2008

EPA Superfund
Record of Decision

LAKE CITY ARMY AMMUNITION PLANT
EPA ID: MO3213890012
INDEPENDENCE, MO
JANUARY 2008

FINAL

Record of Decision for Remedial Actions at Installation-Wide Operable Unit Lake City Army Ammunition Plant Independence, Missouri

Prepared for
Lake City Army Ammunition Plant

January 2008

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1. DECLARATION FOR THE RECORD OF DECISION

1.1 Site Name and Location

The Lake City Army Ammunition Plant (LCAAP), Comprehensive Environmental Response, Compensation, and Liability Information System Identification Number (CERCLIS ID#) MO3213890012, is an active, government-owned, contractor-operated (GOCO) facility. It was listed on the National Priorities List (NPL) in 1987. The Installation is located at the junction of Highways 7 and 78 in Independence, Jackson County, Missouri **(Figure 1)**. Cleanup work at the Installation has been divided into operable units to facilitate site management. This Record of Decision (ROD) pertains to the Installation-Wide Operable Unit (IWOU) of the LCAAP.

1.2 Statement of Basis and Purpose

This decision document describes the Selected Remedies for the LCAAP IWOU, which were chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA) and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The remedy for the IWOU was jointly selected by the U.S. Army (Army) and the United States Environmental Protection Agency (USEPA) based on the contents of the Administrative Record File for the IWOU. The State of Missouri (Missouri Department of Natural Resources [MDNR]) concurs with the Selected Remedies.

1.3 Assessment of the Site

The response actions selected in this ROD are necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

1.4 Description of Selected Remedies

Operations at Lake City include manufacture, assembly, storage, and test firing of small-caliber ammunition. Ancillary operations include wastewater treatment; hazardous waste storage, treatment, and disposal; and incineration/demilitarization of off-spec ammunition. Industrial operations have generated large quantities of potentially hazardous wastes including oils/greases, solvents, explosives, and metals. An active outdoor range is also located at the LCAAP where small arms ammunition is tested. This ammunition has, in the past, included limited depleted uranium (DU) rounds, in addition to other metals constituents, which have been released to the environment. Other chemicals of concern (COCs) at the Installation include volatile and semi-volatile organic compounds, metals, perchlorate, polychlorinated biphenyls (PCBs), and explosives. Typical chemicals used at the LCAAP include soaps, detergents, bleaches, acids, pyrotechnics, metals, phosphate cleaners, oils, explosive compounds, and solvents. Historically, waste treatment and disposal at the LCAAP occurred on site in lagoons, landfills, and burn pits, which are the focus of the ongoing cleanup actions. The LCAAP is the only major small arms manufacturing facility for the Department of the Army. Due to its unique position as a major small arms ammunition manufacturing facility, there is no plan to cease production. The LCAAP has operated in the same mission except during the period between 1945 and 1950, when the LCAAP was placed on standby status. Future use of LCAAP has been defined as industrial for the purposes of risk assessments. Because it is the primary supplier of small-caliber ammunition to the armed forces, there is little likelihood that LCAAP will be used for any purposes other than industrial in the foreseeable future. There is

no reasonable probability that the facility will ever be used for anything other than industrial purposes (i.e., residential purposes) (EA 1995).

Because of the complexity of the site, Lake City has been divided into four operable units (OUs): OU1 – IWOU, which is the subject of this ROD (**Figure 2**); OU2 – Area 18 OU; OU3 – Northeast Corner OU (NECOU); and OU4 – Area 10 OU. Selected remedies for OU1 through OU3 will be implemented during 2007, and OU4 will be addressed at a later date.

The IWOU consists of 30 sites and includes all LCAAP Areas, with the exception of Area 10 (which makes up the Area 10 OU); Area 18 (which makes up Area 18 OU); and Areas 11, 16,and 17 (which make up the NECOU). Two removal actions have been completed within the IWOU. These actions address the Inactive Sumps and Surficial Debris or "Housekeeping" sites. A remedial investigation/feasibility study (RI/FS) and Proposed Plan have been completed.

The Area 18 OU is located along the northern boundary in the central portion of the Installation. Eight surface impoundments existed in this area in the 1950s, in which industrial wastewater treatment plant (IWTP) waste grease and oil, solvents, and trash were burned. Fifteen additional pits used for burning and disposal of IWTP and other wastes were also located throughout the area. The primary contaminants are lead and PCBs in the soil and volatile organic compounds (VOCs) in soil and groundwater resulting from past disposal of solvents and other liquid wastes in the area. A Non-Time Critical Removal Action was implemented between 1996 and 1997 to address contaminated groundwater in Area 18. This action involved installation and operation of a groundwater extraction and aboveground treatment system. The purpose of this removal action was to prevent impacted groundwater from migrating off site and to reduce the overall mass of contaminants in on-site groundwater.

In 1999, the Army issued a ROD for Area 18 calling for soil vapor extraction (SVE) and excavation in combination with groundwater extraction and treatment. The groundwater extraction and treatment component of the ROD was the continued operation of the treatment system implemented as a non-time critical removal action, described above. An investigation conducted to support full-scale system design found that the vertical and horizontal extents of the source areas and associated groundwater plumes were larger than originally believed, leading to additional characterization and re-evaluation of the selected remedy, which has now been completed. In October 2006, the Army published a Proposed Plan to document the proposed changes to the Selected Remedy for Area 18 OU. The Final ROD for the Area 18 Operable Unit was signed in September 2007.

The NECOU is located along the northern border in the northeast portion of the Installation. It includes the Area 11 Burning Ground, Area 16, and Area 17. Area 11 was used for the open burning of propellants and waste pyrotechnics mixtures. It has been closed under Resource Conservation and Recovery Act (RCRA) authority, but the closure did not address groundwater, which was deferred to the CERCLA process. Area 16 contains the abandoned landfill, solvent pits, old burning ground area, and a closed firing range. Area 17 contains three closed oil and solvent pits; a waste, glass, paint, and solvents area; an old burning pad; the closed sanitary landfill; and the active pistol qualifying range. Primary OU contaminants are oils and solvents, which were disposed in pits in Area 17. VOC groundwater plumes have been identified.

An Interim Remedial Action (IRA) ROD was signed in September 1998 which called for installation of a permeable reactive wall (PRW) to treat groundwater from the NECOU and the construction of a vegetative

cover over the Area 17B Oil and Solvent Pits to reduce infiltration into the pits. The PRW and cover were installed between July 2000 and January 2001. The Army upgraded the engineered cover over the 8.8-acre Area 16 Abandoned Landfill in 2003 to minimize infiltration. Groundwater monitoring wells were also installed to determine if the landfill is a source area contributing to the NECOU groundwater plumes. Leachate collection tanks were installed in 2003 to collect leachate and treat it prior to discharge. This work was performed as non-time critical removal actions. The Final ROD for the NECOU was signed in September 2007.

The Area 10 sand piles contain waste sand that was used in bullet catchers on the Area 27 firing range and contains mixed waste (DU and metals) and unexploded ordinance. A RI/FS is currently underway to be followed by remediation and decommissioning of the OU. The Army is planning to conduct a non-time critical removal action at Area 10; however, the Action Memorandum has not yet been signed. The schedule for completion of the work at the Area 10 sand pile has not been finalized pending receipt of funding.

The selected remedies for the various Areas **(Figure 3)** at the IWOU are as follows:

- Area 2: Focused soil excavation and off-site disposal of lead-impacted soil to prevent potential exposure to site and construction workers and to prevent potential leaching to groundwater;

- Area 3: Vegetative cover and land use controls (LUCs) to prevent potential exposure of polynuclear aromatic hydrocarbons (PAHs) and metals-impacted soils to human and ecological receptors;

- Area 9: Focused soil excavation and off-site disposal of lead- and trichloroethene (TCE)-impacted soil to prevent potential exposure to site workers;

- Area 13: Focused soil excavation and off-site disposal of metals-impacted soil to prevent potential exposure to site workers;

- Area 23: Implementation of LUCs to protect construction/utility workers from potential exposure to manganese in wind-blown fugitive dust;

- Area 30: Vegetative cover and LUCs to prevent potential exposure of metals-impacted soils to human and ecological receptors;

- Area 34: Focused soil excavation and off-site disposal of metal and explosive-impacted sediment to prevent potential exposure of sediment to ecological receptors and to prevent potential leaching to groundwater;

- IWOU-Wide Groundwater: Monitored natural attenuation (MNA), LUCs, groundwater extraction and ex-situ treatment, and installation of an in-situ treatment system at Area 12 via enhanced reductive dechlorination (ERD) to prevent potential exposure of human receptors to groundwater; and

- Areas 4, 7, 13, 15, 19, 21, and 33: LUCs are necessary to prevent exposure to contaminated soil associated with inactive sumps that are located next to production buildings or areas that prohibit removal of the sumps at this time. The following sumps require future work and will be addressed as they become available through maintenance or construction activities, or at installation closure or

transfer: 1SU2, 3SU3, 33CSU1, 33DSU1, 34BSU1, 34DSU1, 52ASU1, 52BSU1, 97ASU2, and 136ASU1. In addition, five inactive sumps at Area 13 have been abandoned beneath buildings (35SU10 through 35SU14). These sumps are presumed to have been filled or removed during construction activities and were not addressed as part of the Removal Action. If in the future it is determined that these sumps require additional work, they will be addressed as access to them becomes available due to construction, maintenance, or at Installation closure or transfer.

For all other Areas at the IWOU that are not listed above, the IWOU RI/FS found that there was no unacceptable potential risk to human health or the environment based on either the current or the anticipated future industrial land use scenario. The Army does not anticipate any additional investigation or action for soil at Areas 1, 5, 6, 8, 12, 14, 20, 22, 24, 25, 26, 28, 29, 31, and 32 under an industrial land use scenario other than the implementation of LUCs to maintain the industrial setting of the property, with the exception of those areas listed above that cannot currently be accessed.

A primary objective of the LCAAP Installation Action Plan is to "identify environmental cleanup requirements at each site or area of concern and propose a comprehensive, installation-wide approach to conduct investigations and necessary remedial actions." Combined with the response actions for the other three OUs (Section 2.4) and the previous Removal Actions at the IWOU (Section 2.2), the selected remedy for IWOU will provide a comprehensive remedy for hazardous substances that have been or are threatened to be released into the environment for the Site. All remedial alternatives in this ROD were evaluated based on the assumption that land use within the IWOU will continue to be for industrial purposes in the future. Because the Selected Remedies for the IWOU may not be protective if land use were to change, land use controls to maintain industrial land use will be a component of all the remedies to maintain industrial land use. The Army will be responsible for implementing and maintaining these LUCs.

1.5 Statutory Determinations

The statutory determination for the Selected Remedies for each of the Areas is provided in the following sections.

1.5.1 Area 2

The selected remedy for Area 2 is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions. The selected remedy for this Area is excavation of lead contaminated soils, off-site disposal and land use controls. The lead will be treated on site via stabilization, if necessary, following excavation of the soil. The objective is to dispose of the soil as non hazardous; therefore, the soil will be treated on site if necessary. Therefore, the statutory preference for treatment as a principal element would be met for this Area, and the selected remedy will result in no impacted soil being left on site above the selected cleanup levels based on an industrial use setting. No source materials constituting principal threats are present at this Area. The selected remedy for this Area relies on LUCs to maintain industrial land use.

To evaluate the effectiveness of the remedy over time, a statutory review will be conducted within 5 years of the previous Five-Year Review for the LCAAP. The first and only Five-Year Review for the LCAAP was signed in September 2005 for the review period of April 1999 through January 2005. The subsequent statutory reviews for the IWOU will be conducted as part of the site-wide review at 5-year intervals from this most

recent review to ensure that the Selected Remedies are, or will be protective of, human health and the environment.

1.5.2 Area 3

The Selected Remedy for Area 3 is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions. The selected remedy for this Area does not satisfy the statutory preference for treatment as a principal element of the remedy because the impacts are due to immobile PAH constituents that are not amenable to treatment. No source materials constituting principal threats are present at this Area. The selected remedy for this Area relies on LUCs to maintain industrial land use and impacted soil with COCs at concentrations higher than cleanup levels to be placed under a vegetative cover at Area 3.

Because industrial land use must be maintained, a statutory review will be conducted within 5 years of the previous Five-Year Review for the LCAAP. The first and only Five-Year Review for the LCAAP was signed in September 2005 for the review period of April 1999 through January 2005. The subsequent statutory reviews will be conducted at 5-year intervals from this most recent review to ensure that the Selected Remedies are, or will be, protective of human health and the environment.

1.5.3 Area 9

The Selected Remedy for Area 9 is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions. The Selected Remedy for this Area is excavation and off-site disposal as well as LUCs. The soil impacts are generally due to immobile metals and a minimal extent of VOC constituents that are not amenable to treatment. Therefore, the statutory preference for treatment as a principal element would not be met for this Area, although the Selected Remedy will result in no impacted soil being left on site above the selected cleanup levels. No source materials constituting principal threats are present at this Area. The Selected Remedy for this Area relies on LUCs to maintain industrial land use.

Because industrial land use must be maintained, a statutory review will be conducted within 5 years of the previous Five-Year Review for the LCAAP. The first and only Five-Year Review for the LCAAP was signed in September 2005 for the review period of April 1999 through January 2005. The subsequent statutory reviews will be conducted at 5-year intervals from this most recent review to ensure that the Selected Remedies are, or will be, protective of human health and the environment.

1.5.4 Area 13

The Selected Remedy for Area 13 is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions. The Selected Remedy for this Area is excavation and off-site disposal as well as LUCs. The soil impacts are generally due to immobile metal constituents that are not amenable to treatment. Therefore, the statutory preference for treatment as a principal element would not be met for this Area, although the Selected Remedy will result in no impacted soil being left on site above the selected cleanup levels. No source materials constituting principal threats are present at this Area. The Selected Remedy for this Area

relies on LUCs to maintain industrial land use. In addition, LUCs will be implemented for the inaccessible soil that remains at Area 13 beneath the berm.

Because industrial land use must be maintained, a statutory review will be conducted within 5 years of the previous Five-Year Review for the LCAAP. The first and only Five-Year Review for the LCAAP was signed in September 2005 for the review period of April 1999 through January 2005. The subsequent statutory reviews will be conducted at 5-year intervals from this most recent review to ensure that the Selected Remedies are, or will be, protective of human health and the environment.

1.5.5 Area 23

The Selected Remedy for Area 23 is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions. The Selected Remedy for this Area does not satisfy the statutory preference for treatment as a principal element of the remedy because the only environmental impacts resulting in unacceptable risk to human health and the environment for the current land use are caused by the presence of manganese in wind-blown fugitive dust, which is not amenable to treatment. No source materials constituting principal threats are present at this Area. The Selected Remedy for this Area relies on engineering controls to protect site workers and LUCs to maintain industrial land use.

Because industrial land use must be maintained, a statutory review will be conducted within 5 years of the previous Five-Year Review for the LCAAP. The first and only Five-Year Review for the LCAAP was signed in September 2005 for the review period of April 1999 through January 2005. The subsequent statutory reviews will be conducted at 5-year intervals from this most recent review to ensure that the Selected Remedies are, or will be, protective of human health and the environment.

1.5.6 Area 30

The Selected Remedy for Area 30 is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions. The Selected Remedy for this Area does not satisfy the statutory preference for treatment as a principal element of the remedy because the impacts are due to immobile metal constituents that are not amenable to treatment. No source materials constituting principal threats are present at this Area. The Selected Remedy for this Area relies on LUCs to maintain industrial land use and impacted soil with COCs at concentrations that are higher than cleanup levels to be placed under a vegetative cover at Area 30.

Because industrial land use must be maintained, a statutory review will be conducted within 5 years of the previous Five-Year Review for the LCAAP. The first and only Five-Year Review for the LCAAP was signed in September 2005 for the review period of April 1999 through January 2005. The subsequent statutory reviews will be conducted at 5-year intervals from this most recent review to ensure that the Selected Remedies are, or will be, protective of human health and the environment.

1.5.7 Area 34

The Selected Remedy for Area 34 is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective,

and utilizes permanent solutions. The Selected Remedy for this Area is excavation and off-site disposal as well as LUCs. The soil impacts are generally due to immobile metal and explosive constituents that are not amenable to treatment. Therefore, the statutory preference for treatment as a principal element would not be met for this Area, although the Selected Remedy will result in no impacted soil being left on site at concentrations above the selected cleanup levels. No source materials constituting principal threats are present at this Area. The Selected Remedy for this Area relies on LUCs to maintain industrial land use.

Because industrial land use must be maintained, a statutory review will be conducted within 5 years of the previous Five-Year Review for the LCAAP. The first and only Five-Year Review for the LCAAP was signed in September 2005 for the review period of April 1999 through January 2005. The subsequent statutory reviews will be conducted at 5-year intervals from this most recent review to ensure that the Selected Remedies are, or will be, protective of human health and the environment.

1.5.8 IWOU-Wide Groundwater

The selected remedy for the IWOU-Wide Groundwater is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. The remedy also satisfies the statutory preference for treatment as a principal element of the remedy through the use of an In-situ Reactive Zone (IRZ) at Area 12 (i.e., reduces the toxicity, mobility, or volume of pollutants or contaminants as a principal element through treatment). The selected remedy for IWOU-Wide Groundwater includes ERD via IRZ, MNA for the IWOU groundwater plumes, groundwater extraction and ex-situ treatment, and LUCs.

Because the Selected Remedy results in pollutants or contaminants remaining on site at concentrations above levels that allow for unlimited use and unrestricted exposure (industrial land use must be maintained), a statutory review will be conducted within 5 years of the previous Five-Year Review for the LCAAP. The first and most recent Five-Year Review for the LCAAP was signed in September 2005 for the review period of April 1999 through January 2005. The subsequent statutory reviews will be conducted at 5-year intervals from this most recent review to ensure that the Selected Remedies are, or will be, protective of human health and the environment.

1.6 Data Certification Checklist

The following information is provided in this ROD. Additional information can be found in the Administrative Record file for this site.

- COCs and their respective concentrations (Sections 2.6 through 2.35);
- Baseline risk represented by the COCs (Sections 2.6 through 2.35);
- Cleanup levels established for COCs and the basis for these levels (Sections 2.6 through 2.35; Table 7, Table 21);
- How source materials constituting principal threats are addressed (Sections 2.6 through 2.35);

- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD (Section 2.35);

- Potential land and groundwater use that will be available at the site as a result of the selected remedy (Section 2.6 through 2.35);

- Estimated capital, annual operations and maintenance (O&M), and total present-worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (Table 8); and

- Key factor(s) that led to selecting the remedy (i.e., describe how the selected remedy provides the best balance between the balancing and modifying criteria, highlighting criteria key to the decision) (Section 2.6 through 2.35).

1.7 Signature and Support Agency concurrence on the Remedy

The foregoing represents the selection of a remedial action by the Army and USEPA with the concurrence of MDNR.

Concur and recommend for immediate implementation:

U.S. DEPARTMENT OF THE ARMY

29 Feb 08

Michael P. O'Keefe
Colonel, CM
Commanding

Date

U.S. ENVIRONMENTAL PROTECTION AGENCY, REGION 7

3/12/08

Cecilia Tapia
Director
Superfund Division

Date

The foregoing represents the selection of a remedial action by the Army and USEPA with the concurrence of MDNR.

Concur and recommend for immediate implementation:

MISSOURI DEPARTMENT OF NATURAL RESOURCES

Doyle Childers
Director

6-19-08
Date

2. DECISION SUMMARY

2.1 Site Name, Location, and Description

The USEPA proposed the LCAAP, CERCLIS ID# MO3213890012, referred to as either LCAAP or the Installation, for listing on the NPL on October 15, 1984. Final listing occurred on July 22, 1987, effective August 21, 1987. The Army is the lead agency for LCAAP, and USEPA Region 7 and the MDNR are support agencies, with the USEPA serving as the lead agency for oversight. The principal source of funding for cleanup activities at LCAAP is the Department of Defense's Defense Environment Restoration Program (DERP).

The LCAAP is a 3,935-acre government-owned, contractor-operated facility located at the intersection of U.S. Highways 7 and 78, mostly within the corporate boundary of Independence, Jackson County, Missouri (**Figure 1**). The LCAAP was established in 1941 to manufacture and test small caliber ammunition for the Army, and has remained in continuous operation except for one 5-year period between 1946 and 1950.

2.2 Site History and Enforcement Activities

Operations at the LCAAP include manufacture, assembly, storage, and test firing of small-caliber ammunition. Ancillary operations include wastewater treatment; hazardous waste storage, treatment, and disposal; solid waste and sludge disposal; and incineration/demilitarization of off-spec ammunition. Typical chemicals used at LCAAP include soaps, detergents, bleaches, acids, pyrotechnics, metals, phosphate cleaners, oils, explosive compounds, and solvents. Historically, waste treatment and disposal at the LCAAP occurred on site. LCAAP relied on lagoons, landfills, and burn pits for waste disposal.

Industrial operations generated large quantities of potentially hazardous wastes and hazardous substances including oils/greases, solvents, explosives, and metals. An active outdoor firing range (Area 27) is also located at the LCAAP where small arms ammunition is tested. This ammunition has, in the past, included limited DU rounds, in addition to other metals constituents, which have been released to the environment. Other contaminants of concern at the Installation include volatile and semi-volatile organic compounds, metals, perchlorate, PCBs, and explosives.

The Army, USEPA Region 7, and MDNR signed a CERCLA Section 120 Federal Facility Agreement (FFA) that went into effect on November 28, 1989. The FFA identifies the roles and responsibilities of the parties for response actions at LCAAP. The FFA states that properly selected remedial actions shall satisfy the groundwater corrective action requirements for the RCRA-regulated units within Areas 1, 2, 4, 5, 6, 7, and 8, which were not clean-closed. The Army has implemented and is maintaining the closure and post-closure care requirements for the RCRA-regulated units within Areas 1, 2, 4, 5, 6, 7, and 8. The remedial action that has been selected in accordance with this ROD for Area 9 will address the applicable substantive RCRA closure and post-closure requirements for the mercurous nitrate storage area near Building 60.

RCRA activities conducted at LCAAP are summarized below.

Area 1 RCRA Closure Activities

RCRA closure samples were collected from the soil excavation from 6 to 30 inches beneath the base of the lagoon. Eighty confirmation samples were analyzed for Chemical Oxygen Demand (COD), Extraction Procedure (EP) toxicity lead, and trinitroresorcinol (TNR). In addition, an organics scan was performed on select samples consisting of VOCs, acid extractable organics, and base/neutral and acid extractable organic compounds (BNAs).

All the final confirmatory samples collected during the RCRA closure of the lagoons in Areas of Interest (AOIs) 1A, 1B, and 1C were negative for EP toxicity. TNR was not detected in any confirmation samples. The samples with the highest COD levels were extracted from 6 to 30 inches. The levels of COD in the confirmation samples were below background cleanup criteria. Samples with high COD concentrations were analyzed for VOCs and semi-volatile organic compounds (SVOCs), but neither VOCs nor SVOCs were detected in these soil samples. AOI 1C was certified as closed by statistical analysis of Total Kjeldahl Nitrogen (TKN) results because the COD results were inconclusive. Long-term monitoring associated with the former RCRA lagoons is summarized in Section 2.35 and discussed in detail in the Remedial Design/Remedial Action Work Plan (RD/RAWP).

Area 2 RCRA Closure Activities

RCRA Lagoon Closure activities were performed within AOI 2B under a plan approved by MDNR in 1985. Closure consisted of removal of liquid, sediment, and underlying soil from both the North and South lagoons. Certification of closure was based on the analysis of 198 confirmatory samples collected from the bottoms and sidewalls of the lagoons. The sample analytes, which were selected based on sludge analyses performed in 1983, were toxicity characteristic leaching procedure (TCLP) lead, total lead, strontium, and aluminum. Based on the results of the closure data, the MDNR approved the closure of the two Area 2 lagoons with no additional soil removal required. Long-term monitoring associated with the former RCRA lagoons is summarized in Section 2.35 and discussed in detail in the RD/RAWP.

Area 4 RCRA Closure Activities

Six sediment and three liquid samples were collected from the backline lagoons prior to the RCRA closure of the four impoundments. The four lagoons within AOI 4A were closed under RCRA between 1985 and 1987 under an MDNR-approved closure plan. Closure criteria were based on removal of sludge and underlying soil to a background lead level of 49 milligrams per kilogram (mg/kg). Forty-eight samples were analyzed for total lead, and one sample was analyzed for an organics scan consisting of volatile organics, acid extractable organics, and base-neutral extractable organics. The closure was performed in accordance with an MDNR-approved Closure Plan, and the closure activities were verified in a Certification of Closure. This certification was submitted to MDNR in response to a request from MDNR to certify the closure of the lagoons instead of stating that the plans and specifications had been followed during closure activities. Long-term monitoring associated with the former RCRA lagoons is summarized in Section 2.35 and discussed in detail in the RD/RAWP.

Area 5 RCRA Closure Activities

RCRA Lagoon Closure activities for AOI 5A were performed under an MDNR-approved closure plan. Closure activities consisted of removal of liquid, sediment, and underlying soil from the lagoon. Certification of closure was based on the analysis of 48 confirmatory samples collected from the bottom and sidewalls of the lagoon. The sample analytes, which were selected based on sludge analyses performed in 1983, were TCLP lead, total lead, strontium, and aluminum. Based on the results of the closure data, the MDNR approved the closure of the AOI 5A lagoon with no additional soil removal required. Long-term monitoring associated with the former RCRA lagoons is summarized in Section 2.35 and discussed in detail in the RD/RAWP.

Area 6 RCRA Closure Activities

RCRA Lagoon Closure activities within AOI 6A were performed under an MDNR-approved closure plan. Twelve sediment samples from the lagoon at AOI 6A were sampled and analyzed during the pre-RCRA closure sampling activities. Closure consisted of removal of liquid, sediment, clay liner, and underlying soil from the lagoons. Closure was based on the underlying soil concentrations attaining a total COD equal to or less than 10 times background. Based on the results of the closure data, the MDNR approved the closure of the Area 6 lagoon with no additional soil removal required. Long-term monitoring associated with the former RCRA lagoons is summarized in Section 2.35 and discussed in detail in the RD/RAWP.

Area 7 RCRA Closure Activities

Prior to the closure of the lagoons associated with AOI 7A (East) and AOI 7A (West), samples of the sludge were collected and submitted for metals and EP toxicity metals analyses. These results indicated that the sludge did not leach metals at significant levels because none of the results exceeded the EP toxicity criteria.

The AOI 7A (East) lagoons were closed and capped under RCRA in 1989. The liquids and sediments in the lagoons were removed along with the contaminated soil. The vitrified clay pipe leading from the IWTP to the first lagoon was removed and disposed with the contaminated soil. Soil samples were collected from 38 locations, and the soil was analyzed for lead. Confirmation soil samples collected during RCRA closure activities were all interpreted to be within background.

The excavation was backfilled, and a soil cap was installed over the excavated area. Confirmation samples were collected from three lagoons at AOI 7A (East) and analyzed for total antimony, barium, copper, lead, and zinc. Thirty-three sample locations were cored at Lagoon 1, 46 sample locations were cored at Lagoon 2, and 37 sample locations were cored at Lagoon 3. In addition, 38 sample locations were cored from the ditch adjacent to AOI 7A (East) and the pipe that runs from the IWTP. Confirmation soil samples collected during RCRA closure activities were all interpreted to be within background. As a result, AOI 7A (East) was backfilled and capped in 1989. The RCRA closure of these lagoons was certified in 1989.

The liquids and sediments in the lagoons associated with AOI 7A (West) were removed along with the contaminated soil under an MDNR-approved closure plan in 1989. The lagoons were then retrofitted with double synthetic liners. Confirmation samples were collected from three lagoons at AOI 7A (West) and analyzed for total antimony, barium, copper, lead, and zinc. Thirty-five sample locations were cored at Lagoon 1, 33 sample locations were cored at Lagoon 2, and 38 sample locations were cored at Lagoon 3. In addition, 45 sample locations were cored from the ditch adjacent to AOI 7A (West). Confirmation soil samples were

- Restoration Advisory Board (RAB) - The RAB has been formed to facilitate public input in the CERCLA cleanup at LCAAP and meets quarterly. In addition to U.S. Army, USEPA, and State of Missouri personnel, the RAB includes local community members from the surrounding area.

- Mailing list - A mailing list of all interested parties in the community is maintained and periodically updated by the Army.

- Fact sheet - Fact sheets describing the status of various activities of the Installation Restoration Program (IRP) are distributed periodically.

The Proposed Plan for the LCAAP IWOU was submitted to the public on January 12, 2007. This document was made available to the public in both the Administrative Record File at the LCAAP and in the site Information Repository noted above. The notice of availability for these documents was published in the *Independence Examiner* and the *Kansas City Star* on January 13, 2007. A public comment period was held between January 15 and February 13, 2007. In addition, a public meeting was held on January 23, 2007 where representatives from the U.S. Army, USEPA, and MDNR were available to answer questions and accept comments regarding the remedial actions under consideration. The public was given the opportunity to comment on the anticipated future land use, potential future uses of groundwater, and proposed remedial actions at the IWOU. A response to the comments received during this period is included in the Responsiveness Summary, which is part of this ROD.

This ROD is based on the contents of the Administrative Record File for the IWOU, in accordance with CERCLA (as amended by SARA) and the NCP. The RI/FS reports and the Proposed Plan for the IWOU provide information about the IWOU and the Selected Remedies. These documents are available at the Information Repositories at LCAAP (Buildings 3 and 6) and the Mid-Continent Public Library located in Independence, Missouri.

2.4 Scope and Role of Operable Unit Response Action

As is the case at many Superfund sites, the environmental problems at LCAAP are complex. As a result, work at the Installation was divided into four OUs, which are identified as follows:

OU1 – IWOU

The IWOU consists of 30 Areas of Concern (AOCs) and includes all LCAAP Areas, with the exception of Area 10 (Area 10 OU); Area 18 (Area 18 OU); and Areas 11, 16, and 17 (NECOU) **(Figure 2)**. Two removal actions have been completed within the IWOU. These actions addressed the Inactive Sumps (identified as sumps that no longer received influent from any source), and the Surficial Debris or "Housekeeping" sites.

The Inactive Sumps group consists of 103 inactive sumps located throughout the IWOU. A Removal Action was completed in 2007 to address the removal of inactive sumps and associated contaminated soils at Areas 4, 6, 7, 9, 13, 15, 19, 20, 21, 33, and 00 in the IWOU. This Removal Action was successful in removing the contaminated sumps and contaminants of concern in soil, and resulted in a no further action recommendation (other than LUCs to maintain an industrial land use) for Areas 4, 6, 7, 15, 19, 20, 21, 33, and 00. Additional remedial action is required at Areas 9 and 13 to address the residual VOC and metals contamination remaining

in the soils. In addition, additional remedial action will be necessary to remove the sumps that could not be accessed, as described in Section 1.4.

The Housekeeping sites are various locations that were used for the disposal of asbestos tiles, roofing materials, general construction debris, and process wastewater. Waste materials and contaminated soils that were present at five Areas (Areas 2, 15, 25, 26, and 31) within the IWOU were removed between 2005 and 2007 as part of a Non-Time Critical Removal Action. The Removal Action removed the waste materials and contaminants of concern in soil, resulting in a no further action determination for Areas 15, 25, 26, and 31. This Removal Action is documented in the *IWOU Housekeeping Removal Action Completion Report* (ARCADIS 2007). Additional remedial action is required at Area 2 to address residual metals contamination remaining in the soils.

This ROD addresses the remaining environmental issues at the IWOU, which are primarily impacted soils and contaminated groundwater. The groundwater contains chemicals at concentrations above regulatory standards, and the contaminants pose a potential threat to on-site personnel who use the groundwater and off-site residents who could potentially be affected if the contamination in the groundwater is allowed to migrate off site. The sources of chemicals in the soil and groundwater at IWOU are various historical operations that allowed plant wastes, including solvents and hydrocarbons, to be released to soil and groundwater. The soil contains chemicals at concentrations above regulatory standards, and the contaminants pose a potential threat to site workers and construction workers who may have direct contact with or ingest soil, or who may breathe fugitive dust containing chemicals at concentrations above cleanup levels.

The FFA states that properly selected remedial actions shall satisfy the groundwater corrective action requirements for the RCRA-regulated units within Areas 1, 2, 4, 5, 6, 7, and 8, which were not clean-closed. The Army has implemented and is maintaining the closure and/or post-closure care requirements for the RCRA-regulated units within Areas 1, 2, 4, 5, 6, 7, and 8. The remedial action that implemented in accordance with this agreement for Area 9 will address the applicable substantive RCRA closure and post-closure requirements for the mercurous nitrate storage area near Building 60 (in Area 9).

The actions associated with the IWOU ROD will be the final remedial action for this OU, with the exception of Area 27 and AOI 8F. AOI 8F was originally regulated under the MDNR Solid Waste Program but it was deferred to the MDNR Hazardous Waste Program when it was determined that RCRA-listed hazardous waste had been disposed of in the pits. AOI 8F will be RCRA closed in the future; therefore, it is not addressed in this Proposed Plan.

Remedial Action Objectives (RAOs) have been identified to prevent current and future exposure to contaminated media through various combinations of treatment, excavation, and containment of soil and groundwater at the IWOU. Combined with the response actions for the other three OUs, the selected remedy for IWOU will provide a comprehensive solution for environmental impacts throughout the LCAAP.

OU2 – Area 18 OU

The Area 18 OU is located in the central portion of the Installation, along the northern boundary. In the 1950s, eight surface impoundments were used to burn waste grease and oil from the IWTP, solvents, and trash. Fifteen other pits located throughout the area were used for burning and disposal of IWTP and other wastes. The primary contaminants of concern in Area 18 are lead, PCBs, and VOCs in the soil and VOCs in groundwater.

The initial RI/FS activities were completed for Area 18 between 1990 and 1996, identifying both soil and groundwater contamination related to the former waste disposal practices. A Non-Time Critical Removal Action was implemented in 1996 and 1997 to prevent contaminated groundwater from migrating off the Installation and to reduce the overall mass of contaminants in groundwater. The removal action involved installation and operation of extraction wells 17-FF and 17-R (located in Area 18) and extraction well 17-S (located in Area 16). Extracted groundwater is treated at Building 163 in Area 18 prior to being discharged to the Little Blue Valley Sewer District.

In April 1999, the Army signed a ROD selecting a remedy consisting of SVE and multi-phase extraction (MPE) to address contamination in the VOC source area, excavation of contaminated soils, installation of a vegetative cover, and operation of a groundwater extraction and treatment system. The groundwater extraction and treatment component of the ROD was the continued operation of the treatment system described above. The groundwater extraction and treatment portion of the remedy was implemented and is currently being used to contain the groundwater plume, but other components of the remedy were not implemented.

In 2000, an investigation was conducted at Area 18 to support the full-scale system design. The results of this and other investigations indicated that the vertical and horizontal extents of the source areas and associated groundwater plumes were larger than originally perceived, leading to additional characterization and re-evaluation of the Selected Remedy, which have been completed. A Proposed Plan was published in October 2006, and a ROD amendment is in preparation.

OU3 – NECOU

The NECOU is located in the northeast portion of the Installation, along the northern boundary. It includes the Area 11 Burning Ground, Area 16, and Area 17. The burning ground in Area 11 was used for the open burning of propellants and waste pyrotechnics mixtures. This area was closed under RCRA, but the RCRA closure did not address groundwater, which was deferred to the CERCLA Process. Area 16 contains the abandoned landfill, solvent pits, old burning ground area, and a closed firing range. Area 17 contains three closed oil and solvent pits; a waste, glass, paint, and solvents area; an old burning pad; the closed sanitary landfill; and the active pistol qualifying range. Primary COCs in the NECOU are oils and solvents, which were disposed in pits in Area 17.

An IRA ROD was signed in September 1998. The major components of the 1998 IRA stated in Section 1.5 of the IRA ROD were:

- Installation of a subsurface PRW to treat contaminated groundwater in place (in-situ).
- A monitoring program to evaluate the effectiveness of the PRW in treating the contaminated groundwater and to determine the replacement period of the reactive media.
- Installation of a soil cover over the Area 17B Oil and Solvent Pits (a principal threat waste) located adjacent to the current sanitary landfill in the NECOU to minimize infiltration of water through the pits and subsequently into groundwater.

A groundwater pump-and-treat containment system (Well 17-S/EW-2 and Building 163) was put in place prior to the Interim Remedial Action ROD to contain the off-site migration of contaminants from the NECOU.

Construction of the other components of the interim remedy, which included the PRW and the vegetative cover over the Area 17B source pits, was completed in 2000. The PRW is currently not performing as designed, and additional action is required. Although the PRW can reduce contaminant levels in the groundwater that travels through the wall, some contaminated groundwater appears to be migrating around the wall without treatment.

Beginning in 2003, the Army upgraded the engineered cover over the 8.8-acre Area 16 Abandoned Landfill to minimize infiltration. Groundwater monitoring wells were also installed to determine if the landfill is a source area contributing to the NECOU groundwater plumes. Leachate collection tanks were installed in 2005 to collect leachate and treat it prior to discharge. This work was performed as a non-time critical removal action for the Area 16A Abandoned Landfill and completed in 2005.

To address the remaining environmental issues at the NECOU, which are primarily impacted surficial soils and contaminated groundwater, a Proposed Plan was published in October 2006, and a Final ROD was submitted for signature in July 2007.

OU4 – Area 10 OU

The Area 10 OU is located in the center of the Installation. During the 1960s and 1970s, LCAAP deposited residual waste from firing range munitions in sand piles located within Area 10 OU. The sand piles in Area 10 OU contain waste sand that was used in bullet catchers on the Area 27 firing range. Under supervision of the Nuclear Regulatory Commission (NRC), field investigations were conducted in 1990 and 1994, followed by a partial remediation in 1998 to address DU within the sand piles. During these activities, hazardous lead concentrations and radioactive unexploded ordnance (UXO) were discovered in the sand material in addition to DU.

In 2001, the NRC deferred oversight of the remediation of chemical and radiological impacts in Area 10 OU to USEPA. Area 10 was previously addressed as part of the IWOU; however, due to IWOU funding constraints, Area 10 has been converted to an independent OU. A RI/FS is currently underway to be followed by remediation and/or decommissioning of the OU. The Army is planning to conduct a non-time critical removal action at Area 10; however, the Action Memorandum has not yet been signed.

Combined with the response actions for the other three OUs, the selected remedy for IWOU will provide a comprehensive solution for environmental impacts throughout the LCAAP. The NECOU and IWOU remedies will be implemented first, followed by Area 18 remediation, and lastly by Area 10 remediation.

