1.0 INTRODUCTION

The Radford Army Ammunition Plant (RFAAP) is an active military installation located in the mountains of southwest Virginia, and covers approximately 4,080 acres in Montgomery and Pulaski County, Virginia.

The United States Environmental Protection Agency (USEPA) issued a RCRA Corrective Action Permit to Alliant Ammunition and Powder Company (Alliant) and the U.S. Department of the Army (Army) on October 31, 2000. Within the RCRA Corrective Action permit is a listing of 31 identified Site Screening Areas (SSAs) which are to be investigated in accordance with this EPA approved Site Screening Process (SSP). Should additional SSAs be identified at RFAAP, a site screening will need to be completed in accordance with this SSP.

This SSP has been developed as the central document describing how site screening will be applied to the RFAAP. Overall, the SSP is devised to expedite investigations of SSAs at RFAAP to determine what level of evaluation is appropriate for these identified areas. The SSP will help determine whether there have been releases of hazardous substances, pollutants, contaminants, hazardous wastes, or hazardous constituents to the environment from an SSA, and determine whether an SSA should proceed further through the RFI process, be the subject of an interim removal action or be considered for no further action.

Once a SSA is identified, the following five distinct tasks will be undertaken:

- Performance of a Desktop Audit and site visit to determine the scope of the SSP site-specific Work Plan(s);
- Development of an SSP site-specific Work Plan outlining a Sampling and Analysis Plan as well as a risk screening plan (human health and ecological, as appropriate) for EPA approval;
- Performance of SSP field work in accordance with the approved SSP Work Plan;
- Evaluation of SSP data and completion of pre-remedial risk screening; and
- Determination of the need for further investigation of the SSA, an interim removal action at the SSA or preparation of a No Further Action Decision Document, per the RCRA Corrective Action permit, based on results of the SSP and risk screening.

The following sections detail these SSP tasks.

2.0 SITE VISIT AND DESKTOP AUDIT

The purpose of the Desktop Audit is to evaluate and document, through review of existing information, if operations at the SSA(s) have resulted in the release of hazardous substances, pollutants, contaminants, hazardous wastes or hazardous constituents to the environment. The Desktop Audit process includes a search of all documents related to operations at the SSA as well as interviews with personnel knowledgeable about the site. Available information for each SSA, including location and a site map, description of past and current land uses, and a description of releases and associated cleanups, will form the basis for the Desktop Audit. Other information sources will include the administrative record and other local, state and federal documentation containing information pertinent to the site.

Typical existing information that will be examined during the Desktop Audit will include site use, ownership and operational history, groundwater and surface water use and characteristics, soil exposure characteristics, and air exposure pathways. This information can be obtained from maps, publications by the United States Geological Survey (USGS) and state geological surveys, regional databases and geographic information systems, and aerial photography. On the basis of information collected during the Desktop Audit, a list of chemicals potentially stored, handled, released, or disposed at each SSA will be compiled.

In addition to the Desktop Audit, a site visit will be conducted at each SSA. The site visit will include a visual inspection of the SSA to aid in site characterization, including identifying potential contaminant sources; chemical migration pathways; potential human and ecological receptors; and receptor exposure pathways. Additionally, potential media to be sampled and sampling locations will be identified for the SSP.

Results of the Desktop Audit and site visit will be presented in a summary report. Included in the report will be an SSA-specific Conceptual Site Model (CSM) depicting potential contaminant sources, environmental and exposure pathways of concern, and potential human and ecological receptors. The CSM will maximize the usability of analytical data derived from site characterization efforts for subsequent risk assessments, and will form the basis for any additional data collection to support the human health and ecological risk screening. These results will be used in formulating the SSP Work Plan, including the need for human health and ecological risk screening.

3.0 DEVELOPMENT OF SITE SCREENING INSPECTION SAMPLING AND ANALYSIS STRATEGY

A site-specific Work Plan will be developed for each SSA investigated under the SSP. The Work Plans will reference the Desktop Audit Summary, providing a detailed description of historical information, SSA conditions, results of previous investigative work and results of the site visit. The Work Plans will also present a Sampling and Analysis Plan (SAP) that describes the number, types and locations of samples to be collected, sample analyses, and the rationale for the sampling plan. The purpose of sample collection and analysis will be to assess the presence or absence of hazardous substances, contaminants, hazardous wastes, or hazardous constituents, and to provide data for performing human health and ecological risk screening in order to evaluate if there is a potential threat to human health or the environment at the SSA.

Media sampled during the SSP will be identified based upon Desktop Audit and site visit findings, and approval of the USEPA Region III.

Potential media of interest in the SSP may include surface soil (0 to 1 feet below ground surface [bgs] 0-6 inches for constituents other than VOCs, 6-12 inches for VOCs), subsurface soil, groundwater, surface water, sediment, and animal and plant tissue (e.g., fish). Where appropriate, geophysical techniques will be used to aid in placement of groundwater and soil sample locations and to confirm and delineate suspected buried waste material identified during the Desktop Audit and site visit. Field screening for explosives using immunoassay-type sampling kits can be performed at SSAs (a complete list of all explosive compounds and respective detection limits using this method will be included in the Work Plan). However, immunoassay-type analytical data cannot be used for risk screening, unless it can be shown through confirmation sampling and analysis that the results of the field test kits are of equivalent precision and accuracy to standard methods of analysis.

Groundwater samples collected during SSP investigations may be obtained via direct push techniques (DPT) or from groundwater monitoring wells, depending on site conditions and data needs. For groundwater samples collected from monitoring wells, only unfiltered organic and metals results will be considered in the assessments (except in circumstances where monitoring wells do not produce samples with sufficiently low solids for a reasonable risk screening to be performed). For DPT groundwater samples, only the filtered metals and unfiltered organic results will be considered in the assessment. Groundwater parameters measured during field activities should include pH, Eh, dissolved oxygen, specific conductance, temperature, salinity, and turbidity, as appropriate, depending on the medium- and SSA-specific conditions.

All environmental media samples collected during the SSP will be analyzed for the full suite of Contract Laboratory Procedure (CLP) constituents and other constituents based on the findings of the Desktop Audit including additional analytes requested by EPA. The analytical target list will include Target Compound List (TCL) volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs) and dioxins, and Target Analyte List (TAL) inorganic chemicals, including cyanide. Based on past uses of specific SSAs for explosives treatment, and the results of field screening immunoassay methods, it may be necessary to analyze specific samples for nitramine/nitroaromatic compounds. Depending on the history of the SSA and other available information, it may be necessary to

analyze specific samples for perchlorates. Soil samples should be analyzed for physical properties (e.g., bulk density, grain size, specific gravity, percent moisture, and total organic carbon [TOC]), as necessary.

