse effects on aquatic and terrestrial organisms from exposure to chemical warfare agent breakdown products, VOCs, SVOCs, metals, pesticides/PCBs, and explosives associated with soil, sediment, surface water, and groundwater at the 12 sites.

The scope of the baseline ERA includes both terrestrial and aquatic organisms that may be directly or indirectly exposed to contaminants associated with the sites. Concentration data may exist for contaminants in various environmental media at the sites (e.g., soil, surface water, sediment, groundwater, and biota). Semi-quantitative ecological surveys designed to determine the abundance and distribution of indicator organisms and historical survey information will form the basis of the habitat and receptor characterizations. Site contaminants will be screened for assessment as ecological contaminants of concern (ecoCOC) based on their environmental concentrations relative to toxicity-threshold concentrations and their mobility and persistence characteristics. Field measurements of contaminant concentrations, measurements of exposure (i.e., body burdens), and published toxicity data allow a semi-quantitative estimate of risk based on the ratio of environmental exposure concentrations to toxicity threshold concentrations. This information will be used to characterize the magnitudes of risks to ecological resources from contaminated media on a location-by-location basis at the site.

The planned soil, sediment, surface water, groundwater and biota samples from the 12 OUs will provide the data needed for agent breakdown products, VOCs, SVOCs, metals, pesticides/PCBs, and explosives. The exposure of organisms will be estimated by measurement and modeling. Measurement of contaminant body burdens will be taken at three sites (Range L, Landfill #2, and Landfill #3). Whole-body analyses will be completed on four or more organisms at each of the four locations. The full set of chemical analyses is recommended for the sampled organisms. Candidate organisms are earthworms, small mammals, fish, amphibians, or snakes. Reference biota measurements will be obtained at one of the soil or sediment/surface water background sites. Three soil samples at each of the biological sampling sites (3 sites and 1 reference) and all sediment samples will be analyzed for grain size distribution. Temperature pH, conductivity, and dissolved oxygen measurements will be obtained in the field at each surface water sampling site. Biological oxygen demand will be measured in the laboratory for each surface water sample.

#### **5.3.2.2 Problem Formulation**

In the problem formulation activity of the baseline ERA, the ecological resources at the site and the ecological contaminants of concern (ecoCOCs) will be identified. Information pertinent to the conceptualization of potential problem areas at Fort McClellan will be obtained from previous ecological assessments, Fort McClellan Natural Resources surveys, previous and ongoing environmental investigations, and the SI and RI data.

#### **5.3.2.3 Habitat Characterization**

The habitat characterization of the site will include a description of the regional vegetation as well as vegetation and wildlife species in different habitats at the 12 sites. Ecological information for the habitat characterization will be obtained predominately from the natural resources department of the Fort McClellan Environmental Management office. Historical survey information will be gathered to determine whether there are threatened or endangered species or critical habitats near the sites.

#### 5.3.2.4 Ecological Contaminants of Concern

According to USEPA (1991b), factors determining whether a contaminant should qualify as an ecoCOC include: environmental concentration, frequency of occurrence, background levels, bioavailability, physical and chemical properties (e.g., adsorption), potential for bioaccumulation, toxicity, and effects. Potential ecoCOCs at the site will first be identified from a comparison of site and background concentrations in soil, sediment, and surface water, the frequency of occurrence, and sample quantification limits. These will then be screened as ecoCOCs on the basis of their thresholds for toxicity, mobility, and persistence.

Thresholds for toxicity, mobility, and persistence will be chosen using available data in standard reference texts and electronic databases. Thresholds for many VOCs, SVOCs, metal, and pesticides/PCBs are established and these data will be used for this site. Data will be sought to establish thresholds for agent breakdown products and explosives. For toxicity, three toxicity thresholds will be considered for each potential ecoCOC depending on its presence in three environmental media (soil, water, and sediment) corresponding to three primary modes of exposure (ingestion of soil for terrestrial organisms, direct contact with water for aquatic organisms, and direct contact with or ingestion of sediments for sediment dwellers). Single thresholds will be chosen for each of two measures of mobility (soil sorption, water solubility), and two measures of persistence (degradation half-life, bioconcentration factor). These thresholds are described below:

**Toxicity** - Toxicity threshold values for potential ecoCOCs found at a site will be based on toxicity data obtained from government sources (NOAA, or toxicological databases [IRIS (USEPA 1992), Hazardous Substances Data Bank (NLM 1993), Aquatic Information Retrieval (AQUIRE 1992), Registry of Toxic Effects of Chemical Substances (NIOSH 1992)]). Published toxicity data will be used in the following order of preference:

- U.S. government standards [e.g., U.S. EPA Ambient Water Quality Criteria (AWQC)]
- Concentrations showing no effect [e.g., No Observed Adverse Effect Level (NOAEL)]
- Chronic toxicity concentrations [e.g., LD<sub>50</sub>, Lowest Toxic Dose (TDL<sub>0</sub>)], and

#### 5.3.2.5 Exposure Assessment

Exposure assessment includes quantification of release, migration, and fate of contaminants; characterization of receptors; and quantification of concentrations at the point where organisms are actually exposed (USEPA 1991b). Environmental concentrations of the potential ecoCOCs at the site will be tabulated.

*Transport and Exposure Pathways* - Contaminant sources at the site will be identified and described based on data from the site characterization field studies. When evaluating the exposure of terrestrial and aquatic biota to ecoCOCs from site sources, soil, sediment, surface water, groundwater, and biota will be considered the primary environmental exposure media.

A pathway analysis will link contamination in the biota to contaminant sources (e.g., soil, sediment, surface water) via mechanisms of release to the environment and the movement of contaminants through the ecosystem. External exposure by means of direct contact with contaminants is assumed to be unavoidable when an organism lives in a contaminated medium, e.g., aquatic biota living in the pond at Range L. Internal exposures, which are potentially avoidable, can result from direct ingestion of contaminated abiotic material or indirectly from ingesting contaminated organisms. Primary producers can mobilize contaminants from soil and sediment. Uptake of contaminants by plants could lead to subsequent exposure to herbivores and omnivores from ingestion of the contaminated vegetation. Contaminants that bioaccumulate in primary producers or their animal consumers, or bioconcentrate in organisms directly exposed to contaminated media, often further accumulate in secondary consumers (i.e., carnivores and omnivores), including transient top predators, such as hawks and owls. Sampling and analysis of tissues of prey animals (e.g., fish, snakes, rodents) will directly indicate whether these receptors and their predators are exposed to site contaminants.

The relative importance of the various exposure pathways to ecological receptors will be summarized in the baseline ERA as exposure factors. These exposure factors are multiplied by the measured contaminant concentration in the appropriate medium to derive

exposure concentrations which are then divided by the appropriate toxicity threshold concentration to calculate an exposure quotient (XQ). Where pertinent information is available, exposure to receptors will be further defined by the size of home ranges, proportion of contaminated habitat relative to home range, and proportion of diet that is contaminated.

*Ecological Receptors* - Species of terrestrial and aquatic organisms will be selected from the list of those identified at the site to serve as proxies for the many species constituting the ecological communities at the site (e.g., earthworms, small mammals, fish, amphibians, crustaceans). Proxy species serve as substitutes for larger numbers of species that potentially are exposed to ecoCOCs by similar modes and pathways (i.e., ecological receptor classes).

#### **5.3.2.6 Effects Assessment**

An effects assessment quantitatively links concentrations of contaminants to adverse effects in ecological receptors (USEPA 1991a). Because it is unlikely that site-specific toxicology studies will be conducted and few laboratory toxicological studies have been conducted using many wildlife species, the effects assessment for the baseline ERA will use toxicological data obtained from compiled databases [e.g., RTECS (NIOSH 1992), IRIS (USEPA 1992g), HSDB (NLM 1992), AQUIRE (1992)]. Examples of the kinds of toxicological data that will be used to assess effects of site contaminants on ecological receptors are:

- LD<sub>50</sub> - the amount of contaminant per unit diet consumed per unit body weight that causes 50% mortality in a test species;
- LDLo - the lowest lethal dose of a contaminant;
- EC<sub>20</sub> - the concentration of contaminant in water that causes 20% of a test population to show a particular response or effect, and;
- LC<sub>50</sub> - the concentration of contaminant in water that causes 50% mortality in exposed aquatic species.

Toxicity data for both terrestrial and aquatic biotic receptors will be considered where appropriate.

### 5.3.2.7 Risk Characterization

An evaluation of the risk of the ecoCOCs at the site and an evaluation of the uncertainties in the risk estimates will form the basis of the risk characterization in the baseline ERA (USEPA 1992d). The use of quotient methods for calculating the risks to ecological receptors is supported by available guidance (USEPA 1989b, 1992d). This ratio or "ecological quotient" (EQ) approach compares the environmental concentration of a contaminant to its toxicity threshold concentration (Barnhouse et al. 1986). Any quotient greater than or equal to unity indicates that there is the potential for adverse ecological effects, and the more the ratio exceeds unity the greater the risk of potential effects. In addition, the relative risks of ecoCOCs to ecological receptors exposed via different modes and pathways will be assessed using exposure quotients (XQs), the ratio of exposure concentrations (i.e., the environmental concentration corrected for exposure) to the toxicity threshold concentration. In addition, how uncertainties in the problem formulation and exposure and effects characterizations result in either under- or overestimates of risk will be discussed.

*Current Risks* - Calculating EQs and XQs requires a toxicity threshold for each contaminant for the appropriate mode of exposure. The toxicity thresholds used to screen contaminants as ecoCOCs are also used to calculate these quotients. The EQs for the ecoCOCs in the various source media at a site are calculated for both mean and the 95 percent upper confidence limit ( $UL_{95}$ ) of the mean by dividing the concentration by the toxicity-threshold values:

$$EQ = \frac{\text{Environmental Concentration}}{\text{Toxicity Threshold Concentration}}$$

In some cases, an EQ cannot be calculated for an ecoCOC because insufficient data are available to establish a toxicity threshold. This may be the case for warfare agents and their breakdown products.