2.5 Site Characteristics

The IWOU occupies approximately 1,200 acres of both developed and undeveloped land. The principal developed areas include the manufacturing areas. These areas collectively comprise approximately 550 acres. The manufacturing areas include office buildings, warehouses, plant buildings, shipping facilities, security facilities, maintenance facilities, a fire station, and other operations associated with manufacturing. The remaining areas consist of largely undeveloped areas and include the firing range and the undeveloped uplands areas. This area is used primarily for the firing range and is occasionally opened for hunting during certain times of the year.

Operations at the IWOU include manufacturing, assembling, storing, and testing of small-caliber ammunition. Other operations historically conducted at the IWOU included wastewater treatment; hazardous waste storage, treatment, and disposal; solid waste and sludge disposal; and incineration/demilitarization of off-spec ammunition. These activities relate to the primary mission at LCAAP of small arms ammunition manufacturing.

There are 30 separate Areas at the IWOU, 29 of which are the subject of the *Final Installation-Wide Operable Unit Remedial Investigation/Feasibility Study* (ARCADIS 2006). Area 27, the Installation's active firing range used to test fire the ammunition produced at LCAAP for function and accuracy, was not included in the Final IWOU RI/FS and is not addressed in this ROD because it is an active Area. The Areas included as part of the IWOU and this ROD are shown on Figure 3.

This ROD presents assumptions as to the anticipated future use of the land and other natural resources potentially impacted by contamination released at the IWOU. The current and anticipated future land use is industrial only. Based on a conversation with the City of Independence, MO Zoning Department and review of the City's Zoning Map, LCAAP is zoned M2, or "Industrial Park District" which includes manufacturing and industrial land use. It is expected to remain an industrial site under future uses either for small arms ammunition manufacturing or in some other industrial use capacity. The current zoning for LCAAP of manufacturing/industrial land use prohibits future residential use at LCAAP. As such, LUCs for soil will be required because unlimited use and unrestricted exposure (UUUE) will not be achieved. Land use controls based on specific use assumptions are necessary to ensure that land and resource uses remain consistent with these assumptions over the long term. Land use will be reviewed as part of the Five-Year Review process, and should the future use of the property differ from the current/expected use, potential implications will be evaluated at that time.

2.5.1 Geology, Topography, and Hydrogeology

A comprehensive description of LCAAP geology and hydrogeology is included in the *Final Installation-Wide Operable Unit Remedial Investigation/Feasibility Study* (ARCADIS 2006). In general, regional geology consists of significant alluvial deposits associated with flood plains of the Missouri River, Little Blue River, and the Lake City Valley, which is described as a paleochannel associated with an ancient flow path of the Missouri River. These alluvial deposits are underlain by nearly flat-lying sedimentary strata which dip gently westward. The sedimentary strata consist of sequences of shale, claystone, and limestone, with some occurrences of sandstone and coal.

The topography at LCAAP is reflective of the underlying geology. The flat northwest and north-central portions of the Installation, which are underlain by the alluvial-filled paleochannel, are referred to as the "alluvial flats". The south and east portions of the Installation form uplands, which were created by lengthening of the Lake City Valley by erosion at the valley head of the underlying Pennsylvanian (Pleasanton Group and Kansas City Group) sedimentary strata. These uplands have narrow-crested ridges with approximately 150 to 160 feet of relief from the valley floor to ridge top.

Based on historical groundwater level measurements, groundwater flow mimics surface topography in general although, in the paleochannel, it appears to be influenced by vertical gradients induced by groundwater pumping in the underlying Lake City Aquifer. While the Lake City Aquifer, consisting of paleochannel

alluvial sands and gravels, is the most dominant groundwater feature underlying the LCAAP, three distinct hydrogeologic units have been identified and characterized **(Figure 4)**:

- The silt/clay water-bearing hydrostratigraphic unit (HSU) consisting of silts, clays, and fine sands covering most of the Installation. Groundwater is first encountered in this unit, which overlies the Lake City Aquifer or the bedrock in upland areas where the Lake City Aquifer is not present.

- The Lake City Aquifer, a prolific water-bearing unit found in the paleochannel, consisting of fine-grained to coarse-grained sand and gravel of alluvial origin overlying the bedrock

- The bedrock aquifer, consisting of interbedded shale, claystone, and limestone

The Hydrogeologic Model of LCAAP illustrates the distribution of these monitoring zones **(Figure 5)**.

2.5.2 Conceptual Site Model

A conceptual site model (CSM) was developed for each Area at the IWOU in the Final IWOU RI/FS (ARCADIS 2006). The CSM presents the potential sources at each Area, release mechanisms, and exposure pathways. The CSM for each Area is based on the site geology and hydrogeology to provide a framework for understanding the distribution of COCs in each Area and their potential for migration to sensitive receptors. It also recaps the nature and locations of contaminant sources and identifies the sources that are linked to soil and groundwater contamination.

The CSM demonstrates how the historical and supplemental RI sampling performed in 2004 satisfied the data quality objectives (DQOs) for each site. The DQOs that were established for the IWOU are as follows:

Soils

DQO 1.1: Determine if concentrations of analytes exceed USEPA Region 9 Industrial PRGs;

DQO 1.2: Determine if subsurface soils could be leaching contaminants to groundwater by comparing soil concentrations to USEPA Region 9 Soil Screening Levels (SSLs) at a DAF of 20 (DAF-20 SSLs);

DQO 1.3: Determine if arsenic and chromium exceedances of soil screening criteria are above anticipated background levels;

DQO 1.4: Determine the magnitude, and lateral and vertical extents of contamination as defined by the above criteria; and

DQO 1.5: Determine the source of contamination.

Groundwater

DQO 2.1: Determine if concentrations of analytes exceed maximum contaminant levels (MCLs);

DQO 2.2: Determine if concentrations of analytes for which MCLs have not been established exceed EPA Region 9 Tap Water PRGs;

DQO 2.3: Determine the magnitude and extent of contamination as defined by the above criteria; and

DQO 2.4: Determine the source of contamination.

Surface Water

DQO 3.1: Determine if concentrations of analytes exceed the Missouri Water Quality Criteria (MOWQC);

DQO 3.2: Determine if contamination, as defined by the criteria above, is migrating from the area; and

DQO 3.3: Determine the source of contamination.

The site-specific CSM was developed to evaluate exposure media and to graphically assess data usability and data gaps that potentially existed at each area subsequent to historical sampling. If an exposure medium exists (i.e., surface soil, subsurface soil, or groundwater), then the DQOs were evaluated to determine if historical information and data evaluated for each Area satisfied the DQOs. The information and conclusions presented in the CSM were used as a basis for the sampling strategy for samples collected as part of the 2004 RI. If there is no completed pathway for an exposure medium at a specific AOI, then no further investigation was required.

A final Conceptual Site Exposure Model (CSEM) was prepared for each Area in support of the Risk Assessment. The CSEM shows the migration pathway for contaminants leaving those sources that are linked to contamination. The migration pathways and receptors developed from the CSEM are presented by Area as described in the following sections. The details of the CSEM are provided for each Area in the sub-sections below.

2.6 Area 1 – Building 83 Wastewater Lagoons

2.6.1 Site Characteristics

Area 1 occupies approximately 41 acres and is located in the south-central portion of the Installation, north of the Big Ditch and west of Owens Schoolhouse Road. Neutralized wastewater from the production of TNR was discharged into lagoons. Five RCRA lagoons have operated intermittently in this Area between 1941 and 1986. Four of the five lagoons were removed under an approved RCRA closure plan between 1986 and 1988. A post-closure plan included post-closure care and groundwater monitoring requirements.

The suspected sources of potential contamination at Area 1 are the lagoons. **Figure 6** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. There have been three previous rounds of investigations at Area 1. Surface soil samples were collected by Arrowhead Contracting in July 1989 in the vicinity of Building 83. The Phase II Investigation performed at Area 1 was conducted by EA Engineering, Science and Technology and involved surface water and sediment sampling near Building 83 and completion of a geophysical survey and two soil borings in AOI 1F. The Phase II Investigation also included the installation of 13 additional monitoring wells. The

Supplemental Field Investigation involved installing three soil borings within AOI 1D in 1999. Sediment and surface water samples were also collected near Building 82 as part of the 2004 RI performed by ARCADIS.

2.6.2 Current and Potential Future Land and Water Uses

Area 1 is located within the active manufacturing area. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Although Area 1 is not currently being used, it is maintained as an active manufacturing area. People using this area would include LCAAP employees responsible for maintaining the area or utilizing the adjacent areas. Current land use of Area 1 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the Human Health Risk Assessment (HHRA).

2.6.3 Summary of Human Health Risk Assessment – Area 1

The HHRA for Area 1 - Building 83 Wastewater Lagoons characterized potential risks in a manner consistent with the risk assessment principles and practices established by the USEPA Risk Assessment Guidance for Superfund (USEPA 1989). The HHRA is discussed further in the Final IWOU RI/FS (ARCADIS 2006) and is summarized in the following sections.

2.6.3.1 Identification of Chemicals of Concern

The observed concentrations of the human health risk drivers and the calculated and exposure concentrations are summarized in **Table 2**. The 95th Upper Confidence Limit of the mean was calculated and used as the exposure concentration following USEPA guidance. Arsenic in groundwater was identified as the only COC in Area 1.

2.6.3.2 Exposure Assessment

The assessment of exposure includes characterization of the physical environment, identification of exposure pathways (including migration pathways, exposure points, and exposure routes), and identification of potentially exposed individuals and populations. Due to the industrial nature of the LCAAP and the IWOU in particular, the exposure scenarios evaluated in the HHRA were limited to industrial exposure frequencies and durations. Based on the current and reasonably anticipated future land uses of Area 1, the following complete or potentially complete exposure pathways and receptors were identified:

- Future site workers may be exposed to chemicals of potential concern (COPCs) in surface soil via incidental ingestion and inhalation of wind-blown fugitive dust. Future site workers may also be exposed to COPCs in groundwater via ingestion of groundwater used as potable water and dermal contact while washing hands

- Future construction/utility workers may be exposed to COPCs in combined surface and subsurface soil via incidental ingestion, dermal contact, and inhalation of dust during excavation activities. Future construction/utility workers may also be exposed to COPCs in groundwater via dermal contact.

- Current and future maintenance workers may be exposed to COPCs in surface soil via incidental ingestion, dermal contact, and inhalation of wind-blown fugitive dust.

- Current and future adult and youth recreational users may be exposed to COPCs in surface soil via incidental ingestion and dermal contact. Current and future adult and youth recreational users may also be exposed to COPCs in surface water via dermal contact and COPCs in sediments via incidental ingestion and dermal contact.

Table 3 tabulates key exposure assumptions and intake parameters used in the evaluations. The migration pathways and receptors developed from the CSEM are shown on **Figure 8.**

2.6.3.3 Toxicity Assessment

The toxicity assessment results in the selection of appropriate toxicity values to use in estimating potential health risks associated with exposure. This is accomplished by reviewing the available information on the toxicity of the COCs and summarizing the factors pertinent to the exposures being assessed.

Chemical-specific cancer slope factors (CSFs) and weight-of-evidence classifications were compiled for cancer endpoints. The weight-of-evidence classification describes the likelihood that a chemical is a human carcinogen, based on the supporting evidence of carcinogenicity in human and animal studies (USEPA 1999b). Cancer toxicity values are summarized in **Table 4.**

Chemical-specific reference doses (RfDs) were compiled for non-cancer health effects. Chronic RfDs were used to assess long-term exposures ranging from 7 years to a lifetime. Subchronic RfDs were used to evaluate the potential for adverse health effects associated with exposure to constituents over a period of 2 weeks to 7 years. Subchronic RfDs were used to evaluate the short-term construction worker hazards. Non-cancer toxicity values are summarized in **Table 5.**

2.6.3.4 Risk Characterization

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time with a reference dose derived for a similar exposure period. The ratio of the exposure to toxicity is called a hazard quotient (HQ). An HQ lower than 1 indicates that a receptor's dose of a single contaminant is lower than the reference dose, and that toxic noncarcinogenic effects from that chemical are unlikely. The Hazard Index (HI) is generated by adding the HQs for all COCs that affect the same target organ or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI lower than 1 indicates that, based on the sum of all HQs from different COCs and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI higher than 1 indicates that site-related exposure may present a potential risk to human health.

Potential carcinogenic (cancer) risks are classified by the increased probability of a person getting cancer in his or her lifetime (i.e., excess lifetime cancer risks) from being exposed to known or suspected cancer-causing chemicals at the site. Excess lifetime cancer risks are determined by multiplying the exposure with the slope factor. These risks are probabilities that are generally expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that, as a plausible upper bound, an individual has a one in 1,000,000 chance of developing cancer over a 70-year lifetime as a result of site-related exposure to a carcinogen under the specific exposure conditions at a site. USEPA's generally acceptable carcinogenic risk range is between 1×10^{-4} and 1×10^{-6}. This means that there is an increased probability of one additional case in 10,000 to one case

in 1,000,000 that an individual will develop cancer above the expected normal rate of 250,000 per 1,000,000 (or one in four).

Table 6 summarizes risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of exposure as well as the toxicity of the COCs. The total risk from exposure to impacted soil and groundwater at Area 1 is 1×10^{-4} for a future site worker. Additionally, total risk for exposure to impacted soil and groundwater are presented in detail (by pathway) in **Appendix A.** The unacceptable cancer risk is driven by potential exposure to groundwater used as a potable water supply. Exposure to chemicals in soil does not result in unacceptable risk to a future site worker. These risk levels indicate that, if no cleanup action is taken, an individual would have an unacceptable probability of adverse health effects as a result of site-related exposure to the arsenic in groundwater if used as a potable water supply in Area 1. Remedial action associated with arsenic in groundwater is discussed in Section 2.35.

Results of the HHRA indicate that contaminants are not present in soil above human health levels, and there will be no remedial action performed for soil at this Area; however, arsenic is present in groundwater above screening levels, as shown on **Figure 7**. Groundwater at Area 1 will be addressed as part of the IWOU-Wide Groundwater program. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.7 Area 2 - Building 85/83A Wastewater Lagoons

2.7.1 Site Characteristics

Area 2 occupies approximately 20 acres and is located in the south-central portion of the Installation immediately north of Area 1. The main manufacturing buildings located within Area 2 are Buildings 83A and 85. Neutralized wastewater from the production of lead-based initiating compounds (tetrazene, lead styphnate) was discharged into two large lagoons and one small lagoon. The two large lagoons were removed in 1990 as part of an MDNR-approved RCRA Closure. A post-closure plan included post-closure care and groundwater monitoring requirements.

The suspected sources of potential contamination are the lagoons. **Figure 9** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. Two main investigation activities have been conducted at Area 2. The Phase II Investigation at Area 2 was conducted by EA Engineering, Science and Technology and consisted of drilling and sampling of one soil boring in AOI 2A and collecting four surface soil samples in the lagoon overflow area to the north-northeast of AOI 2B (North). The Supplemental Investigation at Area 2 was performed by Burns and McDonnell in an effort to assess the volume of sludge present in AOI 2A by installing one soil boring.

RCRA Lagoon Closure activities were performed within AOI 2B under a plan approved by MDNR in 1985, as described in Section 2.2. In addition, a Removal Action was conducted at AOI 2A in 2005 in which approximately 1,200 cubic yards (CY) of RCRA-listed hazardous waste (lead-impacted soil) was removed and disposed off site. Results of confirmation sampling conducted after completion of the removal action found that lead is still present in soil at 1 foot below ground surface (bgs) above the Industrial PRG of 800 mg/kg. In addition, the TCLP analytical results and concentrations of lead remaining in soil at Area 2 indicate that lead may potentially leach to groundwater. Historical groundwater results collected from wells downgradient of

AOI 2A prior to the Removal Action at AOI 2A show elevated lead in groundwater and indicate that lead is likely leaching to groundwater. The excavation was backfilled, graded, and reseeded following the removal action activities. Concentrations of lead in soil are illustrated on **Figure 10.**

The TCLP data that were collected from the surficial soil at AOI 2C demonstrate that the lead in surficial soils is leachable. The TCLP results, as well as lead results from groundwater samples collected at Area 2, indicate that there is a need to reduce the mobility of lead in soil and thus protect groundwater at this Area. Reducing mobility of lead in soil will reduce potential future risks to groundwater. Additionally, the TCLP results from the investigation indicate that the soil would need to be treated prior to off-site disposal of excavated soil as a non-hazardous material.

2.7.2 Current and Potential Future Land and Water Uses

Area 2 is within the active manufacturing area. A fence currently surrounds LCAAP, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. In addition, Area 2 is located within the inner fence, which surrounds the currently active manufacturing area, making it difficult for unauthorized visitors or trespassers to access. Current land use of Area 2 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA. Many of the buildings in Area 2 are currently used on a regular basis. People using this area would include LCAAP site employees working in Area 2 and employees responsible for maintaining the area or utilizing the adjacent areas.

2.7.3 Summary of Human Health Risk Assessment – Area 2

The HHRA for Area 2 - Building 139 Backline Impoundment characterized potential risks in a manner consistent with the risk assessment principles and practices established by the USEPA Risk Assessment Guidance for Superfund (USEPA 1989). The HHRA is discussed further in the Final IWOU RI/FS (ARCADIS 2006) and is summarized in the following sections.

2.7.3.1 Identification of Chemicals of Concern

The observed concentrations of the human health risk drivers and the calculated and exposure concentrations are summarized in **Table 2.** The 95th Upper Confidence Limit of the mean was calculated and used as the exposure concentration following USEPA guidance. Lead in soil was identified as the only COC in Area 2.

2.7.3.2 Exposure Assessment

The assessment of exposure includes characterization of the physical environment, identification of exposure pathways (including migration pathways, exposure points, and exposure routes), and identification of potentially exposed individuals and populations. Due to the industrial nature of the LCAAP and the IWOU in particular, the exposure scenarios evaluated in the HHRA were limited to industrial exposure frequencies and durations. Based on the current and reasonably anticipated future land uses of Area 2, the following complete or potentially complete exposure pathways and receptors were identified:

- Current and future site workers may be exposed to COPCs in surface soil via incidental ingestion and inhalation of wind-blown fugitive dust. Future site workers may also be exposed to COPCs in groundwater via ingestion of groundwater used as potable water and dermal contact while washing hands.

- Future construction/utility workers may be exposed to COPCs in combined surface and subsurface soil via incidental ingestion, dermal contact, and inhalation of dust during excavation activities. Future construction/utility workers may also be exposed to COPCs in groundwater via dermal contact.

- Current and future maintenance workers may be exposed to COPCs in surface soil via incidental ingestion, dermal contact, and inhalation of wind-blown fugitive dust.

- Current and future adult and youth visitors/trespassers may be exposed to COPCs in surface soil via incidental ingestion and dermal contact.

Note that no sediments or surface waters are present at Area 2; therefore, associated exposure pathways are not evaluated. Additionally, no volatile COPCs were observed in groundwater; thus, inhalation of volatile COPCs in groundwater migrating to indoor air was not a complete pathway.

Table 3 tabulates key exposure assumptions and intake parameters used in the evaluations. The migration pathways and receptors developed from the CSEM are shown on **Figure 11.**

2.7.3.3 Toxicity Assessment

The toxicity assessment results in the selection of appropriate toxicity values to use in estimating potential health risks associated with exposure. This is accomplished by reviewing the available information on the toxicity of the COCs and summarizing the factors pertinent to the exposures being assessed.

Neither a cancer slope factor nor a reference dose has been developed for lead. Instead, potential risks associated with exposure to lead in surface and subsurface soil were evaluated using the USEPA Adult Lead Model (ALM) to predict quasi-steady-state blood lead concentrations for each receptor. The predicted blood-lead levels were then compared to the USEPA (1994) benchmark of 5 percent probability of exceeding 10 micrograms per deciliter (ug/dL) blood lead level.

2.7.3.4 Risk Characterization

Table 6 presents summary risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of exposure as well as the toxicity of the COCs. The ALM predicted a 14 percent probability that both future site worker and future construction worker exposure to lead in soil would result in a blood-lead level higher than the benchmark. Additionally, total risk from exposure to impacted soil and groundwater are presented in detail (by pathway) in **Appendix A**. These probabilities indicate that, if no cleanup action is taken, an individual would have an unacceptable probability of adverse health effects as a result of site-related exposure to lead in soil.

Consistent with EPA guidance, the baseline blood-lead level and geometric standard deviation used in the ALM are based on data from Phase 2 of the National Health and Nutrition Evaluation Survey (USEPA, 2002), which

included the evaluation sensitive populations. These values-are representative of all race/ethnicities throughout the country. It is unlikely that these values under-estimate potential risks associated with exposure to lead at the site. However, if the baseline blood-lead level and/or geometric standard deviation in employees of Lake City Army Ammunition Plant are higher than the national average, the associated risk may be higher than predicted using the ALM.

Although chemicals are not present in groundwater at Area 2 that present a potentially unacceptable risk, lead is present above the MCL; therefore, groundwater will be monitored as part of the IWOU-Wide Groundwater program. MCLs are considered ARARs and must be achieved through remediation. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.7.4 Area 2 Remedial Action Objectives

The RAOs are site-specific cleanup objectives established for protecting human health and the environment. The RAOs are intended to be specific to the affected media, but sufficiently broad so as not to unreasonably restrict the potential remedial technology available. The RAOs developed for the IWOU include the COCs, media of concern, and potential exposure pathways identified during the risk assessment. Because of the industrial nature of the LCAAP, the exposure scenarios evaluated in the human health risk assessment were primarily limited to industrial exposure frequencies and durations. Because of the use restriction imposed by the industrial exposure scenarios, LUCs will be a required component of the selected remedies at the IWOU to be protective of sensitive populations and the higher exposure frequencies and durations that would be associated with a UUUE scenario. Therefore, use restrictions would be implemented by the Army at the IWOU to limit future use of the site to industrial only. The RAOs for Area 2 are to:

- Prevent exposure to lead in soil exceeding an average concentration of 1,197 mg/kg to achieve a predicted blood level lower than 10 ug/dL with a 95 percent probability. The basis for the limit of 1,197 mg/kg is that it is the level needed to achieve a predicted blood level lower than 10 ug/dL with a 95 percent probability. The basis for the 10 ug/dL and 95 percent probability was established based on the EPA Adult Lead Model and EPA Guidance.

- Prevent contaminant migration to groundwater from soil above the cleanup levels identified in Table 7.

The rationale for the first RAO is to protect receptors from contaminated media at unacceptable potential risk levels. Achieving this RAO will eliminate the potential risk by removing impacted soil above cleanup levels, thus eliminating exposure to contaminated soil. The second RAO is included to prevent migration of lead at concentrations above cleanup levels from the soil to surrounding groundwater that could cause exceedances of drinking water standards (i.e., via leaching).

The proposed actions for soil remediation would successfully meet the RAOs and comply with applicable or relevant and appropriate requirements (ARARs) as presented in **Appendix B.**

2.7.5 Description of Area 2 Alternatives

The estimated extent of surface soil identified as having lead concentrations above the cleanup level is approximately 40,000 square feet (**Figure 12**). The lead is generally in the upper 6 inches of soil, with maximum depths of up to 1 foot.

Detailed cost estimates for each of the Area 2 remedial alternatives are provided in the Final IWOU RI/FS (ARCADIS 2006). **Figure 12** identifies the locations of impacted surface soil and delineates the areas for remedial action. Details of the selected remedy were evaluated during the feasibility study in accordance with the nine remedy selection criteria in the NCP. This evaluation is summarized below.

Alternative 1: No Further Remedial Action

Estimated Capital Cost: $0
Estimated Annual O&M Cost: $0
Estimated Present Value: $0

The NCP and USEPA's guidance for conducting RI/FS investigations requires that the "No Action" option be developed and examined as a potential remedial action for all sites. The "No Action" option is retained and examined as a baseline with which other remedial actions are compared. The "No Action" alternative does not address the baseline conditions associated with unacceptable risk to potential future site workers or construction/utility workers and does not achieve the Area 2 RAOs.

Overall Protection

This alternative provides no controls to limit exposure to the contaminated soil and therefore will not reduce the risks to human health or the environment. Lead will remain in surface soil at levels that exceed the allowable levels for exposure as determined in the HHRA.

Compliance with ARARs

There are no chemical-specific ARARs for soil. Alternative 1 would not comply with all location-specific ARARs. There are no action-specific ARARs for Alternative 1.

Long-term Effectiveness

This alternative includes no long-term management measures and therefore, it will not mitigate any risk associated with the lead in surface soil, over the long term.

Reduction of Mobility, Toxicity, and Volume through Treatment

This alternative includes no treatment and therefore will not reduce the toxicity, mobility, or volume of lead contamination in the soil at Area 2 through treatment.

Short-term Effectiveness

The no action alternative is not effective in the short term based on the findings in the HHRA that unacceptable risks for future site workers and future construction/utility workers could be attributed to the lead-impacted soil.

Implementability

Due to the lack of technical and administrative components, the no action alternative is implementable, and will not limit or interfere with the ability to perform future remedial actions. However, it is unlikely that the no action alternative would be accepted by government agencies or the public.

Cost

Because no remedial actions are performed in connection with this alternative, there are no associated O&M or capital costs.

Alternative 2: Compacted Clay Cover and Land Use Controls

Estimated Capital Cost: $302,000
Estimated Annual O&M Cost: $6,700
Estimated Present Value: $460,000

This remedial alternative includes on-site containment using an engineered cover and LUCs to restrict activities that might impact the effectiveness of the containment system. The clay layer would act as a barrier between the soil of concern and the surrounding environment to limit the potential for direct exposure and minimize the associated risk. The compacted clay and non-permeable liner would minimize surface water infiltration, reducing the potential for downward migration of lead from the leachable surface soil. The engineered cover would be made of a minimum 18-inch-thick compacted clay layer and a 6-inch-thick topsoil layer to support vegetation, and would contain geotextile liners necessary to facilitate runoff and minimize percolation.

This alternative would not pose significant impacts to human health or the environment during either the construction or operational period, and would cause only minimal disturbance of the overall operational activities of the surrounding LCAAP facilities. Minimal long-term maintenance would be required to prevent excess erosion of the cover or ponding.

LUCs will be required to restrict activities, such as building, filling, grading, and maintain the long-term integrity of the clay cover. LUCs will be managed in accordance with the Land Use Control Implementation Plan (LUCIP). The Army will enforce these LUCs and maintain the industrial land use.

Overall Protection

Alternative 2 will eliminate the potential for direct contact with the waste material, eliminating the health concerns associated with lead at AOI 2C. The construction of the compacted clay cover will also eliminate the potential for leachable lead to impact groundwater. Soil with contaminant concentrations exceeding the chemical-specific remedial levels will remain beneath the cover.

Compliance with ARARs

There are no chemical-specific ARARs for soil. This alternative complies with the action-specific and location-specific ARARs for Alternative 2 (action-specific ARARs in Table B-1 and location-specific ARARs in Table

B-2). The key ARARs for this alternative include 10 CSR 80-2.030, which require the maintenance of the cover integrity and vegetative growth to protect cover material and surface water drainage systems.

Long-term Effectiveness

Installation of a cover and implementation of LUCs will reduce the human health and environmental risks associated with lead in soil at Area 2 by mitigating the potential for exposure to the contaminants. For as long as the cover and land use controls are maintained, Alternative 2 will have long-term effectiveness and permanence. A long-term management plan is necessary for inspection and maintenance of the containment system to ensure the permanence of LUCs.

Reduction of Mobility, Toxicity, and Volume through Treatment

Because no treatment will be occurring, this alternative will not reduce the mobility, toxicity or volume of hazardous substances.

Short-term Effectiveness

Installation of a cover can be conducted in a relatively short period of time, and will provide an immediate reduction in risk to human health receptors. Construction activities associated with installation of the cover can generate contaminated dust and particulates. These fugitive emissions can present an inhalation risk for site workers and may have an adverse impact on the environment; however, fugitive emissions can be minimized using dust control measures and proper health and safety procedures to reduce airborne migration of dust and limit exposures. In addition, the construction work associated with the installation of a clay cover is less intrusive than remedial alternatives including excavation activities. This alternative does not require any ex-situ handling of contaminated materials, minimizing the potential for production of fugitive emissions and limiting the short-term risks posed to both the community and workers.

Implementability

All services and materials required for installation of a cover are readily available, making this a technically feasible and easy-to-implement alternative.

Cost

The capital cost to install the clay cover is approximately $302,000. The cost for annual O&M of the vegetative cover is approximately $6,700 based on current year dollars. The present worth cost for Alternative 2 is approximately $460,000 based on installation and 30 years of long-term maintenance activities.

Alternative 3: Excavation and Off-Site Disposal

Estimated Capital Cost: $573,500
Estimated Annual O&M Cost: $0
Estimated Present Value: $573,500

This alternative would include soil excavation, stabilization as needed to reduce the toxicity and leachability of the excavated soil, and off-site disposal of the treated soil. Alternative 3 would create minimal disturbance of the overall operational activities at the surrounding LCAAP facilities and would allow for removal of the contaminated soil from Area 2 above the cleanup level of 1,197 mg/kg, eliminating risks associated with direct contact with the impacted soil and potential leaching of lead to groundwater.

Based on the results of the TCLP testing performed in AOI 2C, it is estimated that approximately 75 percent of the material after removal would be considered a RCRA characteristic hazardous waste requiring treatment prior to disposal. The contaminated material would be physically removed using conventional construction equipment.

LUCs will be implemented as described in this section. LUCs will be selected as part of this ROD and implemented in accordance with the LUCIP. The Army will enforce these LUCs and maintain the integrity of the remedial technologies at Area 2. LUCs must be enforced to maintain industrial land use.

Overall Protection

Excavation, stabilization, and off-site disposal will allow for the complete removal of soil containing lead at concentrations that pose a potentially unacceptable risk to human health and the environment. The volume of soil demonstrating characteristic properties will be stabilized to minimize the potential for leaching and to reduce the toxicity of the excavated waste. Dust control and safe materials handling procedures during excavation, stabilization, and hauling activities will ensure the protection of excavation workers. Appropriate precautions will also be necessary during off-site hauling and disposal operations to ensure public protection.

Compliance with ARARs

There are no chemical-specific ARARs for soil. This alternative complies with the action-specific and location-specific ARARs for Alternative 3 (action-specific ARARs in Table B-1 and location-specific ARARs in Table B-2). The ARARs for Alternative 3 include 40 CFR 261 A, B, C, and D, which ensure proper handling and disposal of excavated material.

Long-term Effectiveness

This alternative removes all soil containing lead at concentrations that exceed target cleanup levels, eliminating associated human health and environmental risks, with no long-term management required. The contaminated soil will be stabilized to minimize toxicity and leachability, reducing the associated risk to human health and the environment.

Reduction of Mobility, Toxicity, and Volume through Treatment

The total volume of soil exceeding the chemical-specific remedial levels will be excavated and transported to an off-site disposal facility. Soil will be stabilized on site as necessary, which will permanently reduce toxicity and mobility of the lead in soil.

Short-term Effectiveness

Activities associated with excavation can generate contaminated dust and particulates. These fugitive emissions can present an inhalation risk for site workers and may have an adverse impact on the environment during excavation. Fugitive emissions can be minimized using dust control measures and proper health and safety procedures in order to reduce airborne migration of dust and limit exposures. Ex-situ treatment will be implemented using approved methods employing engineering controls to protect the community, workers, and the environment. Risks to the public during off-site hauling operations will be minimized by employing approved engineering controls to reduce the potential for exposure. Soil excavation and treatment operations can be completed in a relatively short period of time.

Implementability

Soil excavation and ex-situ stabilization are widely used and can be performed using conventional techniques. A temporary on-site treatment pad will be installed in the immediate proximity of Area 2 to allow for reagent and soil mixing. It is anticipated that, after stabilization, less administrative effort will be required to arrange for disposal of the excavated soil because it will not require manifesting, labeling, transport, and disposal as a RCRA characteristic waste. Therefore, all services and materials required for ex-situ treatment, excavation, and transportation of the excavated soil will be readily available, making this an implementable alternative.

Cost

This alternative does not include any long-term O&M costs, so present-worth analysis is not necessary. Capital costs, including all on-site excavation and stabilization work, as well as transportation and disposal costs are estimated to be $573,500.

Alternative 4: In-situ Stabilization, Vegetative Cover, Land Use Controls

Estimated Capital Cost: $278,000
Estimated Annual O&M Cost: $6,700
Estimated Present Value: $430,000

This alternative would include in-situ stabilization to limit leaching and reduce the toxicity of the contaminated soils, followed by the installation of a vegetative cover to prevent disturbance of the treated soil and limit erosion. Solidifying agents, such as cement, lime, thermoplastics, or organic polymers, would be mixed into the subsurface soil using specialized machinery with augers and rotary-type mixers to reduce the toxicity, leachability, and exposure potential of the COCs within the soil. After in-situ treatment is complete, a limited vegetative cover consisting of a 6-inch-thick topsoil layer would be installed to support vegetation. This vegetative layer would minimize erosion and enhance the natural habitat, while also creating a protective barrier above the treated soil. LUCs would also be implemented in order to restrict activities on, over, or under the land (including building, filling, grading, and excavating) to minimize the possibility for interaction with the treated soil.

This alternative would not pose significant adverse impacts to human health or the environment during either the construction or operational period and would cause minimal disturbance of the overall operational activities of the surrounding LCAAP facilities.

LUCs will be implemented as described in this section. LUCs will be selected as part of this ROD and implemented in accordance with the LUCIP. The Army will enforce these LUCs and maintain the integrity of the remedial technologies at Area 2. LUCs must be enforced to maintain industrial land use.

Overall Protection

In-situ stabilization with a limited topsoil cover to support vegetation will be protective of human health and the environment. The lead-impacted soil at AOI 2C will be stabilized, reducing the toxicity of the contaminated soil. Subsequent installation of the limited vegetative cover and implementation of LUCs will limit the possibility of direct contact with the treated soil, minimizing the potential for adverse human health or environmental effects due to direct contact with the lead-impacted material.

Compliance with ARARs

There are no chemical-specific ARARs for soil. This alternative complies with the action-specific and location-specific ARARs for Alternative 4 (action-specific ARARs in **Table B-1** and location-specific ARARs in **Table B-2).** The key ARARs for Alternative 4 include 10 CSR 80-2.030, which require the maintenance of the cover integrity and vegetative growth to protect cover material and surface water drainage systems.

Long-term Effectiveness

In-situ stabilization with a vegetative cover will reduce the human health risks associated with lead in soil at Area 2 by eliminating the potential for exposure to the contaminant. Alternative 4 will be effective for eliminating the risks associated with the site on a long-term basis. A long-term management plan is necessary for inspection and maintenance of the containment system to ensure the permanence of LUCs.

Reduction of Mobility, Toxicity, and Volume through Treatment

In-situ stabilization will reduce the toxicity of the soil at Area 2, as the lead in the treated soil will no longer be bio-available, thereby reducing the toxicity and exposure risks associated with it. The stabilization process will also reduce the mobility of metals in contaminated soil at Area 2.

Short-term Effectiveness

In-situ stabilization and installation of a limited vegetative cover can be conducted in a relatively short period of time and will provide an immediate reduction in risk to human health and the environment. Construction activities associated with stabilization and installation of the cover can generate contaminated dust and particulates. These fugitive emissions can present an inhalation risk for site workers and may have an adverse impact on the environment; however, fugitive emissions can be minimized using dust control measures and proper health and safety procedures to reduce airborne migration of dust and limit exposures. In addition, in-situ stabilization and installation of a vegetative cover is less intrusive than remedial alternatives including excavation. In-situ stabilization reagents will be incorporated using augers; therefore, this alternative does not require any ex-situ handling of contaminated materials, minimizing the potential for production of fugitive emissions and limiting the short-term risks posed to both the community and workers.

Implementability

In-situ soil stabilization at Area 2 will be a straightforward application of enhanced soil mixing processes, as the volume to be remediated only extends to approximately 1 foot bgs. At this limited depth, the stabilization material can be completely mixed using discs or augers. A bench-scale study will be conducted prior to implementation to determine the appropriate type and concentration of stabilizing agent to be utilized in the treatment process. The in-situ treatment process and installation of the soil cover can be completed with conventional construction equipment. Alternative 4 is a technically feasible and implementable alternative.

Cost

The capital cost to stabilize the contaminated soil in situ and install a limited vegetative cover is approximately $278,000. The cost for annual O&M of the vegetative cover is approximately $6,700 based on current year dollars. The present-worth cost for Alternative 4 is approximately $430,000 based on installation and 30 years of long-term maintenance activities.

Alternative 5: Removal and Off-Site Disposal

Estimated Capital Cost: $793,700
Estimated Annual O&M Cost: $0
Estimated Present Value: $793,700

This alternative would allow for complete removal of the contaminated soil from Area 2, eliminating risks associated with direct contact with the soil and potential leaching of lead to groundwater.

The contaminated material would be physically removed using conventional construction equipment and disposed at an appropriate off-site facility based on the characterization sampling results. This alternative does not propose any on-site treatment of the soil prior to disposal at an off-site facility.

LUCs will be implemented as described in this section. LUCs will be selected as part of this ROD and implemented in accordance with the LUCIP. The Army will enforce these LUCs and maintain the integrity of the remedial technologies at Area 2. LUCs must be enforced to maintain industrial land use.

Overall Protection

Excavation and off-site disposal will allow for the complete removal of soil containing lead at concentrations that pose a potentially unacceptable risk to human health and the environment. Dust control and safe materials handling procedures will be required during excavation and transportation activities to ensure the protection of excavation workers. Appropriate precautions will also be necessary during off-site hauling and disposal operations to ensure public protection.

Compliance with ARARs

There are no chemical-specific ARARs for soil. This alternative complies with the action-specific and location-specific ARARs for Alternative 5 (action-specific ARARs in **Table B-1** and location-specific ARARs in **Table B-2).** The key ARARs for Alternative 5 include 10 CSR 80-2.030, which require the maintenance of the cover

integrity and vegetative growth to protect cover material and surface water drainage systems, and 40 CFR 261 A, B, C, and D, which ensure proper handling and disposal of excavated material.

Long-term Effectiveness

This alternative removes all soil containing lead at concentrations that exceed chemical-specific remedial levels, eliminating associated human health and environmental risks, with no long-term management required. The contaminants will be permanently removed from the site and, if necessary, can be treated at an off-site treatment or disposal facility.

Reduction of Mobility, Toxicity, and Volume through Treatment

The total volume of soil exceeding the risk-based cleanup levels will be excavated and transported to an off-site disposal facility. Because the lead results indicate that the soil will be considered a hazardous material, the soil will be treated off-site prior to disposal. Therefore, there would be a permanent reduction in mobility and toxicity of the material, eliminating any long-term toxicity or mobility issues associated with the soil

Short-term Effectiveness

Activities associated with excavation can generate contaminated dust and particulates. These fugitive emissions can present an inhalation risk for on-site workers and may have an adverse impact on the environment during excavation procedures. These impacts can be minimized using dust control measures and proper health and safety procedures to reduce airborne migration of dust and limit exposures. Risks to the public during off-site hauling operations will be minimized by employing approved engineering controls to reduce the potential for exposure. Soil excavation and off-site disposal operations can be completed in a relatively short period of time.