Analytical methods used in the SSP will generally be USEPA CLP/Standard Methods and/or SW-846 Methods. Polynuclear aromatic hydrocarbons (PAHs) and pesticides/PCBs may be analyzed using low detection methods. For example, the National Oceanographic and Atmospheric Administration (NOAA) Status and Trends Methods (USEPA Method No. 1668 [GC/MS, congener standards]; USEPA, 1995d) will be used to meet PCB method detection limits (MDLs) required for the human health and ecological risk screening. An analysis of risk-based concentrations (RBCs) and Biological Technical Assistance Group (BTAG) screening levels relative to analytical reporting limits (RLs) will be conducted as part of Work Plan preparation to ensure that RLs do not exceed screening concentrations (to the greatest extent practicable).

CLP laboratory analytical data will be subjected to data validation in accordance with the Innovative Approaches for Validation of Organic and Inorganic Data, as amended by USEPA Region III (USEPA, 1995a). Section 5 describes the data validation and data evaluation process that will be used in the SSP.

4.0 PERFORMANCE OF FIELD WORK

All SSP field work at SSAs will be performed in accordance with the Master Project Plans for RFAAP and the SSA-specific SSP Work Plan described in Section 3.0 above. The Master Project Plan, including a Field Sampling Plan, Quality Assurance Project Plan, and Health and Safety Plan, addresses the full range of potentially applicable activities that could be required throughout the SSP.

5.0 DATA VERIFICATION, VALIDATION AND USABILITY ASSESSMENT

5.1 Data Verification

Data will be verified in accordance with USEPA Region III Innovative Approaches for Data Validation (USEPA, 1995). Verification for organic data will be performed at Manual Level M2 and the verification for inorganic data will be performed at Manual Level IM1 (if a determination is made that an SSA does require a RFI and formal baseline risk assessment, the existing SSP data will be re-validated at the M3 and IM2 level, respectively). Particular emphasis will be placed on holding time compliance, equipment calibration, spike recoveries, and blank results, although all required elements of the verification process will be considered. The analytical results for nonCLP parameters will be verified based on the Region III Modifications to the National Functional Guidelines further modified to reflect the acceptance specifications of the referenced method to the extent that those specifications differ from those in the Region III Modifications to the National Functional Guidelines. Data qualifiers will be assigned based on the results of verification findings. Laboratory deliverable packages will be equivalent to USEPA CLP deliverable packages, containing complete quality control (QC) summary reports, quality assurance (QA) documentation, and raw data.

Data qualifiers provide information pertaining to the degree of confidence to be considered relative to the presence (or absence) of reported chemicals, and also identify numerical results considered to be less accurate and/or precise than is normal for the method. A list of the data qualifiers that may be applied during the verification effort and their definitions are presented below.

Data Qualifier Codes	
J	The analyte was positively identified. The associated result is the approximate concentration of the analyte in the sample.
K	The analyte was detected. Reported value may be biased high.
R	Serious analytical problems were encountered and quality control criteria were not met. The data point is rejected. The analyte may or may not be present in the sample.
N	Tentative identification. Consider present. Special methods may be needed to confirm its presence or absence in future sampling efforts
L	The analyte was detected. Reported value may be biased low.
U	The analyte was analyzed for, but not detected above the reported quantitation limit.
UL	The analyte was not detected. The reported quantitation limit is approximate and may be lower.
UJ	The analyte was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
B	The analyte was analyzed for, but was not detected substantially above the level reported in the laboratory or field blanks.

Data tables must report non-detects with the following format: < xx, where xx is the sample reporting limit (but not the method detection limit, the instrument detection limit, the contract detection limit, etc.). Thus, all data tables will have either a blank to show that a constituent was not analyzed, a number to show the numeric value of the detected constituent, or a less than symbol followed by the sample reporting limit. The usual data qualifiers will be added as necessary. A data validation report with hand annotated Form 1s will be prepared to present data validation findings.

5.2 Data Validation and Usability Assessment

Data that are compliant with the minimum specifications of the subject analytical methods, still may not provide sufficient qualitative and/or quantitative quality to make decisions at the requisite statistical confidence. To assess risks associated with chemicals of potential concern (COPCs) at a SSA, data of known quality must be used (USEPA, 1992a). An understanding of analytical data quality is necessary for evaluation of uncertainties related to the data, and consideration of these uncertainties in the decision-making process for the SSAs. To facilitate this goal, data from the SSPs will be evaluated for quality and usability prior to its use in the human health and ecological risk screening.

Guidance such as Guidance for the Data Quality Objective Process (EPA QA/G-4, 1994), Guidance for the Data Quality Assessment Process (EPA QA/G-9, 2000), Risk Assessment Guidance for Superfund, Volume I (USEPA, 1989), and Guidance for Data Usability in Risk Assessment (USEPA, 1992a) will be used to evaluate data for usability in the human health and ecological risk screening. Data will be evaluated for quality based on information in the data verification report. Specifically, data will be evaluated for appropriateness of analytical methods and qualifiers, significant blank contamination, and tentatively identified compounds (TICs). Further, and perhaps more importantly, biases and variability inherent in the data will be assessed in relation to the relative interval between the risk screening level and the reported concentration. Additionally, given that a statistical relationship can be defined between variability, the number of samples in a given data set, and the statistical confidence with which a given conclusion may be drawn, the sampling plan and reported results will be evaluated in relationship to the DQOs established during the planning process.

All validated data that is not qualified and data that is qualified with J, L, K, U, UL, UJ, and B will be used to identify COPCs in the risk screening process, unless the inherent limitations of the analytical method and/or matrix effects obviate this use. Data qualified as rejected (i.e., R) will not be used in COPC identification.

Analytical results for the essential nutrients, calcium, sodium, potassium, and magnesium, in both solid and aqueous media, will not be considered in the assessments. All other metals, including iron, and all organic chemicals, including laboratory contaminants not disqualified in the data verification and validation processes, will be considered in the COPC identification process if detected at least once in environmental samples at an SSA.

5.3 Tentatively Identified Compounds

Chemical analysis to identify and quantify organic compounds is performed with gas chromatography-mass spectrometry (GC-MS) methods. The GC-MS instrument is calibrated for a series of target analytes using chemical standards of known concentration and purity. Quantification of these target analytes is performed against specific internal standards as identified in the respective method. Identification of these target analytes is based on a comparison of the unknown analyte to the chemical standards used during calibration based on the analyte's retention time and mass spectra.