For the characterization of relative risk, the  $UL_{95}$  concentration or the maximum, whichever is less, is taken as the RME. When calculated as the ratio of the uncorrected RME to the toxicity threshold concentration, EQs represent an estimate of the risk to various biota based on the RME concentration. This assumes that the environmental concentration of the ecoCOC is not altered by physical or biological processes in the transport and exposure pathways. EQs will be calculated for each contaminant in each environmental media at each of the 12 OUs at the site. To further characterize the relative risk to various classes of receptors, XQs will be calculated for each ecoCOC in each environmental media at each distinct geographical unit at the site. Environmental concentrations at the site are multiplied by exposure factors to calculate hypothetical exposure concentrations for each ecoCOC resulting from dilution or accumulation processes. Hypothetical exposure concentrations are divided by toxicity threshold concentrations to give XQs:

$$XQ = \frac{(\text{Environmental concentration})(\text{Exposure Factor})}{\text{Toxicity Threshold concentration}}$$

To derive hypothetical exposure factors, assumptions regarding chemical behavior, exposure duration, and diet must be made where there is no site-specific ecological data. The calculated risks to the ecological receptors at the site will be the risks of individual contaminants. The risks from exposure to multiple contaminants depend on contaminant interactions; effects could be additive, synergistic, or antagonistic. The baseline ERA provides a foundation for an extended characterization of the risks to exposure to multiple contaminants.

***Future Risks*** - The risks to key receptors as quantified by these methods can be considered long-term risks. Toxicity threshold concentrations are based on chronic or subacute exposures. Based on their half-lives, adsorptivities, and water solubilities, the ecoCOCs at the site can be expected to persist for extended periods of time. If current conditions are not artificially maintained, typical ecological succession would most likely

occur, resulting in changes in the abundance and distribution of ecological receptors exposed to site contaminants.

The results of the baseline ERA will be summarized and interpreted in the final report. Both current and future risks to ecological receptors at the site will be discussed in light of the associated uncertainties in the risk estimates. For each OU or discrete geographical unit at a site, the ecoCOCs will be classified according to the order of magnitude of the risk estimates. Combined with an interpretation of XQs, the ecoCOCs posing the greatest risk to ecological receptors in different media at the site will be identified. The baseline ERA will also provide a foundation for deriving risk-based remedial goal options for the various contaminated media at the site to complement existing ARARs.

### ***5.3.3 Feasibility Study Risk Assessment***

Remedial actions may be required for some or all sites on the basis of interpretation of the RI data. The purpose of the risk assessment performed during the Feasibility Study will be to weigh the health effects associated with each remedial alternative at each area of concern. The FS is required to select remedial alternatives that are protective of human health and the environment.

The FS risk assessment will be conceptually analogous to and largely based on the methods utilized in the baseline risk assessment. The same conceptual site modes, fate and transport assumptions, and sample results will be used in both the RI and FS risk assessments. Additional exposure assessment may be necessary, however, for scenarios not assessed during the RI such as for remedial workers involved in remedy implementation. Further, air modelling may be necessary to assess exposures to the community if groundwater treatment systems are likely to produce volatile emissions into the atmosphere.

The need for additional quantitative risk assessment for the FS will be evaluated. It is presently anticipated that the FS risk assessment will be based on the same or analogous receptor populations and exposures considered in the baseline risk assessment.

### **5.3.3.1 Remediation Goals**

Remediation goals developed as a result of the FS risk assessment will include the following elements:

- Identification of environmental media of concern
- Identification of chemicals of concern (COCs)
- Land uses of concern
- Toxicity information for COCs
- Acceptable target risk levels

### **5.3.3.2 Preliminary Remediation Goals (PRG's)**

Preliminary remediation goals (PRGs) address both ARARs and human health risk as developed in the risk assessment. PRGs will be developed as early as practical during the RI/FS to provide the FS team with cleanup targets early enough to use during the analysis of remedial alternatives. PRGs are preliminary in that they will be a first step in the development of final remediation goals. In addition, PRGs based on human health effects do not address the requirements of environmental protection (ecological effects), or short- and long-term effectiveness. Furthermore, PRGs are substance-specific concentrations that do not address the combined effects of multiple contaminants that may exist in the areas of concern.

### **5.3.3.3 Final Remediation Goals**

Final remediation goals are refinements of the PRGs and are developed after the remedial alternative is selected. Remedial goals are target cleanup levels that must be protective of both human health and the environment. They differ from PRGs in that they address issues that include short and long-term effectiveness and the combined health effects of multiple contaminants. In addition, the final remediation goals incorporate any additional information that may become available during the RI/FS. The selected remedial alternatives will undergo risk-based screening of the alternatives which will support the remedial decision-making process. The risk-based screening of alternatives is one of the many elements, including professional judgement, that must be considered in the final selection of a remedy.

#### **5.3.2.4 Short and Long-Term Effectiveness**

The FS risk assessment will evaluate both short-term and long-term effectiveness of the remedial alternatives. The FS risk characterization must address concerns that there will be no unacceptable exposures to the community or to remedial workers as a result of the implementation of the remedy. The short-term effectiveness of the remedial alternatives applies to the community, remedial workers, and the environment during the implementation of the alternative. Environmental fate and transport of contaminants may differ from that considered in the RI risk assessment because of the unique activities related to implementation of remedial alternatives. Movement of heavy equipment, installation of remediation equipment, excavations and removal actions may produce exposures that would not otherwise exist.

Long-term effectiveness refers to the permanence of and reduction in the magnitude of baseline risk after remediation. The remedy selection process must demonstrate protection of human health and the environment over time.

#### ***5.3.4 Summary and Interpretation of the Results of Baseline Risk Assessment***

The results of risk assessment will be evaluated following USEPA guidelines presented in the NCP and the Risk Assessment Guidance for Superfund (USEPA 1989a). With regard to noncarcinogenic effects, if the sum of Hazard Index scores (HI) is greater than 1 for a given exposure scenario, then it may be concluded that there is the potential for adverse noncarcinogenic effects related to site exposures. For carcinogenic effects, the total risk of all contaminants must fall within (or below) a target range of  $10^{-4}$  to  $10^{-6}$ . Although the  $10^{-6}$  risk level is identified by USEPA as a "point of departure" in evaluating the results of risk assessment, the revised NCP clearly indicates that the  $10^{-4}$  level is the upper bound of the target risk range (55 FR 8666).

If risks are found to exceed USEPA human health targets or ecological limits defined in the report, then clean-up goals for site media will be developed. These preliminary remediation goals (PRGs) are calculated concentrations that do not exceed USEPA target parameters based on risk assessment. PRGs are calculated for individual compounds of

concern and across all sampled media, and thus do not account for the presence of chemical mixtures. By design, PRGs provide a starting point that may subsequently be refined during the process of focusing risk management and remedial efforts.

As provided in the NCP, cleanup efforts must weigh both compliance with applicable or relevant and appropriate requirements (ARARs), and the potential for health risk. If conditions are within USEPA targets but exceed Federal or state criteria, then additional studies or remediation may be warranted. Alternately, it may be possible to achieve compliance with ARARs but the risk estimates may exceed USEPA health risk targets. In that case, overall protection of human health cannot be demonstrated and remediation may be required.

As previously stated, the objectives of the baseline public health risk assessment will be to evaluate the potential risks of adverse health effects and to determine the need for site remediation. Three exposure scenarios will be developed as the basis of the baseline risk assessment: residential (future land use only), trespasser-recreational (current land use), and occupational (current land use) scenarios. Each of these exposure scenarios will be defined by a set of exposure pathways. Each of the exposure pathways will be characterized by a set of assumptions for evaluating "most likely" and "upper-bound" risks of noncarcinogenic and carcinogenic effects in adult receptors and children. The baseline risk assessment will in this manner avoid reporting overly simplistic single point estimates and will thus provide more flexibility for interpretation of the results.

#### **5.4 FEASIBILITY STUDY TASKS**

The overall objective of the feasibility study (FS) is to screen and evaluate remedial alternatives that will provide adequate protection to public health and the environment. The FS will consist of six tasks:

- Development of remedial action objectives
- Development of general response actions

- Identification of volumes or areas of media
- Identification and screening of technologies and process options
- Development of remedial alternatives
- Detailed analysis of remedial alternatives.

These tasks are described in more detail below.

#### ***5.4.1 Development of Remedial Action Objectives***

Remedial action objectives consist of medium-specific or operable unit-specific goals for protecting human health and the environment. These remedial action objectives should specify:

- the contaminants of concern (COCs)
- exposure routes and receptors
- an acceptable contaminant level or range of levels for each exposure route (i.e., a preliminary remediation goal [PRG]).

Protectiveness to human health can be achieved by reducing exposure (e.g., capping of an area, limiting access, or providing an alternate supply) as well as by reducing the contaminant levels to specified target cleanup levels. Although the PRGs are based on readily available information (e.g., reference doses [RfDs] and risk-specific doses [RSDs]) or frequently used standards (e.g., ARARs), the final exposure levels will be determined on the basis of the results of the baseline risk assessment and an evaluation of the expected exposures and the associated risks for each alternative.

The COCs at Fort McClellan in soil are volatile organics and metals in soil and groundwater. The COCs in groundwater include trichloroethylene, 1,1-dichloroethylene, benzene, methyl isobutyl ketone, 1,1,2-trichloroethane, chromium, nickel, lead, beryllium, 1,3,5-trinitrobenzene, and 2,4-dinitrotoluene. In addition, chemical warfare agents and their breakdown products also may exist in the soil. Contamination is not anticipated in the surface water or sediments. The exposure pathways at concern at Fort McClellan are direct contact, ingestion, and inhalation. The preliminary remedial action objectives at Fort McClellan are:

- Prevent direct contact with and ingestion of contaminated soil having an excess cancer risk within a range of  $10^{-4}$  to  $10^{-7}$
- Prevent inhalation of contaminated soil having an excess cancer risk within a range of  $10^{-4}$  to  $10^{-7}$
- Removal of chemical warfare agents and their breakdown products in contaminated soil
- Prevent direct contact with and ingestion of contaminated groundwater having carcinogens in excess of the maximum contaminant levels (MCLs) and an excess cancer risk within a range of  $10^{-4}$  to  $10^{-7}$
- Prevent direct contact and ingestion of contaminated groundwater having noncarcinogens in excess of MCLs or RfDs
- Restore groundwater concentrations to meet the ARARs and be protective of the environment.