Implementability

Soil excavation is widely used and can be performed using conventional techniques. It is anticipated that some administrative effort will be required to arrange for disposal of the excavated soil, but all services and materials required for excavation and transportation of the excavated soil will be readily available, making this an implementable alternative.

Cost

This alternative does not include any long-term O&M costs, so present-worth analysis is not necessary. Capital costs including all on-site work, transportation, and disposal costs are estimated to be $793,700. .

Land Use Controls

Because the RAOs for the IWOU are based on industrial use, and because residual pollutants or contaminants remain at the IWOU at concentrations above UUUE levels, LUCs will be required to limit the potential for exposure to residual pollutants or contaminants. LUCs, as described below, will be a necessary component of each of the remedial alternatives for the IWOU (except for the no action alternatives) and must be maintained to preserve industrial land use and protect the integrity of the engineering controls.

LUCs will be implemented to restrict land and resource uses at the IWOU to prevent exposure to COC concentrations in soil and groundwater that present an unacceptable risk and to protect the integrity of the remedial actions implemented at the IWOU. Because the HHRAs were based on an industrial land use scenario, all areas of the IWOU will, at a minimum, be restricted to industrial use. If the IWOU is used for other purposes in the future, additional risk assessment and possibly additional remedial action will be required. More specific restrictions may be required in certain areas. In these cases, LUCs would encompass sufficient area surrounding the contaminated areas to ensure that RAOs are satisfied.

Use restrictions and the LUCs will apply to all of the areas within the boundaries of the IWOU (Figure 3). People using the IWOU area would include LCAAP employees responsible for security, administrative employees, employees working in the manufacturing areas, and employees maintaining the area or utilizing the adjacent areas. The residential military housing is surrounded by a security fence and is isolated from the main part of the Installation.

Details of the specific mechanisms that will be used to implement the use restrictions and the LUCs that will be used to ensure that use restrictions remain in place will be presented in the LUCIP, to be included in the RD/RAWP. The RD/RAWP shall be prepared and submitted for review within 90 days of signing the ROD, in accordance with the requirements of the FFA for primary documents, and will contain implementation and maintenance actions, including periodic inspections. The LUCIP will include a process for evaluating and identifying specific land use control mechanisms that best accomplish the use objectives set out in the ROD. The land use control mechanisms will be classified into four categories for evaluation: governmental controls, proprietary controls, enforcement tools, and informational devices. These mechanisms were screened for general applicability, effectiveness, and implementability in the FS.

The LUCIP will establish periodic monitoring of the environmental use restrictions and institutional controls. The monitoring results will be included in a separate section or appendix of another environmental report and provided to the USEPA and MDNR. The results of the monitoring will be used in preparation of the Five-Year Review to evaluate the effectiveness of the remedy.

An objective of the LUCIP is the preservation of the controls put in place to protect human health and the environment at those areas cleaned up to anything less than UUUE levels until such time as unrestricted land use levels are achieved. Under a restricted land use classification, the Areas would remain subject to regulation under RCRA and CERCLA as long as contaminants are present at levels that pose an unacceptable risk to human health or the environment. The controls described in the LUCIP shall be implemented to achieve the following objectives:

- The continued compliance with all terms and conditions of the RCRA permits and CERCLA;
- Ensure that activities at the IWOU and future uses remain in compliance with the restrictions outlined in the IWOU ROD;
- Prohibit the access to or use of untreated contaminated groundwater except for limited use for remedial activities and investigative monitoring only;
- Control the access or use of groundwater within the limits of the Land Use Control boundary.

- Ensure the use of appropriate engineering controls to prevent inhalation of vapors and direct contact with untreated groundwater at Area 5 and Area 13;

- Prohibit the access to or contact with contaminated soil that cannot be removed as a result of ongoing facility operations;

- Ensure that additional investigation and, if necessary, remedial action of contaminated soil is completed for soil that cannot be removed as a result of ongoing facility operations, including the inactive sumps identified in Section 1.4 and the soil beneath the berm at Area 13;

- Ensure that routine maintenance activities required to ensure the integrity of remediation systems are performed;

- Retain access by the FFA Parties to the contaminated areas for continued monitoring, maintenance, and any other remedial activities required;

- Prohibit drilling, boring, digging, construction, earth moving, or other activities within the contaminated areas of the IWOU that are not related to remedial activities or that could compromise the integrity or effectiveness of the remediation systems; and

- Prohibit the future development of the IWOU for residential housing, schools (for grades kindergarten through 12), child care facilities, playgrounds, and any other uses inconsistent with the assumptions upon which the risk assessment was based.

The specific land use control strategy will be designed to maintain the long-term effectiveness of any agreements, contracts, covenants, easements, deed records, maintenance, monitoring, and inspection plans, and any other instruments that may be executed to achieve these land use control objectives, even if the Army transfers ownership or control of the property to another entity. Although the Army may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the Army shall retain ultimate responsibility for remedy integrity including LUCs. In addition, appropriate on-site monitoring, as well as engineering and LUCs, will be used to ensure the health and safety of all on-site construction/utility workers in the IWOU.

Specific land use control mechanisms will be identified in the LUCIP to implement the use restrictions presented above. The land use controls generally fall into one of four categories identified by USEPA guidance (USEPA, 2000a). Multiple mechanisms will be used to provide "layering" for additional durability. The USEPA land use control categories are as follows.

- Proprietary controls – such as easements and covenants are based in real property law and generally create legal property interests

- Governmental controls – are generally implemented and enforced by state or local governments and can include zoning restrictions, well drilling regulations, building permits, ordinances, or similar mechanisms that restrict land or resource use

- Enforcement and permit tools with land use control components – CERCLA Federal Facility Agreements, and CERCLA Unilateral Administrative Orders can be used to enforce or restrict site activities as can RCRA permits and orders

- Informational devices – such as state registries, deed notices, information centers, markers, and advisories provide information that a site contains residual or capped contamination

LUCs will be implemented to restrict future uses of the site until UUUE is achieved. At a minimum, the entire IWOU will be restricted to industrial land use for perpetuity unless a new risk assessment is completed. The assumptions in developing the selected remedies have been based on this assumption for current and future land use.

The LUCs will be applied to the areas of remediation or areas where exposure scenarios dictate that certain receptors may be adversely affected by prolonged exposure to COCs. LUCs will include sufficient area surrounding the contaminated areas to ensure RAOs are satisfied.

Potentially applicable mechanisms identified for LCAAP, either for property owned by the federal government or property that is transferred away from federal ownership, include:

- Enforcement of Land Use Controls through the provisions of the FFA.

- Missouri regulates the construction of wells pursuant to 10 CSR 23 Chapter 3 Well Construction Code.

- Requirements imposed on property listed on the Missouri Registry of Confirmed Abandoned or Uncontrolled Hazardous Waste Disposal Sites pursuant to 10 CSR 25-10.010.

- Implementation of a LCAAP-wide Army Regulation to Restrict Land Use for Army Activities.

- Modification of the Facility Use Contract to Restrict Land Use for the Operating Contractor.

- Incorporation of the ROD into Real Estate Records.

- Environemntal covenants developed consistent with the Missouri Environmental Covenants Act

- *Implement applicable signage at* LCAAP.

The LUCIP will establish periodic monitoring of the LUCs.. The monitoring results will be included in a separate section or appendix of another environmental report and provided to the USEPA and MDNR. The results of the monitoring will be used in preparation of the Five-Year Review to evaluate the effectiveness of the remedy.

2.7.6 Summary of Comparative Analysis of Alternatives

In accordance with CERCLA Section 121, the NCP (USEPA 1990), and USEPA RI/FS guidance (USEPA 1988a and 2000), each alternative must undergo detailed analysis based on the threshold, primary, and modifying criteria discussed below. The comparative analysis is intended to aid in selection of an alternative

that satisfies the RAOs, complies with the ARARs; provides a permanent solution using alternative treatment technologies or resource-recovery technologies to the maximum extent practicable; and reduces toxicity, mobility, and volume of area-specific COCs for each targeted area including surface soil and VOC source area soil and groundwater.

2.7.6.1 Threshold Criteria

Threshold criteria are the minimum requirements that each alternative must satisfy to be eligible for selection as the preferred alternative. They are as follows:

- **Overall Protection of Human Health and the Environment** - Addresses how the alternative protects human health and the environment. This assessment focuses on how an alternative achieves protection over time and indicates how each source of contamination would be minimized, reduced, or controlled through treatment, engineering, or LUCs. The evaluation of the degree of overall protection associated with each alternative is based largely on the exposure pathways and scenarios set forth in the risk assessment.

- **Compliance with ARARs** - Addresses whether the alternative complies with ARARs. ARARs are defined as cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site. The ARARs are used to develop quantitative RAOs that determine the appropriate extent of site cleanup and govern the implementation and operation of the selected action.

- Because of their site-specific nature, identification of ARARs requires evaluation of federal and state regulations regarding COCs, site characteristics, and proposed remedial alternatives. The USEPA generally evaluates three categories of ARARs, i.e., ARARs specific to the contaminant, location, or action.

- Chemical-specific requirements set health- or risk-based concentration limits or ranges for specific substances in various environmental media.

- Location-specific requirements set restrictions on activities according to characteristics of the site or its immediate environs (e.g., regulations pertaining to development in a 100-year floodplain). These requirements may apply if the CERCLA site is located in such a restricted area.

- Action-specific requirements set controls or restrictions on specific activities related to the management of hazardous substances (e.g., RCRA standards for design and operation of hazardous waste management facilities). These requirements are not chemical-specific but are specific to remedial actions.

Chemical-specific ARARs identified for the IWOU are listed in **Table 9**. Location-specific and action-specific ARARs for the selected remedies at each Area are presented in **Appendix B**.

2.7.6.2 Primary Balancing Criteria

Primary balancing criteria are those considerations that form the core of the evaluation process by bringing out the unique strengths and weaknesses of the individual alternatives. These criteria are as follows:

- **Long-term Effectiveness and Permanence** - Addresses the results of an alternative in terms of the residual risk remaining at the site after the RAOs have been met. The primary focus of this evaluation is the extent and effectiveness of the controls that will be applied to manage the risk posed by the residuals of the treatment process and untreated waste. The components of this criterion include the magnitude of the remaining risk measured by numerical standards such as cancer risk, adequacy, and suitability of control used to manage treatment of residual or untreated wastes, and the long-term reliability of management controls for providing continued protection from residuals (i.e., the assessment of potential failure of the technical components).

- **Reduction of Mobility, Toxicity, or Volume through Treatment** - Addresses the statutory preference for selecting remedial actions that include treatment technologies aimed at permanently and significantly reducing the mobility, toxicity, or volume of hazardous substances present at the IWOU. Factors of this criterion to be evaluated include the treatment process employed; the amount of hazardous material destroyed or treated; the degree of reduction in toxicity, mobility, or volume expected; the degree to which the treatment will be irreversible; and the type and quantity of treatment residuals. Each of the alternatives describes whether or not the statutory preference for treatment as a principal element is satisfied.

- **Short-term Effectiveness** - Addresses potential human health and environmental impacts of the alternative during the construction and implementation phase until remedial response objectives are met and the length of time until protection is achieved.

- **Implementability** - Addresses the technical and administrative feasibility of implementing an alternative and the availability of services and materials required during implementation. Implementability is further categorized into technical feasibility, administrative feasibility, and availability criteria.

- **Cost** - Addresses the capital and O&M costs and includes a present-worth analysis of all costs. The capital costs consist of direct costs (construction) and indirect costs (non-construction and overhead). Direct capital costs include construction costs, equipment costs, land and site development costs, relocation expenses, and disposal costs. Indirect capital costs include engineering expenses, legal fees and license or permit costs, startup costs, and contingency allowances.

  O&M costs are post-construction costs necessary to ensure the continued effectiveness of a remedial action. These costs include operating labor costs, monitoring, maintenance materials and labor costs, auxiliary materials and energy, treatment residue disposal costs, purchased services, administrative costs, insurance, taxes, licensing costs, maintenance reserve and contingency funds, rehabilitation costs, and costs of periodic site reviews, if required.

  The cost estimates were developed utilizing USEPA guidance, professional engineering judgment, and quotations from appropriate vendors. In accordance with USEPA guidance, the cost estimates were prepared to provide accuracy in the range of less than 30 to more than 50 percent (USEPA 2000). All capital and O&M cost estimates are expressed in 2005 dollars.

A present-worth analysis of the overall remedial action costs associated with each alternative was conducted after development of the capital and O&M costs. A present-worth analysis relates costs that occur over different periods to present costs by discounting all future costs to the present worth. This allows the costs of alternatives to be compared on the basis of a single number that represents the capital required in 2005 dollars to construct, operate, and maintain the alternative throughout its planned life. The present-worth calculations are based on a discount rate of 3.4 percent, based on an average of the previous 5 years (2001 through 2005) 30-year Real Treasury Interest Rates (OMB 2005). Life-cycle costs are calculated for each alternative.

2.7.6.3 Modifying Criteria

The modifying criteria address the acceptability of the selected remedy to regulatory agencies and the community as follows:

- **Regulatory Acceptance** - Addresses the technical and administrative issues and concerns of the state (or support agency) regarding the alternative.

- **Community Acceptance** - Addresses public issues and concerns regarding the alternative.

2.7.7 Comparative Analysis of Area 2 Alternatives

The comparative analysis of Area 2 alternatives is provided in the following sections and summarized in **Table 10. Table 8** summarizes cost associated with each alternative.

2.7.7.1 Overall Protection of Human Health and the Environment

With the exception of Alternative 1, each alternative is protective of human health and the environment. Alternative 1 is not preferred because it is not protective of human health and the environment. Alternatives 3 and 5 would satisfy the RAOs by completely removing all soil containing lead at concentrations that pose a potentially unacceptable risk to human health and the environment. Alternative 2 satisfies the RAOs by limiting the possibility of direct contact with the waste and minimizing the potential for leaching to groundwater, however under this alternative the lead-impacted soil would remain on site and long term maintenance would be required. Alternative 4 satisfies the RAOs by stabilizing the lead-impacted soil, reducing the toxicity of the contaminated material, and by limiting the possibility of direct contact with the waste.

2.7.7.2 Compliance with ARARs

There are no chemical-specific ARARs for chemicals of concern in soil, but there are location- and action-specific ARARs. Alternatives 2 through 5 can be designed to comply with the location- and action-specific ARARs as identified in **Appendix B**.

2.7.7.3 Long-Term Effectiveness and Permanence

Alternatives 3 and 5 provide long-term effectiveness by completely removing all soil containing lead at concentrations that exceed chemical-specific cleanup levels presented in **Table 7** Alternatives 3 and 5 are

preferred because no long-term monitoring and maintenance requirements are necessary, and no additional LUCs would be necessary beyond those required to limit the land use to industrial. Alternative 2 would be effective as long as the compacted clay cover and LUCs are maintained; however, long term monitoring and maintenance would be required. Alternative 4 provides long-term effectiveness by stabilizing the soil and reducing the toxicity of the lead in soil. Alternatives 2 and 4 require long-term monitoring and maintenance.

2.7.7.4 Reduction of Mobility, Toxicity, and Volume through Treatment

Only Alternatives 3, 4, and 5 involve treatment. Under Alternative 3, contaminated soils would be stabilized as necessary prior to disposal off site so that the soil is disposed of as non-hazardous. Under Alternative 4, contaminated soils would be stabilized prior to on-site disposal. Under Alternative 5, the soil would be treated as necessary off site prior to disposal. The stabilization processes under all of these alternatives would reduce the mobility and toxicity of contaminants of concern; however, the soil would remain on site under Alternative 4. Alternative 3 is preferred over all other alternatives because it both reduces the mobility and toxicity of the lead, and does not require long-term maintenance since the material is disposed off site as non hazardous soil.

2.7.7.5 Short-Term Effectiveness

The timeframe until RAOs would be achieved is similar for Alternatives 2 through 5, as each of the alternatives can be conducted in approximately 12 months. Construction activities associated with Alternatives 2, 3, 4, and 5 can potentially generate fugitive emissions, which may present a short-term inhalation risk for site workers and have an adverse impact on the environment; however, fugitive emissions can be minimized using dust control measures and proper health and safety procedures to reduce airborne migration of dust and limit exposures. The construction work associated with Alternatives 2 and 4 is less intrusive than that associated with Alternatives 3 and 5. Alternatives 2 and 4 do not include any ex-situ handling of contaminated materials, minimizing the potential for production of fugitive emissions and limiting the short-term risks posed to both the community and workers. Potential releases to the environment during construction activities will be mitigated through the use of sediment erosion control measures. In addition, the volume of excavated material under each of the alternatives would not result in a significant number of truckloads being transported off site, limiting potential risks to the community and the environment

2.7.7.6 Implementability

Each alternative can be completed with conventional construction equipment and is readily implementable.

2.7.7.7 Cost

The estimated present-worth costs for each of the alternatives are as follows:

Alternative 1: $0
Alternative 2: $460,000
Alternative 3: $573,500
Alternative 4: $430,000
Alternative 5: $793,700

Table 8 provides further information regarding cost.

2.7.7.8 State Agency Acceptance

The State of Missouri has expressed its support for the U.S. Army's selected alternative as described in Section 2.7.9 of this document (Selected Remedy).

2.7.7.9 Community Acceptance

Comments offered by the public were used to assess whether the proposed alternatives were acceptable to the community. The Army received four written comments during the public comment period. One of the written comments supported the Preferred Remedies, one did not support the Preferred Remedies, one was in the form of a question, and one was neutral towards the Preferred Remedies. Questions were posed to the Army regarding the proposed remedies for the IWOU during the public meeting held on 23 January 2007. Questions about the remedies posed during the public meeting appeared to be satisfactorily addressed during the meeting. During the meeting, Mr. Greg Perry read a written statement that he opposed the remedial actions that were presented for the IWOU. Mr. Leonard Heman and other members of the public seemed to be supportive of the remedial actions at the IWOU. The questions and concerns of the community are discussed in the Responsiveness Summary, which is **Appendix C** of this ROD.

2.7.8 Principal Threat Wastes

The NCP establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable (NCP §300.430[a][1][iii][A]). Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure.

There are no existing principal threat wastes at Area 2. Low-level threat wastes have been identified in surface and subsurface soil at Area 2. Removal strategies were selected to provide complete removal of contaminants.

2.7.9 Selected Remedy for Area 2

Based on the requirements of CERCLA, comparative analysis using the nine criteria, public comments, and in consultation with the USEPA and the state, the USEPA and Army have selected Alternative 3 - Soil Excavation and Off-Site Disposal. For the Selected Remedy, the LUCs will be imposed to ensure that the site remains industrial use only.

2.7.9.1 Summary of the Rationale for the Selected Remedy for Area 2

Excavation and off-site disposal is protective of human health and the environment and is cost-effective. In Alternative 2 and 4 the soil would remain on site, which will require long-term maintenance. Alternative 5 is protective and although the soil would be treated; it is twice as costly. This remedial action also satisfies the RAOs within a reasonable timeframe. There are no chemical-specific ARARs for soil, so soil clean up standards are selected on the basis of risk-based criteria. Excavation and off-site disposal is cost-effective, implementable, permanent, and effective. The selected remedy includes treatment of the soil as necessary

following excavation that will reduce the toxicity and mobility of the lead-impacted soil without the need for long-term maintenance or LUCs, and is therefore the selected remedy for Area 2.

In addition, because the TCLP analytical results and concentrations of lead in soil at Area 2 indicate that lead may potentially leach to groundwater, the selected remedy reduces the mobility of lead of the stabilized soil and is therefore protective of groundwater. The remedy eliminates the unacceptable risk associated with lead at Area 2 and does not require long-term O&M costs. Although the cost associated with the Selected Remedy is slightly higher than those of other alternatives that were evaluated, the Selected Remedy provides the best balance of screening criteria.

2.7.9.2 Description of the Selected Remedy for Area 2

The selected remedy includes removal of approximately 1,420 CY of soil contaminated with lead above an average concentration of 1,197 mg/kg concentration, stabilization to reduce the toxicity and leachability of the excavated soil if the soil fails TCLP lead, and off-site disposal of the treated soil. This remedy will create minimal disturbance of the overall operational activities at the surrounding LCAAP facilities and will allow for complete removal of the contaminated soil from Area 2, eliminating any risks associated with its presence. LUCs will be imposed to ensure that the site remains industrial use only. **Figure 12** shows the extent of the remedial action.

The contaminated material will be physically removed using conventional construction equipment. Staging areas will be used to prepare wastes for treatment and disposal. After treatment, waste characterization samples will be collected to ensure that the excavated material has been effectively stabilized and to demonstrate that the stabilized material can be sent off site as a non-hazardous waste at an appropriate permitted facility. Waste characterization samples will be collected of any untreated excavated material to ensure the soil meets the TCLP lead value of 5 mg/L.

Confirmation samples will be collected from the base and perimeter of the excavation area to verify the removal of contaminated soil exceeding an average concentration of 1,197 mg/kg lead and to verify that the residual risk associated with lead-impacted material has been reduced to within the acceptable risk levels.

2.7.9.3 Summary of the Estimated Remedy Costs for Area 2

The information in the cost estimate summary provided in **Table 11** is based on the best available information regarding the anticipated scope of the remedial alternative. Cost elements are likely to change as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an explanation of significant differences (ESD), or a ROD amendment. The cost provided in **Table 11** is an order-of-magnitude engineering cost estimate that is expected to be within 30 to 50 percent of the actual project cost.

2.7.9.4 Expected Outcomes of the Selected Remedy at Area 2

The purpose of the response action for Area 2 is to remove impacted soil with concentrations of lead that are higher than cleanup levels (**Table 7**). Exposure for these AOCs is controlled through off-site disposal of residuals. No concentrations of COCs higher than cleanup levels will remain on site within Area 2.

- The current and future land use for LCAAP has been determined to be industrial, so the land use must remain consistent with this determination. There are no additional restrictions on land use following completion of the remedial response action.

- The cleanup levels for soil at IWOU are provided on **Table 7**. These cleanup levels were determined based on an evaluation of ARARs and risk-based cleanup levels. LUCs will remain in place at the IWOU as long as concentrations in soil and groundwater do not meet UUUE. It is estimated that the cleanup levels will be achieved within approximately 1 year. No unacceptable risk will remain following the remedial response action as long as the land use remains industrial.

- The beneficial socio-economic and community revitalization impacts include elimination of identified contamination at this particular Area. Due to the nature of the operations at LCAAP and the long-term management that will be required in the IWOU, the remaining benefits are not applicable.

- Environmental and ecological benefits will occur as a result of removing impacted surface soil in this Area.

2.7.9.5 Selected Remedy Performance Objectives and Performance Criteria for Area 2

The selected remedy provides protectiveness by applying immediate mass removal through shallow soil excavation and soil stabilization of lead-impacted surface soil, which achieves the following RAOs:

- Prevent exposure to lead in soil exceeding an average concentration of 1,197 mg/kg to achieve a predicted blood level lower than 10 ug/dL with a 95 percent probability.

- Prevent contaminant migration of lead to groundwater from soil with concentrations above the cleanup levels identified in **Table 7.**

The performance objectives of the excavation and off-site disposal for this Area are to prevent exposure to COCs at concentrations above cleanup levels, prevent contaminant migration to groundwater from soil with concentrations above cleanup levels, and to achieve cleanup levels as verified through confirmation sampling. Upon completion of the Selected Remedy for Area 2, the Area will be available for industrial/commercial use. The performance evaluation criterion to determine that these objectives have been achieved is to collect confirmation samples within the excavation area to determine that no COCs remain in soil at concentrations above cleanup levels presented in Table 7. In addition, the performance evaluation criterion to determine that lead is not migrating to groundwater is to perform groundwater monitoring at Area 2 as described in Section 2.35. Confirmation sampling procedures will be detailed in the RD/RAWP. LUCs will be provided indefinitely or until UUUE is achieved.

2.7.10 Statutory Determinations

Section 121 of CERCLA and the NCP establish several statutory requirements and preferences. These specify that, when complete, the selected remedy must achieve adequate protection of human health and the environment and comply with ARARs unless a statutory waiver is justified. The selected remedy must also be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that

employ treatment (as a principal element) that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes with a bias against off-site disposal of untreated wastes. The following sections describe how the Selected Remedy satisfies or does not satisfy the statutory requirements of CERCLA Section 121.

2.7.10.1 Protection of Human Health and the Environment

The selected remedy addresses health and environmental issues that were identified in the Area 2 Remedial Investigation and Risk Assessments in the media of soil. Specifically, the remedial actions:

- Prevent exposure to COCs in soil at Area 2 at concentrations exceeding the cleanup levels by excavating.
- Prevent contaminant migration of COCs to groundwater from soil at Area 2 by excavating.

The selected soil remedy will achieve RAOs for soil and result in a blood-lead level lower than 10 ug/dL with a 95 percent probability.

2.7.10.2 Compliance with ARARs

The Selected Remedy for Area 2 complies with location- and action-specific ARARs set forth in **Appendix B.** Cleanup levels are presented in **Table 7**.

2.7.10.3 Cost Effectiveness

The Selected Remedy is cost-effective and represents a reasonable value for the money to be spent. The following definition was used when making this determination: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (NCP §300.430[f][1][ii][D]). Overall effectiveness was compared to costs of the alternatives to determine cost effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence, this alternative represents a reasonable value for the money to be spent. The estimated present-worth cost of the Selected Remedy is $573,500, and it will satisfy CERCLA requirements.

2.7.10.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Extent Possible

The selected remedy meets the statutory requirement to utilize permanent solutions and treatment technologies to the maximum extent practicable for the IWOU as follows:

- Focused excavation will permanently remove contaminated soil.
- Ex-situ stabilization will permanently immobilize lead in surface soil following excavation.

2.7.10.5 Preference for Treatment as a Principal Element

The NCP establishes an expectation that USEPA will use treatment to address the principal threats posed by a site wherever practicable (NCP §300.430[a][1][iii][A]). No principal threat wastes have been identified at Area 2.

Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure. Groundwater data demonstrate that chemicals are not leaching at a rate sufficient to adversely impact groundwater, because lead concentrations in groundwater are within the acceptable risk range based on the risk assessment and an industrial use scenario. Because of the low mobility of lead in soil at Area 2 and absence of potential human health risk, it is considered a low-level threat waste.

Five-Year Review Requirements

Five-year reviews of the Selected Remedy will be performed because contaminants will remain in soil and groundwater at concentrations that do not allow for UUUE. These reviews will be conducted at least every 5 years after commencement of the remedial action, until concentrations of contaminants are reduced to levels that allow for UUUE, to ensure that the remedy continues to adequately protect human health and the environment.

2.7.11 Documentation of Significant Changes

All written and verbal comments submitted during the January 2007 public meeting and comment period were reviewed, and it was determined that no significant changes to the remedy, as outlined in the 2007 Proposed Plan, were necessary or appropriate.

2.8 Area 3 - Demolition Waste Disposal Area

2.8.1 Site Characteristics

Area 3 occupies approximately 41 acres and is located in the far northwest corner of the Installation, north of the main gate. A series of sand quarry pits and small lagoons were used between the 1950s and the mid-1970s for disposal of Installation construction materials and demolition/remodeling debris, IWTP sludge, and reportedly limited off-site material.

The suspected source material is a series of sand quarry pits and small lagoons containing demolition/remodeling debris and IWTP sludge. **Figure 13** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. There have been five previous investigations at Area 3. EA Engineering, Science, and Technology conducted a PA/SI between 1987 and 1989. In 1988, a Phase I Investigation was conducted by Roy F. Weston to determine possible impacts to the soil and groundwater associated with activities in Area 3. A staged Phase II Investigation was conducted by EA Engineering, Science, and Technology in 1990 and 1992 to further identify and evaluate the nature and extent of potential contamination in soil and groundwater associated with the IWTP

sludge disposal in the area and included a geophysical survey and soil vapor contaminant assessment (SVCA) survey. A site characterization and analysis penetrometer system (SCAPS) investigation was conducted to evaluate the potential extent of VOCs in groundwater at the boundary of the Installation. A Supplemental RI was conducted by Burns and McDonnell to confirm earlier subsurface soil sampling results from the Phase II soil borings. Trenching activities were conducted at all four AOIs to determine the horizontal extent of the disposal areas as part of the 2004 RI performed by ARCADIS.

2.8.2 Current and Potential Future Land and Water Uses

Area 3 consists of an open field at the northern boundary of the Installation north of the active manufacturing area. Area 3 is currently unused, and no inhabitable buildings are present. A fence currently surrounds the Installation, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Current land use of Area 3 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA. Area 3 is currently unused and no inhabitable buildings are present.

2.8.3 Summary of Human Health Risk Assessment – Area 3

The Area 3 – IWTP and Demolition Waste Disposal Pits HHRA characterized potential risks in a manner consistent with the risk assessment principles and practices established by the USEPA Risk Assessment Guidance for Superfund (USEPA 1989). The HHRA is discussed further in the Final IWOU RI/FS (ARCADIS 2006) and is summarized in the following sections.

2.8.3.1 Identification of Chemicals of Concern

The observed concentrations of the human health risk drivers and the calculated and exposure concentrations are summarized in Table 2. The 95th Upper Confidence Limit of the mean was calculated and used as the exposure concentration following USEPA guidance. Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthrene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and naphthalene were identified as COCs in soil in Area 3.

2.8.3.2 Exposure Assessment

The assessment of exposure includes characterization of the physical environment, identification of exposure pathways (including migration pathways, exposure points, and exposure routes), and identification of potentially exposed individuals and populations. Due to the industrial nature of the LCAAP, particularly the IWOU, the exposure scenarios evaluated in the HHRA were limited to industrial exposure frequencies and durations. Based on the current and reasonably anticipated future land uses of Area 3, the following complete or potentially complete exposure pathways and receptors were identified:

- Future site workers may be exposed to COPCs in surface soil via incidental ingestion and inhalation of wind-blown fugitive dust. Future site workers may also be exposed to COPCs in groundwater via ingestion of groundwater used as potable water, dermal contact while washing hands, and inhalation of volatile COPCs migrating to indoor air.

- Future construction/utility workers may be exposed to COPCs in combined surface and subsurface soil via incidental ingestion, dermal contact, and inhalation of dust during excavation activities. Future construction/utility workers may also be exposed to COPCs in groundwater via dermal contact and inhalation of VOCs.

- Current and future maintenance workers may be exposed to COPCs in surface soil via incidental ingestion, dermal contact, and inhalation of wind-blown fugitive dust. Maintenance workers may also be exposed to COPCs in surface water via dermal contact and COPCs in sediment via incidental ingestion and dermal contact.

- Current and future adult and youth visitors/trespassers may be exposed to COPCs in surface soil via incidental ingestion and dermal contact. Current and future adult and youth visitors/trespassers may also be exposed to COPCs in surface water via dermal contact and COPCs in sediments via incidental ingestion and dermal contact.

Table 3 tabulates key exposure assumptions and intake parameters used in the evaluations. The migration pathways and receptors developed from the CSEM are shown on **Figure 15.**

2.8.3.3 Toxicity Assessment

The toxicity assessment results in the selection of appropriate toxicity values to use in estimating potential health risks associated with exposure. This is accomplished by reviewing the available information on the toxicity of the COCs and summarizing the factors pertinent to the exposures being assessed.

Chemical-specific CSFs and weight-of-evidence classifications were compiled for cancer endpoints. The weight-of-evidence classification describes the likelihood that a chemical is a human carcinogen based on the supporting evidence of carcinogenicity in human and animal studies (USEPA 1999b). Cancer toxicity values are summarized in **Table 4.**

Chemical-specific RfDs were compiled for non-cancer health effects. Chronic RfDs were used to assess long-term exposures ranging from 7 years to a lifetime. Subchronic RfDs were used to evaluate the potential for adverse health effects associated with exposure to constituents over a period of 2 weeks to 7 years. Subchronic RfDs were used to evaluate the short-term construction worker hazards. Non-cancer toxicity values are summarized in **Table 5.**

COCs in Area 3 soil elicit cancer effects. The primary source for toxicity values, such as cancer slope factors and reference doses, is USEPA's Integrated Risk Information System (IRIS). In addition, the following provisional or draft toxicity values were utilized in the Area 3 HHRA: CSFs for PAHs, with the exception of benzo(a)pyrene, were estimated using USEPA's relative potency approach. This approach utilizes toxicity equivalency factors (TEFs) to adjust the cancer slope factor for benzo(a)pyrene for a particular PAH based on its relative potency.

2.8.3.4 Risk Characterization

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time with a reference dose derived for a similar exposure period. The ratio of the exposure to toxicity is an HQ. An

HQ lower than 1 indicates that a receptor's dose of a single contaminant is lower than the reference dose, and that toxic noncarcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all COCs that affect the same target organ or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI lower than 1 indicates that, based on the sum of all HQs from different COCs and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI higher than 1 indicates that site-related exposure may present a potential risk to human health.

Potential carcinogenic (cancer) risks are classified by the increased probability of a person getting cancer in his or her lifetime (i.e., excess lifetime cancer risks) from being exposed to known or suspected cancer-causing chemicals at the site. Excess lifetime cancer risks are determined by multiplying the exposure with the slope factor. These risks are probabilities that are generally expressed in scientific notation (e.g., 1 x 10^{-6}). An excess lifetime cancer risk of $1x10^{-6}$ indicates that, as a plausible upper bound, an individual has a one in 1,000,000 chance of developing cancer over a 70-year lifetime as a result of site-related exposure to a carcinogen under the specific exposure conditions at a site. USEPA's generally acceptable carcinogenic risk range is between 1 x 10^{-4} and 1 x 10^{-6}. This means that there is an increased probability of one additional case in 10,000 to one case in 1,000,000 that an individual will develop cancer above the expected normal rate of 250,000 per 1,000,000 (or one in four).

Table 6 summarizes risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of exposure as well as the toxicity of the COCs. The potential risk from exposure to impacted soil within in the waste area at Area 3 exhibits a cancer risk of 1 x 10^{-4} for youth visitor/trespassers, 6 x 10^{-4} for site workers, and 3 x 10^{-4} for adult visitor/trespassers due to exposure to surface soil and a cancer risk of 1 x 10^{-4} for construction/utility workers due to exposure to surface and subsurface soil. Additionally, cumulative potential risks from exposure to waste area soils and to Area-wide soil, groundwater, surface water, and sediment are presented in detail (by pathway) in **Appendix A**. These risk levels indicate that, if no cleanup action is taken, potential receptors would be exposed to an unacceptable risk as a result of site-related exposure to the benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthrene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and napthalene in soil in Area 3.

2.8.4 Summary of Ecological Risk Assessment – Area 3

In addition to an assessment of human risk, USEPA also requires that the baseline risk be evaluated for ecological receptors, such as animals, that live in and around the contaminated areas. An Ecological Risk Assessment (ERA) was conducted in accordance with the Final Risk Assessment Work Plan for LCAAP (ARCADIS 2004a) to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents. As discussed in the Final Risk Assessment Work Plan for LCAAP (ARCADIS, 2004a), an ERA was performed only for inactive Areas that are not within the manufacturing area of the plant including Area 3.

2.8.4.1 Identification of Chemicals of Concern

The observed concentrations for the COCs, the ecological toxicity values used to identify the ecological risk drivers, and the medium-specific exposure concentrations are summarized in **Table 12**. These evaluation criteria identified the following COCs in Area 3:

- Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene , naphthalene, phenanthrene, pyrene, copper, and zinc in surface soil

The exposure concentration used in the risk calculations was the maximum detected concentration or the 95th Upper Confidence Limit for each constituent, whichever was lowest. This approach is consistent with USEPA guidance for ecological risk assessment.

2.8.4.2 Exposure Assessment

Area 3 is bounded on the west by the Installation boundary and Missouri State Hwy 7, on the north by Perimeter Road and the Installation boundary, and on the south by Lake City-Buckner Road. Grasslands similar to those present within the area boundaries are located to the east. A small pond is located in the northern portion of the site.

This section also provides an evaluation of potential exposures to individual organisms of threatened and endangered species at the site. A threatened and endangered species literature survey was conducted for Jackson County to identify the listed species in the vicinity of LCAAP. A Certified Ecologist and a wildlife biologist conducted an ecological reconnaissance at Area 3 to characterize the available habitat and evaluate whether suitable habitat was present for the listed species.

Ten endangered species were listed for Jackson County (MDC 2005a). There are no known occurrences of any state or federally listed threatened or endangered species at LCAAP, including Area 3 (MDC 2005b).

A complete exposure pathway is "one in which the chemical can be traced or expected to travel from the source to a receptor that can be affected by the chemicals" (USEPA 2001a). Therefore, a chemical, its release and migration from the source, a receptor, and the mechanisms of toxicity of that chemical must be demonstrated before a complete exposure pathway can be identified.

The table below summarizes the potential exposure routes for Area 3.

Organism	Possible Exposure Routes
Terrestrial animals (including soil invertebrates)	Ingestion, inhalation, surface contact, and food web
Terrestrial plants	Surface contact with soil
Aquatic or semi-aquatic animals	Ingestion, surface contact, food web
Aquatic or Semi-Aquatic plants	Uptake of surface water and surface contact with surface water and sediment

Although inhalation is listed as a possible exposure route, under most exposure conditions, inhalation pathways do not represent a significant contribution to receptor risk (USEPA 2005) and are not evaluated quantitatively in this ERA.

Ecological exposure pathways of concern, including receptors, are summarized in **Table 13.**

2.8.4.3 Ecological Effects Assessment

Assessment endpoints are the explicit expression of the ecological values to be protected (USEPA 1997). The selection of assessment endpoints depends on knowledge of the receiving environment, knowledge about the constituents released (including their toxicological properties and the relevant concentrations), and understanding of the values that will drive risk management decision-making (Suter et al. 1995).

"For the SLERA, assessment endpoints are any adverse effects on ecological receptors, where receptors are plant and animal populations and communities, habitats, and sensitive environments. Many of the ecotoxicity screening values are based on generic assessment endpoints and are assumed to be widely applicable to sites around the United States" (USEPA 1997). The vast majority of ecotoxicity screening values are limited to just a few species and a limited number of studies per species. As such, their robustness and ultimate relationship to the assessment endpoint may be limited.

Because direct measurement of assessment endpoints is often difficult (or impossible), surrogate endpoints (called measurement endpoints) are used to provide the information necessary to evaluate whether the values associated with the assessment endpoint are being protected. A measurement endpoint is a measurable ecological characteristic and/or response to a stressor (USEPA 1998). Measurement endpoints are also referred to as measures of potential effect (USEPA 1998). Measurement endpoints, such as mortality, reproductive effects, and reduced growth are considered for the ERA; however, they are not directly measured. These measurement endpoints are indirectly evaluated in the ERA through the use of HQs. An HQ is the ratio of a constituent concentration to an associated ecotoxicity screening value. The assessment and measurement endpoints used to evaluate the ecological risk drivers are summarized in **Table 13.**

2.8.4.4 Ecological Risk Characterization

Potentially unacceptable risks to terrestrial ecological receptors may result from exposure to surface soil impacted with PAHs, copper, and zinc at a few locations at Area 3.