Chromatographic peaks in volatile/semivolatile fractions analyses that are not target analytes, surrogates, or internal standards are potential Tentatively Identified Compounds (TICs). TICs must be qualitatively identified by a National Institute of Standards and Technology (NIST) mass spectral library search and the identification assessed by the data reviewer. For each sample, the laboratory conducts a mass spectral search of the NIST library and report the possible identity for the 10 VOC and/or 20 SVOC largest fraction peaks that are not surrogates, internal standards, or target compounds, but that have an area or height greater than 10 percent of the area or height of the nearest internal standard. TIC results are reported for each sample on the Organic Analyses Data Sheet (Form I - VOC-TIC or SVOC -TIC)

TICs will be reported and included in the COPC identification based upon the degree of match, evidence of similar pattern, analyst professional judgment, availability of toxicity data (e.g., IRIS, HEAST, or NCEA reference doses and/or slope factors), and consultation with EPA Region III (see Section 6.1.1.1). The top 20 TICs will be reported by name and CAS Registry number and may be quantified. Quantification of TICs will be based on input from EPA staff. Positive identification and quantification of TICs will be accomplished by acquiring the appropriate standards and calibrating the GC-MS for the tentatively identified compounds. TICs that lack toxicity data will be discussed in the uncertainty section of the screening risk assessment results.

6.0 SCREENING PROCEDURES

Human health and ecological screening procedures will be performed as a part of the SSP. Section 6.1 presents the methodology for the human health screening procedures and Section 6.2 presents the methodology for the ecological risk screening .

6.1 Human Health Screening Procedures

Human health screening procedures will be conducted in accordance with the USEPA Risk Assessment Guidance for Superfund (RAGS) (USEPA, 1989 and 1991b) and USEPA Region III guidance (USEPA, 1991c, 1993a, and 1998a) with modifications. The purpose of the screening step is to evaluate site data with respect to conservative criteria so that sites requiring no further action can be eliminated from further consideration. This process will also be used to identify sites requiring further evaluation to proceed through additional steps. The conceptual site model (CSM) developed in Section 2.0 will be used to identify those media that are associated with identified exposure pathways. If potential current and future exposure pathways associated with a particular medium are determined to be incomplete, then it may not be necessary to carry that medium through the screening process, given approval by EPA.

The screening procedure will involve the following steps:

1. Identification of COPCs and Cumulative Risk Screening

2. Chemical-Specific Screening for Lead and Iron

3. Comparison to Soil Screening Levels (SSLs)

4. Comparison to ARARs

5. Background Comparisons

These steps are described in the following sections.

6.1.1 Identification of COPCs and Cumulative Risk Screening

6.1.1.1 Identification of COPCs for Human Health Cumulative Risk Screening

As stated previously, chemicals detected at least once in environmental samples at an SSA will be evaluated in the COPC identification stage of the human health screening. The essential nutrients calcium, sodium, potassium, and magnesium; chemicals disqualified in the validation process; and TICs not positively identified, will be eliminated as COPCs.

COPCs will be identified by comparing maximum detected concentrations (MDCs) in a specific medium with chemical-specific risk-based screening criteria, unless the data display the statistical properties required to calculate a valid 95% upper confidence limit (UCL). If this is the case, then the 95% UCL will be employed. Chemicals with MDCs exceeding risk-based

criteria will be identified as COPCs and will be carried through to the cumulative risk screening step of the assessment.

Soil and Sediment. COPCs in surface and subsurface soil and sediment will be identified by comparing MDCs (or a 95% UCL if appropriate) in these media to Risk-Based Concentrations (RBCs) in the most recent version of the USEPA Region III Risk-Based Concentration Table for soil ingestion using the residential and industrial scenarios (USEPA 2000).

For soils and sediments that are exposed a significant portion of the year (i.e., > 6 months/year), screening levels shall correspond, or be adjusted to correspond, to an increased cancer risk of 1 x 10-6 and a noncancer Hazard Quotient (HQ) of 0.1. COPCs can be identified if the MDCs (or a 95% UCL if appropriate) are greater than the screening values for the ingestion and/or inhalation pathways. For sediments that are not exposed, comparisons to adjusted soil screening levels may be used to decide on the need for further evaluation (e.g., quantitative risk assessment), further investigation or response action.

Groundwater and Surface Water. COPCs in groundwater and surface water will be identified by comparing MDCs (or a 95% UCL if appropriate) of chemicals in these media to RBCs in the most recent version of the USEPA Region III Risk-Based Concentration Table for tap water (USEPA 2000), and to federal and state Maximum Contaminant Levels (MCLs) for groundwater and surface water used as a source of drinking water.

For groundwater, as well as surface water that may be a source of drinking water, RBC screening levels shall correspond, or be adjusted to correspond, to an increased cancer risk of 1 x 10-6 and a noncancer Hazard Quotient (HQ) of 0.1. For other surface water, comparisons to adjusted groundwater screening levels may be used to decide on the need for further evaluation (e.g., quantitative risk assessment), further investigation, or response action. Note that all ground water is considered a source of drinking water unless deemed non-potable (i.e., Class III).

Fish. COPCs in fish will be identified by comparing MDCs (or a 95% UCL if appropriate) of chemicals in fish tissue samples to screening level RBCs for fish in the USEPA Region III Risk-Based Concentration Table (USEPA, 2000). Screening levels shall correspond, or be adjusted to correspond, to an increased cancer risk of 1 x 10-6 and a noncancer Hazard Quotient (HQ) of 0.1.

Chemicals Lacking RBCs

For chemicals lacking Region III published RBCs, but having available associated toxicity data that are peer-reviewed, risk assessors will obtain information from the following sources, which are listed in order of preference: USEPA's Integrated Risk Information System (IRIS), Health Effects Assessment Summary Tables (HEAST), and provisional values from the National Center for Environmental Assessment (NCEA). From these sources, the Army will make a good faith effort to propose alternative screening values, for EPA concurrence.

Summary. In summary, a detected chemical will be retained as a COPC for a specific medium if the MDC (or a 95% UCL if appropriate) is greater than the corresponding screening criteria described above.

6.1.1.2 Cumulative Risk Screening

The cumulative risk screening process will consist of calculating ratios between the maximum exposure point concentrations (EPCs) of COPCs in an environmental medium and the corresponding USEPA Region III residential and industrial RBCs. COPCs are those chemicals brought forward from the COPC identification step (see Section 6.1.1.1). Carcinogenic and noncarcinogenic effects will be evaluated for exposure to chemicals in each environmental medium sampled.