#### ***5.4.2 Development of General Response Actions***

General response actions describe those actions that will satisfy the remedial action objectives specific to each medium. General response actions include containment, institutional actions, excavation, extraction, treatment, and disposal. The potential general response actions at Fort McClellan are containment, excavation, treatment and disposal for contaminated soil; and, extraction, treatment, and disposal for contaminated groundwater.

#### ***5.4.3 Identification of Volumes and Areas of Media***

An initial determination of areas and volumes of media to which the general response actions apply will be made using available site characterization data and the PRGs. These areas and volumes will be refined further taking into consideration acceptable exposure levels and potential exposure routes, site conditions, and the nature and extent of contamination.

At Fort McClellan, site characterization data from the Site Investigation Report (SAIC 1993) indicate that remedial action may not be required at Sites T-4, T-5, and Landfill #1. Contaminated soil present at the following sites may require remedial action:

- Site T-24 (two pits, about 16 feet by 16 feet by 6 feet)
- Site T-38 (former sump, about 20 feet deep)

- Landfill #2
- Landfill #3
- Detection and identification (D&I) Area
- Range J (drums)
- Range K (surface debris)
- Old Water Hole (85 feet by 40 feet munitions dump)
- Range L (Lima Pond).

Groundwater remediation may be required at Landfill 3 (about 30 to 40 feet deep) and at Landfill #2 (about 5 to 15 feet deep). Groundwater contamination by organics (trichloroethylene, 1,1-dichloroethene, benzene, methyl isobutyl ketone, 1,1,2-trichloroethane), metals (chromium, nickel, lead, and beryllium), and other explosive related compounds (1,3,5-trinitrobenzene and 2,4-dinitrotoluene) was detected at Landfill 3. Groundwater contamination was not detected at Landfill 2 during the SI sampling. Exact area and volume of contaminated groundwater to be extracted and treated will be determined from the results of the RI.

#### ***5.4.4 Identification and Screening of Technologies and Process Options***

The term "technology types" refers to the general categories of technologies such as chemical treatment, thermal treatment, immobilization, capping, and dewatering. The term "process options" refers to specific processes within each technology type. For example, the chemical treatment technology type includes such process options as precipitation, ion exchange, and oxidation/reduction.

The first step in the identification and screening of technologies is an evaluation of potentially applicable technologies and process options on the basis of technical implementability. Various sources will be used to identify the potentially applicable technology types and process options for groundwater remediation, including references developed by USEPA for application to Superfund sites, and more standard engineering texts. Some of these sources are listed here.

- Standard Handbook of Hazardous Waste Treatment and Disposal (Freeman 1989)
- Compendium of Technologies Used in the Treatment of Hazardous Wastes (USEPA 1987)
- Guide to Treatment Technologies for Hazardous Wastes at Superfund Sites (USEPA 1989)
- The Superfund Innovative Technology Evaluation Program: Technology Profiles, Fifth Edition (USEPA 1992)
- Hazardous Waste Treatment Processes (WPCF 1976)
- Hazardous Waste Treatment Technologies (Rich and Cherry 1987).

In addition, the following on-line data bases also will be accessed:

- The Risk Reduction Engineering Laboratory (RREL) Treatability Data Base
- USEPA Vendor Information System for Innovative Treatment Technologies (VISITT) Data Base.

Technologies and process options that cannot be effectively implemented at the site on the basis of readily available information from the RI site characterization (i.e., contaminant types, concentrations, and onsite conditions) will be screened. Two factors that will be considered in this initial screening are:

- ***Contaminant Types and Concentrations***

Certain technologies used in the remediation of contaminated groundwater may be specifically applicable for certain types of contaminants. For example, aerobic biological degradation may be screened if pesticides are present in groundwater at the site. Similarly, some technologies are viable only for contaminants present above certain concentration levels. For example, steam stripping is preferred on contaminated groundwater containing total volatile organic concentrations more than 100 mg/L (USEPA 1987).

- ***Subsurface Site Conditions***

Various subsurface site conditions might affect the initial screening of technology types and process options for groundwater remediation. These include:

- Disposition of subsurface contaminants including munitions and chemical warfare agents
- Vadose zone characteristics
- Depth of water table
- Vertical extent of contamination
- Amount of contaminated groundwater
- Depth of bedrock
- Degree of fracture in bedrock confining layer
- Hydraulic conductivity and groundwater flow velocity.

The technology processes considered to be implementable will be evaluated in more detail by selecting one or two representative process options. Innovative treatment technologies and process options will be retained for further evaluation until additional information may be obtained from treatability studies. The selected process options will be screened further based on the following three criteria:

- ***Effectiveness***—This criterion focuses on the potential effectiveness of the technology in handling the estimated areas or volumes of media and meeting the required discharge limitations. Other factors to be considered are reliability and availability of adequate data for the technology with respect to the contaminants and conditions of the specific site and the potential impact on human health and the environment during construction and implementation.
- ***Implementability***—This criterion encompasses both the technical and administrative feasibility of implementing a technology process. Technical implementability issues include the design, construction time, and the availability of necessary equipment, skilled workers, and adequate space. Administrative issues include the ability to obtain necessary permits and the availability of interim treatment, storage, and disposal services.
- ***Relative Cost***—Relative costs will be used to compare two or more similar technologies. Technologies that have higher relative costs yet provide the same technical effectiveness with no distinct advantage with respect to implementability will not be considered further.

#### **5.4.5 Development of Remedial Alternatives**

Alternatives will be initially developed by assembling the selected process options to meet a set of remedial action objectives for each medium of interest. Each alternative will provide protection of human health and the environment from each potential pathway of concern at the site. Several sites or specific areas at a site may be grouped into "operable units" on the basis of similar site characteristics and contaminant concentrations so that alternatives can be developed and evaluated for these sites or areas as a whole. Three groups will be considered at Fort McClellan on the basis of available site information. The preliminary remedial alternatives identified for these three groups are:

**Group 1: Sites T-4 and T-5, Landfill 1, and Range K**

Alternative 1-1: No Action

Alternative 1-2: Limited Action

**Group 2: Sites T-24 and T-38, D&I, and Range J**

Alternative 2-1: No Action

Alternative 2-2: Capping

Alternative 2-3: Excavation, Treatment (onsite or offsite), Disposal

**Group 3: Range L and Old Water Hole**

Alternative 3-1: No Action

Alternative 3-2: Capping

Alternative 3-3: In situ treatment

Alternative 3-4: Excavation, Treatment (onsite or offsite), Disposal

**Group 4: Landfill 2 and Landfill 3 (Groundwater remediation only)**

Alternative 3-1: No Action

Alternative 3-2: Containment (with capping and slurry wall)

Alternative 3-3: In situ treatment

Alternative 3-4: Extraction, Treatment (onsite or offsite), Disposal

#### **5.4.6 Detailed Analysis of Remedial Alternatives**

The remedial alternatives will be evaluated in greater detail using nine criteria (USEPA 1988). These criteria are shown in Figure 5-2 and are listed below.

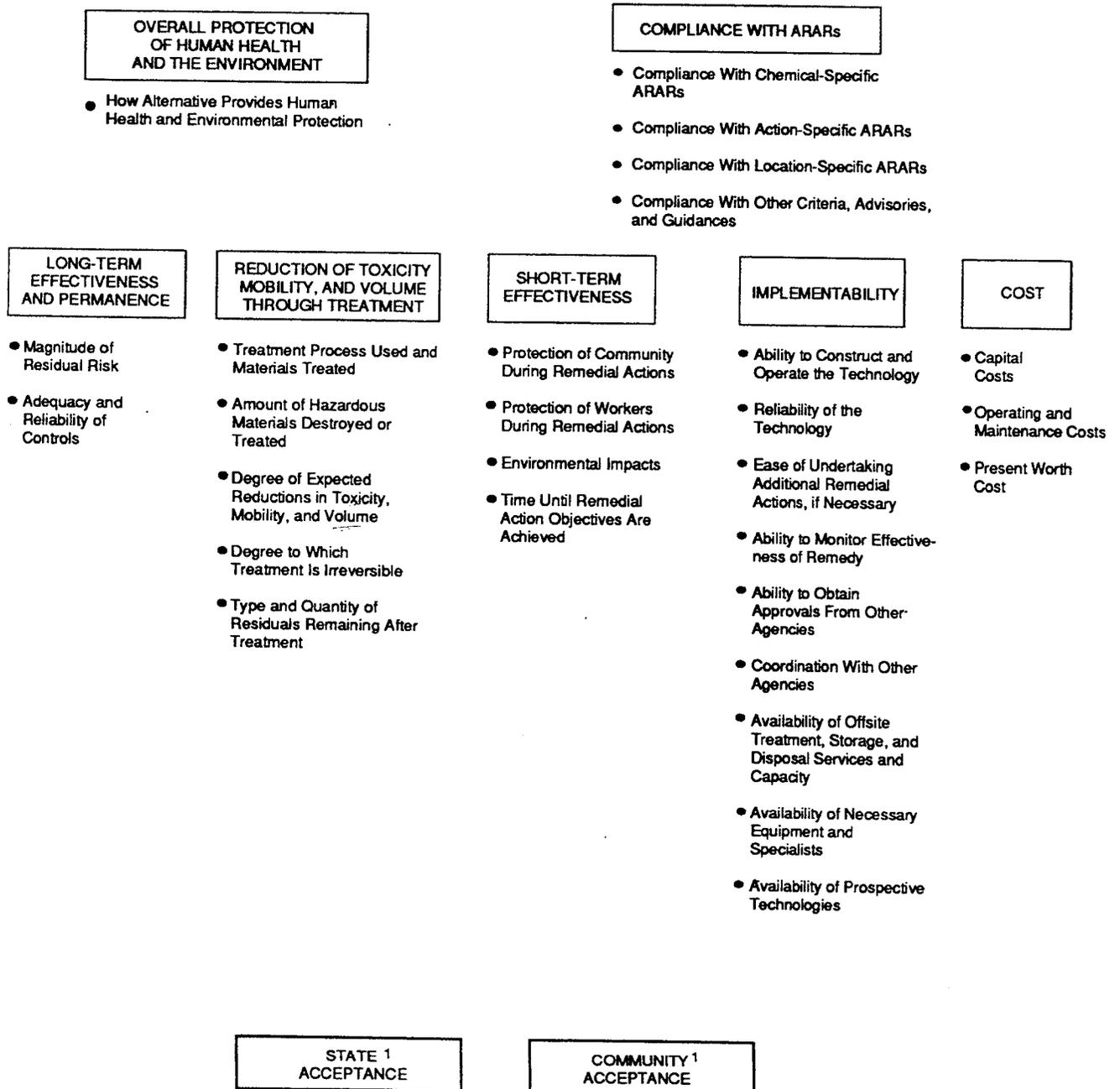
- Overall protection of human health and the environment
- Compliance with applicable or relevant and appropriate requirements (ARARs)
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance.