Risks were characterized for terrestrial and aquatic ecological receptors at Area 3 based on HQs (direct contact exposure and food web modeling), with emphasis on the weight of evidence, such as conservatism of the Ecological Screening Values (ESVs), Ecological Screening Levels (ESLs), and USEPA Ecological Soil Screening Levels (EcoSSLs), the spatial extent of elevated HQs, background levels relative to site-related concentrations, and the quality of the available terrestrial and aquatic habitat. An HQ less than or equal to a value of 1 indicates that adverse impacts to wildlife are considered unlikely (USEPA 2001b). However, there is no clear guidance for interpreting the HQs that exceed a value of 1, except that this point of departure indicates that adverse effects of some kind may have occurred in the past or may occur in the future. The toxicity units (TUs) are considered representative of cumulative impacts, with TUs greater than 1 indicating the potential for adverse impacts. The conclusions drawn based on the HQs, TUs, and analysis of supporting information are summarized below.

Risks to terrestrial wildlife are not likely to occur via direct contact for most of the COCs evaluated in this ERA. However, concentrations of some PAHs and two metals (copper and zinc) were elevated in one or more of the samples collected at Area 3. The concentrations of several PAHs detected in one sample (Sample ID

03B16) were elevated above concentrations detected in other site samples. The ERA indicates that potentially unacceptable direct contact risks may result from exposure to soil impacted with PAHs at one location (i.e., 03B16) in Area 3, and from exposure to soil impacted with copper and zinc at a few locations in Area 3.

Results from the food web modeling indicate that concentrations of copper at a few locations resulted in HQs that exceed 1 for the short-tailed shrew. However, these HQs calculated using the conservative No-Observed Adverse Effect Level (NOAEL) under the refined scenario are only marginally above 1. The HQ calculated using the Lowest-Observed Adverse Effect Level (LOAEL) (a more realistic indicator of toxicity) is lower than 1 when using the average concentration as the exposure point concentration (EPC) in the refined scenario. Considering the limited number of shrews and other insectivorous mammals that might be impacted (if any), population-level adverse impacts are unlikely to occur for shrews and for other insectivorous mammals exposed to copper in Area 3. The results of the food web modeling for the American robin indicates that none of the COCs should represent a significant risk to insectivorous birds under average exposure conditions in Area 3.

Risks to aquatic wildlife are not expected in the pond at Area 3. Based on the overall analysis of direct contact HQs and TUs, adverse impacts are considered unlikely for any aquatic wildlife, and sediment-dwelling organisms that might be exposed to the COPCs in the surface water and sediment of the pond.

2.8.5 Area 3 Remedial Action Objectives

The RAOs are site-specific cleanup objectives established for protecting human health and the environment. The RAOs are intended to be specific to the affected media, but sufficiently broad so as not to unreasonably restrict the potential remedial technology available. The RAOs developed for the IWOU include the COCs, media of concern, and potential exposure pathways identified during the risk assessment. Because of the industrial nature of the LCAAP, the exposure scenarios evaluated in the HHRA were primarily limited to industrial exposure frequencies and durations. Because of the use restriction imposed by the industrial exposure scenarios, LUCs will be a required component of the Selected Remedies at the IWOU to be protective of sensitive populations and the higher exposure frequencies and durations that would be associated with a LUUE scenario. Therefore, use restrictions would be implemented by the Army at the IWOU to limit future use of the site to industrial only. The RAOs for Area 3 are to:

- Prevent exposure to PAHs in soil at concentrations above the cleanup levels identified in **Table 7.**
- Prevent exposure of ecological receptors to soils containing COCs at levels that would result in adverse population-level impacts through elimination of direct contact.

The rationale for both RAOs is to protect receptors to contaminated media to a sufficiently protective standard defined in terms of cleanup levels developed from the risk assessment or ARARs. Achieving these RAOs will eliminate the potential risk by placing a soil cover on the contaminated soil, thus eliminating contact with contaminated soil.

The proposed actions for soil remediation would successfully meet the RAOs and would comply with ARARs.

2.8.6 Description of Area 3 Alternatives

The remedial alternatives for each Area in the IWOU are presented in **Table** 8, along with their estimated present-value life-cycle costs. A narrative description of these remedial alternatives is given in the following section. The contaminants of concern at Area 3 are PAHs including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, benzo(k)fluranthene, and naphthalene based on the results of the risk assessment. Results of sampling indicate that PAH compounds are present in soil at depths ranging from 0 to 7.5 feet bgs at Area 3 above the human health risk levels and may pose a risk to future and current site workers who might be exposed to these PAHs in surface and subsurface soil. Concentrations of PAHs detected in soil are presented on **Figure 14**. In addition, it was determined in the ERA that there are some locations in Area 3 where exposure to soil impacted with PAHs, copper, and zinc may pose an unacceptable risk to terrestrial ecological receptors. Remedial action is necessary to prevent exposure to contaminated soils. Although chemicals that present a potentially unacceptable risk are not present in groundwater at Area 3, groundwater will be monitored as part of the IWOU-Wide Groundwater program in order to ensure that the remaining waste does not impact groundwater. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

Three remedial action alternatives were developed for Area 3. The aerial extent of surface and subsurface soil identified as having concentrations of COCs in exceedance of cleanup levels is approximately 148,000 square feet **(Figure 16)**.

Detailed cost estimates for each of the Area 3 remedial alternatives are provided in the Final IWOU RI/FS (ARCADIS 2006). **Figure 16** identifies the locations of impacted surface and subsurface soil and delineates the areas for remedial action.

Alternative 1: No Further Remedial Action

Estimated Capital Cost: $0
Estimated Annual O&M Cost: $0
Estimated Present Value: $0

The NCP and USEPA's guidance for conducting RI/FS investigations requires that the "No Action" option be developed and examined as a potential remedial action for all sites. The "No Action" option is retained and examined as a baseline with which other remedial actions are compared. The "No Action" alternative does not address the baseline conditions associated with unacceptable risk to potential future site worker and construction/utility worker exposures and does not achieve the RAOs established at the IWOU.

Overall Protection

This alternative provides no controls to limit exposure to the contaminated soil and will not reduce the risks to human health or ecological receptors. COCs will remain in surface soil at levels that exceed the allowable levels for exposure, as determined in the HHRA and ERA.

Compliance with ARARs

There are no chemical-specific ARARs for soil. Alternative 1 would not comply with all location-specific ARARs. There are no action-specific ARARs for Alternative 1.

Long-term Effectiveness

This alternative does not include any controls for exposure and includes no long-term management measures. Therefore, it will not mitigate any risk associated with the COCs, making it ineffective in the long term.

Reduction of Mobility, Toxicity, and Volume through Treatment

This alternative includes no treatment, containment, or removal actions and therefore will not actively reduce the toxicity, mobility, or volume of COCs in soil at Area 3.

Short-term Effectiveness

The no action alternative is not effective in the short term, as it was determined in the HHRA and ERA that human health and ecological risks could be attributed to the COCs in the impacted surface and subsurface soil.

Implementability

Due to the lack of technical and administrative components, the no action alternative is implementable, and will not limit or interfere with the ability to perform future remedial actions. However, it is unlikely that the no action alternative would be accepted by government agencies or the public.

Cost

Because no remedial actions are performed in connection with this alternative, there are no associated O&M or capital costs.

Alternative 2: Vegetative Cover and Land Use Controls

Estimated Capital Cost: $386,700
Estimated Annual O&M Cost: $8,900
Estimated Present Value: $595,000

This remedial alternative includes on-site containment using an engineered cover and LUCs. The engineered cover would be made up of a minimum 18-inch-thick compacted protective layer and a 6-inch-thick topsoil layer. A vegetation layer would be installed to control erosion at the site. The vegetative cover would act as a barrier between the soil of concern and the surrounding environment to limit the potential for direct exposure and minimize the associated risk.

This alternative would not pose significant adverse impacts to human health or the environment during either the construction or operation periods, and would cause minimal disturbance of the overall operational activities

of the surrounding LCAAP facilities. Long-term maintenance would be required to prevent excess erosion of the cover or ponding.

LUCs will be implemented as described in Section 2.7.5. LUCs will be selected as part of this ROD and implemented in accordance with the LUCIP. The Army will enforce these LUCs and maintain the integrity of the remedial technologies at Area 3. LUCs must be enforced to maintain industrial land use.

Overall Protection

Alternative 2 will eliminate the only complete exposure pathway identified in the HHRA and ERA (direct contact with the impacted soils and waste material), thus eliminating environmental and health concerns associated with the COCs at the site. Although the contaminants will not be removed, they would no longer pose a potentially unacceptable risk to human health or ecological receptors. Soil with contaminant concentrations exceeding the chemical-specific remedial levels will remain beneath a vegetative cover.

Compliance with ARARs

There are no chemical-specific ARARs for soil. This alternative complies with the action-specific and location-specific ARARs for Alternative 2 (action-specific ARARs in Table B-3 and location-specific ARARs in Table B-4). The key ARARs for Alternative 2 include 10 CSR 80-2.030, which require the maintenance of the cover integrity and vegetative growth to protect cover material and surface water drainage systems.

Long-term Effectiveness

Installation of a vegetative cover and implementation of LUCs will reduce the human health and environmental risks associated with COCs in soil at Area 3 by mitigating the potential for exposure to the contaminants. For as long as the vegetative cover and LUCs are maintained, Alternative 2 will have long-term effectiveness and permanence. A long-term management plan is necessary for inspection and maintenance of the containment system to ensure the permanence of LUCs.

Reduction of Mobility, Toxicity, and Volume through Treatment

The COCs in soil at Area 3 have been shown to be immobile, as no historic impacts to groundwater have been observed. Because no removal will be occurring, this alternative will not reduce the volume or toxicity of COCs in soil.

Short-term Effectiveness

Installation of a vegetative cover can be conducted in a relatively short period of time and will provide an immediate reduction in risk to human health and the environment. Construction activities associated with stabilization and installation of the cover can generate contaminated dust and particulates. These fugitive emissions can present an inhalation risk for site workers and may have an adverse impact on the environment; however, fugitive emissions can be minimized using dust control measures and proper health and safety procedures to reduce airborne migration of dust and limit exposures. In addition, the construction work associated with the installation of a vegetative cap is less intrusive than remedial alternatives including

excavation activities. As Area 3 is in close proximity to the perimeter of the facility, public involvement to inform the residents of the remedial activities being performed will be necessary.

Implementability

All services and materials required for installation of a vegetative cover are readily available, making this a technically feasible and easy-to-implement alternative.

Cost

The capital cost to install the vegetative cover is approximately $386,700. The cost for annual O&M of the vegetative cover is approximately $8,900 per year based on current year dollars. The present-worth cost for Alternative 2 is approximately $595,000 based on installation and 30 years of long-term maintenance.

Alternative 3: Removal and Off-Site Disposal

Estimated Capital Cost: $7,520,000
Estimated Annual O&M Cost: $0
Estimated Present Value: $7,520,000

Under Alternative 3, surface and subsurface soils exceeding the cleanup levels identified in Table 7 would be excavated and transported off site for disposal. Excavation at Area 3 would create minimal disturbance of the overall operational activities at the surrounding LCAAP facilities. Any risks associated with the soil under an industrial use scenario would be eliminated. The contaminated material would be physically removed using conventional construction equipment and disposed of at an appropriate off-site facility.

LUCs will be implemented as described in Section 2.7.5. LUCs will be selected as part of this ROD and implemented in accordance with the LUCIP. The Army will enforce these LUCs and maintain the integrity of the remedial technologies at Area 3. LUCs must be enforced to maintain industrial land use.

Overall Protection

Excavation and off-site disposal will allow for the complete removal of all surface and subsurface soil containing COCs at concentrations that pose a potentially unacceptable risk to human health and ecological receptors. Dust control and safe materials handling procedures will be required during excavation and transportation activities to ensure the protection of excavation workers. Appropriate precautions will also be necessary during off-site hauling and disposal operations to ensure public protection.

Compliance with ARARs

There are no chemical-specific ARARs for soil. This alternative complies with the action-specific and location-specific ARARs for Alternative 3 (action-specific ARARs in **Table B-3** and location-specific ARARs in **Table B-4**). The ARARs for Alternative 3 include 40 CFR 261 A, B, C, and D, which ensure proper handing and disposal of excavated material.

Long-term Effectiveness

This alternative removes all soil COCs at concentrations that exceed chemical-specific remedial levels, eliminating associated human health and environmental risks, with no long-term management required. The contaminants will be permanently removed from the site, making this alternative effective in the long term.

Reduction of Mobility, Toxicity, and Volume through Treatment

The total volume of soil exceeding the risk-based remedial levels will be excavated and transported to an off-site disposal facility, removing the volume of concern and eliminating any long-term toxicity or mobility issues associated with its presence at Area 3.

Short-term Effectiveness

Activities associated with excavation can generate contaminated dust and particulates. These fugitive emissions can present an inhalation risk for on-site workers and may have an adverse impact on the environment during excavation. These impacts can be minimized using dust control measures and proper health and safety procedures to reduce airborne migration of dust and limit exposures. Risks to the public during off-site hauling operations will be minimized by employing approved engineering controls to reduce the potential for exposure.

As Area 3 is in close proximity to the perimeter of the facility, public involvement to inform the residents of the excavation and off-site disposal activities being performed will be necessary.

Soil excavation and off-site disposal operations can be completed in a relatively short period of time.

Implementability

Soil excavation is widely used and can be performed using conventional techniques. It is anticipated that some administrative effort will be required to arrange for disposal of the excavated soil, but all services and materials required for excavation and transportation of the soil will be readily available, making this an implementable alternative.

Cost

This alternative does not include any long-term O&M costs, so present-worth analysis is not necessary. Capital costs, including all on-site work, transportation, and disposal costs, are estimated at $7,520,000.

2.8.7 Summary of Comparative Analysis of Alternatives

Each alternative must undergo detailed analysis based on the threshold, primary, and modifying criteria discussed in Section 2.7.6.3.

2.8.8 Comparative Analysis of Area 3 Alternatives

The comparative analysis of the Area 3 alternatives is provided in the following sections and summarized in **Table** 14. **Table** 8 summarizes cost associated with each surface soil alternative.

2.8.8.1 Overall Protection of Human Health and the Environment

With the exception of Alternative 1, each alternative is protective of human health and the environment. Alternative 2 satisfies the RAOs by limiting the potential for exposure to the soil containing COCs at concentrations above the cleanup levels. Alternative 3 would satisfy the RAOs by completely removing all soil containing COCs at concentrations that pose a potentially unacceptable risk to human health and ecological receptors.

2.8.8.2 Compliance with ARARs

There are no chemical-specific ARARs for COCs in soil, but there are location- and action-specific ARARs as identified in the Final IWOU RI/FS. Alternatives 2 and 3 can be designed to comply with the location- and action- specific ARARs.

2.8.8.3 Long-Term Effectiveness and Permanence

Alternative 3 provides long-term effectiveness by completely removing all COCs in soil at concentrations that exceed the target cleanup levels in **Table 7**. No long-term monitoring and maintenance requirements are necessary for Alternative 3. Alternative 2 would be effective as long as the LUCs and vegetative cover are maintained. Alternative 2 requires long-term monitoring and maintenance.

2.8.8.4 Reduction of Mobility, Toxicity, and Volume through Treatment

Neither Alternative 2 nor 3 involve any treatment to reduce the mobility, toxicity, or volume of contaminated materials.

2.8.8.5 Short-Term Effectiveness

The timeframe until RAOs would be achieved is similar for Alternatives 2 and 3, as each of these alternatives can be completed in approximately 12 months. Construction activities associated with Alternatives 2 and 3 can potentially generate fugitive emissions, which may present a short-term inhalation risk for site workers and have an adverse impact on the environment; however, fugitive emissions can be minimized using dust control measures and proper health and safety procedures to reduce airborne migration of dust and limit exposures. The construction work associated with Alternative 2 is less intrusive than that of Alternative 3 and does not include any ex-situ handling of contaminated materials, minimizing the potential for production of fugitive emissions and limiting the short-term risks posed to both the community and workers.

2.8.8.6 Implementability

Both Alternatives 2 and 3 can be completed with conventional construction equipment and are readily implementable.

2.8.8.7 Cost

The estimated present-worth costs for each of the alternatives are as follows:

Alternative 1: $0
Alternative 2: $595,000
Alternative 3: $7,520,000

Alternative 3 is greater than one order of magnitude higher than Alternative 2. **Table 8** provides further information regarding cost.

2.8.8.8 State Agency Acceptance

The State of Missouri has expressed its support for the U.S. Army's selected alternative as described in Section 2.8.10 of this document (Selected Remedy).

2.8.8.9 Community Acceptance

Comments offered by the public were used to assess whether the proposed alternatives were acceptable to the community. The Army received four written comments during the public comment period. One of the written comments supported the Preferred Remedies, one did not support the Preferred Remedies, one was in the form of a question, and one was neutral towards the Preferred Remedies. Questions were posed to the Army regarding the proposed remedies for the IWOU during the public meeting held on 23 January 2007. Questions about the remedies posed during the public meeting appeared to be satisfactorily addressed during the meeting. During the meeting, Mr. Greg Perry read a written statement that he opposed the remedial actions that were presented for the IWOU. Mr. Leonard Heman and other members of the public seemed to be supportive of the remedial actions at the IWOU. The questions and concerns of the community are discussed in the Responsiveness Summary, which is **Appendix C** of this ROD.

2.8.9 Principal Threat Wastes

The NCP establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable (NCP §300.430[a][1][iii][A]). Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure.

There are no existing principal threat wastes at Area 3. Low-level threat wastes have been identified in surface and subsurface soil at Area 3. Containment strategies were selected to provide sustained isolation of contaminants and to limit direct contact over long periods.

2.8.10 Selected Remedy for Area 3

Based on the requirements of CERCLA, comparative analysis using the nine criteria, public comments, and in consultation with the USEPA and the state, the USEPA and Army have selected Alternative 2 - Placement of a Vegetative Cover and LUCs.

2.8.10.1 Summary of the Rationale for the Selected Remedy for Area 3

The Selected Remedy includes placement of a vegetative cover and implementation of LUCs. Placement of a vegetative cover and LUCs is the Selected Remedy because exposure of COCs to human and ecological receptors is mitigated, and the cost differential between this remedy and the other alternatives is significant, with the cost of the Selected Remedy being more than one order of magnitude lower than the cost of the other alternative. Alternative 3 includes complete removal of the material. Since the material is solid waste, it would be difficult and costly to remove. In addition, the subsurface material is not amenable to confirmation sampling. The Selected Remedy provides protection to human and ecological receptors by eliminating direct contact with the impacted soil through the installation and maintenance of a vegetative soil cover. The selected remedy can be conducted in a relatively short period of time, and will provide an immediate reduction in risk to human health receptors, and provides long-term effectiveness and implementability with minimal cost. The Selected Remedy does not reduce the toxicity, mobility, or volume of the contaminated media. The COCs in soil at Area 3 have been shown to be immobile, as no impacts to groundwater have been observed.

2.8.10.2 Description of the Selected Remedy for Area 3

The Selected Remedy for Area 3 includes placement of a vegetative soil cover over impacted soil. Under this remedy, contaminants will be left in place at the site, and it will be necessary to limit the potential for exposure and minimize any environmental impacts. The vegetative cover will act as a barrier between the soil of concern and the surrounding environment to limit the potential for direct exposure and minimize the associated risk. The vegetative cover will be made up of a minimum 18-inch-thick compacted protective layer and a 6-inch-thick topsoil layer. This will be sufficient cover to be protective of human health and ecological receptors. A vegetation layer will be installed to control erosion at the site. **Figure 16** shows the extent of remedial action.

This alternative will not pose significant impacts to human health or the environment during either the construction or operational period, with minimal disturbance of the overall operational activities of the surrounding LCAAP facilities. Minimal long-term maintenance will be required to prevent excess erosion of the cover or ponding. LUCs will also be implemented to restrict activities such as building, filling, grading, and excavating, ensuring the integrity of the protective cover.

The implementation of LUCs is a component of the Selected Remedy for Area 3. The LUCs for Area 3 will be designed to prohibit excavation, construction, and any other activities that would compromise the integrity of the vegetative cover and ensure that routine maintenance activities are performed to ensure the integrity of the vegetative cover. LUCs will remain in place until cleanup levels (unrestricted use) are met. The performance of the LUCs will be evaluated in regular monitoring reports.

2.8.10.3 Cost Effectiveness

The Selected Remedy is cost-effective and represents a reasonable value for the money to be spent. The following definition was used in making this determination: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (NCP §300.430[f][1][ii][D]). Overall effectiveness was compared to costs for alternatives to determine cost effectiveness. An alternative is determined to be cost effective if RAOs are achieved by all the alternatives; however, one alternative is significantly less expensive than the others, as in the case of Alternative 2. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence, this alternative represents a reasonable value for the money

to be spent. The estimated present-worth cost of the Selected Remedy is $573,500 and will satisfy CERCLA requirements.

2.8.10.4 Summary of the Estimated Remedy Costs for Area 3

The information in the cost estimate summary provided in **Table 15** is based on the best available information regarding the anticipated scope of the remedial alternative. Cost elements are likely to change as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD amendment. The cost provided in **Table 15** is an order-of-magnitude engineering cost estimate that is expected to be within 30 to 50 percent of the actual project cost.

2.8.10.5 Expected Outcomes of the Selected Remedy at Area 3

The purpose of the response action for this Area is to control risks posed by direct contact with impacted surface soil through engineering and LUCs only. Exposure will be controlled by providing a barrier to contaminated soil. Long-term LUCs (via LUCIP) and site inspections will be used to ensure that the vegetative cover remains an effective barrier to direct contact. LUCs will remain in place at IWOU as long as concentrations in soil do not meet UUUE.

- The current and future land use for LCAAP has been determined to be industrial, so the land use must remain consistent with this determination.

- The beneficial socio-economic and community revitalization impacts include the containment of identified contamination at this Area. Due to the nature of the operations at LCAAP and the long-term management that will be required in the IWOU, the remaining benefits are not applicable.

- Environmental and ecological benefits will occur by containment of impacted surficial soil and prevention of direct contact with ecological receptors.

2.8.10.6 Selected Remedy Performance Objectives and Performance Criteria for Area 3

Through installation and maintenance of a vegetative soil cover, the Selected Remedy achieves the following RAOs:

- Prevent exposure to PAHs in soil above the cleanup levels identified in Table 7.

- Prevent exposure of ecological receptors to soils containing COCs at levels that would result in adverse population-level impacts through elimination of direct contact via vegetative soil cover.

The performance objectives of the vegetative cover and LUCs for this Area are to prevent exposure to COCs at concentrations above cleanup levels and to prevent exposure of ecological receptors to COCs in soil. Additionally, long-term viability and integrity of the vegetative cover is a performance objective for Area 3. In addition to proper construction and maintenance of the cover, LUCs are provided for Area 3 to ensure maintenance of the integrity of the vegetative cover. Upon completion of the active remedy for Area 3, the Area will be available for industrial/commercial use. The performance evaluation criteria to determine that

these objectives have been achieved are to ensure that the vegetative cover meets appropriate specifications, to confirm that a 2-foot cover is maintained by performing regular visual inspections, and to ensure that the cover is sufficient by surveying the location and extent of the cover. The vegetative cover will be repaired if necessary. An additional performance evaluation criterion is to collect confirmation samples outside the limits of the vegetative cover to determine that no COCs remain in soil at concentrations above cleanup levels presented in **Table 7**. Confirmation sampling procedures will be detailed in the RD/RAWP. LUCs will be provided indefinitely or until UUUE is achieved.

2.8.11 Statutory Determinations

Section 121 of CERCLA and the NCP establish several statutory requirements and preferences. These specify that, when complete, the selected remedy must achieve adequate protection of human health and the environment and comply with ARARs unless a statutory waiver is justified. The selected remedy must also be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment (as a principal element) that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes, with a bias against off-site disposal of untreated wastes. The following sections describe how the Selected Remedy satisfies or does not satisfy the statutory requirements of CERCLA Section 121.

2.8.11.1 Protection of Human Health and the Environment

The Selected Remedy addresses health and environmental issues that were identified in the Area 3 Remedial Investigation and Risk Assessments in the media of soil. Specifically, the remedial actions:

- Prevent exposure of human receptors to COCs in soil at Area 3 by installing a vegetative cover and implementing LUCs.

- Prevent exposure of ecological receptors to soils containing COCs at Area 3 by installing a vegetative cover.

2.8.11.2 Compliance with ARARs

The Selected Remedy for Area 3 complies with location- and action-specific ARARs. There are no chemical-specific ARARs for soil.

2.8.11.3 Cost Effectiveness

The Selected Remedy is cost-effective and represents a reasonable value for the money to be spent. The following definition was used in making this determination: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (NCP §300.430[f][1][ii][D]). Overall effectiveness was compared to costs to determine cost effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence, this alternative represents a reasonable value for the money to be spent. The estimated present-worth cost of the Selected Remedy is $595,000 and will satisfy CERCLA requirements.

2.8.11.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Extent Possible

The Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at Area 3. Of those alternatives that are protective of human health and the environment and comply with ARARs, the Selected Remedy provides the best balance of trade-offs in terms of the five balancing criteria while also considering the statutory preference for treatment as a principal element and bias against off-site treatment and disposal and considering state and community acceptance.

2.8.11.5 Preference for Treatment as a Principal Element

The NCP establishes an expectation that USEPA will use treatment to address the principal threats posed by a site wherever practicable (NCP §300.430[a][1][iii][A]). No principal threat wastes have been identified at Area 3.

Groundwater data demonstrate that chemicals are not leaching at a rate sufficient to adversely impact groundwater. Because of the immobility and indicated non-hazardous nature of chemicals in surface and subsurface soil, they are considered a low-level threat waste.

Five-Year Review Requirements

Five-year reviews of the Selected Remedy will be performed because contaminants will remain in soil and groundwater at concentrations that do not allow for UUUE. These reviews will be conducted at least every 5 years after commencement of the remedial action, until concentrations of contaminants are reduced to levels that allow for UUUE, to ensure that the remedy continues to adequately protect human health and the environment.

2.8.12 Documentation of Significant Changes

All written and verbal comments submitted during the January 2007 public meeting and comment period were reviewed, and it was determined that no significant changes to the remedy, as outlined in the 2007 Proposed Plan, were necessary or appropriate.

2.9 Area 4 - Explosives Surface Impoundment

2.9.1 Site Characteristics

Area 4 occupies approximately 18 acres and is located in the south-central portion of the Installation on the southern end of the Fuse Line Area. A series of small lagoons was used for disposal of wastewater from the neutralization of lead styphnate slurry, lead azide, primer mix, and cyclonite (RDX). Two small lagoons also accepted chemical laboratory wastes. The wastewater lagoons were removed between 1985 and 1987 as part of a MDNR-approved RCRA closure. A post-closure plan included post-closure care and groundwater monitoring requirements.

The suspected sources of potential contamination are a series of small RCRA lagoons and building sumps. Figure 17 presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. The RI program for Area 4 has been conducted in two phases.

The Phase II Investigation was conducted by EA Engineering, Science and Technology and included a geophysical survey and the drilling of two borings. The Phase II Investigation also included installation of four deep/shallow well pairs near the former impoundments. One surface soil sample (04SS02) was collected during the Supplemental Field Investigation performed by Burns and McDonnell in 1999. Several activities were conducted as part of the 2004 RI performed by ARCADIS including collecting groundwater samples from monitoring wells near AOI 4A, conducting geophysical surveys and subsequent soil samples from AOIs 4B (East) and 4B (West), and collecting soil and groundwater samples as part of the inactive sumps investigation. Area 4 was part of the Inactive Sumps Removal Action that removed sumps and surface soil associated with explosives contamination in this Area.

2.9.2 Current and Potential Future Land and Water Uses

Area 4 is located within the active manufacturing area. The buildings in Area 4 are no longer used regularly for production and preparation of high explosives; however, the area is still active, and employees may occasionally utilize some of the buildings. People using this area would include LCAAP site employees accessing one of the buildings and employees responsible for maintaining the area or utilizing the adjacent areas. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Current land use of Area 4 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.9.3 Summary of Human Health Risk Assessment – Area 4

Potential risks and hazards to human health associated with site conditions at Area 4 are depicted in the CSEM presented on **Figure 18**. Under the existing conditions at Area 4, the total excess lifetime upper-bound risk estimates for current and future receptors are all lower than or within the USEPA target risk range (1×10^{-6} to 1×10^{-4}). The HIs for all receptors were less than 1, indicating that it is unlikely that adverse effects would occur under the conditions evaluated. USEPA (1991a) guidance on the *Role* of *Risk Assessment in Superfund Remedy Selection Decisions* states that, "where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts." These results indicate that, under the current site conditions at Area 4, constituents in soil, groundwater, surface water, and sediment do not pose an unacceptable risk to human health under the exposure scenarios evaluated in this HHRA.

The total potential risks from exposure to soil and groundwater are presented in detail (by pathway) in Appendix A. Because LCAAP is an operating industrial facility, and because the future land use is not expected to change, the HHRA evaluated industrial exposure pathways. Therefore this Area, as with all areas within LCAAP, will be restricted to industrial use only.

Results of the baseline risk assessment indicate that chemicals are not present in soil or groundwater at levels that pose an unacceptable human health risk. Therefore, there will be no further remedial action performed for soil or groundwater at this Area. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.10 Area 5 - Building 139 Impoundments

2.10.1 Site Characteristics

Area 5 occupies approximately 32 acres and is located in the central portion of the Installation, north of Area 4 and within the Fuse Line Area. Neutralized wastewater from the production of explosive compounds, as well as from solvent cleaning and disposal activities, was discharged into a lagoon. The lagoon operated intermittently until 1988. RCRA closure was performed in 1989 under an MDNR-approved closure plan. A post-closure plan included post-closure care and groundwater monitoring requirements.

The suspected sources of potential contamination are the RCRA lagoons and a disposal area. **Figure 19** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. There have been four previous investigations at Area 5. The Phase I RI at Area 5 was conducted by Roy F. Weston and included well installation and groundwater sampling. The Phase II Investigation of Area 5 was conducted by EA Engineering, Science and Technology/EA Waste Management and included a geophysical survey, a soil vapor survey, and soil boring installations. The USACE performed a SCAPS Investigation in Area 5. Finally, five subsurface soil borings were collected during the Supplemental Field Investigation. Several activities were conducted as part of the 2004 RI performed by ARCADIS which included collecting groundwater samples from monitoring wells near AOI 5A; conducting geophysical surveys and subsequent soil samples from AOI 5B; collecting direct-push groundwater samples and subsequently installing two additional monitoring wells at AOI 5B; and, as part of the area-wide investigation, collecting a surface water sample and several groundwater samples.

2.10.2 Current and Potential Future Land and Water Uses

Area 5 is located within the active manufacturing area. Area 5 buildings are no longer used on a regular basis for production and preparation of high explosives. However, the area is still maintained as an active area within the Installation, and employees may occasionally utilize some of the buildings. People using this area would include LCAAP site employees accessing one of the many buildings and employees responsible for maintaining the area or utilizing the adjacent areas. A fence currently surrounds the LCAAP, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Current land use of Area 5 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.10.3 Summary of Human Health Risk Assessment – Area 5

The Area 5 HHRA characterized potential risks in a manner consistent with the risk assessment principles and practices established by the USEPA Risk Assessment Guidance for Superfund (USEPA 1989). The HHRA is discussed further in the Final IWOU RI/FS (ARCADIS 2006) and is summarized in the following sections.

2.10.3.1 Identification of Chemicals of Concern

The observed concentrations of the human health risk drivers and the calculated and exposure concentrations are summarized in **Table 2**. The 95th Upper Confidence Limit of the mean was calculated and used as the exposure concentration following USEPA guidance. Tetrachloroethene (PCE), TCE, vinyl chloride, RDX, 2-nitrotoluene, and arsenic were identified as COCs in groundwater in Area 5.

2.10.3.2 Exposure Assessment

The assessment of exposure includes characterization of the physical environment, identification of exposure pathways (including migration pathways, exposure points, and exposure routes), and identification of potentially exposed individuals and populations. Due to the industrial nature of the LCAAP, particularly the IWOU, the exposure scenarios evaluated in the HHRA were limited to industrial exposure frequencies and durations. Based on the current and reasonably anticipated future land uses of Area 5, the following complete or potentially complete exposure pathways and receptors were identified:

- Current and future site workers may be exposed to volatile COPCs in groundwater migrating to indoor air via inhalation. Future site workers may also be exposed to COPCs in groundwater via ingestion of groundwater used as potable water and dermal contact while washing hands.

- Future construction/utility workers may be exposed to COPCs in combined surface and subsurface soil via incidental ingestion, dermal contact, and inhalation of dust during excavation activities. Future construction/utility workers may also be exposed to COPCs in groundwater via dermal contact and inhalation of VOCs.

Note that no sediments or surface water are present at Area 5; therefore, exposure pathways are not presented here. Additionally, the only COPC identified in surface soil was arsenic. Arsenic in surface soil was determined to be consistent with background levels; therefore, exposure to surface soil was not further evaluated.

Table 3 tabulates key exposure assumptions and intake parameters used in the evaluations. The migration pathways and receptors developed from the CSEM are shown on **Figure 21.**

2.10.3.3 Toxicity Assessment

The toxicity assessment results in the selection of appropriate toxicity values to use in estimating potential health risks associated with exposure. This is accomplished by reviewing the available information on the toxicity of the COCs and summarizing the factors pertinent to the exposures being assessed.

Chemical-specific CSFs and weight-of-evidence classifications were compiled for cancer endpoints. The weight-of-evidence classification describes the likelihood that a chemical is a human carcinogen based on the supporting evidence of carcinogenicity in human and animal studies (USEPA 1999b). Cancer toxicity values are summarized in **Table 4.**

Chemical-specific RfDs were compiled for non-cancer health effects. Chronic RfDs were used to assess long-term exposures ranging from 7 years to a lifetime. Subchronic RfDs were used to evaluate the potential for adverse health effects associated with exposure to constituents over a period of 2 weeks to 7 years. Subchronic RfDs were used to evaluate the short-term construction worker hazards. Non-cancer toxicity values are summarized in **Table 5.**

Primary organs/systems affected by COCs in Area 5 are the liver (PCE, TCE, and vinyl chloride) and the skin/vascular system (arsenic). The remaining COCs elicit cancer effects. The primary source for toxicity

values, such as CSFs and RfDs, is USEPA's IRIS. In addition, the following provisional or draft toxicity values were utilized in the HHRA:

- Provisional toxicity values for TCE were obtained from the National Center for Environmental Assessment (NCEA).

- CSFs for PCE were obtained from the California Environmental Protection Agency.

2.10.3.4 Risk Characterization

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time with a reference dose derived for a similar exposure period. The ratio of the exposure to toxicity is an HQ. An HQ lower than 1 indicates that a receptor's dose of a single contaminant is lower than the reference dose, and that toxic noncarcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all COCs that affect the same target organ or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI lower than 1 indicates that, based on the sum of all HQs from different COCs and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI higher than 1 indicates that site-related exposure may present a potential risk to human health.

Potential carcinogenic (cancer) risks are classified by the increased probability of a person getting cancer in his or her lifetime (i.e., excess lifetime cancer risks) from being exposed to known or suspected cancer-causing chemicals at the site. Excess lifetime cancer risks are determined by multiplying the exposure with the slope factor. These risks are probabilities that are generally expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that, as a plausible upper bound, an individual has a one in 1,000,000 of developing cancer over a 70-year lifetime as a result of site-related exposure to a carcinogen, under the specific exposure conditions at a site. The USEPA's generally acceptable carcinogenic risk range is between 1×10^{-4} and 1×10^{-6}. This means that there is an increased probability of one additional case in 10,000 to one case in 1,000,000 that an individual will develop cancer above the expected normal rate of 250,000 per 1,000,000 (or one in four).

Table 6 summarizes risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of exposure as well as the toxicity of the COCs. The total cancer risk for a future site worker exposed to groundwater used as a potable water supply at Area 5 is 5×10^{-4}, and the hazard index is 7. In addition, the total cancer risk for a future construction worker exposed to groundwater via dermal contact is 3×10^{-4}. Additionally, total risks for exposure to impacted soil and groundwater are presented in detail (by pathway) in **Appendix A**. These risk levels indicate that, if no cleanup action is taken, an individual would experience an unacceptable probability of adverse health effects as a result of site-related exposure to PCE, TCE, vinyl chloride, RDX, 2-nitrotoluene, and arsenic in groundwater used as a potable water supply in Area 5. Remedial action associated with COCs in groundwater is included in Section 2.35.

Results of the baseline risk assessment indicate that contaminants are not present in soil above human health or ecological risk levels, and there will be no remedial action performed for soil at this Area; however, PCE, TCE, vinyl chloride, RDX, 2-nitrotoluene, and arsenic are present in groundwater above screening levels as shown on Figure 20. Groundwater at Area 5 will be addressed as part of the IWOU-Wide Groundwater program.

Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.11 Area 6 - Building 65 Impoundment

2.11.1 Site Characteristics

Area 6 occupies approximately 32 acres and is located in the central portion of the Installation northeast of the Fuse Line Area. One lagoon is present in Area 6. It was used for disposal of wastewater from the load/assemble/pack activities for 20 millimeter ammunition. This lagoon was removed under an approved MDNR closure in 1990. A post-closure plan included post-closure care and groundwater monitoring requirements.

The suspected source of potential contamination is a RCRA lagoon. **Figure 22** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. Several monitoring wells have been installed and sampled at Area 6, along with the recent field activities that included the collection of three additional groundwater samples, as well as soil and groundwater sampling from the inactive sumps. One groundwater sample (06MW08) at Area 6 was collected as part of the Background Characterization Study conducted by ARCADIS in 2005.

AOI 6A was RCRA-closed in 1990, with the removal of liquids and sediments from the lagoon, and removal of the clay liner and contaminated soil. Fifty confirmatory samples were collected and analyzed for TKN and total strontium, and all soil results were interpreted to be below background.

Area 6 was part of the Inactive Sumps Removal Action, which included removal of the contents (including the percolation media) associated with three percolation sumps. No further action was required based on the results of the confirmation samples collected from beneath the sumps.