6.1.1.2.1 Estimation of Exposure Point Concentrations

For purposes of this screening process, maximum detected concentrations (MDCs) (or a 95% UCL if appropriate) will be considered in the cumulative risk screening as representative exposure point concentrations (EPCs) for the SSA as a conservative measure. The selection of the MDC for the exposure point concentration in most cases is motivated by the recognition that in many cases when the number of samples is small, the alternative approach reverts to the maximum detected concentration because the calculated 95% UCL exceeds the MDC.

6.1.1.2.2 Human Health Effects - Carcinogens

The potential for carcinogenic risk will be evaluated by estimating excess cancer risk for each COPC. Using the maximum EPC and the respective screening level RBC value, excess residential and industrial cancer risk can be estimated using the following formula:

$$Excess\,Cancer\,Risk = TR\frac{Max.EPC_i}{RBC_i}$$

Where:

	TR	=	The target lifetime cancer risk of 1x10-6
	EPCi	=	EPC of COPCi detected in soils and fish (mg/kg) or water (g/L)
	RBCi	=	RBC for COPCi in soils and fish (mg/kg) or water (g/L) based on carcinogenic effects at the TR stated above

Finally, the cumulative residential and industrial excess cancer risk is estimated for each SSA. The cumulative excess cancer risk for exposure to multiple COPCs is estimated using the following equation:

$$Cumulative\ Excess\ Cancer\ Risk = \sum \left[TR\ x \frac{Max.EPC_i}{RBC_i} \right]$$

In accordance with 40 Code of Federal Regulations (C.F.R.) 300.430, carcinogenic risk within the benchmark range of 1x10-4 (1 cancer case in 10,000) to 1x10-6 (1 cancer case in 1,000,000) is generally considered acceptable. The following statement is from 40 C.F.R. 300.430 (2000): "For known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk to an individual of between 10-4 to 10-6 using information on the relationship between dose and response. The 10-6 risk level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available or are not sufficiently protective because of the presence of multiple contaminants at a site or multiple pathways of exposure."

Multiplying the EPC/RBC ratio by USEPA's point of departure risk level, 10-6, results in an excess cancer risk estimate for the COPC. Excess cancer risk estimates for all COPCs will be summed to account for potential carcinogenic effects associated with multiple chemical exposures (USEPA, 1989) for each medium. The results of cumulative risk screening will be evaluated as follows:

- If the calculated cumulative excess cancer risk is greater than or equal to 1×10^{-5} for any of the medium, then a quantitative risk assessment would be performed for the SSA, or

- If the calculated cumulative excess cancer risk is: 1) below 1×10^{-5} for all media; and 2) no other screening criteria, as defined by this document, have been exceeded, then no further action (NFA) would be recommended for the SSA.

6.1.1.2.3 Human Health Effects - Noncarcinogens

The potential for adverse noncarcinogenic health effects will be evaluated by calculating a residential and industrial HQ for each COPC. Using the maximum EPC and a respective noncarcinogenic RBC, a residential or industrial HQ can be estimated with the following formula:

$$HQ = THQ \frac{Max.EPC_i}{RBC_i}$$

Where: THQ = The target HQ of 0.1
EPCi = EPC of COPCi detected in soils and fish (mg/kg) or groundwater (g/L)
RBCi = RBC for COPCi in soils and fish (mg/kg) or Groundwater (g/L) based on noncarcinogenic effects at the THQ stated above.

Finally, the cumulative residential and industrial non-carcinogenic hazard index (HI) for exposure to multiple COPCs is estimated as follows:

$$Cumulative\ Noncarcinogenic\ HI = \sum \left[THQ\, x \frac{Max.EPC_i}{RBC_i} \right]$$

Per USEPA guidance for a Baseline Risk Assessment, when the HI exceeds 1, there is a potential for adverse noncarcinogenic health effects (USEPA, 1989). Generally, the more the HI exceeds unity, the greater the potential for adverse health effects. Additionally, when the HI exceeds 1, and multiple chemicals contribute to the exceedance, the HI is segregated on the basis of toxic effects and target organs (i.e., hepatic, renal, respiratory, cardiovascular, gastrointestinal, hematological, musculoskeletal, dermal, ocular effects, neurological, reproductive, developmental, and immune system).

For the cumulative risk screening procedure, HI segregation will involve obtaining the most recent and reliable noncarcinogenic health effects data for COPCs, such as data in the Integrated Risk Information System database (EPA) and databases developed by the Agency for Toxic Substances and Disease Registry (ATSDR). Health effects will be considered for only chronic exposure to COPCs. For COPCs with multiple target organs, the organ that the chemical primarily targets will be considered in hazard segregation.

The results of the cumulative hazard screening will be evaluated as follows:

- In accordance with Region III guidance for risk screening, if the cumulative noncarcinogenic HI for a SSA, computed by this method, is greater or equal than 0.5 for any target organ, then a quantitative risk assessment would be performed for the SSA, or

- If the cumulative noncarcinogenic HI for an SSA, computed by this method, is: 1) less than 0.5 for all target organs; and 2) no other screening criteria, as defined by this document, have been exceeded, then NFA would be recommended for the SSA.

6.1.1.3 Uncertainty Analysis

Uncertainties associated with the cumulative risk screening will be qualitatively evaluated to determine the accuracy of the approach. Factors that may contribute to uncertainty include the use of RBC age-adjusted ingestion and inhalation rates, the use of toxicity information provided by NCEA when RBCs are not available, and the level of uncertainty due to a lack of dermal risk estimates. Uncertainty in the assessment could also arise if health-based RBCs are less than analytical method detection limits.

Uncertainty is associated with the use of RBCs and SSLs because they do not consider dermal uptake. The Site Screening Process is geared towards a risk-based identification of COPCs and preliminary assessment of human and ecological risks that is objective and quantitative. As such, it hinges on the availability of appropriate, risk-based screening levels. No such levels have been identified for dermal exposures to soil, sediment, water or air. Given the conservative nature of the screening process (e.g., use of MDC for exposure point concentrations, use of residential screening level RBCs for soil and groundwater), it is considered very unlikely that omission of

dermal exposures in the risk screening process will result in failure to identify a SSA that would require further investigation or response. To guard against this possibility, contaminant concentrations at all SSAs that pass the risk screening will be scrutinized for the occurrence of contaminants that are known to be easily absorbed through the skin, and if necessary, dermal risks for selected contaminants will be calculated in accordance with USEPA's Dermal Exposure Guidance (USEPA, 1992c, 1997a). These dermal risks may be added to the Cumulative Excess Cancer Risk or Cumulative Noncarcinogenic HI computed above.