These criteria are described in detail below. The state and community acceptance criteria will be completed after review of the draft report by the state and the public.

***Overall Protection of Human Health and the Environment***—The assessment of this criterion describes how the alternative achieves and maintains protection of human health and the environment. The overall assessment of protection draws on the assessments conducted under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with applicable or relevant and appropriate requirements (ARARs).

Evaluation of the overall protectiveness of an alternative focuses on whether a specific alternative achieves adequate protection and describes how site risks posed through each potential pathway are eliminated, reduced, or controlled through treatment, engineering, or institutional controls. This evaluation also allows for consideration of whether the alternative poses any unacceptable short-term or cross-media impacts.

Figure 5-2. Criteria for Detailed Analysis of Alternatives



<sup>1</sup> These criteria will be assessed following comment on the RI/FS report and the proposed plan.

***Compliance with ARARs***—The assessment of this criterion describes how the alternative complies with ARARs, or if a waiver is required and how it is justified. The assessment also addresses other information from advisories, criteria, and guidance that the lead and support agencies have agreed is "to be considered." This evaluation criterion is used to determine whether each alternative would meet all of its Federal and State ARARs. The following classes were addressed for each alternative during the detailed analysis of ARARs:

- Compliance with chemical-specific ARARs (e.g., maximum contaminant levels)
- Compliance with location-specific ARARs (e.g., preservation of historic sites)
- Compliance with action-specific ARARs (e.g., RCRA minimum technology standards)
- Compliance with other criteria advisories and guidances.

***Long-term Effectiveness and Permanence***—The assessment of this criterion evaluates the long-term effectiveness of alternatives in maintaining protection of human health and the environment after response objectives have been met. The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes.

The following components of the criterion are addressed:

- ***Magnitude of residual risk***—This factor assesses the residual risk remaining from untreated waste or treatment residuals at the conclusion of remedial activities, (e.g., after groundwater plume management activities are concluded). The potential for this risk may be measured by numerical standards such as cancer risk levels, or the volume or concentration of contaminants in waste, media, or treatment residuals remaining on the site. The characteristics of the residuals are considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate.
- ***Adequacy and reliability of controls***—This factor assesses the adequacy and reliability of controls, if any, that are used to manage treatment residuals or untreated wastes that remain at this site. It may include an assessment of containment systems and institutional controls to determine if they are sufficient to ensure that any exposure to human and environmental receptors is within

protective levels. This factor also addresses the long-term reliability of management controls for providing continued protection from residuals. It includes the assessment of the potential need to replace technical components of the remedy (such as a treatment system), the potential exposure pathways, and the risks posed should components of the remedial action need replacement.

***Reduction of Toxicity, Mobility, and Volume through Treatment***—The assessment of this criterion evaluates the anticipated performance of the specific treatment technologies employed. This evaluation criterion addresses the statutory preference for selecting treatment actions that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances as their principal element. This preference is satisfied when treatment is used to reduce the principal threats at a site through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, irreversible reduction in contaminant mobility, or reduction of the total volume of contaminated media. This evaluation focuses on the following specific factors:

- Treatment processes to be used and the materials treated
- Amount of hazardous materials to be destroyed or treated, including how the principal threat(s) is addressed
- Degree of expected reduction in toxicity, mobility, or volume measured as a percentage of reduction (or order of magnitude)
- Degree to which the treatment is irreversible
- Type and quantity of treatment residuals that remain following treatment.

***Short-term Effectiveness***—The assessment of this criterion examines the effectiveness of the alternative in protecting human health and the environment during the construction and implementation and until response objectives are met. The following factors are addressed as appropriate under this criterion:

- ***Protection of the community during remedial action.*** This aspect of short-term effectiveness addresses any risk that results from implementation of the proposed remedial action, such as transportation of hazardous materials, or air-quality impacts from a stripping tower operation that may affect human health.

- *Protection of workers during remedial actions.* This factor assesses threats that may be posed to workers and the effectiveness and reliability of protective measures that would be taken.
- *Environmental impacts.* This factor addresses the potential adverse environmental impacts that may result from the construction and implementation of the alternative and evaluates the reliability of the available mitigation measures in preventing or reducing the potential impacts.
- *Time until remedial response objectives are achieved.* This factor includes an estimate of the time required to achieve protection for either the entire site or individual elements associated with specific site areas or threats.

***Implementability***—This assessment evaluates the technical and administrative feasibility of alternatives and the availability of required goods and services. This criterion involves analysis of the following factors:

- ***Construction and operation***—This relates to the technical difficulties and unknowns associated with a technology.
  - *Reliability of technology.* This focuses on the likelihood that technical problems associated with implementation will lead to schedule delays.
  - *Ease of undertaking additional remedial action.* This includes a discussion of what, if any, future remedial actions may need to be undertaken and how difficult it would be to implement such additional actions.
  - *Monitoring considerations.* This addresses the ability to monitor the effectiveness of the remedy and includes an evaluation of the risks of exposure should monitoring be insufficient to detect a system failure.
- ***Administrative feasibility***
  - Activities needed to coordinate with other offices and agencies (e.g., obtaining permits for offsite activities or rights-of-way for construction)
- ***Availability of services and materials***
  - Availability of adequate offsite treatment, storage, and disposal capacity and services
  - Availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources

- Availability of services and materials, plus the potential for obtaining competitive bids, which may be particularly important for innovative technologies
- Availability of prospective technologies.

*Cost*—This assessment evaluates the capital, and operation and maintenance (O&M) costs of each alternative. Relative costs are provided, for example, low, moderate, or high. In some cases, capital and O&M costs for typical units are also provided.

## 5.5 PROPOSED PLAN

The detailed analysis of alternatives presented in the RI/FS report provides sufficient information for the USEPA to identify the preferred alternative for Fort McClellan prior to holding a formal public comment period on the proposed cleanup at the site. The preferred alternative is identified as the protective, ARAR-compliant approach that is judged to provide the best tradeoff with respect to the five balancing criteria (long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; time for implementation, implementability; and cost). The evaluation will also consider the state and community acceptance of each alternative, when that information is available.

The preferred alternative for Fort McClellan will be presented to the public in a proposed plan. The proposed plan will provide a brief summary of the alternatives studied in the detailed analysis phase of the RI/FS, highlighting the key factors that led to the identification of the preferred alternative. The proposed plan will be made available for public comment, in addition to the RI/FS and other information in the administrative record.

Table 5-6 provides an outline for the proposed plan. The purpose of the proposed plan is to facilitate public participation in the remedy selection process. In general, the proposed plan will specify the following:

- Identify the preferred alternative for a remedial action at the site or operable unit and explain the rationale for the preference

- Describe other remedial options that were considered in the RI/FS report
- Solicit public review and comment on all the alternatives described
- Provide information on how the public can be involved in the remedy selection process

## 5.6 RECORD OF DECISION (ROD)

Following receipt of public comments and any final comments from the support agency, a remedy will be selected and documented in the ROD for Fort McClellan. The ROD will document the remedial action plan for Fort McClellan, and will serve three basic purposes:

- The ROD will serve a legal function in that it certifies that the remedy selection process was carried out in accordance with the requirements of CERCLA and to the extent practicable, the National Contingency Plan (NCP).
- The ROD will be a technical document that outlines the engineering components and the remediation goals of the selected remedy.
- The ROD will be informational, providing the public with a consolidated source of information about the history, characteristics, and risks posed by the conditions at Fort McClellan, as well as a summary of the cleanup alternatives considered, their evaluation, and the rationale behind the selected remedy.

Table 5-7 provides a proposed outline of the ROD for Fort McClellan. The ROD will consist of three basic components:

- The **Declaration** will provide an abstract for the key information contained in the ROD. The Declaration also will contain the signature by the USEPA Regional Administrator or the Assistant Administrator.
- The **Decision Summary** will provide an overview of the site characteristics, the alternatives evaluated, and the analysis of those options. The Decision Summary also will identify the selected remedy and explain how the remedy fulfills the statutory requirements.
- The **Responsiveness Summary** will address the public comments received on the Proposed Plan, the RI/FS report, and other information in the administrative record.