2.11.2 Current and Potential Future Land and Water Uses

Area 6 is located within the active manufacturing area. The buildings in Area 6 are not currently in use, and site workers are not expected to access this Area on a regular basis. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Current land use of Area 6 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.11.3 Summary of Human Health Risk Assessment – Area 6

Potential risks and hazards to human health associated with site conditions at Area 6 are depicted in the CSEM presented on Figure 23. Under the existing conditions at Area 6, the total excess lifetime upper-bound risk estimates for current and future receptors are all lower than or within the USEPA target risk range (1×10^{-6} to 1×10^{-4}). The HIs for all receptors were less than 1, indicating that it is unlikely that adverse effects would occur under the conditions evaluated. USEPA (1991a) guidance on the *Role* of *Risk Assessment in Superfund Remedy Selection Decisions* states that, "where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there

are adverse environmental impacts." These results indicate that, under the current site conditions at Area 6, constituents in soil, groundwater, surface water, and sediment do not pose an unacceptable risk to human health under the exposure scenarios evaluated in this HHRA.

The total potential risks from exposure to groundwater are presented in detail (by pathway) in Appendix A. Because LCAAP is an operating industrial facility, and because the future land use is not expected to change, the HHRA evaluated industrial exposure pathways. Therefore, this Area, as with all areas within LCAAP, will be restricted to industrial use only.

Results of the baseline risk assessment indicate that chemicals are not present in soil or groundwater at levels that pose an unacceptable human health risk. Therefore, there will be no further remedial action performed for soil or groundwater at this Area. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.12 Area 7 - Industrial Wastewater Lagoons Area

2.12.1 Site Characteristics

Area 7 occupies approximately 110 acres and is located in the center of the Installation to the north of Ditch A. Nine unlined lagoons were used as settling basins for "finished" wastewater from the IWTP. The northernmost set of three lagoons became inactive and was covered in 1952 but was never remediated. The two remaining sets of three lagoons were RCRA-closed in 1989. A post-closure plan included post-closure care and fulfillment of groundwater monitoring requirements. One set of closed lagoons was retrofitted with double liners and a leachate collection system that currently accepts IWTP sludge for dewatering.

The suspected sources of potential contamination are RCRA lagoons, building sumps, a solvent impoundment, fuel spill area, and burning grounds. **Figure 24** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. Remedial investigation activities have been conducted in Area 7 as part of four rounds of investigation since 1989. Most of the soil borings within Area 7 were advanced by EA in 1990 and 1992 as part of the Phase II Investigation. One soil boring was advanced and several sediment and surface water samples in drainage ditches were sampled by Weston as part of the Phase I Investigation in 1990, and a few soil borings were advanced by Burns & McDonnell as part of the Supplemental Field Investigation in 1998. A SCAPS Investigation was conducted by the USACE in 1999 and included 101 sample locations set up on a grid pattern across Area 7. The purpose of the SCAPS Investigation was to make in-situ determinations of the potential extent of VOCs and explosives in groundwater.

Several activities were conducted as part of the 2004 RI conducted by ARCADIS and are summarized as follows. In order to evaluate trends in explosives detections in Area 7, select monitoring wells were sampled for two semi-annual sampling events. Direct-push groundwater samples were also collected to monitor explosive concentrations in groundwater. Three groundwater wells were sampled at Area 7 as part of the Background Characterization Study (07MW14 through 07MW16). Trenching activities were conducted at AOI 7D to determine the horizontal extent of the disposal area, and a soil sample was collected to determine the geotechnical parameters of the soil cover if present at AOI 7D. Soil and groundwater samples were collected as part of the inactive sumps investigation. Area 7 was part of the Inactive Sumps Removal Action, which included removal of sumps and surface soil associated with VOC, explosive, and metal contamination in this

Area. One inactive sump within Area 7 scheduled for removal is located next to production buildings or areas and cannot be removed at this time without the potential for plant disturbance to plant infrastructure and significant disturbance of plant production. This sump requires future work and will be addressed as it becomes available through maintenance or construction activities, or at installation closure or transfer.

2.12.2 Current and Potential Future Land and Water Uses

Area 7 is located in the active manufacturing area. The buildings in Area 7 consist of the active IWTP and explosive waste incineration processes. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. In addition, Area 7 is located within the inner fence which surrounds the currently active manufacturing area, making it difficult for unauthorized visitors or trespassers to access.

Current land use of Area 7 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.12.3 Summary of Human Health Risk Assessment – Area 7

The Area 7 HHRA characterized potential risks in a manner consistent with the risk assessment principles and practices established by the USEPA Risk Assessment Guidance for Superfund (USEPA 1989). The HHRA is discussed further in the Final IWOU RI/FS (ARCADIS 2006) and is summarized in the following sections.

2.12.3.1 Identification of Chemicals of Concern

The observed concentrations of the human health risk drivers and the calculated and exposure concentrations are summarized in **Table 2.** The 95th Upper Confidence Limit of the mean was calculated and used as the exposure concentration following USEPA guidance. Vinyl chloride, RDX, and arsenic were identified as COCs in groundwater in Area 7.

2.12.3.2 Exposure Assessment

The assessment of exposure includes characterization of the physical environment, identification of exposure pathways (including migration pathways, exposure points, and exposure routes), and identification of potentially exposed individuals and populations. Due to the industrial nature of the LCAAP, particularly the IWOU, the exposure scenarios evaluated in the HHRA were limited to industrial exposure frequencies and durations. Based on the current and reasonably anticipated future land uses of Area 7, the following complete or potentially complete exposure pathways and receptors were identified:

- Current and future site workers may be exposed to COPCs in surface soil via incidental ingestion and inhalation of wind-blown fugitive dust. Current and future site workers may also be exposed via inhalation to volatile COPCs in groundwater and soil migrating to indoor air. In addition, future site workers may also be exposed to COPCs in groundwater via ingestion of groundwater used as potable water and dermal contact while washing hands.

- Future construction/utility workers may be exposed to COPCs in combined surface and subsurface soil via incidental ingestion, dermal contact, and inhalation of VOCs and dust during excavation activities. Future

construction/utility workers may also be exposed to COPCs in groundwater via dermal contact and inhalation of VOCs.

- Current and future maintenance workers may be exposed to COPCs in surface soil via incidental ingestion, dermal contact, and inhalation of wind-blown fugitive dust and VOCs in subsurface soil.

- Current and future adult and youth visitors/trespassers may be exposed to COPCs in surface soil via incidental ingestion and dermal contact.

Note that no sediments or surface water are present at Area 7; therefore, exposure pathways are not presented here.

Table 3 tabulates key exposure assumptions and intake parameters used in the evaluations. The migration pathways and receptors developed from the CSEM are shown on Figure 26.

2.12.3.3 Toxicity Assessment

The toxicity assessment results in the selection of appropriate toxicity values to use in estimating potential health risks associated with exposure. This is accomplished by reviewing the available information on the toxicity of the COCs and summarizing the factors pertinent to the exposures being assessed.

Chemical-specific CSFs and weight-of-evidence classifications were compiled for cancer endpoints. The weight-of-evidence classification describes the likelihood that a chemical is a human carcinogen based on the supporting evidence of carcinogenicity in human and animal studies (USEPA 1999b). Cancer toxicity values are summarized in Table 4.

Chemical-specific RfDs were compiled for non-cancer health effects. Chronic RfDs were used to assess long-term exposures ranging from 7 years to a lifetime. Subchronic RfDs were used to evaluate the potential for adverse health effects associated with exposure to constituents over a period of 2 weeks to 7 years. Subchronic RfDs were used to evaluate short-term construction worker hazards. Non-cancer toxicity values are summarized in Table 5.

Primary organs/systems affected by COCs at Area 7 are the liver (vinyl chloride) and skin/vascular system (arsenic). These COCs also elicit cancer effects. The primary source for toxicity values, such as CSFs and RfDs, is USEPA's IRIS.

2.12.3.4 Risk Characterization

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time with a reference dose derived for a similar exposure period. The ratio of the exposure to toxicity is an HQ. An HQ lower than 1 indicates that a receptor's dose of a single contaminant is lower than the reference dose and that toxic noncarcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all COCs that affect the same target organ or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI lower than 1 indicates that, based on the sum of all HQs from different COCs and exposure routes, toxic noncarcinogenic effects from all

contaminants are unlikely. An HI higher than 1 indicates that site-related exposure may present a potential risk to human health.

Potential carcinogenic (cancer) risks are classified by the increased probability of a person getting cancer in his or her lifetime (i.e., excess lifetime cancer risks) from being exposed to known or suspected cancer-causing chemicals at the site. Excess lifetime cancer risks are determined by multiplying the exposure with the slope factor. These risks are probabilities that are generally expressed in scientific notation (e.g., 1 x 10^{-6}). An excess lifetime cancer risk of $1x10^{-6}$ indicates that, as a plausible upper bound, an individual has a one in 1,000,000 chance of developing cancer over a 70-year lifetime as a result of site-related exposure to a carcinogen under the specific exposure conditions at a site. USEPA's generally acceptable carcinogenic risk range is between 1 x 10^{-4} and 1 x 10^{-6}. This means that there is an increased probability of one additional case in 10,000 to one case in 1,000,000 that an individual will develop cancer above the expected normal rate of 250,000 per 1,000,000 (or one in four).

Table 6 summarizes risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of exposure as well as the toxicity of the COCs. The total cancer risk for a future site worker exposure to groundwater used as a potable water supply from exposure to impacted soil and groundwater at Area 7 is 3 x 10^{-4}. Additionally, total risk from exposure to impacted soil and groundwater are presented in detail (by pathway) in **Appendix A.** These risk levels indicate that, if no cleanup action is taken, an individual would have an unacceptable risk as a result of site-related exposure to vinyl chloride, RDX, and arsenic as COCs in groundwater in Area 7. Remedial action associated with vinyl chloride, RDX, and arsenic in groundwater is included in Section 2.35.

Results of the baseline Risk Assessment indicate that contaminants are not present in soil above human health or ecological risk levels, and there will be no further remedial action performed for soil at this Area; however, vinyl chloride, RDX, and arsenic are present in groundwater above screening levels as shown on Figure 25. Groundwater at Area 7 will be addressed as part of the IWOU-Wide Groundwater program. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

RDX was detected above the Industrial PRG in two shallow soil samples collected from the drainage ditch just north of AOI 7A (West). RDX detected in the drainage ditch was investigated as part of the Area 34 RI/FS. Results of sampling indicate that this COC is not present in soil above human health or ecological risk levels based on the results of the risk assessment; however, RDX has been detected in groundwater downgradient of the ditch and appears to be leaching to groundwater. A remedial action (excavation and off-site disposal) will include the sediment and surface soil in the unnamed drainage ditch with the RDX-impacted soil and sediment that is a potential threat to groundwater. The remedial action extent for the east/west trending unnamed ditch in Area 7 is further discussed in Section 2.33 of this ROD as part of Area 34.

2.13 Area 8 - Solid Waste Landfill

2.13.1 Site Characteristics

Area 8 occupies approximately 45 acres in the southwest corner of the Installation. Four earth pits, two of which contained engineered clay liners, were used to dispose of sludge from the IWTP Basins (Area 7). Five

earth pits north and west of the IWTP disposal area were used to dispose of IWTP-related material. Eight trenches in AOI 8E were closed under an MDNR-approved RCRA closure plan in 1988. A post-closure plan included post-closure care and groundwater monitoring requirements.

AOI 8F was originally regulated under the MDNR Solid Waste Program, but deferred to the Hazardous Waste Program when it was discovered that RCRA-listed hazardous waste was disposed of in the pits. AOI 8F will be RCRA-closed in the future; therefore, it is not addressed in this ROD.

The suspected sources of potential contamination are the IWTP disposal areas. Figure 27 presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. A Phase I Investigation conducted by Roy F. Weston, Inc. included performing geophysical surveys to delineate the extent of sludge disposal and the drilling and sampling of soil borings at AOI 8C and AOI 8D. A Phase II Investigation was conducted by EA Engineering, Science, and Technology and consisted of the drilling and sampling of several soil borings and the collection of surface soil samples at AOIs 8A, 8B, 8C, and 8D. Trenching activities were conducted at the IWTP disposal areas to determine the horizontal extent of the potential disposal area. Soil borings were advanced to collect geotechnical parameters of the soil cover, if present, and groundwater samples were collected to determine if potential leaching to groundwater was occurring at the disposal areas.

2.13.2 Current and Potential Future Land and Water Uses

Area 8 is located in the southwest corner of the Installation on the boundary of the active manufacturing area and the uplands. Area 8 is currently unused, and no inhabitable buildings are present. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Current land use of Area 8 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.13.3 Summary of Human Health Risk Assessment - Area 8

Potential risks and hazards to human health associated with site conditions at Area 8 are depicted in the CSEM presented on **Figure 28**. Under the existing conditions at Area 8, the total excess lifetime upper-bound risk estimates for current and future receptors are all lower than or within the USEPA target risk range (1×10^{-6} to 1×10^{-4}). The HIs for all receptors were lower than 1, indicating that it is unlikely that adverse effects would occur under the conditions evaluated. USEPA (1991a) guidance on the *Role* of *Risk Assessment in Superfund Remedy Selection Decisions* states that, "where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} and the noncarcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts." These results indicate that, under the current site conditions at Area 8, constituents in soil, groundwater, surface water, and sediment do not pose an unacceptable risk to human health under the exposure scenarios evaluated in this HHRA.

The total potential risks from exposure to soil, groundwater, surface water, and sediment are presented in detail (by pathway) in Appendix A. Because LCAAP is an operating industrial facility, and because the future land use is not expected to change, the HHRA evaluated industrial exposure pathways. Therefore, this Area, as with all areas within LCAAP, will be restricted to industrial use only.

Results of the baseline risk assessment indicate that chemicals are not present in soil or groundwater at levels that pose an unacceptable human health risk. Therefore, there will be no further remedial action performed for soil or groundwater at this Area. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.13.4 Summary of Ecological Risk Assessment – Area 8

In addition to an assessment of human risk, USEPA also requires that the baseline risk be evaluated for ecological receptors, such as animals, that live in and around the contaminated areas. An ERA was conducted in accordance with the Final Risk Assessment Work Plan for LCAAP (ARCADIS 2004a) to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents. An ERA was performed for Areas that are not located in the manufacturing area of the plant, including Area 8. No COCs were identified in the ERA for Area 8. Results of the baseline risk assessment indicate that contaminants are not present in soil or groundwater at levels that pose an unacceptable human health or ecological risk. Therefore, there will be no further remedial action performed for soil or groundwater at this Area. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.14 Area 9 - Building 60 Treatment Facility

2.14.1 Site Characteristics

Area 9 occupies approximately 54 acres and is located in the northeast portion of the Installation directly south of Area 18. Previous activities at Area 9 included charging and loading of small-caliber ammunition, case and bullet manufacture, tracer charging, and metal plating. Building 60 was associated with the treatment of cyanide and mercurous nitrate wastes. This Area contains five in-ground tanks for treatment of mercurous nitrate generated from crack testing of small arms cartridges. The tanks in the Mercurous Nitrate Storage Area near Building 60 will be closed in accordance with RCRA guidance as part of the CERCLA process and this ROD. This Area also contains a sludge-drying bed for zinc cyanide sludge generated from chromium plating of steel cartridge cases.

The suspected sources of potential contamination are the mercurous nitrate tanks, building sumps, and sludge drying beds. **Figure 29** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. There have been five previous investigations at Area 9. General Testing Laboratories advanced six soil borings (09A through 09F) east of AOI 9A in 1985. Surface soil samples were collected by Langston Laboratories as part of two sampling events in 1986 and 1987 (09-01B through 09-09B; 09-27B through 09-32B; 09-10/10B through 09-26/26B). In 1988, a Phase I Investigation was conducted by Roy F. Weston to determine possible impacts to the ditch sediments and subsurface soil from activities associated with the flooding of the mercurous nitrate tanks and zinc cyanide drying beds. During the 1990 Phase II Investigation, an extensive soil-boring program was carried out in Area 9. Soil and groundwater samples were collected at Area 9 as part of the 2004 RI conducted by ARCADIS.

2.14.2 Current and Potential Future Land and Water Uses

Area 9 is located within the active manufacturing area. The buildings in Area 9 are no longer active, and they are not used on a daily basis by Installation employees. A fence currently surrounds the facility, and the

perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. In addition, Area 9 is located within the inner fence, which surrounds the currently active manufacturing area, making it difficult for unauthorized visitors or trespassers to access this site.

2.14.3 Summary of Human Health Risk Assessment – Area 9

The Area 9 HHRA characterized potential risks in a manner consistent with the risk assessment principles and practices established by the USEPA Risk Assessment Guidance for Superfund (USEPA 1989). The HHRA is discussed further in the Final IWOU RI/FS (ARCADIS 2006) and is summarized in the following sections.

2.14.3.1 Identification of Chemicals of Concern

The observed concentrations of the human health risk drivers, and the calculated and exposure concentrations are summarized in **Table 2**. The 95th Upper Confidence Limit of the mean was calculated and used as the exposure concentration following USEPA guidance. TCE and lead were identified as COCs in soil in Area 9.

2.14.3.2 Exposure Assessment

The assessment of exposure includes characterization of the physical environment, identification of exposure pathways (including migration pathways, exposure points, and exposure routes), and identification of potentially exposed individuals and populations. Due to the industrial nature of the LCAAP, particularly the IWOU, the exposure scenarios evaluated in the HHRA were limited to industrial exposure frequencies and durations. Based on the current and reasonably anticipated future land uses of Area 9, the following complete or potentially complete exposure pathways and receptors were identified:

- Future site workers may be exposed to COPCs in surface soils via incidental ingestion, inhalation of wind-blown fugitive dust, and inhalation of VOCs in indoor air migrating from subsurface soil. Future site workers may also be exposed to COPCs in groundwater via ingestion of groundwater used as potable water, dermal contact while washing hands, and inhalation of volatile COPCs migrating to indoor air.

- Future construction/utility workers may be exposed to COPCs in combined surface and subsurface soil via incidental ingestion, dermal contact, and inhalation of VOCs and dust during excavation activities. Future construction/utility workers may also be exposed to COPCs in groundwater via dermal contact and inhalation of VOCs.

- Current and future maintenance workers may be exposed to COPCs in surface soil via incidental ingestion, dermal contact, and inhalation of wind-blown fugitive dust.

- Current and future adult and youth visitors/trespassers may be exposed to COPCs in surface soil via incidental ingestion and dermal contact.

Note that no sediments or surface water are present at Area 9; therefore, exposure pathways are not presented here.

Table 3 tabulates key exposure assumptions and intake parameters used in the evaluations. The migration pathways and receptors developed from the CSEM are shown on **Figure 31**.

2.14.3.3 Toxicity Assessment

The toxicity assessment results in the selection of appropriate toxicity values to use in estimating potential health risks associated with exposure. This is accomplished by reviewing the available information on the toxicity of the COCs and summarizing the factors pertinent to the exposures being assessed.

Chemical-specific CSFs and weight-of-evidence classifications were compiled for cancer endpoints. The weight-of-evidence classification describes the likelihood that a chemical is a human carcinogen based on the supporting evidence of carcinogenicity in human and animal studies (USEPA 1999b). Cancer toxicity values are summarized in **Table 4.**

Chemical-specific RfDs were compiled for non-cancer health effects. Chronic RfDs were used to assess long-term exposures ranging from 7 years to a lifetime. Subchronic RfDs were used to evaluate the potential for adverse health effects associated with exposure to constituents over a period of 2 weeks to 7 years. Subchronic RfDs were used to evaluate the short-term construction worker hazards. Non-cancer toxicity values are summarized in **Table 5.**

The primary organ/system affected by noncarcinogenic chemical COCs is the liver (TCE). TCE also elicits cancer effects. The primary source for toxicity values, such as CSFs and RfDs, is USEPA's IRIS. In addition, provisional toxicity values were obtained for TCE from the NCEA.

Neither a CSF nor an RfD has been developed for lead. Instead, potential risks associated with exposure to lead in surface and subsurface soil were evaluated using the USEPA ALM to predict quasi-steady-state blood-lead concentrations for each receptor. The predicted blood-lead levels were then compared to the USEPA (1994) benchmark of 5 percent probability of exceeding 10 ug/dL blood-lead level.

2.14.3.4 Risk Characterization

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time with an RfD derived for a similar exposure period. The ratio of the exposure to toxicity is an HQ. An HQ lower than 1 indicates that a receptor's dose of a single contaminant is less than the reference dose, and that toxic noncarcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all COCs that affect the same target organ or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI lower than 1 indicates that, based on the sum of all HQs from different COCs and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI higher than1 indicates that site-related exposure may present a potential risk to human health.

Potential carcinogenic (cancer) risks are classified by the increased probability of a person getting cancer in his or her lifetime (i.e., excess lifetime cancer risks) from being exposed to known or suspected cancer-causing chemicals at the site. Excess lifetime cancer risks are determined by multiplying the exposure with the slope factor. These risks are probabilities that are generally expressed in scientific notation (e.g., 1 x 10^{-6}). An excess lifetime cancer risk of 1x10^{-6} indicates that, as a plausible upper bound, an individual has a one in 1,000,000 chance of developing cancer over a 70-year lifetime as a result of site-related exposure to a carcinogen, under the specific exposure conditions at a site. USEPA's generally acceptable carcinogenic risk range is between 1 x 10^{-4} and 1 x 10^{-6}. This means that there is an increased probability of one additional case in 10,000 to one case

in 1,000,000 that an individual will develop cancer above the expected normal rate of 250,000 per 1,000,000 (or one in four).

Table 6 summarizes risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of exposure as well as the toxicity of the COCs. The total cancer risk for a future construction worker exposure to TCE-impacted soil at Area 9 is 2×10^{-4}. In addition, the ALM predicts a 7 percent probability (site worker) and an 8 percent probability (construction worker) that exposure to lead in soil would result in a blood-lead level higher than the benchmark. Additionally, total risks from exposure to impacted soil and groundwater are presented in detail (by pathway) in **Appendix A**. These risk levels indicate that, if no cleanup action is taken, an individual would have a potentially unacceptable cancer risk as a result of site-related exposure to TCE and a greater than 5 percent probability of elevated blood lead concentrations (i.e., above 10 ug/dL) as a result of site-related exposure to lead in soil in Area 9.

2.14.4 Area 9 Remedial Action Objectives

The RAOs are site-specific cleanup objectives established for protecting human health and the environment. The RAOs are intended to be specific to the affected media, but sufficiently broad so as not to unreasonably restrict the potential remedial technology available. The RAOs developed for the IWOU include the COCs, media of concern, and potential exposure pathways identified during the risk assessment. Because of the industrial nature of the LCAAP, the exposure scenarios evaluated in the HHRA were primarily limited to industrial exposure frequencies and durations. Because of the use restriction imposed by the industrial exposure scenarios, LUCs will be a required component of the Selected Remedies at the IWOU to be protective of sensitive populations and the higher exposure frequencies and durations that would be associated with a UUUE scenario. Therefore, use restrictions would be implemented by the Army at the IWOU to limit future use of the site to industrial only. The RAOs for Area 9 are to:

- Prevent contaminant migration to groundwater from soil above the cleanup levels identified in Table 7.
- Prevent exposure to lead in soil exceeding an average concentration of 1,197 mg/kg to achieve a predicted blood level lower than 10 ug/dL with a 95 percent probability.
- Prevent exposure to TCE in soil above the cleanup levels identified in **Table 7.**

The rationale for the first RAO is to prevent migration of lead and TCE above cleanup levels from the soil to surrounding groundwater that could cause exceedances of drinking water standards (i.e., via leaching). The rationale for the second and third RAOs is to protect receptors from contaminated media at unacceptable potential risk levels. Achieving these RAOs will eliminate the potential risk by removing impacted soil above cleanup levels, thus eliminating exposure to contaminated soil.

2.14.5 Description of Area 9 Alternatives

The COCs at Area 9 are TCE and lead based on the results of the risk assessment. Area 9 was part of the Inactive Sumps Removal Action, which included removal of sumps and surface soil associated with VOC and SVOC contamination in this Area. TCE is still present in soil from 0 to 3 feet bgs above the human health risk levels and may pose an unacceptable risk to current and future site workers who might be exposed to TCE in

soil via volatilization of the chemical through the subsurface and inhalation of indoor air. In addition, lead (present from 0 to 1 foot bgs) and TCE concentrations in soil may pose an unacceptable risk to future site workers and construction/utility workers who might be exposed to the chemicals in combined surface and subsurface soil. Concentrations of TCE and lead in soil are presented on Figure 30. Remedial action is necessary to prevent exposure to contaminated soils. TCE and lead are not present in groundwater above human health risk levels; therefore, there will be no remedial action performed for groundwater at this Area. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

The remedial alternatives for each Area in the IWOU are presented in Table 8, along with their estimated present-worth life-cycle costs. A narrative description of these remedial alternatives is given in the following section.

Due to the limited extent of waste material at Area 9 and the limited applicability of appropriate technologies for the treatment of isolated contaminated soil locations, alternatives of no action and excavation and off-site disposal were the only remedial alternatives considered for Area 9; as such, the technology screening process for the general response actions was not conducted. Excavation and off-site disposal was the only active remedy considered because it is the most conservative and practical approach to removal of contaminants in soil at isolated locations.

Alternative 1: No Further Remedial Action

Estimated Capital Cost: $0
Estimated Annual O&M Cost: $0
Estimated Present Value: $0

The NCP and USEPA's guidance for conducting RI/FS investigations requires that the "No Action" option be developed and examined as a potential remedial action for all sites. The "No Action" option is retained and examined as a baseline with which other remedial actions are compared. The "No Action" alternative does not address the baseline conditions associated with unacceptable risk to potential future site worker and construction/utility worker exposures and does not achieve the RAOs established at the IWOU.

Alternative 2: Excavation and Off-site Disposal

Estimated Capital Cost: $44,800
Estimated Annual Operations and Maintenance (O&M) Cost: $0
Estimated Present Value: $44,800

The risk assessment results for Area 9 indicate that TCE is present in soil at unacceptable risks at one location, and that elevated lead is present in soil at two sample locations. The aerial extent of surface and subsurface soil identified as having TCE concentrations in exceedance of cleanup levels is approximately 400 square feet **(Figure 32)**, and the aerial extent of surface soil identified as having lead concentrations in exceedance of cleanup levels is approximately 400 square feet **(Figure 32).** The lead is present generally in the upper 1 foot of soil, and the TCE is present generally in the upper 5 feet of soil.

Excavation and off-site disposal of the waste materials and impacted soil is proposed as Alternative 2. Under this alternative, the waste materials will be excavated and disposed of at an appropriate off-site facility. Confirmation samples will be collected from the bases and perimeters of the hotspot excavations to verify the removal of contaminated material and to verify that the residual risk associated with these hotspots has been eliminated.

LUCs will be implemented as described in Section 2.7.5. LUCs will be selected as part of this ROD and implemented in accordance with the LUCIP. The Army will enforce these LUCs and maintain the integrity of the remedial technologies at Area 9. LUCs must be enforced to maintain industrial land use.

2.14.6 Principal Threat Wastes

The NCP establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable (NCP §300.430[a][1][iii][A]). Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure.

There are no existing principal threat wastes at Area 9. Low-level threat wastes (i.e., non-mobile, non-toxic lead) have been identified in surface and subsurface soil at Area 9. Removal strategies were selected to provide complete removal of contaminants.

2.14.7 Selected Remedy for Area 9

Based on the requirements of CERCLA, comparative analysis using the nine criteria, public comments, and in consultation with the USEPA and the state, the USEPA and Army have selected the following remedy for Area 9. For all of the Selected Remedies, the LUCs will be imposed to ensure that the site remains industrial use only. The Selected Remedy for Area 9 is Alternative 2 - Soil Excavation and Off-Site Disposal.

2.14.7.1 Summary of the Rationale for the Selected Remedy for Area 9

The Selected Remedy for Area 9 is excavation and off-site disposal because it:

- Eliminates the unacceptable risk associated with the TCE and lead by removing the soil and thus the potential for contact with the TCE and lead in soil and

- Is protective of human health and the environment by ensuring that potentially unacceptable risks are eliminated in the future and provides a permanent reduction in risk by removing TCE and lead in soil and sediment from three locations.

Alternative 1 (No Action) does not meet ARARs. Excavation and off-site disposal, which is the only other alternative that was evaluated, is conservatively protective of human health and the environment and is cost-effective. This remedial action also satisfies the RAOs within a reasonable timeframe. There are no chemical-

specific ARARs for soil, so CERCLA requirements are satisfied by the Selected Remedy. Excavation and off-site disposal is cost-effective, implementable, permanent, and effective.

2.14.7.2 Description of the Selected Remedy for Area 9

The Selected Remedy includes removal and off-site disposal of approximately 75 CY of impacted soil, the waste materials will be excavated and disposed of at an appropriate off-site facility. LUCs will be imposed to ensure that the site remains industrial use only. Figure 32 shows the extent of remedial action.

Confirmation samples will be collected from the bases and perimeters of the hotspot excavations to verify the removal of contaminated material and to verify that the residual risk associated with these hotspots has been eliminated.

The RCRA closure of the mercurous nitrate treatment tanks within Area 9 will be completed during implementation of the Selected Remedy in accordance with the approved Closure Plan. The RCRA closure activities within Area 9 will be documented within the Remedial Action Report (i.e., investigation data, any remediation work, and groundwater monitoring).

2.14.7.3 Summary of the Estimated Remedy Costs for Area 9

The information in the cost estimate summary provided in **Table 16** is based on the best available information regarding the anticipated scope of the Selected Remedy. Cost elements are likely to change as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD amendment. The cost provided in **Table 16** is an order-of-magnitude engineering cost estimate that is expected to be within 30 to 50 percent of the actual project cost.

2.14.7.4 Expected Outcomes of the Selected Remedy at Area 9

The purpose of the response action for Area 9 is to remove impacted soil with concentrations of lead and TCE that are higher than cleanup levels (**Table 7**). Exposure for these areas is controlled through off-site disposal of residuals. No concentrations of COCs higher than cleanup levels will remain on-site.

- The current and future land use for LCAAP has been determined to be industrial, so the land use must remain consistent with this determination. There are no additional restrictions on land use following the remedial response action.

- The cleanup levels for soil at IWOU are provided in **Table 7**. These cleanup levels were determined based on an evaluation of ARARs and risk-based cleanup levels. LUCs will remain in place at the IWOU as long as concentrations in soil and groundwater do not meet UUUE. It is estimated that the cleanup levels will be achieved within approximately 1 year. No residual risk will remain following the remedial response action as long as the land use remains industrial.

- The beneficial socio-economic and community revitalization impacts include elimination of identified contamination at this particular Area. Due to the nature of the operations at LCAAP and the long-term management that will be required in the IWOU, the remaining benefits are not applicable.

- Environmental and ecological benefits will occur as a result of removing impacted surface soil in this Area.

2.14.7.5 Selected Remedy Performance Objectives and Performance Criteria for Area 9

The selected remedy provides protectiveness by applying immediate mass removal through soil excavation of lead-impacted surface soil and TCE-impacted surface and subsurface soil. Through excavation of impacted soil, the Selected Remedy achieves the following RAOs:

- Prevent contaminant migration to groundwater from soil above the cleanup levels identified in **Table 7.**

- Prevent exposure to lead in soil exceeding an average concentration of 1,197 mg/kg to achieve a predicted blood level lower than 10 ug/dL with a 95 percent probability.

- Prevent exposure to TCE in soil above the cleanup levels identified in **Table 7.**

The performance objectives of the excavation and off-site disposal for this Area are to prevent exposure to COCs above cleanup levels, prevent contaminant migration to groundwater from soil above cleanup levels, and to achieve cleanup levels as verified through confirmation sampling. Upon completion of the Selected Remedy for Area 9, the Area will be available for industrial/commercial use. The performance evaluation criterion to determine that these objectives have been achieved is to collect confirmation samples within the excavation area to determine that no COCs remain in soil above cleanup levels presented in **Table 7.** Confirmation sampling procedures will be detailed in the RD/RAWP. LUCs will be provided indefinitely or until UUUE is achieved.

2.14.8 Statutory Determinations

Section 121 of CERCLA and the NCP establish several statutory requirements and preferences. These specify that, when complete, the selected remedy must achieve adequate protection of human health and the environment and comply with ARARs unless a statutory waiver is justified. The selected remedy must also be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment (as a principal element) that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes, with a bias against off-site disposal of untreated wastes. The following sections describe how the Selected Remedy satisfies or does not satisfy the statutory requirements of CERCLA Section 121.

2.14.8.1 Protection of Human Health and the Environment

The Selected Remedy addresses health and environmental issues that were identified in the Area 9 Remedial Investigation and Risk Assessments in the media of soil. Specifically, the remedial actions:

- Prevent exposure to COCs in soil at Area 9 exceeding the cleanup levels by excavating.

- Prevent contaminant migration of COCs to groundwater from soil at Area 9 by excavating.

The selected soil remedies will achieve RAOs for soil and reduce and maintain cumulative risk within the 10^{-4} to 10^{-6} risk range, and result in a blood-lead level lower than 10 ug/dL with a 95 percent probability.

2.14.8.2 Compliance with ARARs

There are no chemical-specific ARARs for soil. This alternative complies with the action-specific and location-specific ARARs for this alternative (action-specific ARARs in **Table B-5** and location-specific ARARs in **B-6**). The key ARARs for Alternative 2 include 261 A, B, C, and D, which ensure proper handling and disposal of excavated material.

2.14.8.3 Cost-Effectiveness

The Selected Remedy is cost-effective and represents a reasonable value for the money to be spent. The following definition was used in making this determination: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (NCP §300.430[f][1][ii][D]). Overall effectiveness was compared to costs to determine cost effectiveness. Because of the limited amount of waste and limited applicability of appropriate technologies, only two alternatives were evaluated for this Area (No Action and Excavation and Off-Site Disposal). The "No Action" alternative does not address the baseline conditions associated with unacceptable risk to potential future site worker and construction/utility worker exposures and does not achieve the RAOs. Therefore, only excavation and off-site removal is effective. The estimated present-worth cost of the Selected Remedy is $44,800 and it will satisfy CERCLA requirements.

2.14.8.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Extent Possible

The Selected Remedy meets the statutory requirement to utilize permanent solutions and treatment technologies to the maximum extent practicable at Area 9 because focused excavation will permanently remove contaminated soil at Area 9.

2.14.8.5 Preference for Treatment as a Principal Element

The NCP establishes an expectation that USEPA will use treatment to address the principal threats posed by a site wherever practicable (NCP §300.430[a][1][iii][A]). No principal threat wastes have been identified at Area 9.

Groundwater data demonstrate that TCE and lead are not leaching at a rate sufficient to adversely impact groundwater; therefore, they are considered low-level threat wastes.

Five-Year Review Requirements

Five-year reviews of the Selected Remedy will be performed because contaminants will remain in soil and groundwater at concentrations that do not allow for UUUE. These reviews will be conducted at least every 5 years after commencement of the remedial action until concentrations of contaminants are reduced to levels that allow for UUUE to ensure that the remedy continues to adequately protect human health and the environment.

2.14.9 Documentation of Significant Changes

All written and verbal comments submitted during the January 2007 public meeting and comment period were reviewed, and it was determined that no significant changes to the remedy, as outlined in the 2007 Proposed Plan, were necessary or appropriate.

2.15 Area 12 - Laboratory Waste Lagoon

2.15.1 Site Characteristics

Area 12 occupies approximately 35 acres and is located in the western portion of the Manufacturing Area along the western boundary of the Installation. The Area includes two lagoons used to dispose of liquid wastes from LCAAP's chemical and metallurgical laboratories located in Building 6.

The suspected sources of potential contamination are two lagoons and the solvent drum storage area. **Figure 33** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. Previous investigations in Area 12 have been conducted as part of five separate programs since 1987. Four shallow groundwater monitoring wells were installed in Area 12 during the PA/SI by EA Engineering, Science, and Technology. The Phase I work at Area 12 by Roy F. Weston included the installation of two monitoring wells, collection of surface water and sediment samples, and completion of a soil gas survey. The location of this soil gas survey is unknown and, therefore, the results were not used during the historical data review and proposed sampling evaluation process performed and included in this RI/FS report. The Phase II Investigation was conducted by EA Engineering, Science, and Technology and included the installation of two monitoring wells (one intermediate and one deep), drilling and sampling of four soil borings, and completion of an SVCA survey. A SCAPS Investigation was conducted by the USACE in Area 12 and included 51 groundwater sampling points. Burns and McDonnell conducted the Supplemental Investigation at Area 12 in an effort to determine if a source of TCE contamination in groundwater could be identified. Nine soil borings were drilled to a depth of 10 feet around Buildings 10, 2, and 206A as part of this program. Several direct-push groundwater samples were collected in order to find the source of the TCE in groundwater as part of the 2004 RI conducted by ARCADIS. Based on the results of the groundwater samples, four additional monitoring wells were installed (12MW09 through 12MW12).

2.15.2 Current and Potential Future Land and Water Uses

Area 12 is located in the western portion of the Manufacturing Area along the western boundary of the installation. The manufacturing areas include office buildings, warehouses, plant buildings, shipping facilities, security facilities, maintenance facilities, a fire station, and other operations associated with manufacturing. People using this area would include LCAAP site employees working in one of the many buildings, and employees responsible for maintaining the area or utilizing the adjacent areas. Current land use of Area 12 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.15.3 Summary of Human Health Risk Assessment – Area 12

The Area 12 HHRA characterized potential risks in a manner consistent with the risk assessment principles and practices established by the USEPA Risk Assessment Guidance for Superfund (USEPA 1989). The HHRA is discussed further in the Final IWOU RI/FS (ARCADIS 2006) and is summarized in the following sections.

2.15.3.1 Identification of Chemicals of Concern

The observed concentrations of the human health risk drivers and the calculated and exposure concentrations are summarized in Table 2. The 95th Upper Confidence Limit of the mean was calculated and used as the exposure concentration following USEPA guidance. TCE in groundwater was identified as the only COC in Area 12.

2.15.3.2 Exposure Assessment

The assessment of exposure includes characterization of the physical environment, identification of exposure pathways (including migration pathways, exposure points, and exposure routes), and identification of potentially exposed individuals and populations. Due to the industrial nature of the LCAAP, particularly the IWOU, the exposure scenarios evaluated in the HHRA were limited to industrial exposure frequencies and durations. Based on the current and reasonably anticipated future land uses of Area 12, the following complete or potentially complete exposure pathways and receptors were identified:

- Current and future site workers may be exposed via inhalation to volatile COPCs in groundwater migrating to indoor air. Future site workers may also be exposed to COPCs in groundwater via ingestion of groundwater used as potable water and dermal contact while washing hands.

- Future construction/utility workers may be exposed to COPCs in groundwater via dermal contact and inhalation of VOCs.

- Current and future students may be exposed via inhalation to volatile COPCs in groundwater migrating to indoor air.

- Future adult and child off-site residents may be exposed to COPCs in groundwater that may migrate from Area 12 via ingestion of drinking water, dermal contact during showering, and inhalation of volatile COPCs migrating to indoor air and during showering.