6.1.2 Chemical-Specific Screening for Lead and Iron

6.1.2.1 Lead

If lead concentrations in soil are greater than 400 mg/kg (USEPA, 1994a), or lead concentrations in groundwater or surface water are greater than 15 g/L (USEPA 1996b), then potential risk associated with lead will be evaluated using the IEUBK model (USEPA, 1994b). The model will be run using site-specific input parameters based on SSP findings and consultation with USEPA Region III. If the percentage of children expected to have blood lead levels of 10 micrograms per deciliter (μg/dL) or greater exceeds 5%, then further investigation or response action will be required for the SSA.

6.1.2.2 Iron

If iron concentrations in soil or water result in an HQ of 0.5 or greater, then a "margin of exposure" evaluation will be performed. Risks from exposure to iron will be characterized by comparing estimated iron intake to the recommended dietary allowance (RDA) and concentrations known to cause adverse effects in children (NCEA, 1996).

6.1.3 Comparison to Soil Screening Levels (SSLs)

USEPA's Soil Screening Guidance (USEPA, 1996a) will be used as the source of information for three types of SSLs, which address:

- Chemical migration of VOCs from subsurface soil to air;
- Chemical migration of contaminants from soil to air via fugitive dust; and
- Chemical migration of contaminants from soil to groundwater.

MDCs (or a 95% UCL if appropriate) of chemicals found in soil and sediment will be compared to screening levels for leaching of contaminants to groundwater, i.e., soil-to-groundwater screening levels (USEPA, 1996a). Many soil-to-groundwater screening values can be found in the USEPA Region III RBC Tables. A dilution attenuation factor (DAF) of 20 may be used unless groundwater is considered to be shallow. In this case, a site-specific DAF should be calculated. Chemicals found at concentrations exceeding soil-to-groundwater screening levels will be evaluated in a qualitative manner to assess the need for further assessment, investigation, or response action. Geotechnical information such as Total Organic Carbon (TOC), pH, groundwater characteristics, etc., will be an integral part of the qualitative evaluation. In

particular, the SSL comparison will be evaluated with respect to its application to site conditions, such as the karst environment which is present throughout RFAAP. Based on the qualitative evaluation, and other relevant information, a recommendation will be made as to whether further evaluation, investigation, or response action should take place for the SSA.

6.1.4 Comparison to ARARs

MDCs (or a 95% UCL if appropriate) of chemicals found at each SSA will be compared to Applicable or Relevant and Appropriate Requirements (ARARs), including, but not limited to: federal and Virginia Maximum Contaminant Levels (MCLs) under the Safe Drinking Water Act, federal Ambient Water Quality Standards under the Clean Water Act, Virginia Water Quality Criteria, Virginia AST/UST TPH guidance level for soil (100 mg/kg) and Virginia AST/UST TPH guidance level for groundwater (1 mg/L) (VDEQ, 1995). Chemicals which are found at concentrations greater than ARARs will be identified. If an MDC (or a 95% UCL if appropriate) is greater than one or more ARARs, a recommendation will be made as to whether further evaluation, investigation, or response action should take place for the SSA. EPA may decide that further evaluation, investigation or response action is required at a SSA, based upon consultation with the Commonwealth if State ARARs are involved.

6.1.5 Background Comparison

As a final step in the human health screening process, MDCs of chemicals identified as COPCs will be compared to the EPA-approved site-specific background concentrations shown in the following table. This table includes inorganic chemicals whose 95% upper tolerance limit (UTL) are greater than residential RBC values and are based on the inorganic background data collected at RFAAP.

Facility-Wide Point Estimates for Soil

[Units in mg/kg]

Chemical	Minimum Concentration	Maximum Concentration	95% UTL of the Mean
Aluminum	3,620	47,900	40,041
Arsenic	1.2	35.9	15.8
Chromium	6.3	75.8	65.3
Iron	7,250	67,700	50,962
Manganese	16.7	2,040	2,543
Thallium	1.3	5	2.11
Vanadium	12.2	114	108

Based on the background comparison, and other relevant information, a recommendation will be made as to whether further investigation or response action is warranted at each SSA.

6.1.6 Summary of Human Health Risk Screening Procedures

The results of each screen will be summarized. If COPCs have been identified, in a particular medium, the SSA will be subject to further evaluation, such as a quantitative risk assessment. The results of the SSP will also be used to further refine the CSM.

6.2 Ecological Risk Screening Procedures

The USEPA Risk Assessment Forum (1992) recommended a general framework for conducting ecological risk assessments (ERAs). The Forum framework is presented in Figure 6-1. USEPA has since refined the framework and prepared ERA guidance (USEPA 1997). The approach taken for the SSA ecological screening at RFAAP follows the ERA eight-step approach in the USEPA guidance. Other guidance documents which may be consulted during the ecological risk screening process include the USEPA Region III BTAG ERA guidelines (USEPA 1995b), and the Tri-Service Procedural Guidelines for ERAs, Volume 1 (Wentsel et al, 1996).

The eight-step process is summarized in Figure 6-2. Since this is an ecological risk screen, the process focuses on Steps 1 and 2. These steps are intended to provide a foundation of information pertaining to ecological resources and potential interactions with site-related contamination in order that risk managers can make conservative decisions regarding ecological risks at individual SSAs.

The following steps will be followed for the ecological risk screening :

Site Reconnaissance

Problem Formulation

Exposure Assessment

Ecological Effects Assessment

Risk Characterization

Figure 6-1 Ecological Risk Assessment Framework (USEPA, 1997)