**Table 5-6. Outline for the Proposed Plan**

***Introduction***

- Provide site name and location
- Identify lead and support agencies
- Introduce document's purpose, which is to:
  - fulfill requirements of Section 117(a)
  - describe alternatives analyzed
  - identify preferred alternative and explain rationale for preference
  - serve as companion to the RI/FS and administrative record file
  - solicit public involvement in selection of a remedy
- Stress importance of public input on all alternatives

***Site Background***

- Provide brief overview of site
- Describe site history

***Scope and Role of Operable Unit or Response Action***

- Describe scope of problem that the action will address
- Describe role of action within site strategy
- Identify how action addresses principal threat(s)

***Summary of Site Risks***

- Provide overview of baseline risk assessment, by describing the:
  - contaminated media
  - chemicals of concern
  - baseline exposure scenarios (e.g., routes of exposure - current and future land-use scenarios)
  - current and potential site risks (including both carcinogenic and noncarcinogenic threats)
- Discuss ecological risk(s), as appropriate

***Summary of Alternatives***

- Provide narrative description of alternatives evaluated in detailed analysis of FS (included engineering components, treatment components, estimates present-worth cost, implementation time, and the major ARARs associated with the alternatives(s))

***Evaluation of Alternatives and the Preferred Alternative***

- Identify the preferred alternative
- Introduce the nine evaluation criteria and discuss how they are utilized in the Superfund program
- Provide the rationale for the preferred alternative by profiling it against the nine criteria and highlighting how it compares to the other alternatives (major advantages and disadvantages); state/support agency and community acceptance should be addressed to the extent adequate information is available at the time
- Discuss the lead agency's belief that the preferred alternative would satisfy the statutory findings, including the preference for treatment as a principal element
- When the support agency concurs with the preferred alternative, its recommendation that the alternative meets the statutory findings also should be included

***Community Participation***

- Provide notice of public comment period (written comments are encouraged)
- Note time and place for a public meeting (if they are scheduled) or offer opportunity for meeting
- Provide the location of administrative record files and information repositories.

\* Community includes the general public and PRPs.

**Table 5-7. Outline for the Record of Decision**

<p><b><i>Declaration</i></b></p> <ul style="list-style-type: none"><li>• Site name and location</li><li>• Statement of basis and purpose</li><li>• Assessment of the site</li><li>• Description of the selected remedy</li><li>• Statutory determinations</li><li>• Signature and support agency acceptance of the remedy</li></ul> <p><b><i>Decision Summary</i></b></p> <ul style="list-style-type: none"><li>• Site name and location</li><li>• Site history and enforcement activities</li><li>• Highlights of community participation</li><li>• Scope and role of operable unit</li><li>• Site characteristics</li><li>• Summary of site risks</li><li>• Summary of comparative analysis of alternatives</li><li>• Select remedy</li><li>• Statutory determinations</li></ul> <p><b><i>Responsiveness Summary</i></b></p> <ul style="list-style-type: none"><li>• Community preferences</li><li>• Integration of comments</li></ul>
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- Acute toxicity concentrations modified [e.g., Michigan Water Resources Commission (1986)].

In all cases, the appropriateness of study methods, chemical species, and test organism relative to the site is considered when establishing toxicity thresholds.

**Mobility** - Mobility is indicated by soil sorption (the organic carbon-water partition coefficient ( $K_{oc}$ ) for organic contaminants and the soil sorption coefficient ( $K_d$ ) for inorganic contaminants) and water solubility. A soil sorption  $K_{oc}$  of 1000 (or  $K_d$  of 100) will be used as the threshold above which a contaminant is not considered a hazard via aquatic exposure pathways. A threshold of 1 mg/L will be used to represent the level of water solubility above which a potential toxicant is considered a potential hazard to organisms exposed to surface or groundwater.

**Persistence** - Persistence is indicated by the bioconcentration factor (BCF) and the degradation half-life of a substance in water, soil, sediment, or organisms. A value of 14 days will be used for the degradation half-life threshold, at or above which a substance is considered persistent, assuming there is no continual source of contaminant. When there is a continual source of a contaminant, the fact that the contaminant is not persistent (e.g., VOCs) is not a basis for rejecting the contaminant as an ecoCOC. The BCF is the tissue concentration of a substance divided by its concentration in the environment. A threshold of 100 was chosen for BCF. A BCF above 100 indicates that a toxicant can become magnified in organisms more than 100 times over the concentration in the ambient environmental medium. A half-life > 14 days or a BCF > 100 means the contaminant will qualify as "persistent" when there is no continual source of the contaminant.

Using these thresholds, the contaminants at each site will be screened as ecoCOCs. Those that qualify as ecoCOCs will be examined further in the exposure and effects assessments and ecological risk characterization.

## 6. COSTS AND KEY ASSUMPTIONS

Detailed costs for completion of the Fort McClellan remedial investigation/feasibility study (RI/FS) are provided in the Project Management Plan according to the work breakdown structure established by the U.S. Army Environmental Center in the statement of work. Key assumptions in the development of these costs are associated with the number and types of analytical samples and analyses, the number of monitoring well installations, and document review cycle durations. Regulatory review of the proposed plans that impact on the established scope of work will also impact the calculated costs. A summary of the project expenditures in hours and dollars is shown in Table 6-1.

**Table 6-1. SUMMARY OF PLANNED HOURS AND EXPENDITURES  
Fort McClellan RI/FS**

Period Ending	Period		Period		Cumulative		Period		EXPENDITURES		% Completion		Total Est. Cost
	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual	Plan	Actual	Plan*	Actual**	
10/08/93	9	376	0	0	376	0	\$26,588	\$0	\$26,588	\$0	2%	0%	\$1,594,309
11/05/93	10	460	0	0	836	0	\$37,399	\$0	\$63,987	\$0	4%	0%	\$1,594,309
12/03/93	11	354	0	0	1190	0	\$21,918	\$0	\$85,905	\$0	5%	0%	\$1,594,309
12/31/93	12	340	0	0	1530	0	\$20,998	\$0	\$106,904	\$0	7%	0%	\$1,594,309
01/28/94	13	90	0	0	1620	0	\$8,444	\$0	\$115,348	\$0	7%	0%	\$1,594,309
02/25/94	1	146	0	0	1766	0	\$11,388	\$0	\$126,736	\$0	8%	0%	\$1,594,309
03/25/94	2	878	0	0	2644	0	\$51,877	\$0	\$178,612	\$0	11%	0%	\$1,594,309
04/22/94	3	654	0	0	3298	0	\$106,991	\$0	\$285,603	\$0	18%	0%	\$1,594,309
05/20/94	4	783	0	0	4081	0	\$51,788	\$0	\$337,391	\$0	21%	0%	\$1,594,309
06/17/94	5	804	0	0	4885	0	\$72,876	\$0	\$410,267	\$0	26%	0%	\$1,594,309
07/15/94	6	833	0	0	5718	0	\$193,827	\$0	\$604,094	\$0	38%	0%	\$1,594,309
08/12/94	7	1374	0	0	7092	0	\$82,408	\$0	\$686,502	\$0	43%	0%	\$1,594,309
09/09/94	8	1233	0	0	8325	0	\$78,868	\$0	\$765,370	\$0	48%	0%	\$1,594,309
10/07/94	9	996	0	0	9321	0	\$686,994	\$0	\$1,452,364	\$0	91%	0%	\$1,594,309
11/04/94	10	330	0	0	9651	0	\$41,532	\$0	\$1,493,895	\$0	94%	0%	\$1,594,309
12/02/94	11	418	0	0	10069	0	\$23,316	\$0	\$1,517,211	\$0	95%	0%	\$1,594,309
12/30/94	12	366	0	0	10435	0	\$24,545	\$0	\$1,541,756	\$0	97%	0%	\$1,594,309
01/27/95	13	140	0	0	10575	0	\$8,112	\$0	\$1,549,868	\$0	97%	0%	\$1,594,309
02/24/95	1	300	0	0	10875	0	\$21,149	\$0	\$1,571,017	\$0	99%	0%	\$1,594,309
03/24/95	2	161	0	0	11036	0	\$9,927	\$0	\$1,580,944	\$0	99%	0%	\$1,594,309
04/21/95	3	28	0	0	11064	0	\$2,272	\$0	\$1,583,216	\$0	99%	0%	\$1,594,309
05/19/95	4	162	0	0	11226	0	\$11,093	\$0	\$1,594,309	\$0	100%	0%	\$1,594,309

**FOOTNOTES:**

\* Cumulative planned expenditures divided by total estimated cost.

\*\* Cumulative actual expenditures divided by total estimated cost.

## 7. PROJECT SCHEDULE

The Fort McClellan remedial investigation/feasibility study (RI/FS) is composed of five phases, including project planning, field investigation, risk assessment, data reporting and feasibility study/decision document preparation. A detailed project schedule is provided in Figure 7-1.