Note that no sediments or surface water are present at Area 12; therefore, exposure pathways are not presented here. Additionally, the only COPC identified in the soil was arsenic. However, arsenic levels observed in the soil were determined to be consistent with background levels; therefore, arsenic was not further evaluated in the HHRA.

Table 3 tabulates key exposure assumptions and intake parameters used in the evaluations. The migration pathways and receptors developed from the CSEM are shown on **Figure 35.**

2.15.3.3 Toxicity Assessment

The toxicity assessment results in the selection of appropriate toxicity values to use in estimating potential health risks associated with exposure. This is accomplished by reviewing the available information on the toxicity of the COCs and summarizing the factors pertinent to the exposures being assessed.

Chemical-specific CSFs and weight-of-evidence classifications were compiled for cancer endpoints. The weight-of-evidence classification describes the likelihood that a chemical is a human carcinogen based on the supporting evidence of carcinogenicity in human and animal studies (USEPA 1999b). Cancer toxicity values are summarized in **Table 4.**

Chemical-specific RfDs were compiled for non-cancer health effects. Chronic RfDs were used to assess long-term exposures ranging from 7 years to a lifetime. Subchronic RfDs were used to evaluate the potential for adverse health effects associated with exposure to constituents over a period of 2 weeks to 7 years. Subchronic RfDs were used to evaluate the short-term construction worker hazards. Non-cancer toxicity values are summarized in **Table 5**.

The primary organ/system affected by noncarcinogenic chemical COCs is the liver (TCE). TCE also elicits cancer effects. The primary source for toxicity values, such as CSFs and RfDs, is USEPA's IRIS. In addition, provisional toxicity values were obtained for TCE from the NCEA.

2.15.3.4 Risk Characterization

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time with an RfD derived for a similar exposure period. The ratio of the exposure to toxicity is an HQ. An HQ lower than 1 indicates that a receptor's dose of a single contaminant is lower than the reference dose, and that toxic noncarcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all COCs that affect the same target organ or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI lower than 1 indicates that, based on the sum of all HQs from different COCs and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI higher than 1 indicates that site-related exposure may present a potential risk to human health.

Potential carcinogenic (cancer) risks are classified by the increased probability of a person getting cancer in his or her lifetime (i.e., excess lifetime cancer risks) from being exposed to known or suspected cancer-causing chemicals at the site. Excess lifetime cancer risks are determined by multiplying the exposure with the slope factor. These risks are probabilities that are generally expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that, as a plausible upper bound, an individual has a one in 1,000,000 chance of developing cancer over a 70-year lifetime as a result of site-related exposure to a carcinogen under the specific exposure conditions at a site. USEPA's generally acceptable carcinogenic risk range is between 1×10^{-4} and 1×10^{-6}. This means there is an increased probability of one additional case in 10,000 to one case in 1,000,000 that an individual will develop cancer above the expected normal rate of 250,000 per 1,000,000 (or one in four).

Table 6 summarizes the risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions

about the frequency and duration of exposure, as well as the toxicity of the COCs. The total risk from exposure to impacted soil and groundwater at Area 12 exhibits an HI of 2 for future site worker, a cancer risk of 5×10^{-4} and an HI of 6 for future adult off-site resident, and a cancer risk of 5×10^{-4} and an HI of 20 for future child off-site resident exposure to groundwater used as a potable water supply. Additionally, total risk from exposure to impacted groundwater is presented in detail (by pathway) in Appendix A. These risk levels indicate that, if no cleanup action is taken, an individual would be exposed to an unacceptable risk or hazard as a result of site-related exposure to TCE in groundwater at Area 12. Remedial action associated with COCs in groundwater is described in Section 2.35.

Results of the baseline risk assessment indicate that contaminants are not present in soil above human health levels; therefore, there will be no remedial action performed for soil at this Area. However, TCE is present in groundwater at concentrations above screening levels as shown on **Figure 34**. Groundwater at Area 12 will be addressed as part of the IWOU-Wide Groundwater program. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.16 Area 13 - Building 35 Drainage Area

2.16.1 Site Characteristics

Area 13 occupies approximately 51 acres and is located in the south-central portion of the Installation in the Explosives Area. This Area accepted wash water and wastewater containing sodium dichromate from metal parts manufacturing processes in Building 35 until 1971. The water emptied directly into a drainage ditch. Building 35 is used for the manufacturing of primer material and is located within a series of bunker complexes. Most of the soils in this Area have been disturbed or removed by construction activities.

The suspected sources of potential contamination are a surface drainage area, a solvent pit, building sumps, and a drum storage area. **Figure 36** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. Three previous investigations have occurred at Area 13. In 1988, a Phase I Investigation was conducted by Roy F. Weston to determine whether the wastewater discharge had impacted the ditch sediments and subsurface soil. An extensive soil sampling program was carried out in Area 13 during the 1990 Phase II Investigation. The most recent investigation in Area 13 was the Supplemental Field Investigation performed by Burns and McDonnell in 1999. The current RI conducted in 2004 by ARCADIS involved additional soil, sediment, surface water, and groundwater sampling within AOI 13A.

Soil and groundwater samples were also collected as part of the inactive sump investigation (AOI 13D). Inactive sumps within Area 13 scheduled for removal are located next to production buildings or areas and cannot be removed at this time without the potential for disturbance to plant infrastructure and significant disturbance of plant production. These sumps require future work (Section 1.4) and will be addressed as they become available through maintenance or construction activities, or at installation closure or transfer.

Based on preliminary results of confirmation samples used during the field work to determine if excavation was complete at sump 35SU7, it was determined that the horizontal extent of soil contamination had been reached and no additional excavation was needed. Upon review of the final data, it was observed that during data validation, the preliminary result for TCE from one sample collected at 2 feet bgs increased from 0.012 mg/kg to 0.12 mg/kg. The sample results and associated maps showing locations of the confirmation samples are

included in the *Final Removal Action Completion Report for Inactive Sumps, Installation-Wide Operable Unit* (ARCADIS, 2007b). As such, the concentration in soil exceeds the cleanup goal of 0.02 mg/kg. The detected concentration of 0.12 mg/kg only slightly exceeds the Region 9 Industrial PRG of 0.11 mg/kg, which is the concentration to which soil was removed during the Inactive Sumps Removal Action. Considering the relatively low concentration of TCE in the referenced sample compared to the Industrial PRG, and the very low detection frequency of TCE in Area 13 (less than 2 percent), incremental risks associated with this sample and impacts on the calculated timeframe to reach the cleanup goals are negligible.

2.16.2 Current and Potential Future Land and Water Uses

Area 13 is located within the active manufacturing area. Many of the buildings in Area 13 are currently used on a regular basis. People using this area would include LCAAP site employees working in Building 35 or one of the other complexes and employees responsible for maintaining the area or utilizing the adjacent areas. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. In addition, Area 13 is located within the inner fence, which surrounds the currently active manufacturing area, making it difficult for unauthorized visitors or trespassers to access.

Current land use of Area 13 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.16.3 Summary of Human Health Risk Assessment – Area 13

The Area 13 HHRA characterized potential risks in a manner consistent with the risk assessment principles and practices established by the USEPA Risk Assessment Guidance for Superfund (USEPA 1989). The HHRA is discussed further in the Final IWOU RI/FS (ARCADIS 2006) and is summarized in the following sections.

2.16.3.1 Identification of Chemicals of Concern

The observed concentrations of the human health risk drivers and the calculated and exposure concentrations are summarized in Table 2. The 95th Upper Confidence Limit of the mean was calculated and used as the exposure concentration following USEPA guidance. TCE and benzo(b)fluoranthene were identified as COCs in groundwater, TCE and lead were identified as COCs in surface soil, and lead was identified as a COC in the combined surface and subsurface soil in Area 13.

2.16.3.2 Exposure Assessment

The assessment of exposure includes characterization of the physical environment, identification of exposure pathways (including migration pathways, exposure points, and exposure routes), and identification of potentially exposed individuals and populations. Based on the current and reasonably anticipated future land uses of Area 13, the following complete or potentially complete exposure pathways and receptors were identified:

- Current and future site workers may be exposed to COPCs in surface soil via incidental ingestion and inhalation of wind-blown fugitive dust. Current and future site workers may also be exposed to volatile COPCs in groundwater migrating to indoor air via inhalation. In addition, future site workers may also be

exposed to COPCs in groundwater via ingestion of groundwater used as potable water and dermal contact while washing hands.

- Future construction/utility workers may be exposed to COPCs in combined surface and subsurface soil via incidental ingestion, dermal contact, and inhalation of dust during excavation activities. Future construction/utility workers may also be exposed to COPCs in groundwater via dermal contact and inhalation of VOCs.

- Current and future maintenance workers may be exposed to COPCs in surface soil via incidental ingestion, dermal contact, and inhalation of wind-blown fugitive dust. Maintenance workers may also be exposed to COPCs in surface water via dermal contact, and COPCs in sediment via incidental ingestion and dermal contact.

- Current and future adult and youth visitors/trespassers may be exposed to COPCs in surface soil via incidental ingestion and dermal contact. Current and future adult and youth visitors/trespassers may also be exposed to COPCs in surface water via dermal contact, and COPCs in sediments via incidental ingestion and dermal contact.

Table 3 tabulates key exposure assumptions and intake parameters used in the evaluations. The migration pathways and receptors developed from the CSEM are shown on Figure 39.

2.16.3.3 Toxicity Assessment

The toxicity assessment results in the selection of appropriate toxicity values to use in estimating potential health risks associated with exposure. This is accomplished by reviewing the available information on the toxicity of the COCs and summarizing the factors pertinent to the exposures being assessed.

Chemical-specific CSFs and weight-of-evidence classifications were compiled for cancer endpoints. The weight-of-evidence classification describes the likelihood that a chemical is a human carcinogen based on the supporting evidence of carcinogenicity in human and animal studies (USEPA 1999b). Cancer toxicity values are summarized in **Table 4.**

Chemical-specific RfDs were compiled for non-cancer health effects. Chronic RfDs were used to assess long-term exposures ranging from 7 years to a lifetime. Subchronic RfDs were used to evaluate the potential for adverse health effects associated with exposure to constituents over a period of 2 weeks to 7 years. Subchronic RfDs were used to evaluate the short-term construction worker hazards. Non-cancer toxicity values are summarized in **Table 5.**

The primary organ/system affected by COCs is the liver (TCE). With the exception of lead, the remaining COCs elicit cancer effects. The following provisional or draft toxicity values, such as CSFs and RfDs, were utilized in the HHRA:

- Provisional toxicity values were obtained for TCE from the NCEA.

- The CSF for benzo(b)fluoranthene was estimated using USEPA's relative potency approach. This approach utilizes TEFs to adjust the cancer slope factor for benzo(a)pyrene based on its relative potency.

In addition, neither a CSF nor an RfD has been developed for lead. Instead, potential risks associated with exposure to lead in surface and subsurface soil were evaluated using the USEPA ALM to predict quasi-steady-state blood-lead concentrations for each receptor. The predicted blood-lead levels were then compared to the USEPA (1994) benchmark of 5 percent probability of exceeding a 10 ug/dL blood-lead level.

2.16.3.4 Risk Characterization

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time with a reference dose derived for a similar exposure period. The ratio of the exposure to toxicity is an HQ. An HQ lower than 1 indicates that a receptor's dose of a single contaminant is lower than the reference dose and that toxic noncarcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all COCs that affect the same target organ or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI lower than 1 indicates that, based on the sum of all HQs from different COCs and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI higher than 1 indicates that site-related exposure may present a potential risk to human health.

Potential carcinogenic (cancer) risks are classified by the increased probability of a person getting cancer in his or her lifetime (i.e., excess lifetime cancer risks) from being exposed to known or suspected cancer-causing chemicals at the site. Excess lifetime cancer risks are determined by multiplying the exposure with the slope factor. These risks are probabilities that are generally expressed in scientific notation (e.g., 1 x 10^{-6}). An excess lifetime cancer risk of $1x10^{-6}$ indicates that, as a plausible upper bound, an individual has a one in 1,000,000 chance of developing cancer over a 70-year lifetime as a result of site-related exposure to a carcinogen, under the specific exposure conditions at a site. USEPA's generally acceptable carcinogenic risk range is between 1 x 10^{-4} and 1 x 10^{-6}. This means that there is an increased probability of one additional case in 10,000 to one case in 1,000,000 that an individual will develop cancer above the expected normal rate of 250,000 per 1,000,000 (or one in four).

Table 6 summarizes risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of exposure as well as the toxicity of the COCs. The total potential risk of site worker exposure to groundwater used as a potable water supply at Area 13 is 6 x 10^{-4}, and the HI is 8. A cancer risk of 4 x 10^{-4} was calculated for a construction worker exposure to groundwater, and an HI of 3 was calculated for a construction worker exposure to surface and subsurface soil. Additionally, total risks from exposure to impacted soil, groundwater, surface water, and sediment are presented in detail (by pathway) in Appendix A. These risk levels indicate that, if no cleanup action is taken, an individual would be exposed to an unacceptable risk or hazard as a result of site-related exposure to TCE and benzo(b)fluoranthene in groundwater, lead in surface soil, and antimony and lead in combined surface and subsurface soil in Area 13.

In addition, the ALM predicted 7 percent and 14 percent probability that a site worker's and construction worker's exposure to lead or soil would result in a blood-lead level higher than the benchmark. Remedial action associated with COCs in groundwater is included in Section 2.35.

2.16.4 Area 13 Remedial Action Objectives

The RAOs are site-specific cleanup objectives established for protecting human health and the environment. The RAOs are intended to be specific to the affected media, but sufficiently broad so as not to unreasonably restrict the potential remedial technology available. The RAOs developed for the IWOU include the COCs, media of concern, and potential exposure pathways identified during the risk assessment. Because of the industrial nature of the LCAAP, the exposure scenarios evaluated in the HHRA were primarily limited to industrial exposure frequencies and durations. Because of the use restriction imposed by the industrial exposure scenarios, land use controls will be a required component of the Selected Remedies at the IWOU to be protective of sensitive populations and the higher exposure frequencies and durations that would be associated with a UUUE scenario. Therefore, use restrictions would be implemented by the Army at the IWOU to limit future use of the site to industrial only. The RAOs for Area 13 are to:

- Prevent contaminant migration to groundwater from soil with concentrations above the cleanup levels identified in **Table 7.**

- Prevent exposure to lead in soil exceeding an average concentration of 1,197 mg/kg to achieve a predicted blood-lead level lower than 10 ug/uL with a 95 percent probability.

- Prevent exposure to antimony in soil at concentrations above the cleanup levels identified in **Table 7.**

The rationale for the first RAO is to prevent migration of lead and antimony above cleanup levels from the soil to surrounding groundwater that could cause exceedances of drinking water standards (i.e., via leaching). The rationale for the second and third RAOs is to protect receptors from contaminated media at unacceptable potential risk levels. Achieving these RAOs will eliminate the potential risk by removing impacted soil above cleanup levels, thus eliminating exposure to contaminated soil.

Because of the industrial nature of the LCAAP, the exposure scenarios evaluated in the HHRA were primarily limited to industrial exposure frequencies and durations. Because of the use restriction imposed by the industrial exposure scenarios, land use controls are required in the final Selected Remedies at the IWOU to be protective of the sensitive populations and higher exposure frequencies and duration associated with a UUUE scenario. Therefore, use restrictions would be implemented by the Army at the IWOU to limit future use of the site to industrial only. The proposed actions for soil remediation would successfully meet the RAOs.

2.16.5 Description of Area 13 Alternatives

The COCs at Area 13 are antimony and lead based on the results of the risk assessment. Area 13 was part of the Inactive Sumps Removal Action, which included removal of sumps and surface soil associated with VOC, PAH, and metal contamination in this Area. Antimony is still present in soil from 0 to 2 feet bgs above human health risk levels, which may pose an unacceptable risk to future construction/utility workers who might be exposed to antimony in combined surface and subsurface soil. In addition, lead is present in soil from 0 to 2 feet bgs above human health risk levels that may pose an unacceptable risk to current and future site workers. Antimony and lead concentrations in soil are presented on **Figure 37**. Remedial action is necessary to prevent exposure to contaminated soils. TCE and benzo(b)fluoranthene are present in groundwater above human health screening levels, as shown on **Figure 38.** Groundwater at Area 13 will be addressed as part of the IWOU-Wide

Groundwater program. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

The remedial alternatives for each Area in the IWOU are presented in **Table 8** along with their estimated present-worth life-cycle costs. A narrative description of these remedial alternatives is given in the following section.

Due to the limited extent of waste material at Area 13 and the limited applicability of appropriate technologies for the treatment of isolated contaminated soil locations, alternatives of no action and excavation and off-site disposal were the only remedial alternatives considered for Area 13; as such, the technology screening process for the general response actions was not conducted. Excavation and off-site disposal was the only active remedy considered because it is the most conservative and practical approach to removal of contaminants in soil at isolated locations.

Alternative 1: No Further Remedial Action

Estimated Capital Cost: $0
Estimated Annual O&M Cost: $0
Estimated Present Value: $0

The NCP and USEPA's guidance for conducting RI/FS investigations requires that the "No Action" option be developed and examined as a potential remedial action for all sites. The "No Action" option is retained and examined as a baseline with which other remedial actions are compared. The "No Action" alternative does not address the baseline conditions associated with unacceptable risk to potential future site worker and construction/utility worker exposures and does not achieve the RAOs established at the IWOU.

Alternative 2: Excavation and Off-Site Disposal

Estimated Capital Cost: $105,100
Estimated Annual O&M Cost: $0
Estimated Present Value: $105,100

The risk assessment results for Area 13 indicate that lead and antimony are present in soil at levels posing unacceptable risks at the Outfall Overflow near AOI 13A. The aerial extent of surface soil identified as having lead and antimony concentrations in exceedance of cleanup levels is approximately 5,200 square feet (**Figure 40**). The metals are generally in the upper 1 foot of soil.

Excavation and off-site disposal of the waste materials and impacted soil is proposed as Alternative 2. Under this alternative, the waste materials will be excavated and disposed of at an appropriate off-site facility. Confirmation samples will be collected from the bases and perimeters of the hotspot excavations to verify the removal of contaminated material and to verify that the residual risk associated with these hotspots has been eliminated.

LUCs will be implemented as described in Section 2.7.5. The Army will enforce these LUCs and maintain the integrity of the remedial technologies at Area 13. LUCs must be enforced to maintain industrial land use.

In addition, LUCs will be implemented to prevent contact with contaminated soil remaining beneath the berm by prohibiting drilling, boring, digging, construction, earth moving, or other activities within the contaminated area.

2.16.6 Principal Threat Wastes

The NCP establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable (NCP §300.430[a][1][iii][A]). Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure.

There are no existing principal threat wastes at Area 13. Low-level threat wastes (i.e., non-mobile, non-toxic lead) have been identified in surface and subsurface soil at Area 13. Removal strategies were selected to provide complete removal of contaminants.

2.16.7 Selected Remedy for Area 13

Based on the requirements of CERCLA, comparative analysis using the nine criteria, public comments, and in consultation with the USEPA and the state, the USEPA and Army have selected the following remedy for Area 13. For all of the Selected Remedies, the LUCs will be imposed to ensure that the site remains industrial use only. The Selected Remedy for Area 13 is soil excavation, off-site disposal, and LUCs. The Selected Remedy for groundwater at Area 13 will be addressed as part of the IWOU-Wide Groundwater program.

2.16.7.1 Summary of Rationale for the Selected Remedy for Area 13

Following the evaluation of the no further action and excavation alternatives, the remedial action selected for Area 13 is excavation and off-site disposal because it is protective of human health and the environment by removing antimony and lead above risk-based levels in soil and sediment from the overflow outfall near AOI 13A. Contact with contaminated soil remaining beneath the berm will be addressed using LUCs.

Excavation and off-site disposal of lead-impacted soil is protective of human health and the environment and is cost-effective. This remedial action also satisfies the RAOs within a reasonable timeframe. There are no chemical-specific ARARs for soil, so CERCLA requirements are satisfied by the Selected Remedy. Excavation and off-site disposal is cost-effective, implementable, permanent, and effective.

2.16.7.2 Description of the Selected Remedy for Area 13

Excavation and off-site disposal of the impacted soil and sediment is the Selected Remedy. Under this remedy, the impacted soil and sediment will be excavated to achieve cleanup levels identified in Table 7 and disposed of at an appropriate off-site facility. LUCs will be imposed to ensure that the site remains industrial use only. Figure 40 shows the extent of remedial action.

Confirmation samples will be collected from the bases and perimeters of the excavations to verify the removal of contaminated material and to verify that the residual risk associated with this hotspot has been eliminated. The confirmation sampling plan will be presented in the Remedial Design/Remedial Action Work Plan.

2.16.7.3 Summary of the Estimated Remedy Costs for Area 13

The information in the cost estimate summary provided in **Table 17** is based on the best available information regarding the anticipated scope of the remedial alternative. Cost elements are likely to change as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD amendment. The cost provided in **Table 17** is an order-of-magnitude engineering cost estimate that is expected to be within 30 to 50 percent of the actual project cost.

2.16.7.4 Expected Outcomes of the Selected Remedy at Area 13

The purpose of the response action for Area 13 is to remove soil with concentrations of lead and antimony higher than cleanup levels (**Table 7**). Exposure for these AOCs is controlled through off-site disposal of residuals. No concentrations of COCs higher than cleanup levels will remain on-site.

- The current and future land use for LCAAP has been determined to be industrial, so the land use must remain consistent with this determination. There are no additional restrictions on land use following completion of the remedial response action.

- The cleanup levels for soil at Area 13 are provided in **Table 7**. These cleanup levels were determined based on an evaluation of ARARs and risk-based cleanup levels. It is estimated that the cleanup levels will be achieved within approximately 1 year. No residual risk will remain following the remedial response action as long as the land use remains industrial. LUCs will remain in place at the IWOU as long as concentrations in soil and groundwater do not meet UUUE.

- The beneficial socio-economic and community revitalization impacts include elimination of identified contamination at this particular Area. Due to the nature of the operations at LCAAP and the long-term management that will be required in the IWOU, the remaining benefits are not applicable.

- Environmental and ecological benefits will occur as a result of removing impacted surface soil in this Area.

2.16.7.5 Selected Remedy Performance Objectives and Performance Criteria for Area 13

The Selected Remedy provides protectiveness by applying immediate mass removal through soil excavation of metals-impacted surface soil. Through excavation and disposal of impacted surface soil, the Selected Remedy achieves the following RAOs:

- Prevent contaminant migration to groundwater from soil at concentrations above the cleanup levels identified in **Table 7.**

- Prevent exposure to lead in soil exceeding an average concentration of 1,197 mg/kg to achieve a predicted blood-lead level lower than 10 ug/dL with a 95 percent probability.

- Prevent exposure to antimony in soil at concentrations above the cleanup levels identified in **Table 7**.

The performance objectives of the excavation and off-site disposal for this Area are to prevent exposure to COCs above cleanup levels, prevent contaminant migration to groundwater from soil above cleanup levels, and to achieve cleanup levels as verified through confirmation sampling. Upon completion of the active remedy for Area 13, the Area will be available for industrial/commercial use. The performance evaluation criterion to determine that these objectives have been achieved is to collect confirmation samples within the excavation area to determine that no COCs remain in soil above cleanup levels presented in **Table 7**. Confirmation sampling procedures will be detailed in the RD/RAWP. LUCs will be maintained indefinitely or until UUUE is achieved. LUCs will be implemented for the inaccessible soil that remains at Area 13 beneath the berm. The soil will be addressed when it becomes available.

2.16.8 Statutory Determinations

Section 121 of CERCLA and the NCP establish several statutory requirements and preferences. These specify that, when complete, the selected remedy must achieve adequate protection of human health and the environment and comply with ARARs unless a statutory waiver is justified. The selected remedy must also be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment (as a principal element) that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes, with a bias against off-site disposal of untreated wastes. The following sections describe how the Selected Remedy satisfies or does not satisfy the statutory requirements of CERCLA Section 121.

2.16.8.1 Protection of Human Health and the Environment

The Selected Remedy addresses health and environmental issues that were identified in the Area 13 Remedial Investigation and Risk Assessments in the medium of soil. Specifically, the remedial actions:

- Prevent exposure to COCs in soil at Area 13 at concentrations exceeding the cleanup levels by excavating.

- Prevent contaminant migration of COCs to groundwater from soil at Area 13 by excavating.

The selected soil remedies will achieve RAOs for soil, reduce and maintain cumulative risk within the 10^{-4} to 10^{-6} risk range, and result in a blood-lead level lower than 10 ug/dL with a 95 percent probability.

2.16.8.2 Compliance with ARARs

The Selected Remedy for Area 13 complies with location- and action-specific ARARs. There are no chemical-specific ARARs for soil. Cleanup levels have been established for the soil COCs at Area 13 based on a site-specific risk assessment to ensure protectiveness of human health and the environment (**Table 7**). This alternative complies with the action-specific and location-specific ARARs for this alternative (action-specific

ARARs in Table B-7 and location-specific ARARs in Table B-8). The ARARs for this alternative include 40 CFR 261 A, B, C, and D, which ensure proper handling and disposal of excavated material.

2.16.8.3 Cost-Effectiveness

The Selected Remedy is cost-effective and represents a reasonable value for the money to be spent. The following definition was used in making this determination: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (NCP §300.430[f][1][ii][D]). Overall effectiveness was compared to costs to determine cost effectiveness. Because of the limited amount of waste and limited applicability of appropriate technologies, only two alternatives were evaluated for this Area (No Action and Excavation and Off-Site Disposal). The "No Action" alternative does not address the baseline conditions associated with unacceptable risk to potential future site worker and construction/utility worker exposures and does not achieve the RAOs. Therefore, only excavation and off-site removal is effective. The estimated present-worth cost of the Selected Remedy is $105,100, and it will satisfy CERCLA requirements.

2.16.8.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Extent Possible

The Selected Remedy meets the statutory requirement to utilize permanent solutions and treatment technologies to the maximum extent practicable for the IWOU because focused excavation will permanently remove contaminated soil at Area 13.

2.16.8.5 Preference for Treatment as a Principal Element

Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure.

Under existing scenarios, there is no exposure to contaminated groundwater. If exposure were to occur, it would present only a low risk to human health. In addition, groundwater at Area 13 is contained within the boundaries of the Installation. Because of the non-hazardous nature of chemicals in soil and groundwater, it is considered a low-level threat waste.

Five-Year Review Requirements

Five-year reviews of the selected remedy will be performed because contaminants will remain in soil and groundwater at concentrations that do not allow for UUUE. These reviews will be conducted at least every 5 Years after commencement of the remedial action, until concentrations of contaminants are reduced to levels that allow for UUUE, to ensure that the remedy continues to adequately protect human health and the environment.

2.16.9 Documentation of Significant Changes

All written and verbal comments submitted during the January 2007 public meeting and comment period were reviewed, and it was determined that no significant changes to the remedy, as outlined in the 2007 Proposed Plan, were necessary or appropriate.

2.17 Area 14 - Sludge Disposal Area

2.17.1 Site Characteristics

Area 14 occupies approximately 32 acres, is located in the north-central portion of the Installation, and consists of two disposal areas. One area (AOI 14A) contains a burning ground that was used by the Installation fire department to dispose of wooden ammunition boxes. The burning ground operated between 1951 and 1967. The second area (AOI 14B) is a sludge disposal area.

The suspected sources of potential contamination are the burning ground and an IWTP disposal area. **Figure** 4.1 presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. There have been five investigations conducted at Area 14. In 1988, a Phase I Investigation was conducted by Roy F. Weston to determine possible impacts to the soil and groundwater associated with activities in Area 14. A staged Phase II Investigation was conducted by EA Engineering, Science, and Technology in 1990 and 1992. A Supplemental Field Investigation was conducted by Burns and McDonnell to confirm earlier subsurface soil sampling results from the Phase II soil borings. A SCAPS Investigation was conducted to evaluate the potential extent of VOCs in groundwater at the northern boundary of the Installation; however, the northern portion of Area 14 included in the SCAPS report is actually considered and included with the discussion for Area 30. The recent field work was conducted at Area 14 by ARCADIS (as part of the RI) which involved collecting soil samples to define the arsenic concentration at location 14SB01, and collecting groundwater samples from the wells at Area 14 to determine if the arsenic exceedance had impacted groundwater.

2.17.2 Current and Potential Future Land and Water Uses

Area 14 is located north of the active manufacturing area. The current land use at Area 14 is as a bulk fuel storage facility. The Area may also potentially be used for rail car storage during the winter months. People accessing this area would include LCAAP employees responsible for maintaining the fuel storage facilities. Properties located north of Area 14, outside the perimeter fence, are predominantly residential. A fence currently surrounds the LCAAP, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Current land use of Area 14 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.17.3 Summary of Human Health Risk Assessment - Area 14

Potential risks and hazards to human health associated with site conditions at Area 14 are depicted in the CSEM presented on **Figure 42**. Under the existing conditions at Area 14, the total excess lifetime upper-bound risk estimates for current and future receptors are all lower than or within the USEPA target risk range (1×10^{-6} to 1×10^{-4}). The HIs for all receptors were less than 1, indicating that it is unlikely that adverse effects would occur under the conditions evaluated. USEPA (1991a) guidance on the *Role* of *Risk Assessment in Superfund Remedy Selection Decisions* states that, "where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts." These results indicate that, under the current site conditions at Area 14, constituents in soil,

groundwater, surface water, and sediment do not pose an unacceptable risk to human health under the exposure scenarios evaluated in this HHRA.

The total potential risks from exposure to soil and groundwater are presented in detail (by pathway) in **Appendix A**. Because LCAAP is an operating industrial facility, and because the future land use is not expected to change, the HHRA evaluated industrial exposure pathways. Therefore this Area, as with all Areas within LCAAP, will be restricted to industrial use only.

Results of the baseline risk assessment indicate that the chemicals are not present in soil or groundwater at levels that pose an unacceptable human health risk. Therefore, there will be no further remedial action performed for soil or groundwater at this Area. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.17.4 Summary of Ecological Risk Assessment - Area 14

In addition to an assessment of human risk, USEPA also requires that the baseline risk be evaluated for ecological receptors, such as animals, that live in and around the contaminated areas. An ERA was conducted in accordance with the Final Risk Assessment Work Plan for LCAAP (ARCADIS 2004a) to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents. An ERA was performed for Areas that were not in the manufacturing area of the plant, including Area 14.

No COCs were identified in the ERA for Area 14.

2.18 Area 15 - Temporary Surface Impoundment

2.18.1 Site Characteristics

Area 15 occupies approximately 24 acres and is located in the south-central part of the Installation due east of Area 13. This Area contains a temporary surface impoundment built to temporarily contain wastewater from Buildings 35, 90C, and 90D during lift station repairs. The impoundment was constructed in the 1970s, and its use was discontinued prior to 1980.

The suspected source of potential contamination is the surface impoundment. **Figure 43** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. Two soil borings were installed within AOI 15A under the Phase I Program by Roy F. Weston, Inc. Two additional borings were drilled during the Supplemental Investigation by Burns and McDonnell. Historical groundwater sampling has also been conducted within Area 15. The 2004 RI conducted by ARCADIS consisted of additional groundwater sampling specific to the temporary lagoon in AOI 15A and on an area-wide basis. Soil and groundwater samples were also collected as part of the inactive sump investigation (AOI 15B). Inactive sumps within Area 15 scheduled for removal are located next to production buildings or areas and cannot be removed at this time without the potential for disturbance to plant infrastructure and significant disturbance of plant production. These sumps require future work and will be addressed as they become available through maintenance or construction activities, or at installation closure or transfer.

2.18.2 Current and Potential Future Land and Water Uses

Area 15 is located within the active manufacturing area. Area 15 contains buildings that support the manufacture and storage of primer compounds. Many of the buildings in Area 15 are currently used on a regular basis. People using this area would include LCAAP site employees working in or accessing one of the several buildings and employees responsible for maintaining the area or utilizing the adjacent areas. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. In addition, Area 15 is located within the inner fence, which surrounds the currently active manufacturing area, making it difficult for unauthorized visitors or trespassers to access.

Current land use of Area 15 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.18.3 Summary of Human Health Risk Assessment - Area 15

The Area 15 HHRA characterized potential risks in a manner consistent with the risk assessment principles and practices established by the USEPA Risk Assessment Guidance for Superfund (USEPA 1989). The HHRA is discussed further in the Final IWOU RI/FS (ARCADIS 2006) and is summarized in the following sections.

2.18.3.1 Identification of Chemicals of Concern

The observed concentrations of the human health risk drivers and the calculated and exposure concentrations are summarized in **Table 2.** The 95th Upper Confidence Limit of the mean was calculated and used as the exposure concentration following USEPA guidance. Benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, and arsenic were identified as COCs in groundwater in Area 15.

2.18.3.2 Exposure Assessment

The assessment of exposure includes characterization of the physical environment, identification of exposure pathways (including migration pathways, exposure points, and exposure routes), and identification of potentially exposed individuals and populations. Due to the industrial nature of the LCAAP, particularly the IWOU, the exposure scenarios evaluated in the HHRA were limited to industrial exposure frequencies and durations. Based on the current and reasonably anticipated future land uses of Area 15, the following complete or potentially complete exposure pathways and receptors were identified:

- Current and future site workers may be exposed to COPCs in surface soil via incidental ingestion and inhalation of wind-blown fugitive dust. Current and future site workers may also be exposed to volatile COPCs in groundwater migrating to indoor air via inhalation. In addition, future site workers may also be exposed to COPCs in groundwater via ingestion of groundwater used as potable water and dermal contact while washing hands.

- Future construction/utility workers may be exposed to COPCs in combined surface and subsurface soil via incidental ingestion, dermal contact, and inhalation of dust during excavation activities. Future construction/utility workers may also be exposed to COPCs in groundwater via dermal contact and inhalation of VOCs.

- Current and future maintenance workers may be exposed to COPCs in surface soil via incidental ingestion, dermal contact, and inhalation of wind-blown fugitive dust.

- Current and future adult and youth visitors/trespassers may be exposed to COPCs in surface soil via incidental ingestion and dermal contact.

Note that no sediments or surface water are present at Area 15; therefore, exposure pathways are not presented here.

Table 3 tabulates key exposure assumptions and intake parameters used in the evaluations. The migration pathways and receptors developed from the CSEM are shown on **Figure 45.**

2.18.3.3 Toxicity Assessment

The toxicity assessment results in the selection of appropriate toxicity values to use in estimating potential health risks associated with exposure. This is accomplished by reviewing the available information on the toxicity of the COCs and summarizing the factors pertinent to the exposures being assessed.

Chemical-specific CSFs and weight-of-evidence classifications were compiled for cancer endpoints. The weight-of-evidence classification describes the likelihood that a chemical is a human carcinogen based on the supporting evidence of carcinogenicity in human and animal studies (USEPA 1999b). Cancer toxicity values are summarized in Table 4.

Chemical-specific RfDs were compiled for non-cancer health effects. Chronic RfDs were used to assess long-term exposures ranging from 7 years to a lifetime. Subchronic RfDs were used to evaluate the potential for adverse health effects associated with exposure to constituents over a period of 2 weeks to 7 years. Subchronic RfDs were used to evaluate the short-term construction worker hazards. Non-cancer toxicity values are summarized in Table 5.

The primary organ/system affected by COCs is the skin/vascular system (arsenic). Arsenic and the other COCs elicit cancer effects. The primary source for toxicity values, such as CSFs and RfDs, is USEPA's IRIS. In addition, CSFs for PAHs (with the exception of benzo[a]pyrene) were estimated using USEPA's relative potency approach (1993). This approach utilizes TEFs to adjust the CSF for benzo(a)pyrene based on its relative potency.

2.18.3.4 Risk Characterization

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time with a reference dose derived for a similar exposure period. The ratio of the exposure to toxicity is an HQ. An HQ lower than 1 indicates that a receptor's dose of a single contaminant is lower than the reference dose and that toxic noncarcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all COCs that affect the same target organ or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI lower than 1 indicates that, based on the sum of all HQs from different COCs and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI higher than 1 indicates that site-related exposure may present a potential risk to human health.

Potential carcinogenic (cancer) risks are classified by the increased probability of a person getting cancer in his or her lifetime (i.e., excess lifetime cancer risks) from being exposed to known or suspected cancer-causing chemicals at the site. Excess lifetime cancer risks are determined by multiplying the exposure with the slope factor. These risks are probabilities that are generally expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of $1x10^{-6}$ indicates that, as a plausible upper bound, an individual has a one in 1,000,000 chance of developing cancer over a 70-year lifetime as a result of site-related exposure to a carcinogen under the specific exposure conditions at a site. USEPA's generally acceptable carcinogenic risk range is between 1×10^{-4} and 1×10^{-6}. This means that there is an increased probability of one additional case in 10,000 to one case in 1,000,000 that an individual will develop cancer above the expected normal rate of 250,000 per 1,000,000 (or one in four).

Table 6 summarizes risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of exposure, as well as the toxicity of the COCs. The total risk at Area 15 is 6×10^{-4}, and the HI for a future site worker is 4. Additionally, total risks from exposure to impacted soil and groundwater are presented in detail (by pathway) in Appendix A. The unacceptable cancer risk and noncancer hazard are driven by potential exposure to groundwater used as a potable water supply. Exposure to chemicals in soil does not result in unacceptable risk to a future site worker. These risk levels indicate that, if no cleanup action is taken, an individual would be exposed to an unacceptable risk or hazard as a result of site-related exposure to benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, and arsenic in groundwater in Area 15. Remedial action associated with COCs in groundwater is included in Section 2.35.

A removal action was conducted in 2005 to remove and dispose of RCRA-listed hazardous waste (metals-impacted soil) at Area 15. Results of sampling conducted after completion of this removal, as well as recent sampling, indicate that these contaminants are not present in soil above screening levels (USEPA Region 9 Industrial PRGs for soil); therefore, there will be no further remedial action performed for soil at this Area. However, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and arsenic are present in groundwater at concentrations above human health screening levels as shown on **Figure 44.** Groundwater at Area 15 will be addressed as part of the IWOU-Wide Groundwater program. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.19 Area 19 - Building 1 Vicinity

2.19.1 Site Characteristics

Area 19 occupies approximately 24 acres and is located in the north-central portion of the Manufacturing Area next to Area 7. This Area encompasses the grounds around and adjacent to active Building 1, where several sumps were previously located.

The suspected sources of potential contamination are a former underground storage tank (UST), a transformer yard, building sumps, and an electrical substation. Figure 46 presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. The electrical substation (AOI 19B) and pole yard (AOI 19C) were investigated as part of the Phase II program, and the reported 1,000-gallon UST (AOI 19D) was investigated as part of the Supplemental Field Investigation. A geophysical survey was conducted and soil samples were collected as part of the 2004 RI conducted by ARCADIS. In addition, the UST at AOI 19D was abandoned during the RI activities. Soil and groundwater

samples were also collected as part of the inactive sump investigation. An inactive sump within Area 19 scheduled for removal is located next to production buildings or areas and cannot be removed at this time without the potential for disturbance to plant infrastructure and significant disturbance of plant production. This sump requires future work and will be addressed as it becomes available through maintenance or construction activities, or at installation closure or transfer. Area 19 was part of the Inactive Sumps Removal Action, which included removal of sumps and surface soil associated with PAH and explosive contamination in this Area.