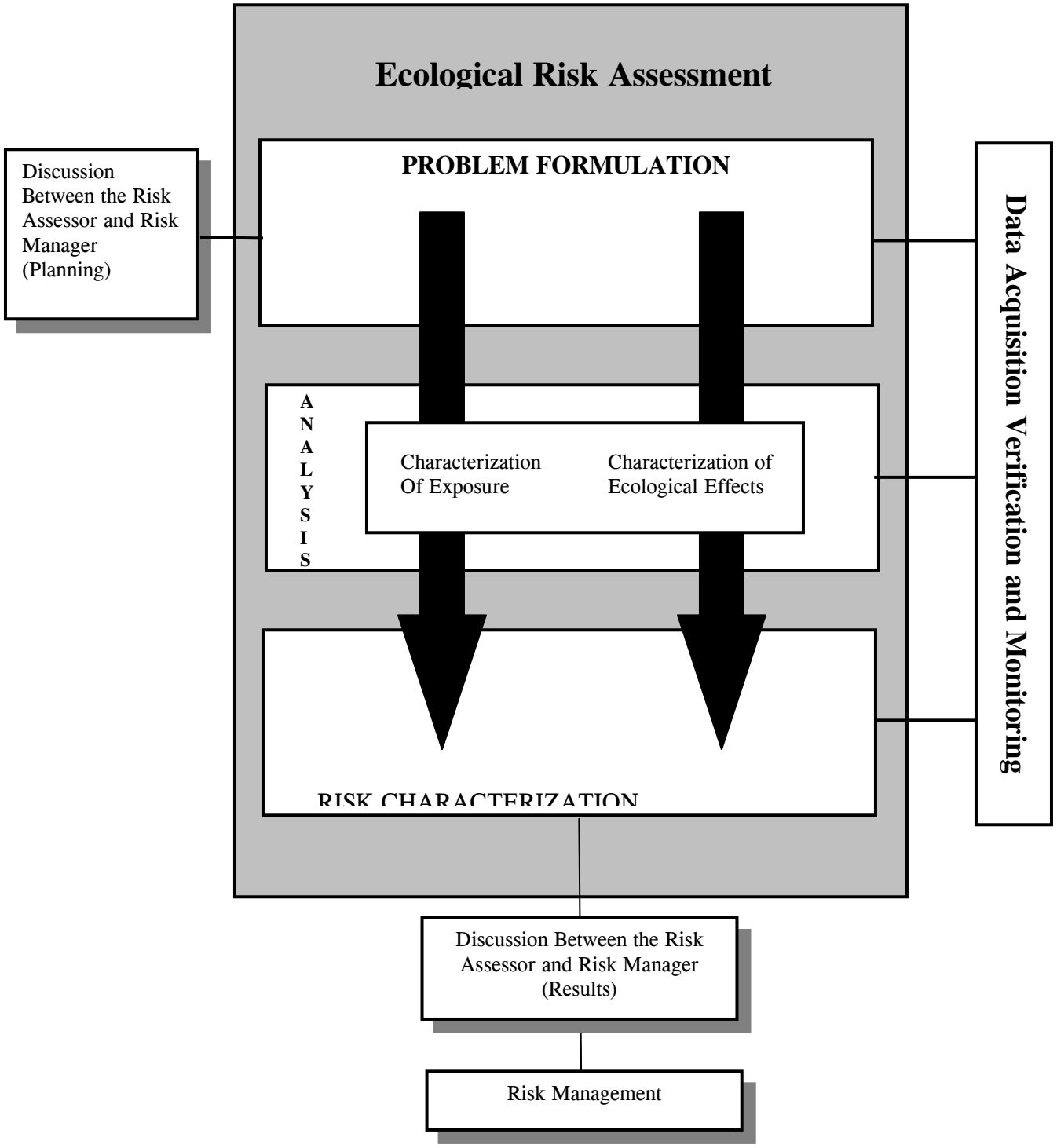
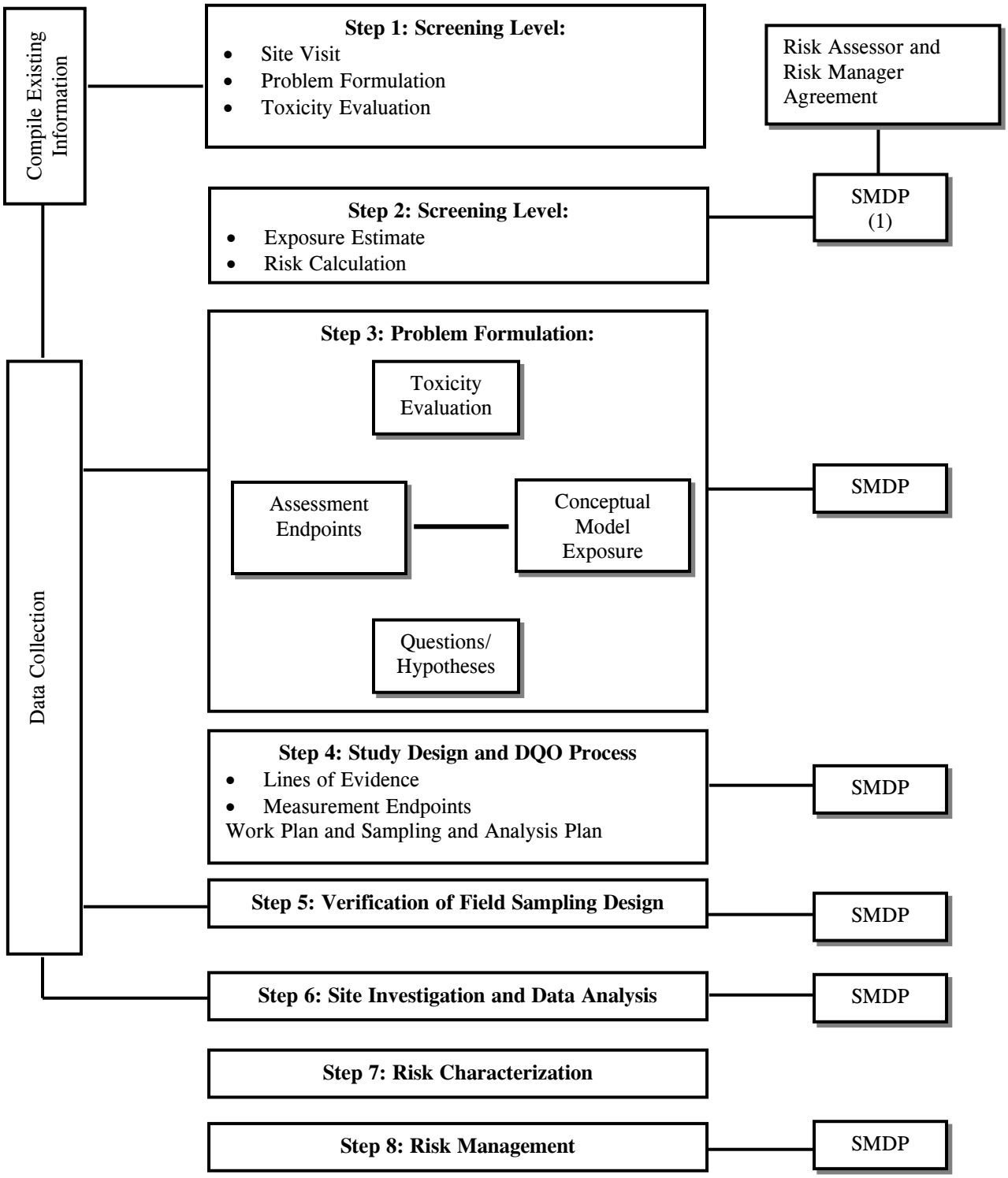


Figure 6-2 Eight-Step Ecological Risk Assessment Process for Superfund (USEPA, 1997)



The ecological risk screening will provide conclusions and recommendations regarding ecological risk at the site. The Army will use these data to make ecological risk management recommendations for each SSA. The scientific/management decision point reached from the ecological risk screening will include one of the following:

- There is adequate information to conclude that ecological risks are negligible and therefore there is no need for further action at the SSA on the basis of ecological risk;

- The information is not adequate to make a decision at this point and further refinement of data is needed to augment the ecological risk screening; or

- The information collected and presented indicates that a more thorough assessment is warranted.