Figure 7-1. Schedule for Fort McClellan Remedial Investigation/ Feasibility Study

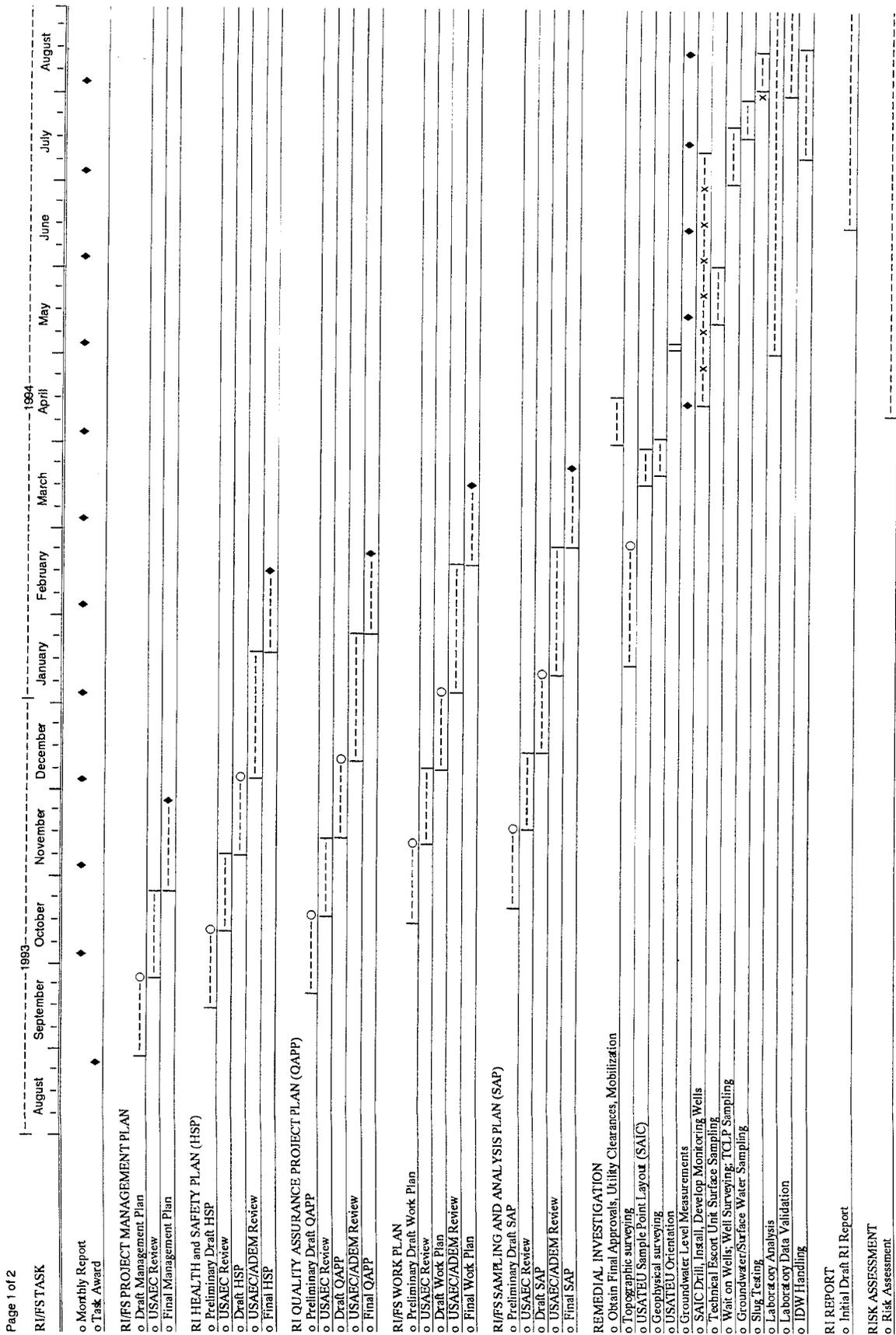
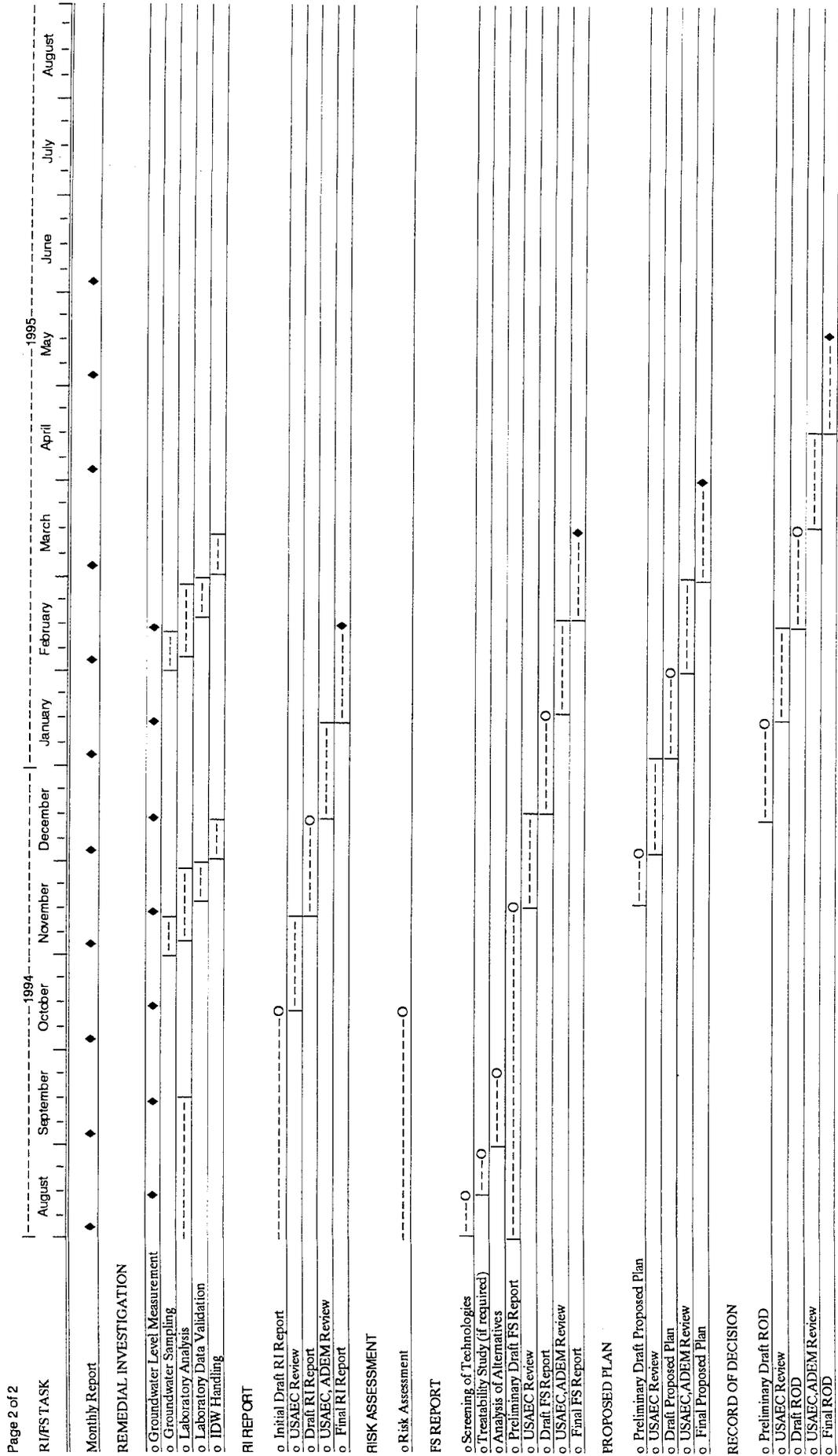


Figure 7 - 1. Schedule for Fort McClellan Remedial Investigation/ Feasibility Study (Cont)



x = SAIC not on site. ◆ = Deliverable due. ○ = Draft deliverable due.

## 8. PROJECT MANAGEMENT

### 8.1 PROJECT ORGANIZATION

The site investigation study at Fort McClellan, Alabama will be conducted by the U.S. Army Environmental Center (USAEC) subcontractor, Science Applications International Corporation (SAIC). The organizational relationships within the project are shown in Figure 8-1. A contact list for key project personnel is provided in Table 8-1.

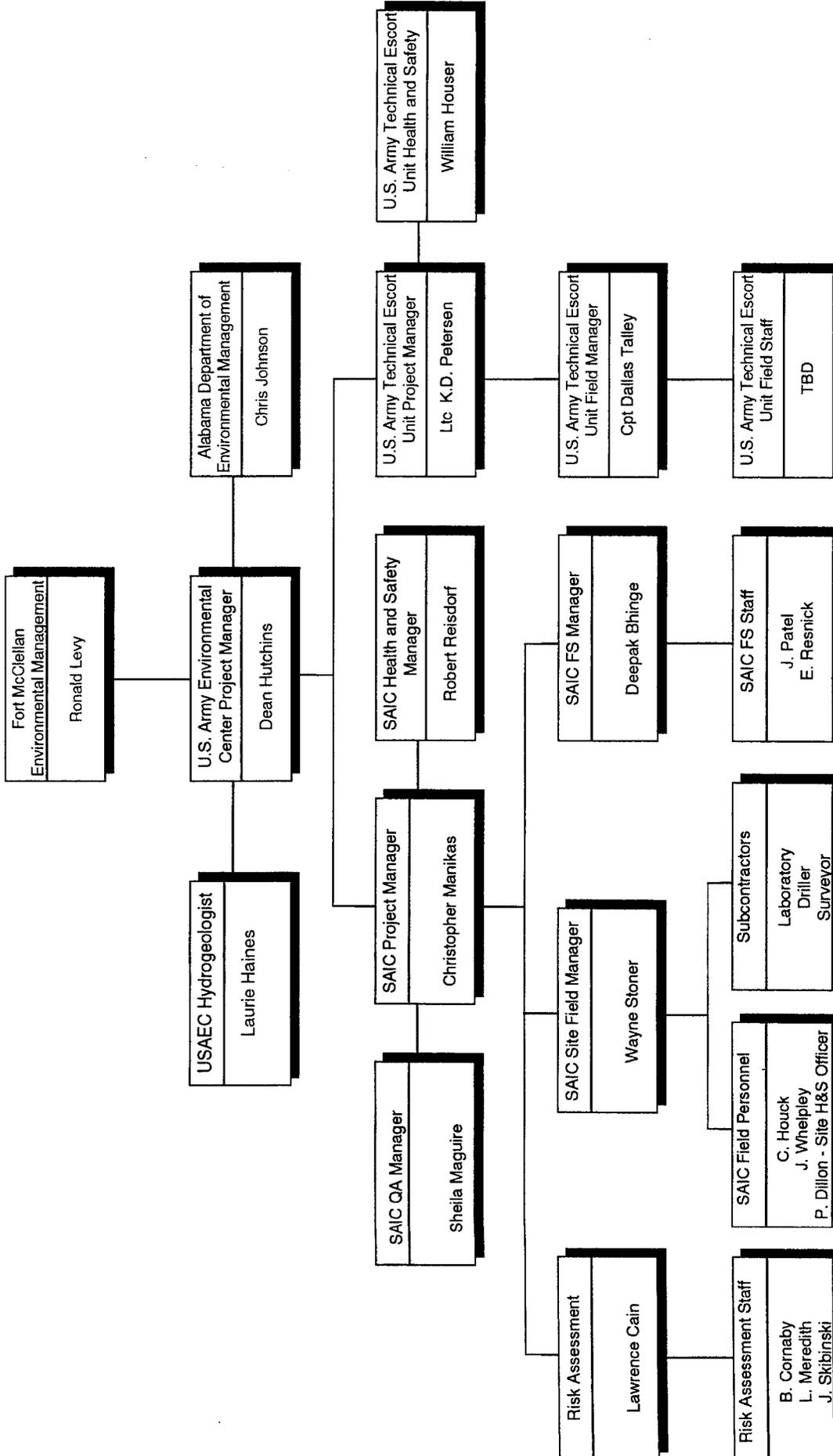
#### *8.1.1 Science Applications International Corporation*

SAIC is the subcontractor retained by USAEC to perform the remedial investigation/feasibility study (RI/FS) activities for the 12 sites at Fort McClellan. The organization and functions within SAIC are described below. Resumes for SAIC personnel are provided in Appendix A.