2.19.2 Current and Potential Future Land and Water Uses

Area 19 is located within the active manufacturing area. Buildings 1 and 5 are located within Area 19. Building 1 is a primary manufacturing building, and Building 5 houses administrative offices. People using this area would include LCAAP site employees working in Building 1 or one of the other buildings and employees responsible for maintaining the area or utilizing the adjacent areas. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. In addition, Area 19 is partially located within the inner fence that surrounds many of the manufacturing and disposal areas, further restricting access to this area. Current land use of Area 19 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.19.3 Summary of Human Health Risk Assessment – Area 19

Potential risks and hazards to human health associated with site conditions at Area 19 are depicted in the CSEM presented on **Figure 47**. Under the existing conditions at Area 19, the total excess lifetime upper-bound risk estimates for current and future receptors are all lower than or within the USEPA target risk range (1×10^{-6} to 1×10^{-4}). The HIs for all receptors were lower than 1, indicating that it is unlikely that adverse effects would occur under the conditions evaluated. USEPA (1991a) guidance on the *Role* of *Risk Assessment in Superfund Remedy Selection Decisions* states that, "where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts." These results indicate that, under the current site conditions at Area 19, constituents in soil, groundwater, surface water, and sediment do not pose an unacceptable risk to human health under the exposure scenarios evaluated in this HHRA.

The total potential risks from exposure to soil and groundwater are presented in detail (by pathway) in Appendix A. Because LCAAP is an operating industrial facility, and because the future land use is not expected to change, the HHRA evaluated industrial exposure pathways. Therefore this Area, as with all areas within LCAAP, will be restricted to industrial use only.

Results of the baseline risk assessment indicate that the chemicals are not present in soil or groundwater at levels that pose an unacceptable human health risk. Therefore, there will be no further remedial action performed for soil or groundwater at this Area. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.20 Area 20 - Building 2 Vicinity

2.20.1 Site Characteristics

Area 20 occupies approximately 35 acres and is located in the northwest portion of the Installation in the Manufacturing Area. This Area encompasses the grounds around and adjacent to active Building 2. An area southeast of the building was identified on aerial photographs as potentially containing buried waste materials. The specific character, age, or quantities of the potential wastes are unknown. Solvents were reported to have been spilled in an area south of the mechanical garage (Building 14). The date of the spill and the quantity of material spilled are unknown.

The suspected sources of potential contamination are an electrical substation, buried waste area, and a solvent spill. **Figure 48** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. There have been two previous investigations conducted at Area 20. The Phase II RI field activities at Area 20 were conducted by EA in 1990 and involved installing two soil borings and collecting two surface soil samples. The purpose of the Phase II work was to further identify and evaluate the nature and extent of potential contamination in soil associated with the electric substation, possible buried waste, and suspected solvent spill in the area. A SCAPS Investigation was conducted by the USACE in 1999, and involved establishing 27 sample locations set up on a grid pattern across Area 20 in nine groups of three. The purpose of the SCAPS Investigation was to make in-situ determinations of the extent of VOCs in groundwater associated with the suspected solvent spill. A geophysical survey was conducted and soil and groundwater samples were collected as part of the 2004 RI conducted by ARCADIS. Based on the results of the groundwater samples, three new monitoring wells (20MW01 through 20MW03) were installed.

2.20.2 Current and Potential Future Land and Water Uses

Area 20 is located within the active manufacturing area. Building 2 is the main manufacturing building in this area. The buildings in Area 20 are used daily by Installation employees. People using this area would include LCAAP site employees working in one of the several buildings and employees responsible for maintaining the area or utilizing the adjacent areas. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Current land use of Area 20 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.20.3 Summary of Human Health Risk Assessment – Area 20

Potential risks and hazards to human health associated with site conditions at Area 20 are depicted in the CSEM presented on **Figure 49.** Under the existing conditions at Area 20, the total excess lifetime upper-bound risk estimates for current and future receptors are all lower than or within the USEPA target risk range (1×10^{-6} to 1×10^{-4}). The HIs for all receptors were lower than 1, indicating that it is unlikely that adverse effects would occur under the conditions evaluated. USEPA (1991a) guidance on the *Role of Risk Assessment in Superfund Remedy Selection Decisions* states that, "where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts." These results indicate that, under the current site conditions at Area 20, constituents in soil,

groundwater, surface water, and sediment do not pose an unacceptable risk to human health under the exposure scenarios evaluated in this HHRA.

The total potential risks from exposure to soil and groundwater are presented in detail (by pathway) in **Appendix A.** Because LCAAP is an operating industrial facility, and because the future land use is not expected to change, the HHRA evaluated industrial exposure pathways. Therefore, this Area, as with all Areas within LCAAP, will be restricted to industrial use only.

Results of the baseline risk assessment indicate that the chemicals are not present in soil or groundwater at levels that pose an unacceptable human health risk. Therefore, there will be no further remedial action performed for soil or groundwater at this Area. However, because carbon tetrachloride in groundwater exceeds the MCL at Area 20, as shown on **Figure 50**, groundwater will be addressed as part of the IWOU-Wide Groundwater program. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.21 Area 21 - Building 3 Vicinity

2.21.1 Site Characteristics

Area 21 occupies approximately 47 acres and is located in the north-central portion of the Installation in the manufacturing area. This Area encompasses the grounds around and adjacent to active Building 3. This Area also includes Buildings 3A and 12A, which were used during the 1960s for the machining and assembly of DU-containing 20 millimeter ammunition. Buildings 3A and 12A were "decontaminated" in 1985 and 1986. Subsequent inspection by the NRC indicated that additional cleanup activities were required for Building 3A. In July 2001, the Army conducted a removal action to demolish and dispose of contaminated debris from Building 3A. In addition, three sumps were removed and disposed of at a permitted disposal facility.

The suspected sources of potential contamination are a former UST, building sumps, and a drainage ditch. **Figure 51** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. The previous investigations in Area 21 have focused on the sumps. There is limited information available regarding previous investigations that may have been conducted in the remaining portions of Area 21 (i.e., AOI 21A and AOI 21C). Soil and sediment samples were collected as part of the 2004 RI conducted by ARCADIS. Area 21 was part of the Inactive Sumps Removal Action, which included removal of sumps and surface soil associated with PAH and perchlorate contamination in this Area.

2.21.2 Current and Potential Future Land and Water Uses

Area 21 is located within the active manufacturing area. Building 3 is the main manufacturing building in this Area. Many of the buildings in Area 21 are currently used on a regular basis. People using this area would include LCAAP site employees working in Building 3 or one of the other buildings, and employees responsible for maintaining the area or utilizing the adjacent areas. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. In addition, Area 21 is located within the inner fence, which surrounds the currently active manufacturing area, making it difficult for unauthorized visitors or trespassers to access.

Current land use of Area 21 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.21.3 Summary of Human Health Risk Assessment – Area 21

Potential risks and hazards to human health associated with site conditions at Area 21 are depicted in the CSEM presented on **Figure 52.** Under the existing conditions at Area 21, the total excess lifetime upper-bound risk estimates for current and future receptors are all lower than or within the USEPA target risk range (1×10^{-6} to 1×10^{-4}). The HIs for all receptors were lower than 1, indicating that it is unlikely that adverse effects would occur under the conditions evaluated. USEPA (1991a) guidance on the *Role* of *Risk Assessment in Superfund Remedy Selection Decisions* states that, "where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts." These results indicate that, under the current site conditions at Area 21, constituents in soil, groundwater, surface water, and sediment do not pose an unacceptable risk to human health under the exposure scenarios evaluated in this HHRA.

The total potential risks from exposure to soil, groundwater, surface water, and sediment are presented in detail (by pathway) in Appendix A. Because LCAAP is an operating industrial facility, and because the future land use is not expected to change, the HHRA evaluated industrial exposure pathways. Therefore this Area, as with all Areas within LCAAP, will be restricted to industrial use only.

Results of the baseline risk assessment indicate that the chemicals are not present in soil or groundwater at levels that pose an unacceptable human health risk. Therefore, there will be no further remedial action performed for soil or groundwater at this Area. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.22 Area 22 - Demolition Waste Dump

2.22.1 Site Characteristics

Area 22 occupies approximately 46 acres and is located in the north-central portion of the Installation at the northern end of Owens Schoolhouse Road along the northern boundary of the Installation. This Area contains a demolition waste dump that is thought to have been active during the 1940s and perhaps in the early 1950s. The exact operating dates and the characteristics of the wastes the dump received are unknown.

The suspected source of potential contamination is a demolition disposal area. **Figure 53** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. There have been three investigations performed at Area 22. EA Engineering, Science and Technology conducted the Phase II RI program for Area 22 in 1990. The program includes conducting an SVCA across the disposal area and collection of surface water, sediment, and soil samples to assess the nature and extent of potential contamination. A Supplemental Remedial Investigation of Area 22 was performed to determine whether elevated concentrations of uranium isotopes were present in surface water. A SCAPS Investigation was conducted in Area 30 in 1999 to assess the extent of VOCs in groundwater at the boundary of the Installation. Several of the SCAPS samples were collected from locations along the perimeter road at the northern boundary of Area 22. In addition to these investigations at Area 22, groundwater samples have been

collected from eight monitoring wells by ARCADIS at Area 22 since June 2004 as part of the Site-wide groundwater sampling program.

2.22.2 Current and Potential Future Land and Water Uses

Area 22 is located north of the active manufacturing area, along the northern boundary of the Installation. Area 22 is not currently used for any purpose and is maintained as an open field. A fence currently surrounds the facility, and the perimeter of the Installation is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Current land use of Area 22 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA. Properties located to the north of Area 22 outside the perimeter fence are predominantly residential in nature.

2.22.3 Summary of Human Health Risk Assessment – Area 22

Potential risks and hazards to human health associated with site conditions at Area 22 are depicted in the CSEM presented on **Figure 54.** Under the existing conditions at Area 22, the total excess lifetime upper-bound risk estimates for current and future receptors are all lower than or within the USEPA target risk range (1×10^{-6} to 1×10^{-4}). The HIs for all receptors were lower than 1, indicating that it is unlikely that adverse effects would occur under the conditions evaluated. USEPA (1991a) guidance on the *Role* of *Risk Assessment in Superfund Remedy Selection Decisions* states that, "where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts." These results indicate that, under the current site conditions at Area 22, constituents in soil, groundwater, surface water, and sediment do not pose an unacceptable risk to human health under the exposure scenarios evaluated in this HHRA.

The total potential risks from exposure to soil and groundwater are presented in detail (by pathway) in **Appendix A**. Because LCAAP is an operating industrial facility, and because the future land use is not expected to change, the HHRA evaluated industrial exposure pathways. Therefore this Area, as with all Areas within LCAAP, will be restricted to industrial use only.

2.22.4 Summary of Ecological Risk Assessment – Area 22

In addition to an assessment of human risk, USEPA also requires that the baseline risk be evaluated for ecological receptors, such as animals, that live in and around the contaminated areas. An ERA was conducted in accordance with the Final Risk Assessment Work Plan for LCAAP (ARCADIS 2004a) to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents. An ERA was performed for Areas that were not in the manufacturing area of the plant, including Area 22. No COCs were identified in the ERA for Area 22.

Results of the baseline risk assessment indicate that contaminants are not present in soil or groundwater at levels that pose an unacceptable ecological or human health risk. Therefore, there will be no further remedial action performed for soil or groundwater at this Area.

2.23 Area 23 - Sludge Burial Pits

2.23.1 Site Characteristics

Area 23 occupies approximately 95 acres and is located in the center of the Installation south of Ditch A. The Area contains buildings that house bulk propellant or gunpowder, which were used throughout the manufacturing area. AOI 23A is an area of suspected IWTP sludge burial. This Area is thought to contain four IWTP sludge burial pits. The pits were reportedly operated during the mid-1960s and ceased operation in 1967.

The suspected source of potential contamination is an IWTP sludge disposal area. **Figure 55** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. One previous investigation was conducted at AOI 23A. During the Phase II RI, a geophysical survey with an electromagnetic (EM-31) terrain conductivity meter was performed to define the SWMU boundaries. The maximum penetration depth of the EM-31 survey is approximately 20 feet bgs. Three clear anomalies and one less distinct anomaly were detected. The Phase II program included drilling a test boring to 10 feet bgs in each of the four geophysical anomalies. Soil samples were collected at AOI 23A as part of the 2004 RI conducted by ARCADIS.

2.23.2 Current and Potential Future Land and Water Uses

Area 23 is located within the active manufacturing area. Area 23 buildings are currently used as storage facilities for propellant used in the manufacturing process. People using this area would include LCAAP site employees accessing the 19-series buildings that house bulk propellant used throughout the manufacturing area and employees responsible for maintaining the area or utilizing the adjacent areas. A fence currently surrounds LCAAP, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Current land use of Area 23 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.23.3 Summary of Human Health Risk Assessment – Area 23

The Area 23 HHRA characterized potential risks in a manner consistent with the risk assessment principles and practices established by the USEPA Risk Assessment Guidance for Superfund (USEPA 1989). The HHRA is discussed further in the Final IWOU RI/FS (ARCADIS 2006) and is summarized in the following sections.

2.23.3.1 Identification of Chemicals of Concern

The observed concentrations of the human health risk drivers and the calculated and exposure concentrations are summarized in **Table 2.** The 95th Upper Confidence Limit of the mean was calculated and used as the exposure concentration following USEPA guidance. Manganese in soil was identified as the only COC in Area 23.

2.23.3.2 Exposure Assessment

The assessment of exposure includes characterization of the physical environment, identification of exposure pathways (including migration pathways, exposure points, and exposure routes), and identification of potentially exposed individuals and populations. Due to the industrial nature of the LCAAP, particularly the

IWOU, the exposure scenarios evaluated in the HHRA were limited to industrial exposure frequencies and durations. Based on the current and reasonably anticipated future land uses of Area 23, the following complete or potentially complete exposure pathways and receptors were identified:

- Future construction/utility workers may be exposed to COPCs in combined surface and subsurface soils via ingestion, dermal contact, and inhalation of dust during excavation activities.

Note that no sediments or surface water are present at Area 23; therefore, exposure pathways are not presented here. Groundwater samples were not collected from Area 23 because soil data indicated that there were no potential impacts to groundwater. Additionally, the only COPC identified in surface soil was arsenic. However, arsenic levels in surface soil were determined to be consistent with background levels, and therefore, was not further evaluated in this HHRA.

Table 3 tabulates key exposure assumptions and intake parameters used in the evaluations. The migration pathways and receptors developed from the CSEM are shown on **Figure 56.**

2.23.3.3 Toxicity Assessment

The toxicity assessment results in the selection of appropriate toxicity values to use in estimating potential health risks associated with exposure. This is accomplished by reviewing the available information on the toxicity of the COCs and summarizing the factors pertinent to the exposures being assessed.

Chemical-specific CSFs and weight-of-evidence classifications were compiled for cancer endpoints. The weight-of-evidence classification describes the likelihood that a chemical is a human carcinogen based on the supporting evidence of carcinogenicity in human and animal studies (USEPA 1999b). Cancer toxicity values are summarized in **Table 4.**

Chemical-specific RfDs were compiled for non-cancer health effects. Chronic RfDs were used to assess long-term exposures ranging from 7 years to a lifetime. Subchronic RfDs were used to evaluate the potential for adverse health effects associated with exposure to constituents over a period of 2 weeks to 7 years. Subchronic RfDs were used to evaluate the short-term construction worker hazards. Non-cancer toxicity values are summarized in **Table 5.**

The primary organ/system affected by COCs is the central nervous system (manganese). Manganese does not elicit cancer effects. The primary source for toxicity values, such as CSFs and RfDs, is USEPA's IRIS.

2.23.3.4 Risk Characterization

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time with a reference dose derived for a similar exposure period. The ratio of the exposure to toxicity is an HQ. An HQ lower than 1 indicates that a receptor's dose of a single contaminant is lower than the reference dose and that toxic noncarcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all COCs that affect the same target organ or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI lower than 1 indicates that, based on the sum of all HQs from different COCs and exposure routes, toxic noncarcinogenic effects from all

contaminants are unlikely. An HI higher than 1 indicates that site-related exposure may present a potential risk to human health.

Table 6 summarizes the risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of exposure, as well as the toxicity of the COCs. The HI for a construction worker's exposure to manganese in soil is 4. Additionally, total risks from exposure to impacted soil are presented in detail (by pathway) in **Appendix A**. These risk levels indicate that, if no cleanup action is taken, an individual would be exposed to an unacceptable hazard as a result of site-related exposure to manganese in soil.

Environmental investigations have uncovered no evidence of buried waste in this Area; however, manganese is present in soil above human health risk levels that may pose an unacceptable risk to future construction/utility workers who might be exposed to manganese in surface soil via inhalation of dust during excavation activities. Remedial action is necessary to prevent exposure to contaminated soils. Contaminants are not present in groundwater at concentrations above human health risk levels; therefore, there will be no remedial action performed for groundwater at this Area. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.23.4 Area 23 Remedial Action Objectives

The RAOs are site-specific cleanup objectives established for protecting human health and the environment. The RAOs are intended to be specific to the affected media, but sufficiently broad so as not to unreasonably restrict the potential remedial technology available. The RAOs developed for the IWOU address the COCs, media of concern, and potential exposure pathways identified during the risk assessment. Because of the industrial nature of the LCAAP, the exposure scenarios evaluated in the human health risk assessment were primarily limited to industrial exposure frequencies and durations. Because of the use restriction imposed by the industrial exposure scenarios, LUCs will be a required component of the Selected Remedies at the IWOU to be protective of sensitive populations and the higher exposure frequencies and durations that would be associated with a UUUE scenario. Therefore, use restrictions would be implemented by the Army at the IWOU to limit future use of the site to industrial only. The RAOs for Area 23 are to:

- Prevent exposure to manganese in soil above the cleanup levels identified in Table 7.

The rationale for the RAO is to protect receptors from contaminated media at unacceptable potential risk levels. Achieving the RAO will eliminate the potential risk by removing impacted soil at concentrations above cleanup levels, thus eliminating exposure to contaminated soil.

The proposed actions for soil remediation would successfully meet the RAOs and comply with ARARs.

2.23.5 Description of Area 23 Alternatives

The remedial alternatives for each Area in the IWOU are presented in **Table 8**, along with their estimated present-worth and life-cycle costs. A narrative description of these remedial alternatives is given in the following section.

The only potentially complete exposure pathway that poses an unacceptable risk to human health is exposure to fugitive dust emissions during construction activities. Due to the limited applicability and lack of practical appropriate methods to mitigate future construction/utility worker exposures to fugitive dust emissions, alternatives of no action and implementation of LUCs (e.g. engineering controls) were the only remedial alternatives considered for Area 23, and the technology screening process for the general response actions was not conducted.

Alternative 1: No Further Remedial Action

Estimated Capital Cost: $0
Estimated Annual O&M Cost: $0
Estimated Present Value: $0

The NCP and USEPA's guidance for conducting RI/FS investigations requires that the "No Action" option be developed and examined as a potential remedial action for all sites. The "No Action" option is retained and examined as a baseline with which other remedial actions are compared. The "No Action" alternative does not address the baseline conditions associated with unacceptable risk to potential future site worker and construction/utility worker exposures and does not achieve the RAOs established at the IWOU.

Alternative 2: Implementation of Land Use Controls

Estimated Capital Cost: $0
Estimated Annual O&M Cost: $10,000
Estimated Present Value: $173,000

The risk assessment results for Area 23 indicate that exposure to manganese via inhalation of dust presents a potentially unacceptable risk associated with soil. LUCs will be designed to address any activities that create the potential for generation of fugitive dust emissions, such as excavation, by requiring the use of dust control measures and proper health and safety procedures during excavation activities. This will be accomplished by setting requirements for the use of dust control measures and proper health and safety procedures, which will be enforced as long as manganese-contaminated soil remains at Area 23. Details of the specific LUCs will be included in the RD/RAWP. LUCs will be selected as part of this ROD and implemented in accordance with the LUCIP. The Army will enforce these LUCs and maintain the integrity of the remedial technologies at Area 23. LUCs must be enforced to maintain industrial land use.

2.23.6 Principal Threat Wastes

The NCP establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable (NCP §300.430[a][1][iii][A]). Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure.

There are no existing principal threat wastes at Area 23. Low-level threat wastes have been identified in surface and subsurface soil at Area 23. Implementation of LUCs was selected to provide sustained mitigation of exposure to contaminants.

2.23.7 Selected Remedy for Area 23

Based on the requirements of CERCLA, comparative analysis using the nine criteria, public comments, and in consultation with the USEPA and the state, the USEPA and Army have selected the following remedy for Area 23. For all the Selected Remedy, the LUCs will be imposed to ensure that the site remains industrial use only. The Selected Remedy for Area 23 is Alternative 2 - Implementation of LUCs.

2.23.7.1 Summary of the Rationale for the Selected Remedy for Area 23

Alternative 1 (No Action) does not meet ARARs. The Selected Remedy for Area 23 is implementation of LUCs, which will be protective of human health and the environment by ensuring that potentially unacceptable risks related to future construction/utility worker exposure to manganese in soil via inhalation of fugitive dust emission are minimized by requiring the use of dust control measures and proper health and safety procedures. These controls would include uses that may require proper personal protective equipment (PPE) for monitoring or construction activities that may result in contact with impacted media. These controls would also protect off-site receptors because Area 23 is located on the interior of the Installation. LUCs will be enforced until UUUE conditions are achieved. Specific controls will be addressed in the LUCIP.

2.23.7.2 Description of the Selected Remedy for Area 23

The Selected Remedy includes the use of LUCs to protect construction/utility worker exposure to wind-blown fugitive dust. At Area 23, LUCs will be designed to address any activities that create the potential for generation of fugitive dust emissions, such as excavation, by requiring the use of dust control measures and proper health and safety procedures during excavation activities. In addition, LUCs will be imposed to ensure that the site remains industrial use only.

The LUCs evaluated during the FS provide administrative support to aid in the overall protection of human health and the environment. In addition, the LUCs comply with ARARs by allowing implementation of necessary restrictions to limit exposure. The implementation of LUCs will provide multiple layers of protection to ensure effectiveness. The specifics regarding the implementation of LUCs at Area 23 will be detailed in the LUCIP.

The implementation of LUCs is the only component of the Selected Remedy for Area 23. The LUCs for Area 23 will be designed to protect construction worker exposure to manganese in soil via inhalation of fugitive dust emission by requiring the use of dust control measures and proper health and safety procedures. These controls would include uses that may require proper PPE for monitoring or construction activities that may result in contact with impacted media. LUCs will remain in place until cleanup levels (unrestricted use at this Area) are met. The performance of the LUCs will be evaluated in regular monitoring reports.

2.23.7.3 Summary of the Estimated Remedy Costs for Area 23

The cost estimate provided in **Table** 8 is based on the best available information regarding the anticipated scope of the remedial alternative. The cost provided is for administrative fees associated with implementing LUCs and the LUCIP. Cost elements are likely to change as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD amendment. The cost provided in **Table** 8 is an order-of-magnitude engineering cost estimate that is expected to be within 30 to 50 percent of the actual project cost.

2.23.7.4 Expected Outcomes of the Selected Remedy at Area 23

The purpose of the response action for this Area is to prevent exposure to impacted soil with concentrations of COCs higher than cleanup levels (Table 7).

- The current and future land use for LCAAP has been determined to be industrial, so the land use must remain consistent with this determination. There are no additional restrictions on land use following the remedial response action.

- The cleanup levels for soil at IWOU are provided in **Table** 7. These cleanup levels were determined based on the USEPA Industrial PRG for manganese. LUCs will remain in place at IWOU as long as concentrations in soil and groundwater do not meet UUUE.

- The beneficial socio-economic and community revitalization impacts include elimination of exposure to identified contamination at this particular AOC. Due to the nature of the operations at LCAAP and the long-term management that will be required in the IWOU, the remaining benefits are not applicable.

2.23.7.5 Selected Remedy Performance Objectives and Performance Criteria for Area 23

The Selected Remedy was selected based on its overall effectiveness and ability to achieve the cleanup levels. Due to the limited applicability of appropriate methods to mitigate future construction/utility worker exposures to fugitive dust emissions, the technology screening process was omitted, and LUCs were the only practical remedial option. Through the use of LUCs, the Selected Remedy achieves the following RAOs:

- Prevent exposure to manganese in soil above the cleanup levels identified in **Table 7.**

The performance objectives of the LUCs for this Area are to prevent exposure to COCs at concentrations above cleanup levels. There is no active remedial action for Area 23, and the Area is currently available for industrial/commercial use. The performance evaluation criterion to determine that these objectives are being achieved is the implementation of LUCs as outlined in the LUCIP. LUCs will be implemented within the boundaries of the Area to ensure that exposure to COCs in dust is eliminated.

2.23.8 Statutory Determinations

Section 121 of CERCLA and the NCP establish several statutory requirements and preferences. These specify that, when complete, the selected remedy must achieve adequate protection of human health and the

environment and comply with ARARs unless a statutory waiver is justified. The selected remedy must also be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment (as a principal element) that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes, with a bias against off-site disposal of untreated wastes. The following sections describe how the Selected Remedy satisfies or does not satisfy the statutory requirements of CERCLA Section 121.

2.23.8.1 Protection of Human Health and the Environment

The Selected Remedy addresses health and environmental issues that were identified in the Area 23 Remedial Investigation and Risk Assessments in the media of soil. Specifically, the remedial actions prevent exposure to manganese in soil at Area 23 by using engineering controls to prevent exposure to wind-blown dust during construction activities.

The selected soil remedies will achieve RAOs for soil and reduce and maintain cumulative risk within acceptable levels.

2.23.8.2 Compliance with ARARs

The Selected Remedy for Area 23 complies with location- and action-specific ARARs. There are no chemical-specific ARARs for soil. Cleanup levels have been established for the soil COCs at Area 23 based on the Region 9 Industrial PRG.

2.23.8.3 Cost Effectiveness

The Selected Remedy is cost-effective and represents a reasonable value for the money to be spent. The following definition was used in m environment **(Table 7).** There are no action-specific ARARs for Alternative 2. Cleanup levels are presented in **Table 7** making this determination: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (NCP §300.430[f][1][ii][D]). Overall effectiveness was compared to costs to determine cost effectiveness. Because of the limited amount of waste and limited applicability of appropriate technologies, only two alternatives were evaluated for this Area (No Action and Implementation of LUCs). The "No Action" alternative does not address the baseline conditions associated with unacceptable risk to potential construction/utility worker exposures and does not achieve the RAOs. Therefore, only implementation of LUCs is effective. The estimated present-worth cost of the Selected Remedy is $173,000, and it will satisfy CERCLA requirements.

2.23.8.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Extent Possible

The Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at Area 23. Of those alternatives that are protective of human health and the environment and comply with ARARs, the selected remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element and bias against off-site treatment and disposal and considering state and community acceptance.

2.23.8.5 Preference for Treatment as a Principal Element

The NCP establishes an expectation that USEPA will use treatment to address the principal threats posed by a site wherever practicable (NCP §300.430[a][1][iii][A]). No principal threat wastes have been identified at Area 23.

Because of the indicated non-hazardous nature of chemicals in dust, manganese is considered a low-level threat waste.

Five-Year Review Requirements

Five-year reviews of the Selected Remedy will be performed because contaminants will remain in soil and groundwater at concentrations that do not allow for UUUE. These reviews will be conducted at least every 5 years after commencement of the remedial action, until concentrations of contaminants are reduced to levels that allow for UUUE, to ensure that the remedy continues to adequately protect human health and the environment.

2.23.9 Documentation of Significant Changes

All written and verbal comments submitted during the January 2007 public meeting and comment period were reviewed, and it was determined that no significant changes to the remedy, as outlined in the 2007 Proposed Plan, were necessary or appropriate.

2.24 Area 24 - Former Sewage Treatment Plant

2.24.1 Site Characteristics

Area 24 occupies approximately 30 acres and is located north of Area 8 and west of Area 7 in the west-central portion of the Installation. This Area is the site of the now-inactive Sanitary Wastewater Treatment Plant, which operated from 1941 until the industrial wastewater and sanitary wastewater streams were combined to go to the Little Blue Valley Sewer District in 1990.

The suspected source of potential contamination is the former sanitary wastewater treatment plant. **Figure 57** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. The sanitary wastewater treatment plant was identified in the PA/SI as one of the 74 potentially contaminated sites; however, it was not included in any site investigations carried out under the PA/SI. In July 2000, the USACE collected six surface soil samples (24SO07 through 24SO12) and analyzed them for SVOCs, PAHs, and explosives. The coordinates were not available for the locations of the surface soil samples; therefore, the sample locations are not defined. Soil and direct-push groundwater samples were collected as part of the 2004 RI conducted by ARCADIS. Based on the results of the groundwater samples, two new monitoring wells (24MW01 and 24MW02) were installed.

2.24.2 Current and Potential Future Land and Water Uses

Area 24 is located within the active manufacturing area. Area 24 includes several abandoned structures that were associated with sewage treatment processes. Area 24 is currently unused, and all buildings have been

abandoned. A fence currently surrounds the LCAAP facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Current land use of Area 24 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.24.3 Summary of Human Health Risk Assessment – Area 24

The Area 24 HHRA characterized potential risks in a manner consistent with the risk assessment principles and practices established by the USEPA Risk Assessment Guidance for Superfund (USEPA 1989). The HHRA is discussed further in the Final IWOU RI/FS (ARCADIS 2006) and is summarized in the following sections.

2.24.3.1 Identification of Chemicals of Concern

The observed concentrations of the human health risk drivers and the calculated and exposure concentrations are summarized in **Table 2.** The 95th Upper Confidence Limit of the mean was calculated and used as the exposure concentration following USEPA guidance. PCE, TCE, vinyl chloride, and manganese were identified as COCs in groundwater.

2.24.3.2 Exposure Assessment

The assessment of exposure includes characterization of the physical environment, identification of exposure pathways (including migration pathways, exposure points, and exposure routes), and identification of potentially exposed individuals and populations. Due to the industrial nature of the LCAAP and the IWOU in particular, the exposure scenarios evaluated in the HHRA were limited to industrial exposure frequencies and durations. Based on the current and reasonably anticipated future land uses of Area 24, the following complete or potentially complete exposure pathways and receptors were identified:

- Future site workers may be exposed to COPCs in surface soil via incidental ingestion and inhalation of wind-blown fugitive dust. Future site workers may also be exposed to COPCs in groundwater via ingestion of groundwater used as potable water, dermal contact while washing hands, and inhalation of volatile COPCs migrating to indoor air.

- Future construction/utility workers may be exposed to COPCs in combined surface and subsurface soil via incidental ingestion, dermal contact, and inhalation of dust during excavation activities. Future construction/utility workers may also be exposed to COPCs in groundwater via dermal contact and inhalation of VOCs.

- Current and future maintenance workers may be exposed to COPCs in surface soil via incidental ingestion, dermal contact, and inhalation of wind-blown fugitive dust.

- Current and future adult and youth visitors/trespassers may be exposed to COPCs in surface soil via incidental ingestion and dermal contact.

Note that no sediments or surface water are present at Area 24; therefore, exposure pathways are not presented here.

Table 3 tabulates key exposure assumptions and intake parameters used in the evaluations. The migration pathways and receptors developed from the CSEM are shown on **Figure 59.**

2.24.3.3 Toxicity Assessment

The toxicity assessment results in the selection of appropriate toxicity values to use in estimating potential health risks associated with exposure. This is accomplished by reviewing the available information on the toxicity of the COCs and summarizing the factors pertinent to the exposures being assessed.

Chemical-specific CSFs and weight-of-evidence classifications were compiled for cancer endpoints. The weight-of-evidence classification describes the likelihood that a chemical is a human carcinogen based on the supporting evidence of carcinogenicity in human and animal studies (USEPA 1999b). Cancer toxicity values are summarized in Table 4.

Chemical-specific RfDs were compiled for non-cancer health effects. Chronic RfDs were used to assess long-term exposures ranging from 7 years to a lifetime. Subchronic RfDs were used to evaluate the potential for adverse health effects associated with exposure to constituents over a period of 2 weeks to 7 years. Subchronic RfDs were used to evaluate the short-term construction worker hazards. Non-cancer toxicity values are summarized in Table 5.

Primary organs/systems affected by COCs are the liver (PCE, TCE, and vinyl chloride) and central nervous system (manganese). With the exception of manganese, the remaining COCs elicit cancer effects. The primary source for toxicity values, such as CSFs and RfDs, is USEPA's IRIS. In addition, the following provisional or draft toxicity values were utilized in the HHRA:

- Provisional toxicity values were obtained for TCE from the NCEA.
- CSFs for PCE were obtained from the California Environmental Protection Agency.

2.24.3.4 Risk Characterization

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time with an RfD derived for a similar exposure period. The ratio of the exposure to toxicity is an HQ. An HQ lower than 1 indicates that a receptor's dose of a single contaminant is lower than the reference dose, and that toxic noncarcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all COCs that affect the same target organ or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI lower than 1 indicates that, based on the sum of all HQs from different COCs and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. An HI higher than 1 indicates that site-related exposure may present a potential risk to human health.

Potential carcinogenic (cancer) risks are classified by the increased probability of a person getting cancer in his or her lifetime (i.e., excess lifetime cancer risks) from being exposed to known or suspected cancer-causing chemicals at the site. Excess lifetime cancer risks are determined by multiplying the exposure with the slope factor. These risks are probabilities that are generally expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that, as a plausible upper bound, an individual has a one in 1,000,000

chance of developing cancer over a 70-year lifetime as a result of site-related exposure to a carcinogen, under the specific exposure conditions at a site. USEPA's generally acceptable carcinogenic risk range is between 1 x 10^{-4} and 1 x 10^{-6}. This means that there is an increased probability of one additional case in 10,000 to one case in 1,000,000 that an individual will develop cancer above the expected normal rate of 250,000 per 1,000,000 (or one in four).

Table 6 summarizes the risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of exposure, as well as the toxicity of the COCs. The total risk for a site worker's exposure to groundwater used as a potable water supply at Area 24 is 6 x 10^{-4}, and the HI is 6. Additionally, total risks from exposure to impacted soil and groundwater are presented in detail (by pathway) in Appendix A. These risk levels indicate that, if no cleanup action is taken, an individual would be exposed to an unacceptable risk or hazard as a result of site-related exposure to PCE, TCE, vinyl chloride, and manganese in groundwater used as a potable water supply in Area 24. Remedial action associated with COCs in groundwater is included in Section 2.35.

Results of the baseline Risk Assessment indicate that contaminants are not present in soil above human health or ecological risk levels; therefore, there will be no remedial action performed for soil at this Area. However, PCE, TCE, vinyl chloride, and manganese are present in groundwater at concentrations above screening levels as shown on Figure 58. Groundwater at Area 24 will be addressed as part of the IWOU-Wide Groundwater program. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.24.4 Summary of Ecological Risk Assessment – Area 24

In addition to an assessment of human risk, EPA also requires that the baseline risk be evaluated for ecological receptors, such as animals, that live in and around the contaminated areas. An ERA was conducted in accordance with the Final Risk Assessment Work Plan for LCAAP (ARCADIS 2004a) to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents. An ERA was performed for Areas that were not in the manufacturing area of the plant, including Area 24. No COCs were identified in the ERA for Area 24.

2.25 Area 25 - Asbestos Siding Disposal Area

2.25.1 Site Characteristics

Area 25 occupies approximately 11 acres and is located in the western portion of the Installation just south of the Big Ditch and adjacent to the western Installation boundary. This Area contains a disposal area that received transite asbestos wastes from Installation construction activities. The transite material was spread out on the ground and was put into a ditch at the dump location. The date when the material was disposed of is unknown.

The suspected source of potential contamination is an asbestos disposal ravine. **Figure 60** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. The only investigation conducted in this area was the Supplemental Field Investigation by Burns and McDonnell in 1999. The purpose of this investigation was to determine if the construction debris

had impacted ditch sediments. Three surface water/sediment samples were collected (25SD/SW01 through 25SD/SW03) from locations upgradient, within, and downgradient of the observed debris in the drainage swale.

A removal action was conducted in 2005 to remove asbestos at Area 25. Results of sampling conducted after completion of this removal indicate that these contaminants are not present in soil at concentrations above screening levels (USEPA Region 9 Industrial PRGs for soil). No further action is proposed for soil or groundwater in this Area. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.25.2 Current and Potential Future Land and Water Use

Area 25 is located on the western boundary of the Installation in the thickly wooded area on the edge of the western uplands. This Area also includes a ravine. Area 25 is currently unused, and no inhabitable buildings are present. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Current land use of Area 25 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.25.3 Summary of Human Health and Ecological Risk Assessment – Area 25

A site-specific HHRA and ERA were not conducted for Area 25 because all contaminated material has been removed. The confirmation sampling results demonstrate that the soil remaining at the base of the excavated area and surrounding soil in the ravine were not impacted by transite materials; therefore, no constituents remaining in soil present an unacceptable risk to human health or the environment under the current site conditions and exposure scenarios considered for Area 25, and a site-specific risk assessment was not prepared. Controls will be necessary to ensure that land and use is restricted to industrial use only.

2.26 Area 26 - Roofing Tar Waste Disposal Area

2.26.1 Site Characteristics

Area 26 occupies approximately 4 acres and is located in the south-central portion of the facility adjacent to the southern property boundary. This Area contains a disposal area that received roofing material from Installation construction activities. The history of the site is largely unknown. The roofing materials waste disposal area is located on the east side of the access road 150 yards from the intersection of the access road with the south perimeter road. The waste consisted of mounds of tarry material interspersed with a covering of coarse-grained sand and fine gravel. Figure 61 presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. Six surface soil samples were collected from the tarry material and sand during the Phase II RI Program.

A removal action was conducted in 2005 to remove waste material at Area 26. Results of sampling conducted after completion of this removal indicate that these contaminants are not present in soil at concentrations above screening levels (USEPA Region 9 Industrial PRGs for soil). No further action is proposed for soil or groundwater in this Area. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.26.2 Current and Potential Future Land and Water Use

Area 26 is located in the western uplands, on the southern boundary of the Installation. Area 26 is currently unused, and no inhabitable buildings are present. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Current land use of Area 26 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.26.3 Summary of Human Health and Ecological Risk Assessment – Area 26

A site-specific HHRA and ERA were not conducted for Area 26 because all contaminated material and waste has been removed. The confirmation sampling results demonstrate that the soils remaining at the base of the excavated area and surrounding soil within Area 26 were not significantly impacted by the debris or waste materials; therefore, no constituents remaining in soil present an unacceptable risk to human health or the environment under the current site conditions and exposure scenarios considered for Area 26. Controls will be necessary to ensure that land and use is restricted to industrial use only.