6.2.1 Problem Formulation

Problem formulation is the first phase of a ecological risk screening and discusses the goals, breadth, and focus of the screening. It involves the collection and analysis of existing data to the greatest extent possible. Problem formulation includes general descriptions of RFAAP SSAs, with emphasis on size of the SSAs, proximity to operational areas and/or sensitive habitats, and the habitats and ecological receptors present. This phase also involves characterization of site contaminants, contaminant sources, migration routes, and an evaluation of complete routes of contaminant exposure to important ecological receptors. Assessment and measurement endpoints that will be evaluated are also selected. Finally, a conceptual model is developed that describes how contaminants associated with the sites in question may come into contact with ecological receptors. Much of this step will have been completed during the site reconnaissance, the review of historical information, and the development of the work plan, as discussed in Sections 2.0 and 3.0, respectively.

The following sections provide more detailed descriptions of the steps involved in the development of the problem formulation component of the ecological risk screening.

6.2.1.1 Site Characterization

The objectives of this step are to initially identify and characterize the site(s) ecological resources, and to preliminarily describe the nature and extent of chemical contamination at the site(s) in question. Information pertaining to site land-use (past, current and future), size, proximity to operable areas and/or sensitive habitats, and habitats and ecological resources will be developed during the site characterization. The SSP is a screening level process that will be used to determine if a site should proceed further through the RFI stage. As such, detailed field sampling and quantitative analysis of biota will not be performed during the SSP. If contamination is identified which may impact ecological receptors, a recommendation in the SSP report would include biota sampling.

This step will actually begin with the site visit discussed in Section 2.0. Information about local ecological resources (including threatened and endangered species) will also be obtained from maps of the study area, available scientific literature, and federal and state agencies (e.g., U.S.

Fish and Wildlife Service, Virginia Department of Game and Inland Fisheries, Department of Natural Heritage database, etc.). The site characterization will also describe likely contaminant sources, release mechanisms, complete migration pathways, the fate of chemicals resulting from site-related activities, as well as important ecological resources that could be adversely affected by these chemicals.

6.2.1.2 Identification of Chemicals of Potential Ecological Concern

COPCs will be identified by comparison of maximum site concentrations to approved Region III BTAG screening values and/or by simple food-web modeling. Initial screening of analytical data will be conducted using general screening values considered protective of all wildlife. Chemicals with MDCs (or a 95% UCL if appropriate) exceeding screening values and/or chemicals for which no screening values are available will be initially identified as COPCs to be carried through to the risk characterization step of the ecological risk screening. Values may be derived from sources such as, Federal and state standard Ambient Water Quality Criteria, Ontario Ministry of the Environment LEL values for freshwater habitats (Ontario Ministry of Environment and Energy, 1993), Great Lakes Research TEL values (Smith et al., 1996) for freshwater habitats, and EPA and ORNL surface soil screening levels (USEPA, 2000b and Will and Suter, 1995a).

6.2.1.3 Identification of Exposure Pathways and Potential Receptors for Analysis

The pathways by which ecological receptors may be exposed to COPCs at the site(s) will be identified along with the receptor groups that could be adversely affected by these chemicals. Several potential exposure pathways may exist at the site(s). For example, terrestrial vegetation may be exposed to contaminants via direct aerial deposition and root translocation, although aerial deposition is highly variable and difficult to quantify. Terrestrial animals may be exposed to soil contaminants through ingestion of contaminated food items and by incidentally ingesting soil while grooming fur, preening feathers, digging, grazing close to the soil, or feeding on items to which soil has adhered (such as roots and tubers). Terrestrial animal receptors may also come into contact with contaminants in surface water by using surface water for drinking water, although this exposure route represents a negligible portion of total exposure for most receptors.

Aquatic and semi-aquatic organisms at the RFAAP may be exposed to contaminants via direct contact with surface water and sediments, incidental ingestion of surface water and sediments, and consumption of contaminated food items. Aquatic and semi-aquatic organisms may also be exposed to constituents from contaminated groundwater that flows into surface water.

For purpose of the SSA ecological risk screening, exposure pathways representing important and likely meaningful routes of contaminate uptake will be assessed for appropriate receptor groups. If sufficient information exists to examine more obscure exposure routes (e.g. aerial deposition or inhalation) or if the assessment of an exposure route will substantially contribute to the risk understanding (e.g. drinking water) it will be examined to assess whether it warrants the evaluation.

Based on the identification of site-specific habitats, food webs, COPCs, and exposure pathways, recommendations will be made for species or species groups to be selected for evaluation in the risk screening. These may include the following receptor groups:

- For terrestrial systems: terrestrial plants, terrestrial invertebrates, reptiles and amphibians, invertebrate-eating birds (e.g., robin), invertebrate-eating mammals (e.g., shrew), carnivorous mammals (e.g. red fox), and carnivorous birds (e.g., red-tailed hawk) may be included. In addition, plant-eating mammals (e.g., rabbit), and omnivorous mammals (e.g. raccoon) may be included.

- For aquatic systems: aquatic plants, benthic invertebrates, fish, reptiles and amphibians, fish-eating birds (e.g. great blue heron), and fish-eating mammals (e.g. mink) may be included.

6.2.1.4 Identification of Assessment and Measurement Endpoints

One of the major tasks in screening problem formulation is the selection of assessment and measurement endpoints. An assessment endpoint is defined as "an explicit expression of actual environmental values that are to be protected" (USEPA, 1992d). Measurement endpoints are "measurable ecological characteristics that are related to the valued characteristic chosen as the assessment endpoint" (USEPA 1992d). Measurement endpoints serve as tools for ranking and evaluating environmental values that are to be protected. While declines in populations and shifts in community structure can be quantified, studies of this nature are generally time-consuming and difficult to interpret. However, measurement endpoints indicative of observed effects on individuals are relatively easy to measure in laboratory toxicity studies and can be related to the site specific assessment endpoint.