***Program Manager*** — The Program Manager will ensure that SAIC's full resources are accessible to the Project Manager and that all staffing and administrative support needs of this project are met in a timely manner. He also will play an active role in client interaction and review all deliverables. The SAIC program manager is Mr. Alfred Wickline.

***Project Manager*** — The Project Manager will provide overall management of this project. He will be the project's technical lead and the principal point of contact. He will develop, monitor, and fill project staffing needs and coordinate with administrative staff to maintain smooth flow of all project activities. The Project Manager will lead the deliverable preparation and production activities. He is directly responsible for meeting schedules and budget requirements of this project. Mr. Christopher Manikas will be the SAIC project manager for the Fort McClellan RI/FS.

***Site Field Manager*** — The Site Field Manager will be located at Fort McClellan to supervise day-to-day activities of the entire RI/FS field data collection effort. He will participate extensively in data interpretation, report writing, and preparation of deliverables. The Site Field Manager's main responsibility is to ensure that work is being conducted as specified in the Work



**Figure 8-1. Project Organization for Remedial Investigation/Feasibility Study at Fort McClellan, Alabama**

Table 8-1. Contact List for Fort McClellan RI/FS

<u>Fort McClellan Environmental Management</u>		
Ronald Levy, Chief		205-848-3758
Lisa Kingsbury		205-848-3539
William Garland		205-848-5517 (fax)
<u>Alabama Department of Environmental Management</u>		
Chris Johnson		205-260-2777
		205-260-2795 (fax)
<u>U.S. Army Environmental Center</u>		
Dean Hutchins (Project Manager)		410-671-1530
Laurie Haines (Project Geologist)		410-671-1548 (fax)
William Houser (Health and Safety)		410-671-4811
<u>U.S. Army Technical Escort Unit</u>		
Cpt Dallas Talley		410-671-4381
		410-671-4259
<u>Science Applications International Corporation (SAIC)</u>		
Alfred Wickline (Program Mngr)		703-734-5514
Christopher Manikas (Project Mngr)		703-827-4832
Wayne Stoner (Site Field Mngr)		703-734-5996
Sheila Maguire (QA/QC Mngr)		703-827-4856
Lawrence Cain (Risk Assessment Mngr)		703-734-5991
Deepak Bhinge (FS Mngr)		703-734-5931
Robert Reisdorf (Health & Safety)		703-821-4634
Joseph Skibinski (Data Mngr)		703-734-5952
Chris Fontana (Sample Mngr)		703-827-4918
Lisa Jones-Bateman (Contracts)		703-734-5503
fax		703-506-9689
Natural Resources Bldg (Fort McClellan)		205-848-3758
<u>Analytical Laboratory</u>		
Richard Goebel (DATACHEM)		801-266-7700
Joseph Vondrick (ES&E)		904-332-3318 (x1463)
<u>Drilling Subcontractor</u>		
Environmental Exploration, Inc.		404-389-0475
<u>Surveying Subcontractor</u>		
Frank Hollis and Assoc, Inc.		205-625-4433
<u>MINICAMS Support</u>		
CMS Research Corporation		205-733-6911
		205-733-6919 (fax)

Plan, Field Sampling and Analysis Plan, and Quality Assurance Project Plan (QAP). The Fort McClellan Field Manager will be Mr. Wayne Stoner.

***Quality Assurance Manager*** — The Quality Assurance (QA) Manager is the primary point-of-contact for the RI/FS on matters concerning field and laboratory quality assurance procedures and will be responsible for ensuring that QA procedures are implemented and that appropriate controls are used to ensure a high level of quality. The QA Manager also will be responsible for preparing the RI/FS Quality Assurance Project Plan (QAPP) and statements of work (SOWs) for any subcontractors providing analytical services. Sample tracking during the RI/FS will be coordinated by the QA Manager. The QA Manager will be responsible for the review, evaluation, and validation of all analytical data for the RI/FS, and will participate extensively in interpretation and presentation of analytical data in the final report. Ms. Sheila Maguire will be the QA Manager for the Fort McClellan RI/FS.

***Feasibility Study Manager*** — The FS Manager will be responsible for assimilating the RI results into cost effective remedial solutions for the investigated sites. The FS Manager will also be responsible for interfacing with regulatory agencies, identification of ARAR's and appropriate technologies, and preparation of the FS report and the Record of Decision. The FS Manager for the Fort McClellan RI/FS is Mr. Deepak Bhinge.

***Risk Assessment Manager*** — The Risk Assessment Manager will be responsible for evaluating the RI chemical data for potential human health and ecological risk impacts. In addition to the evaluation of human health risks, the Risk Assessment Manager will coordinate the evaluation of existing ecological data with the Fort McClellan DEM and natural resources office. The Risk Assessment Manager for the Fort McClellan RI/FS is Mr. Lawrence Cain.

***Data Manager*** — The project Data Manager will be responsible for establishing a comprehensive sample management plan, ensuring that data uploaded to USAEC Installation Restoration Data Management Information System (IRDMIS) has been correctly entered, accessing data from the USAEC Pyramid, and interfacing with the analytical laboratories. The

Data Manager will also be responsible for supporting the risk assessment and Feasibility Study. The Data Manager for the Fort McClellan RI/FS is Mr. Joseph Skibinski.

**Health and Safety Manager** — The Health and Safety Manager will ensure that the physical and chemical hazards are appropriately mitigated through effective execution of the Health and Safety Plan (H&SP), audit project performance according to the plan, and provide technical support as needed in executing the plan. Mr. Robert Reisdorf will be the project Health and Safety Manager. Onsite health and safety will be the responsibility of the Field Manager working in coordination with the project manager and the project Health and Safety Manager.

### **8.1.2 U.S. Army Technical Escort Unit (USATEU)**

The USATEU will be conducting investigative activities at Fort McClellan concurrent with activities to be completed by SAIC. The USATEU Field Manager will interact with SAIC personnel to coordinate sample collection, handling, and shipping protocols to ensure satisfactory completion of these activities.

### **8.1.3 Subcontractors**

Services for laboratory chemical analyses, drilling, and land surveying will be subcontracted by SAIC. The following paragraphs describe the subcontractor support positions to be interfaced with SAIC during the completion of the Fort McClellan RI/FS.

**Laboratory Manager** — The Laboratory Manager is responsible for the technical quality of the laboratory, laboratory personnel management, cost control, and strict adherence to project schedules. His overall quality assurance management responsibilities in the RI/FS are the satisfactory analysis of all samples with complete data documentation and the quality control of data uploaded to the USAEC IRDMIS data management system. SAIC will use a subcontracted laboratories DATACHEM. Inc. of Salt Lake City, Utah, and Environmental Science and Engineering of Gainesville, Florida, to provide these services. Laboratory activities will be monitored by the SAIC QA Manager.

*Drilling Manager* — The Drilling Manager will be responsible for ensuring that capable drilling crews are onsite and equipped to complete the required work. A drilling foreman will be in daily contact onsite with the SAIC Field Manager throughout the work assignment.

*Survey Foreman* — The Survey Foreman will be responsible for ensuring that all land surveying is completed on time and in accordance with state of Alabama and USAEC requirements.

## **8.2 SAIC PROJECT COORDINATION**

The Project Manager is directly responsible for technical direction of subcontractor activities. All coordination requiring USAEC, Fort McClellan personnel, or regulatory input or concurrence will be through the USAEC Project Manager. Daily coordination of field activities will occur between the SAIC Project Manager or Site Field Manager, Fort McClellan, U.S. Army Technical Escort Unit, and subcontractor personnel. USAEC personnel will be kept informed of these communications.

Project elements to be coordinated by the SAIC Project Manager include overall field activities, review cycles on all work plans and reports, written notification to proceed (NTP) required for each step of the Site Investigation, field changes and variances, periodic review of data and status to assess project needs compared to the project plan, monthly status reports, and unanticipated problems.

The Site Field Manager will coordinate field activities on a daily basis and will maintain daily communications with the USAEC and Fort McClellan points-of-contact on activities such as planning and scheduling, onsite equipment, materials, storage and office facilities, permitting for drilling, personnel and subcontractor access to the Base and secure areas, emergency procedures, and unanticipated administrative problems. All inquiries from nonproject parties will be referred to the USAEC and Fort McClellan points-of-contact.