Toxicity data and assessment endpoints shall be discussed with BTAG, and agreed upon, in accordance with the USEPA Guidance (USEPA 1997). This step also includes the development of a conceptual site model (CSM) and identification of the specific objectives and scope of the ecological risk screening. The CSM is designed to diagrammatically identify potentially exposed receptor populations and applicable exposure pathways, based on the physical nature of the site and the potential contaminant source areas. Generally, a separate CSM will be developed for each SSA because the contaminant source, migration pathways, assessment and measurement endpoint, and exposure pathways are site-specific. However, in appropriate cases, more than one SSA can be included in a single CSM if, for example, there are common exposure and/or migration pathways.

6.2.2 Exposure Assessment

This section of the ecological risk screening includes identification of contaminant concentration data used to represent ecological exposure in various media. For each exposure pathway selected for quantitative evaluation, conservative exposure point concentrations (EPCs) will be used and the receptor specific exposure will be quantified. EPCs will be estimated using environmental sampling data either alone or in conjunction with simple environmental fate and transport models.

The food chain modeling will be performed in accordance with current USEPA CERCLA guidance for ecological risk assessment, and use conservative exposure parameter values (maximum ingestion rate, minimum body weight, 100% bioavailability) (USEPA, 1993b). The ecological exposure assessment will consist of two phases. The first, most conservative, phase will be based on conservative exposure assumptions such as:

Maximum analytical results for each medium of concern used as EPCs; and

Site use factor equals 1

The second phase will be based on conservative yet more realistic exposure assumptions such as:

- Site use factor determined based on the size of the SSA, proximity to operational areas and/or sensitive habitats, the quality of habitat present, and behavior of important ecological receptors; and

- Use of average body weight and average intake for selected wildlife receptors.

6.2.3 Ecological Effects Assessment

This step in the ecological risk screening develops toxic reference values (TRVs) for ecological receptors, to be used in the risk characterization. Acknowledging that data pertaining to ecological risk characterization is continually being updated, the Army shall consult with EPA on the most-up-to-date and appropriate data sources, when reaching this stage in the screening process. The toxicity of COPCs to terrestrial and aquatic organisms will be summarized using relevant toxicity data for the selected receptor species. The TRVs to be used in the evaluation of potential adverse effects to terrestrial and aquatic species will be derived from the literature, where possible.

In food web modeling, calculated doses will be compared to toxicological thresholds (no observed adverse effect levels [NOAELs] and lowest observed adverse effect levels [LOAELs]). The Army shall develop TRVs for wildlife receptors derived from NOAELs and LOAELs taken from various literature sources. BTAG will review these values and may provide technical assistance in selecting wildlife derived NOAELs and LOAELs. Only EPA and BTAG approved TRVs will be used in identifying COPCs at SSAs.

6.2.4 Risk Characterization

This step compares exposure point contaminant concentrations with benchmark concentrations protective of ecological receptors. The ratio of the maximum contaminant concentration to the benchmark value is called the HQ or Ecological Effects Quotient (EEQ), and is defined as follows:

$$EEQ = Emax/TRV$$

Where: EEQ = Ecological Effects Quotient for contaminant (unitless)

Emax = Maximum Concentration for contaminant (mg/L or mg/kg)

TRV = Toxicity Reference Value for contaminant (mg/L or mg/kg)

When the ratio of the maximum concentration to its respective benchmark value exceeds 1.0, further assessment may be needed. The EEQ value should not be construed as being probabilistic; rather, it is a numerical indicator of the extent to which a maximum concentration exceeds or is less than a benchmark. When EEQ values exceed 1.0, it is an indication that ecological receptors are potentially at risk based on conservative exposure assumptions.

The preliminary risk characterization will be based on the conservative preliminary exposure assumptions. A major part of the risk characterization is the interpretation of the preliminary estimates of risk in light of the conservative assumptions and uncertainties (see Section 6.2.5).

Additional evaluation of site-specific data may be necessary to confirm with greater certainty whether ecological receptors are actually at risk at the site, especially since most benchmarks are based on conservative exposure assumptions. A refined estimate of EEQs will be made using the refined exposure factors (Section 6.2.2). The results of the conservative and refined risk estimates will be evaluated in light of the uncertainties of the risk assessment process (Section 6.2.5). Furthermore, other factors, such as low frequency of detection, may mitigate potential risks for a COPC with an elevated EEQ value.

6.2.5 Uncertainty Analysis

When the above steps are completed, the results are interpreted and the uncertainties associated with the ecological risk screening are addressed. General uncertainties associated with the ecological risk screening will be qualitatively evaluated to determine the conservatism of the approach. For example, uncertainty in this site screening could arise if ecological based criteria are less than analytical method detection limits. In addition, background screening will be performed at this stage to aid in risk management decisions. Maximum detected concentrations of inorganic constituents may be compared to background values (see Section 6.1.4) to assist in assessing whether or not potential ecological risk is associated with site-related conditions.

7.0 SITE SCREENING PROCESS REPORT

Results of the desktop audit, nature and extent determination (if available), and the human health and ecological screening procedures will be presented in an SSP Report for each SSA with a recommendation for future action. The EPA will review the SSP Report for each SSA and based on results of the screening procedures, a decision will be made as to whether each SSA should be recommended for no further action, or for further action. A need for further action will be based on but not limited to the following: historical use of the SSA, history of documented release (if any), analytical data from the SSA, and the overall weight of the evidence. In general, further action at an SSA may be required under the following circumstances:

- Cumulative Excess Cancer Risk (CECR) greater than 1x10-5
- HI greater than 0.5 per target organ
- Maximum Detected Concentration > SSL for chemical migration from soil to ground water or other screening values (e.g., Virginia AST/UST TPH guidance level for soil; Virginia State and Federal MCLs, Virginia AST/UST TPH guidance level for ground water; or Federal and State Ambient Water Quality Criteria for surface water)
- Ecological risk considerations per Section 6.2

If none of the above circumstances occur, EPA may recommend no further action and memorialize this recommendation in a Decision Document.

If any of the above circumstances occur, further action may be required. Further action may consist of one or more of the following:

- Interim Removal Action, followed by sampling to confirm that risks have been reduced to acceptable levels
- Focused RFI (including additional sampling)
- RFI/CMS

8.0 DISPUTE RESOLUTION

Disputes arising during the course of the SSP shall be resolved using the dispute resolution procedures of the RCRA Corrective Action Permit, Part I, C.

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