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**APPENDIX A**  
**PHYSICAL AND CHEMICAL PROPERTIES OF CHEMICAL WARFARE AGENTS**  
**USED AT**  
**FORT McCLELLAN, ALABAMA**

# Appendix A. Physical and Chemical Properties for Chemical Warfare Agents at Fort McClellan, Alabama

Chemical Warfare Agents	Name	CAS No.	Formula	Physical State	Odor	Relative Vapor Density (Air=1)		Boiling Point (°C)	Vapor Pressure (mm Hg) @20-25°C	Volatility (mg/m <sup>3</sup> ) @20-25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	Flash Point (°C)	Decomposition Temp (°C)	Latent Heat of Vaporization <sup>2</sup> (cal/g)	Solubility in Water (mg/L)	log K <sub>ow</sub>	log K <sub>oc</sub>	Hydrolysis Products	
						(20-25°C)	(20-25°C)												
Cyanogen chloride (CK)		506-77-4	ClCN	Gas	Bitter almonds	2.1	1.18	12.8	1000	612000		None	>100	Soluble	0.46 <sup>4</sup>			HCl, CHOH	
Hydrogen cyanide (AC)		74-90-8	HCN	Liquid	Bitter almonds	1.007	0.687	25.7	742	1075000		0	66	Soluble	0.00 <sup>4</sup>			NH <sub>4</sub> NCOOH	
Mustard (HD)		505-60-2	C <sub>4</sub> H <sub>8</sub> S <sub>2</sub>	Liquid	Garlic	5.5	1.27	217	0.72-1.11	610-920	1.96E-5 <sup>4</sup>	105	177	810 (@20°C) <sup>1</sup>	1.37-2.03 <sup>1</sup>	2.01-2.08 <sup>1</sup>			HCl, thiohydroxyethyl
Hemimustard (GH)		693-30-1	C <sub>4</sub> H <sub>8</sub> ClS <sub>2</sub>	Liquid				4.6E-3						8100	3	1.34			
Bis(2-chloroethyl) sulfide (DS)		111-48-8	C <sub>4</sub> H <sub>8</sub> Cl <sub>2</sub> S	Liquid				1.18-1.22	164-283		2.94E-8 <sup>4</sup>	160-238		72000 <sup>4</sup>	-31	-52			
Diisopropylamine (DA)		602-51-0	C <sub>6</sub> H <sub>15</sub> N	Liquid				60			2.72E-03 <sup>4</sup>			2900	83	1.84			
Mustard sulfide (HD)		5819-08-9	C <sub>4</sub> H <sub>8</sub> S <sub>2</sub>	Solid				.81						95000	-85	91			
p-chlorophenylmethyl sulfone		924-73-6	C <sub>6</sub> H <sub>4</sub> ClS <sub>2</sub>	Solid										11700 <sup>4</sup>	1.69 <sup>4</sup>	1.48 <sup>4</sup>			
p-chlorophenylmethyl sulfonate		471-03-4	C <sub>6</sub> H <sub>4</sub> ClSO <sub>2</sub>	Solid															
1,4-dithiane		505-29-3	C <sub>4</sub> H <sub>8</sub> S <sub>2</sub>	Solid				288						11000	-51	1.1			
1,2-dichloroethane		107-06-2	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	Liquid	sweet	3.42	1.25	83.5	176-200	8-121 <sup>1</sup>	3.53E-5 <sup>4</sup>	13-21		5400	1.25 <sup>4</sup>	1.04 <sup>4</sup>			
1,4-oxathiane		15980-15-1	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub> S	Liquid				147			9.1E-4-2.2E-3	42		7986-8800	1.45-1.48	1.15-2.18			
Phosgene (CG)		75-44-5	COCl <sub>2</sub>	Gas	Mown grass, hay	3.4	1.373	7.6	1173	637000		None	800	Low	1.05 <sup>4</sup>			HCl, CO <sub>2</sub>	
Sarin (GB)		107-44-8	C <sub>4</sub> H <sub>10</sub> FO <sub>2</sub>	Liquid	None	4.86	1.0887	158	2.9	16800		NF	150	v. soluble	.72	1.77		HF, isopropyl alcohol	
Isopropyl methylphosphonic acid (IMPA)		1832-54-8	C <sub>3</sub> H <sub>7</sub> FO <sub>2</sub>	Liquid	Oily	1.1	1.02	102	.0034					48000	-54	1.08			
Methylphosphonic acid		993-13-5	C <sub>2</sub> H <sub>5</sub> FO <sub>2</sub>	Liquid								68		1,160,000 <sup>4</sup>	-0.68 <sup>4</sup>	-89 <sup>4</sup>			
Dimethyl methylphosphonate (DMMP)		756-79-6	C <sub>3</sub> H <sub>9</sub> FO <sub>2</sub>	Liquid															
Diisopropylmethylphosphonate (DIMP)		1445-75-6	C <sub>6</sub> H <sub>13</sub> FO <sub>2</sub>	Liquid															
Diisopropylmethylphosphonate (DIMP)		50782-89-9	C <sub>6</sub> H <sub>13</sub> FO <sub>2</sub>	Liquid															
Diethyl phosphinic acid (EMPA)		108-18-9	C <sub>4</sub> H <sub>10</sub> FO <sub>2</sub>	Liquid	None	9.2	1.0083	298	.0007	~10.5		159	295	30000 (@25°C) <sup>1</sup>	1.992 <sup>1</sup>	1.18 <sup>1</sup>		See 3 below	
Diethyl methylphosphonate (EMPA)		1832-53-7	C <sub>5</sub> H <sub>11</sub> FO <sub>2</sub>	Liquid	ammonia	3.49	.72	84	60-70		2.3E-2	-6.7		400	1.72	2.31			
Diisopropylamine (DA)		6532-44-7	C <sub>6</sub> H <sub>15</sub> N	Liquid										1100	-1.15	.75			
Diisopropylamine (DA)		1619-34-7	C <sub>6</sub> H <sub>15</sub> N	Solid	None	11.6	0.51	320	Negligible					9.5	3.48	3.28			
Diisopropylamine (DA)		532-27-4	C <sub>6</sub> H <sub>15</sub> N	Liquid	gasoline	~4	1.14	75-247	1		2.23E-5 <sup>4</sup>	<4.44		1.2	4.47	3.81		3-Quinoclidinylbenzole	
Diisopropylamine (DA)		7449-11-9	C <sub>6</sub> H <sub>15</sub> N	Solid										2815 <sup>4</sup>	2.08 <sup>4</sup>	1.87 <sup>4</sup>			
Diisopropylamine (DA)		7790-94-5	C <sub>6</sub> H <sub>15</sub> N	Liquid	plungent														

Chemicals	Name	CAS No.	Formula	Physical State	Odor	Relative Vapor Density (Air=1)		Boiling Point (°C)	Vapor Pressure (mm Hg) @20-25°C	Volatility (mg/m <sup>3</sup> ) @20-25°C	Henry's Law Constant (atm-m <sup>3</sup> /mol)	Flash Point (°C)	Decomposition Temp (°C)	Solubility in Water (mg/L)	log K <sub>ow</sub>	log K <sub>oc</sub>	Hydrolysis Products	
						(20-25°C)	(20-25°C)											
Decomposants																		
STB (Super Tropeal Bleach)				Liquid	Chlorine	1.085		100										
ceklum hypochlorite chloride				Solid	Chlorine	2.35				NA		NA						
FFH (Cakium Hypochlorite)		7778-54-3	Ca(OCl) <sub>2</sub>	Solid	Chlorine													
DS-2				Liquid														
Sodium hydroxide (2%)		40-01	NaOH	Liquid														
Diethylenetriamine (70%)		111-40-0	C <sub>4</sub> H <sub>11</sub> N <sub>3</sub>	Liquid	Ammonia	.96		207	.37			102			-1.67	.46		
2-methoxy ethanol (28%)		109-86-4	C <sub>3</sub> H <sub>8</sub> O <sub>2</sub>	Liquid		2.63	.97	125	6-10			46			-77	.96		
DANC		79-34-5	C <sub>4</sub> H <sub>9</sub> N	Liquid	sweet	5.8	1.59	146.2	5-8		3.8-4.56E-4	NF		2900-3230	2.39-2.56	1.66-2.07		
6.25% RH 195 in acetone/tetrahydrofuran				Liquid														
1,3-dichloro-5,5-dimethylhydantoin (DDH)		118-52-5	C <sub>6</sub> H <sub>12</sub> Cl <sub>2</sub> N <sub>2</sub> O	Solid	chlorine	1.5						246	200		NA	NA		hypochlorous acid
Sodium Carbonate		497-19-8	Na <sub>2</sub> CO <sub>3</sub>	Solid	odorless	2.509		Decompose	ell=0			NC						
CLOROX bleach (1.25% sodium hypochlorite)		7681-52-9	NaOCl	Liquid	Chlorine	1.085		100										

<sup>1</sup> U.S. Army Technical Report, Standard Operating Procedures for Chemical Agents, Fort McClellan Site Investigation, March, 1993.  
<sup>2</sup> U.S. Army Chemical Research, Development, and Engineering Center, Material Safety Data Sheets, 3 December 1990.  
<sup>3</sup> U.S. Army Chemical Research, Development, and Engineering Center, Material Safety Data Sheets, 3 December 1990.  
<sup>4</sup> Nonproprietary and Well-known, "Groundwater Chemicals Data Reference, Vols. 1, 11, 1991.  
<sup>5</sup> U.S. Army Chemical Research, Development, and Engineering Center, Material Safety Data Sheets, 3 December 1990.  
<sup>6</sup> Military Chemicals and Chemical Agents, U.S. Army technical manual TM 8-9, 1963.  
<sup>7</sup> U.S. Army Chemical Research, Development, and Engineering Center, Material Safety Data Sheets, 3 December 1990.  
<sup>8</sup> Toxic hydrolysis products include: diethyl methylphosphonate, 2-diisopropylaminoethyl mercaptan, ethyl hydrogen methylphosphonate, bis (2-ethylmethylphosphonic) anhydride, bis (2-diisopropylaminoethyl)methylphosphonodithioate.  
<sup>9</sup> Toxic hydrolysis products form at pH 7-10.  
<sup>10</sup> KISK PRO, General Sciences Corporation, 1990.  
<sup>11</sup> Solid below 39°C, liquid above 39°C.  
 NA = Not applicable.  
 NC = Non-combustible.  
 ND = Data not available.  
 NF = Non-flammable.