2.27 Area 28 - ARCO Pipeline Leak

2.27.1 Site Characteristics

Area 28 occupies approximately 7 acres and encompasses a pipeline leak that was reported to have occurred during the 1950s. The pipeline runs northeast-southwest in the southeast corner of the Installation.

The suspected source of potential contamination is a historical pipeline leak. **Figure 62** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. During the Phase II work at Area 28, EA personnel walked the path of the pipeline in an effort to locate evidence of the remnant leak. No obvious signs of a leak, such as distressed vegetation or soil staining, were found. EA concluded that, due to the age of the reported spill, it was not expected that evidence of a leak would be visible, and that furthermore, the hydrocarbon constituents would have degraded. In addition, EA completed a screening level risk assessment of Area 28 and concluded that there was no need to investigate further, recommending no further action for Area 28. Soil samples were collected as part of the 2004 RI performed by ARCADIS.

2.27.2 Current and Potential Future Land and Water Use

Area 28 is located in the southeastern corner of the Installation in the thickly wooded area of the uplands within the firing range area. Area 28 was not used during any production processes at LCAAP; rather, a historical release occurred in an underground petroleum pipeline. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Current land use of Area 28 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.27.3 Summary of Human Health Risk Assessment – Area 28

Potential risks and hazards to human health associated with site conditions at Area 28 are depicted in the CSEM presented on **Figure 63.** Under the existing conditions at Area 28, the total excess lifetime upper-bound risk estimates for current and future receptors are all lower than or within the USEPA target risk range (1×10^{-6} to 1×10^{-4}). The HIs for all receptors were lower than 1, indicating that it is unlikely that adverse effects would occur under the conditions evaluated. USEPA (1991a) guidance on the *Role* of *Risk Assessment in Superfund Remedy Selection Decisions* states that, "where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts." These results indicate that, under the current site conditions at Area 28, constituents in soil, groundwater, surface water, and sediment do not pose an unacceptable risk to human health under the exposure scenarios evaluated in this HHRA.

The total potential risks from exposure to groundwater are presented in detail (by pathway) in Appendix A. Because LCAAP is an operating industrial facility, and because the future land use is not expected to change, the HHRA evaluated industrial exposure pathways. Therefore, this Area, as with all Areas within LCAAP, will be restricted to industrial use only.

Results of the baseline risk assessment indicate that the chemicals are not present in soil or groundwater at levels that pose an unacceptable human health risk. Therefore, there will be no further remedial action performed for soil or groundwater at this Area. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.27.4 Summary of Ecological Risk Assessment - Area 28

In addition to an assessment of human risk, USEPA also requires that the baseline risk be evaluated for ecological receptors, such as animals, that live in and around the contaminated areas. An ERA was conducted in accordance with the Final Risk Assessment Work Plan for LCAAP (ARCADIS 2004a) to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents. An ERA was performed for Areas that were not in the manufacturing area of the plant including Area 28. No COCs were identified in the ERA for Area 28.

2.28 Area 29 - Construction Landfills

2.28.1 Site Characteristics

Area 29 occupies approximately 66 acres and is located along the western side of the facility next to State Highway 7. This Area contains two dumps situated along the western boundary of the Installation. The northern dump reportedly received debris from the original Installation construction activities in the 1940s. The southern dump was used during construction of the Big Ditch (between 1984 and 1987).

The suspected source of potential contamination is a construction debris landfill. Figure 64 presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. There have been two investigations performed at Area 29. EA conducted a staged Phase II Investigation in 1990 and 1992, and a SCAPS Investigation was conducted by the USACE in 1999. In addition

to these investigations at Area 29, groundwater samples have been collected from five monitoring wells at Area 29 as part of the Site-wide groundwater sampling program conducted by ARCADIS.

2.28.2 Current and Potential Future Land and Water Uses

Area 29 is located west of the active manufacturing area, on the western boundary of the Installation. Area 29 is currently not used for any purpose and is maintained as an open field. A fence currently surrounds the facility, and the perimeter of the Installation is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Current land use of Area 29 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA. Properties located to the west of Area 29 outside the perimeter fence are predominantly residential and agricultural in nature.

2.28.3 Summary of Human Health Risk Assessment – Area 29

Potential risks and hazards to human health associated with site conditions at Area 29 are depicted in the CSEM presented on **Figure 65.** Under the existing conditions at Area 29, the total excess lifetime upper-bound risk estimates for current and future receptors are all lower than or within the USEPA target risk range (1×10^{-6} to 1×10^{-4}). The HIs for all receptors were lower than 1, indicating that it is unlikely that adverse effects would occur under the conditions evaluated. USEPA (1991a) guidance on the *Role* of *Risk Assessment in Superfund Remedy Selection Decisions* states that, "where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts." These results indicate that, under the current site conditions at Area 29, constituents in soil, groundwater, surface water, and sediment do not pose an unacceptable risk to human health under the exposure scenarios evaluated in this HHRA.

The total potential risks from exposure to groundwater are presented in detail (by pathway) in Appendix A. Because LCAAP is an operating industrial facility, and because the future land use is not expected to change, the HHRA evaluated industrial exposure pathways. Therefore, this Area, as with all Areas within LCAAP, will be restricted to industrial use only.

2.28.4 Summary of Ecological Risk Assessment – Area 29

In addition to an assessment of human risk, EPA also requires that the baseline risk be evaluated for ecological receptors, such as animals, that live in and around the contaminated areas. An ERA was conducted in accordance with the Final Risk Assessment Work Plan for LCAAP (ARCADIS 2004a) to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents. An ERA was performed for Areas that were not in the manufacturing area of the plant, including Area 29. No COCs were identified in the ERA for Area 29.

Results of the baseline risk assessment indicate that contaminants are not present in soil or groundwater at levels that pose an unacceptable human health or ecological risk. Therefore, there will be no further remedial action performed for soil or groundwater at this Area. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.29 Area 30 - Burning Ground

2.29.1 Site Characteristics

Area 30 occupies approximately 34 acres and is located due north of Building 5, adjacent to the northern Installation boundary and west of Area 14. This Area was used by the Installation Fire Department to burn wooden ammunition boxes between 1951 and 1967. The Area has also been used to dispose of burning ground fly ash, laboratory glassware, and other lab-related waste.

The suspected sources of potential contamination are the burning grounds and disposal areas. Figure 66 presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. A staged Phase II Investigation was conducted by EA Engineering, Science, and Technology in 1990 and 1992. The purpose of the Phase II work was to identify and evaluate the nature and extent of potential contamination in soil and groundwater associated with former burning and other disposal operations in the area. A SCAPS Investigation was conducted to evaluate the extent of VOCs in groundwater at the boundary of the Installation. Soil and groundwater samples were collected as part of the 2004 RI conducted by ARCADIS.

2.29.2 Current and Potential Future Land and Water Uses

Area 30 is located north of the active manufacturing area, adjacent to the northern fence line where the Union Pacific Railroad borders the facility boundary. Area 30 consists of an open field, is currently unused, and no inhabitable buildings are present. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Current land use of Area 30 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.29.3 Summary of Human Health Risk Assessment - Area 30

The Area 30 HHRA characterized potential risks in a manner consistent with the risk assessment principles and practices established by the USEPA Risk Assessment Guidance for Superfund (USEPA 1989). The HHRA is discussed further in the Final IWOU RI/FS (ARCADIS 2006) and is summarized in the following sections.

2.29.3.1 Identification of Chemicals of Concern

The observed concentrations of the human health risk drivers and the calculated and exposure concentrations are summarized in **Table 2.** The 95th Upper Confidence Limit of the mean was calculated and used as the exposure concentration following USEPA guidance. Lead was identified as a COC in soil in Area 30.

2.29.3.2 Exposure Assessment

The assessment of exposure includes characterization of the physical environment, identification of exposure pathways (including migration pathways, exposure points, and exposure routes), and identification of potentially exposed individuals and populations. Due to the industrial nature of the LCAAP, particularly the IWOU, the exposure scenarios evaluated in the HHRA were limited to industrial exposure frequencies and

durations. Based on the current and reasonably anticipated future land uses of Area 30, the following complete or potentially complete exposure pathways and receptors were identified:

- Future site workers may be exposed to COPCs in surface soil via incidental ingestion and inhalation of wind-blown fugitive dust. Future site workers may also be exposed to COPCs in groundwater via ingestion of groundwater used as potable water, dermal contact while washing hands, and inhalation of volatile COPCs migrating to indoor air.

- Future construction/utility workers may be exposed to COPCs in combined surface and subsurface soil via incidental ingestion, dermal contact, and inhalation of dust during excavation activities. Future construction/utility workers may also be exposed to COPCs in groundwater via dermal contact and inhalation of VOCs.

- Current and future maintenance workers may be exposed to COPCs in surface soil via incidental ingestion, dermal contact, and inhalation of wind-blown fugitive dust.

- Current and future adult and youth visitors/trespassers may be exposed to COPCs in surface soil incidental via ingestion and dermal contact.

Although there are sediments and surface water present at Area 30, exposure pathways associated with those media are addressed as part of the Area 34, Ditch A and Ditch B risk evaluation.

Table 3 tabulates key exposure assumptions and intake parameters used in the evaluations. The migration pathways and receptors developed from the CSEM are shown on **Figure 68**.

2.29.3.3 Toxicity Assessment

The toxicity assessment results in the selection of appropriate toxicity values to use in estimating potential health risks associated with exposure. This is accomplished by reviewing the available information on the toxicity of the COCs and summarizing the factors pertinent to the exposures being assessed.

Neither a CSF nor an RfD has been developed for lead. Instead, potential risks associated with exposure to lead in surface and subsurface soil were evaluated using the USEPA ALM to predict quasi-steady-state blood-lead concentrations for each receptor. The predicted blood-lead levels were then compared to the USEPA (1994) benchmark of 5 percent probability of exceeding the 10 ug/dL blood-lead level.

2.29.3.4 Risk Characterization

Table 6 summarizes risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of exposure, as well as the toxicity of the COCs. Additionally, total risks from exposure to impacted soil and groundwater are presented in detail (by pathway) in **Appendix A**. These risk levels indicate that, if no cleanup action is taken, an individual would be exposed to an unacceptable probability of adverse health effects as a result of site-related exposure to lead in soil in Area 30. The ALM predicted the following probabilities that the blood-lead levels would exceed the benchmark:

- Construction Worker - 79 percent
- Site Worker – 61 percent
- Adult Visitor/Trespasser – 11 to 20 percent, and
- Youth Visitor/Trespasser – 5 to 14 percent.

2.29.4 Summary of Ecological Risk Assessment – Area 30

In addition to an assessment of human risk, USEPA also requires that the baseline risk be evaluated for ecological receptors, such as animals, that live in and around the contaminated areas. An ERA was conducted in accordance with the Final Risk Assessment Work Plan for LCAAP (ARCADIS 2004a) to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents. An ERA was performed for Areas that were not in the manufacturing area of the plant including Area 30.

2.29.4.1 Identification of Chemicals of Concern

The observed concentrations for the chemicals of concern, the ecological toxicity values used to identify the ecological risk drivers, and the medium-specific exposure concentrations are summarized in **Table 12** and identified copper and lead in surface soil as COCs in Area 30.

The exposure point concentration (EPC) used in risk calculation is the maximum detected concentration or the upper confidence limit (UCL) for each constituent, whichever is lowest. UCLs are the 95 percent upper estimates of the mean, assuming a normal distribution.

2.29.4.2 Exposure Assessment

The LCAAP ecosystem can be divided into three principal ecosystems: upland forest, alluvial plains/grasslands, and urban ecosystem. Slightly less than one third of the plant's 3,935 acres is forested. Of the remaining land, 326 acres are improved ground, 983 acres are semi-improved ground, and 1,452 acres are unimproved ground (Shaw 2003). Ecological exposure pathways of concern, including receptors, are summarized in **Table 13**.

In addition, the variety of wildlife observed or potentially present in these habitats was described.

This section also provides an evaluation of potential exposures to individual organisms of threatened and endangered species at the site. A threatened and endangered species literature survey was conducted for Jackson County to identify the listed species in the vicinity of LCAAP. A Certified Ecologist and a wildlife biologist conducted an ecological reconnaissance at Area 30 to characterize the available habitat and evaluate whether suitable habitat was present for the listed species.

Ten endangered species were listed for Jackson County (MDC 2005a). There are no known occurrences of any state or federally listed threatened or endangered species at LCAAP, including Area 30 (MDC 2005b).

A complete exposure pathway is "one in which the chemical can be traced or expected to travel from the source to a receptor that can be affected by the chemicals" (USEPA 2001a). Therefore, a chemical, its release and

migration from the source, a receptor, and the mechanisms of toxicity of that chemical must be demonstrated before a complete exposure pathway can be identified.

The table below summarizes the potential exposure routes for each receptor.

Organism	Possible Exposure Routes
Terrestrial animals (including soil invertebrates)	Ingestion, inhalation, surface contact, and food web
Terrestrial plants	Surface contact with soil
Aquatic or semi-aquatic animals	Ingestion, surface contact, food web
Aquatic or Semi-Aquatic plants	Uptake of surface water and surface contact with surface water and sediment

Although inhalation is listed as a possible exposure route, under most exposure conditions, inhalation pathways do not represent a significant contribution to receptor risk (USEPA 2005), and are not evaluated quantitatively in this ERA.

2.29.4.3 Ecological Effects Assessment

Assessment endpoints are the explicit expression of the ecological values to be protected (USEPA 1997). The selection of assessment endpoints depends on knowledge of the receiving environment, knowledge about the constituents released (including their toxicological properties and the relevant concentrations), and understanding of the values that will drive risk management decision-making (Suter et al. 1995).

"For the SLERA, assessment endpoints are any adverse effects on ecological receptors, where receptors are plant and animal populations and communities, habitats, and sensitive environments. Many of the ecotoxicity screening values are based on generic assessment endpoints and are assumed to be widely applicable to sites around the United States" (USEPA 1997). The vast majority of ecotoxicity screening values is limited to just a few species and a limited number of studies per species. As such, their robustness and ultimate relationship to the assessment endpoint may be limited.

Because direct measurement of assessment endpoints is often difficult (or impossible), surrogate endpoints (called measurement endpoints) are used to provide the information necessary to evaluate whether the values associated with the assessment endpoint are being protected. A measurement endpoint is a measurable ecological characteristic and/or response to a stressor (USEPA 1998). Measurement endpoints are also referred to as measures of potential effect (USEPA 1998). Measurement endpoints, such as mortality, reproductive effects, and reduced growth, are considered for the ERA; however, they are not directly measured. These measurement endpoints are indirectly evaluated in the ERA through the use of HQs. An HQ is the ratio of a constituent concentration to an associated ecotoxicity screening value. The assessment and measurement endpoints used to evaluate the ecological risk drivers are summarized for ecological risk drivers in **Table 13**.

2.29.4.4 Ecological Risk Characterization

Risks were characterized for terrestrial and aquatic ecological receptors at the IWOU based on HQs (direct contact exposure and food web modeling), with emphasis on the weight of evidence (such as conservatism of the ESVs, ESLs, and EcoSSLs), the spatial extent of elevated HQs, background levels relative to site-related concentrations, and the quality of the available terrestrial and aquatic habitat. An HQ lower than or equal to a value of 1 indicates that adverse impacts to wildlife are considered unlikely (USEPA 2001b). However, there is no clear guidance for interpreting the HQs that exceed a value of 1, except that this point of departure indicates that adverse effects of some kind may have occurred in the past or may occur in the future. The TUs are considered representative of cumulative impacts, with TUs greater than 1 indicating the potential for adverse impacts. The conclusions drawn based on the HQs, TUs, and analysis of supporting information are summarized below.

Risks to terrestrial wildlife are not likely to occur via direct contact for most of the chemicals of Environmental Concern (COPECs) evaluated in this ERA. The concentrations of copper and lead in some soil samples (collected in the northeast corner of Area 30 and in the north central area of Area 14 where samples were collected as part of the Area 30 investigation) resulted in HQs based on food web modeling that exceed 1 for the short-tailed shrew and the American robin.

Food web modeling was conducted for the American robin and for the short-tailed shrew because habitat suitable for both these species is present at or adjacent to the site, both species are known to be susceptible to many of the constituents present at the site, and both species are likely to be exposed to constituents via the food web, as they can consume a large quantity of earthworms. The concentrations of copper and lead in some soil samples (collected in the northeast corner of Area 30 and the north central area of Area 14 where samples were collected as part of the Area 30 investigation) resulted in HQs based on food web modeling that exceed 1 for the short-tailed shrew and the American robin. These results indicate that maximally exposed short-tailed shrew (and other insectivorous mammals) and American robin (and other insectivorous birds) could experience reduced reproductive success due to these metals if all exposure assumptions are met. However, when considered in conjunction with pertinent site information on the limited spatial extent of these constituents in soil (less than 1 acre), the potential for population-level impacts is considered very low.

2.29.5 Area 30 Remedial Action Objectives

The RAOs are site-specific cleanup objectives established for protecting human health and the environment. The RAOs are intended to be specific to the affected media, but sufficiently broad so as not to unreasonably restrict the potential remedial technology available. The RAOs developed for the IWOU include the COCs, media of concern, and potential exposure pathways identified during the risk assessment. Because of the industrial nature of the LCAAP, the exposure scenarios evaluated in the human health risk assessment were primarily limited to industrial exposure frequencies and durations. Because of the use restriction imposed by the industrial exposure scenarios, LUCs will be a required component of the Selected Remedies at the IWOU to be protective of sensitive populations and the higher exposure frequencies and durations that would be associated with a UUUE scenario. Therefore, use restrictions would be implemented by the Army at the IWOU to limit future use of the site to industrial only. The RAOs for Area 30 are to:

- Prevent exposure to lead in soil exceeding an average concentration of 1,197 mg/kg to achieve a predicted blood-lead level lower than 10 ug/dL with a 95 percent probability.

- Prevent exposure of ecological receptors to soils containing COCs at levels that would result in adverse population-level impacts through elimination of direct contact via vegetative soil cover.

The rationale for both RAOs is to protect receptors from contaminated media at unacceptable potential risk levels. Achieving these RAOs will eliminate the potential risk by eliminating exposure to contaminated soil.

The proposed actions for soil remediation would successfully meet the RAOs and comply with ARARs.

2.29.6 Description of Area 30 Alternatives

The contaminant of concern at Area 30 is lead based on the results of the risk assessment. Lead is present in soil ranging from 0 to 7.5 feet bgs at Area 30 above the risk-based action level of 1,197 mg/kg. Lead may pose a risk to current and future site workers, construction/utility workers, and current and future visitor and trespassers who might be exposed to lead in surface soil. Concentrations of lead in soil are presented on **Figure 67**. In addition, it was determined in the ERA that potentially unacceptable risks to terrestrial ecological receptors may result from exposure to soils impacted with copper and lead in the northeast corner of Area 30. Remedial action is necessary to prevent exposure to contaminated soils. Although chemicals are not present in groundwater at levels that present a potentially unacceptable risk, groundwater will be monitored as part of the IWOU-Wide Groundwater program in order to ensure that remaining waste does not impact groundwater. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

Remedial alternatives for soil at Area 30 are discussed below, followed by a comparative analysis of the remedial alternatives.

Five remedial action alternatives were developed for Area 30. COCs at Area 30 include lead in surface and subsurface soil. There are no COCs in groundwater at Area 30. The aerial extent of surface and subsurface soil identified as having lead concentrations in exceedance of cleanup levels is approximately 108,000 square feet **(Figure 69)**. The COCs are generally in the upper foot of soil, with maximum depths of up to 5 feet.

Detailed cost estimates for each of the Area 30 soil remedial alternatives are provided in the Final IWOU RI/FS (ARCADIS 2006). **Figure 69** identifies the locations of impacted surface and subsurface soil and delineates the areas for remedial action. Details of the Selected Remedy will be thoroughly designed and evaluated during the remedial design phase in order to realize the optimal balance among the factors of effectiveness, overall remedial timeframe, and cost.

Alternative 1: No Further Remedial Action

Estimated Capital Cost: $0
Estimated Annual O&M Cost: $0
Estimated Present Value: $0

The NCP and USEPA's guidance for conducting RI/FS investigations requires that the "No Action" option be developed and examined as a potential remedial action for all sites. The "No Action" option is retained and examined as a baseline with which other remedial actions are compared. The "No Action" alternative does not

address the baseline conditions associated with unacceptable risk to potential future site worker and construction/utility worker exposures and does not achieve the RAOs established at the IWOU.

Overall Protection

This alternative provides no controls to limit exposure to the contaminated soil and will not reduce the risks to human health or the environment. COCs will remain in surface soil at levels that exceed the allowable levels for exposure, as determined in the HHRA and ERA.

Compliance with ARARs

There are no chemical-specific ARARs for soil, although no remedial action would occur to achieve protectiveness of human health and the environment for soil as defined by the risk assessment. Alternative 1 would not comply with all location-specific ARARs. There are no action-specific ARARs for Alternative 1.

Long term Effectiveness

This alternative does not include any controls for exposure and includes no long-term management measures. Therefore, it will not mitigate any risk associated with the COCs, making it ineffective in the long term.

Reduction of Mobility, Toxicity, and Volume through Treatment

This alternative includes no treatment, containment, or removal actions and therefore will not actively reduce the toxicity, mobility, or volume of lead or copper contamination in the soil at Area 30.

Short-term Effectiveness

The no action alternative is not effective in the short term based on the findings in the HHRA and ERA that unacceptable risks for future site workers, future construction/utility workers, current/future adult visitors/trespassers, and ecological receptors could be attributed to the COCs in the impacted soil.

Implementability

Due to the lack of technical and administrative components, the no action alternative is implementable, and will not limit or interfere with the ability to perform future remedial actions. However, it is unlikely that the no action alternative would be accepted by government agencies or the public.

Cost

Because no remedial actions are performed in connection with this alternative, there are no associated O&M or capital costs.

Alternative 2: Vegetative Cover and Land Use Controls

Estimated Capital Cost: $413,000
Estimated Annual O&M Cost: $9,800

Estimated Present Value: $640,000

This remedial alternative includes on-site containment of contaminated soils using an engineered cover and implementation of LUCs. The engineered cover would be made up of a minimum 18-inch-thick compacted protective layer and a 6-inch-thick topsoil layer. A vegetation layer would be installed to control erosion at the site, and erosion control matting would be installed where necessary in the shallow drainage swale that runs across AOI 30A (East) to prevent erosion of the cover. As surficial contaminants generally pose a more immediate risk than those in the subsurface, the vegetative cap would act as a barrier between the contaminated soil of concern and the surrounding environment to limit the potential for direct exposure and thereby minimize the associated risk.

This alternative would not pose significant adverse impacts to human health or the environment during either the construction or operation periods, with minimal disturbance of the overall operational activities of the surrounding LCAAP facilities. Long-term maintenance would be required to prevent excess erosion of the cover or ponding. LUCs will be implemented as described in Section 2.7.5. LUCs will be selected as part of this ROD and implemented in accordance with the LUCIP. The Army will enforce these LUCs and maintain the integrity of the remedial technologies at Area 30. LUCs must be enforced to maintain industrial land use.

Overall Protection

Alternative 2 will eliminate the only complete exposure pathway identified in the HHRA and ERA (direct contact with the waste), thus eliminating environmental and health concerns associated with the COCs at the site. Although the contaminants will not be removed, they no longer pose a potentially unacceptable risk to human health or the environment. Soil with contaminant concentrations exceeding the chemical-specific remedial levels will remain beneath a vegetative cover.

Compliance with ARARs

There are no chemical-specific ARARs for soil. Cleanup levels have been established for the soil COC (lead) at Area 30 based on a site-specific risk assessment to ensure protectiveness of human health and the environment **(Table 7).** This alternative complies with the action-specific and location-specific ARARs for this alternative (action-specific ARARs in **Table B-10** and location-specific ARARs in **Table B-11**). The key ARARs for Alternative 2 include 10 CSR 80-2.030 which require maintenance of the cover integrity and vegetative growth to protect cover material and surface water drainage systems.

Long-term Effectiveness

Installation of a vegetative cover and implementation of LUCs will reduce the human health and ecological risks associated with lead and copper in soil at Area 30 by mitigating the potential for exposure to the contaminants. For as long as the vegetative cover and land use controls are maintained, Alternative 2 will have long-term effectiveness and permanence. A long-term management plan is necessary for inspection and maintenance of the containment system to ensure the permanence of LUCs.

Reduction of Mobility, Toxicity and Volume through Treatment

The COCs in soil at Area 30 have been shown to be immobile, as no impacts to groundwater have been observed. The use of Area 30 as a disposal area ceased in 1967; therefore, it is expected that recent groundwater data would demonstrate if any impacts to groundwater are present as a result of the COCs in soil. Groundwater samples collected in 2004 did not contain metals at concentrations above the screening levels, indicating that waste material is not currently impacting groundwater. The wells associated with Area 30 have been included in the long-term monitoring program. The data associated with the long-term monitoring of these wells will be evaluated during the 5-year review. Because no removal will be occurring, this alternative will not reduce the volume or toxicity of hazardous substances at the site.

Short-term Effectiveness

Installation of a vegetative cover can be conducted in a relatively short period of time, and will provide an immediate reduction in risk to human health and ecological receptors. Construction activities associated with installation of the cover may generate contaminated dust and particulates. These fugitive emissions can present an inhalation risk for site workers and may have an adverse impact on the environment; however, fugitive emissions can be minimized using dust control measures and proper health and safety procedures to reduce airborne migration of dust and limit exposures. In addition, the construction work associated with the installation of a vegetative cap is less intrusive than remedial alternatives including excavation activities, creating less fugitive emissions. As Area 30 is in close proximity to the perimeter of the facility, public involvement to inform the residents of the remedial activities being performed will be necessary.

Implementability

All services and materials required for installation of a vegetative cover are readily available, making this a technically feasible and easy-to-implement alternative.

Cost

The capital cost to install the vegetative cover is approximately $413,000. The cost for annual O&M of the vegetative cover is approximately $9,800 based on current year dollars. The present-worth cost for Alternative 2 is approximately $640,000 based on installation and 30 years of long-term maintenance activities.

Alternative 3: Excavation and Off-Site Disposal

Estimated Capital Cost: $3,834,000
Estimated Annual O&M Cost: $0
Estimated Present Value: $3,834,000

This alternative would include soil excavation and on-site stabilization/solidification to reduce the toxicity and leachability of the excavated soil and disposal of the treated soil at an off-site location. Alternative 3 would create minimal disturbance of the overall operational activities at the surrounding LCAAP facilities and would allow for complete removal of the contaminated soil from Area 30, eliminating any risks associated with its presence under an industrial use scenario.

The contaminated material would be physically removed using conventional construction equipment and properly disposed off-site.

LUCs will be implemented as described in Section 2.7.5. LUCs will be selected as part of this ROD and implemented in accordance with the LUCIP. The Army will enforce these LUCs and maintain the integrity of the remedial technologies at Area 30. LUCs must be enforced to maintain industrial land use.

Overall Protection

Excavation, ex-situ stabilization/solidification, and off-site disposal will allow for the complete removal of soil containing lead and copper at concentrations that pose a potentially unacceptable risk to human health and the environment. The volume of soil demonstrating characteristic properties will be stabilized to minimize the potential for leaching and to reduce the toxicity of the excavated waste. Dust control and use of safe materials handling procedures during excavation, stabilization, and hauling activities will ensure the protection of excavation workers. Appropriate precautions will also be necessary during off-site hauling and disposal operations to ensure public protection.

Compliance with ARARs

There are no chemical-specific ARARs for soil. Cleanup levels have been established for the soil COC (lead) at Area 30 based on a site-specific risk assessment to ensure protectiveness of human health and the environment **(Table 7).** This alternative complies with the action-specific and location-specific ARARs for this alternative (action-specific ARARs in **Table B-10** and location-specific ARARs in **Table B-11).** The ARARs for Alternative 3 include 40 CFR 261 A, B, C, and D, which ensure proper handling and disposal of excavated material.

Long-term Effectiveness

This alternative removes all soil containing lead and copper at concentrations that exceed target cleanup levels, eliminating associated human health and ecological risks, with no long-term management required. The contaminated soil will be stabilized to minimize toxicity and leachability, reducing the associated risk to human health and the environment.

Reduction of Mobility, Toxicity and Volume through Treatment

The total volume of soil exceeding the chemical-specific remedial levels will be excavated, stabilized, and transported to an off-site disposal facility.. The only treatment process is the stabilization/solidification process, which will limit the toxicity and mobility of metals in the excavated soils, reducing the requirements associated with transportation and disposal.

Short-term Effectiveness

Activities associated with excavation can generate contaminated dust and particulates. These fugitive emissions can present an inhalation risk for site workers and may have an adverse impact on the environment during excavation. Fugitive emissions can be minimized using dust control measures and proper health and safety procedures to reduce airborne migration of dust and limit exposures. Ex-situ treatment will be

implemented using approved methods employing engineering controls to protect the community, workers, and the environment. Risks to the public during off-site hauling operations will be minimized by employing approved engineering controls to reduce the potential for exposure.

As Area 30 is in close proximity to the perimeter of the facility, public involvement to inform the residents of the excavation, stabilization, and off-site disposal activities being performed will be necessary.

Soil excavation and treatment operations can be completed in a relatively short period of time.

Implementability

Soil excavation and ex-situ stabilization/solidification are widely used and can be performed using conventional techniques. A temporary on-site treatment pad will be installed in the immediate proximity of Area 30 to allow for reagent and soil mixing. It is anticipated that, after stabilization/solidification, less administrative effort will be required to arrange for disposal of the excavated soil because it will not require manifesting, labeling, transport, and disposal as a RCRA characteristic waste. Therefore, all services and materials required for ex-situ treatment, excavation, and transportation of the excavated soil will be readily available, making this an implementable alternative.

Cost

This alternative does not include any long-term O&M costs, so present-worth analysis is not necessary. Capital costs, including all on-site excavation and stabilization/solidification work as well as transportation and disposal costs, are estimated to be $3,834,000.

Alternative 4: In-situ Stabilization/Solidification, Vegetative Cover, Land Use Controls

Estimated Capital Cost: $2,035,000
Estimated Annual O&M Cost: $9,800
Estimated Present Value: $2,420,000

This alternative would include in-situ stabilization/solidification to limit leaching and reduce the toxicity of the contaminated soils followed by the installation of a vegetative cover to prevent disturbance of the treated soil and limit erosion. Solidifying agents, such as cement, lime, thermoplastics, or organic polymers, would be mixed into the subsurface soil using specialized machinery with augers and rotary-type mixers to reduce the toxicity, leachability, and exposure potential of the COCs within the soil. After in-situ treatment is complete, a vegetative cover consisting of a 6-inch-thick topsoil layer would be installed to support vegetation, which would minimize erosion and enhance the natural habitat while also creating a protective barrier above the treated soil. Erosion control matting would be installed where necessary in the shallow drainage swale that runs across AOI 30A (East) to prevent erosion of the cover.

LUCs would also be implemented in order to restrict activities (including building, filling, grading, and excavating) on, over, or under the land which might affect the integrity of the remedy and to preserve current and future land use restrictions.

This alternative would not pose significant adverse impacts to human health or the environment during either the construction or operation periods with minimal disturbance of the overall operational activities of the surrounding LCAAP facilities.

LUCs will be implemented as described in Section 2.7.5. LUCs will be selected as part of this ROD and implemented in accordance with the LUCIP. The Army will enforce these LUCs and maintain the integrity of the remedial technologies at Area 30. LUCs must be enforced to maintain industrial land use.

Overall Protection

In-situ stabilization/solidification with a limited topsoil cover to support vegetation will be protective of human health and the environment. The COCs in soil at Area 30 will be stabilized, reducing the toxicity of the contaminated soil. Subsequent installation of the limited vegetative cover and implementation of LUCs will limit the possibility of direct contact with the treated soil, minimizing the potential for adverse human health or environmental effects due to direct contact with the COCs.

Compliance with ARARs

There are no chemical-specific ARARs for soil. Cleanup levels have been established for the soil COC (lead) at Area 30 based on a site-specific risk assessment to ensure protectiveness of human health and the environment (**Table 7**). This alternative complies with the action-specific and location-specific ARARs for this alternative (action-specific ARARs in **Table B-10** and location-specific ARARs in **Table B-11**). The key ARARs for Alternative 4 include 10 CSR 80-2.030, which require maintenance of the cover integrity and vegetative growth to protect cover material and surface water drainage systems.

Long-term Effectiveness

In-situ stabilization/solidification with a vegetative cover will reduce the human health and environmental risks associated with lead and copper in soil at Area 30 by eliminating the potential for exposure to the contaminants. Alternative 4 will be effective for eliminating the risks associated with the site on a long-term basis. A long-term management plan is necessary for inspection and maintenance of the containment system to ensure the permanence of the cover and associated land use controls.

Reduction of Mobility, Toxicity and Volume through Treatment

In-situ stabilization/solidification will reduce the toxicity and mobility of metals in contaminated soil at Area 30. Because there are no removal activities associated with Alternative 4, there will be no reduction in the volume of material at the site.

Short-term Effectiveness

In-situ stabilization/solidification and installation of a limited vegetative cover can be conducted in a relatively short period of time, and will provide an immediate reduction in risk to human health and the environment. Construction activities associated with stabilization may generate contaminated dust and particulates. These fugitive emissions can present an inhalation risk for site workers and may have an adverse impact on the environment; however, fugitive emissions can be minimized using dust control measures and proper health and

safety procedures to reduce airborne migration of dust and limit exposures. In addition, in-situ stabilization/solidification and installation of a vegetative cap will be less intrusive than remedial alternatives including excavation; however, as Area 30 is in close proximity to the perimeter of the facility, public involvement to inform the residents of the remedial activities being performed will be necessary.

Implementability

In-situ soil stabilization/solidification at Area 30 should be a straightforward application of enhanced soil mixing processes, as the entire volume to be remediated is located above the groundwater table in shallow subsurface soils; however, because the expected average depth of remedial action extents to 5 feet bgs, it may be difficult to verify that stabilization/solidification agents have been effectively incorporated throughout the entire depth of remedial action. A bench-scale study will be conducted prior to implementation to determine the appropriate type and concentration of stabilizing/solidifying agent to be utilized in the treatment process. It is expected that the in-situ treatment process and installation of the soil cover can be completed with conventional construction equipment; therefore, Alternative 4 is a technically feasible and implementable alternative.

Cost

The capital cost to stabilize/solidify the contaminated soil in-situ and install a limited vegetative cover is approximately $2,035,000. The cost for annual O&M of the vegetative cover is approximately $9,800 based on current year dollars. The present-worth cost for Alternative 4 is approximately $2,420,000 based on installation and 30 years of long-term maintenance activities.

Alternative 5: Removal and Off-Site Disposal

Estimated Capital Cost: $4,806,000
Estimated Annual O&M Cost: $0
Estimated Present Value: $4,806,000

Under Alternative 5, the contaminated material would be physically removed using conventional construction equipment and properly disposed off site. Excavation at Area 30 would create minimal disturbance of the overall operational activities at the surrounding LCAAP facilities. This alternative does not propose any treatment of the soil prior to disposal at an off-site facility. Removal of the contaminated soil from Area 30 would eliminate any risks associated with its presence under an industrial use scenario.

LUCs will be implemented as described in Section 2.7.5. LUCs will be selected as part of this ROD and implemented in accordance with the LUCIP. The Army will enforce these LUCs and maintain the integrity of the remedial technologies at Area 30. LUCs must be enforced to maintain industrial land use.

Overall Protection

Excavation and off-site disposal will allow for the complete removal of soil containing lead and copper at concentrations that pose a potentially unacceptable risk to human health and the environment. Dust control and safe materials handling procedures will be required during excavation and transportation activities to ensure the

protection of excavation workers. Appropriate precautions will also be necessary during off-site hauling and disposal operations to ensure public protection.

Compliance with ARARs

There are no chemical-specific ARARs for soil. Cleanup levels have been established for the soil COC (lead) at Area 30 based on a site-specific risk assessment to ensure protectiveness of human health and the environment (Table 7). This alternative complies with the action-specific and location-specific ARARs for this alternative (action-specific ARARs in **Table B-10** and location-specific ARARs in **Table B-11**). The key ARARs for Alternative 5 include 10 CSR 80-2.030, which require maintenance of the cover integrity and vegetative growth to protect cover material and surface water drainage systems, and 40 CFR 261 A, B, C, and D, which ensure proper handling and disposal of excavated material.

Long-term Effectiveness

This alternative removes all soil containing lead and copper at concentrations that exceed chemical-specific remedial levels, eliminating associated human health and environmental risks with no long-term management required. The contaminants will be permanently removed from the site and, if necessary, can be treated at an off-site treatment or disposal facility.

Reduction of Mobility, Toxicity and Volume through Treatment

The total volume of soil with COC concentrations exceeding the risk-based cleanup levels will be excavated and transported to an off-site disposal facility,. No on-site treatment would occur through Alternative 5. Total lead data indicate that the soil may be hazardous and may need to be treated (off-site) prior to disposal.

Short-term Effectiveness

Activities associated with excavation can generate contaminated dust and particulates. These fugitive emissions can present an inhalation risk for on-site workers and may have an adverse impact on the environment during excavation procedures. These impacts can be minimized using dust control measures and proper health and safety procedures to reduce airborne migration of dust and limit exposures. Risks to the public during off-site hauling operations will be minimized by employing approved engineering controls to reduce the potential for exposure.

As Area 30 is in close proximity to the perimeter of the facility, public involvement to inform the residents of the excavation and off-site disposal activities being performed will be necessary.

Soil excavation and off-site disposal operations can be completed in a relatively short period of time.

Implementability

Soil excavation is widely used and can be performed using conventional techniques. It is anticipated that some administrative effort will be required to arrange for disposal of the excavated soil, but all services and materials required for excavation and transportation of the excavated soil will be readily available, making this an implementable alternative.

Cost

This alternative does not include any long-term O&M costs, so present-worth analysis is not necessary. Capital costs, including all on-site work as well as transportation and disposal costs, are estimated to be $4,806,000.

2.29.7 Summary of Comparative Analysis of Alternatives

Each alternative must undergo detailed analysis based on the threshold, primary, and modifying criteria discussed in Section 2.7.6.

2.29.8 Comparative Analysis of Area 30 Alternatives

The comparative analysis of the Area 30 alternatives is provided in the following sections and summarized in **Table 18. Table 8** summarizes cost associated with each surface soil alternative.

2.29.8.1 Overall Protection of Human Health and the Environment

With the exception of Alternative 1, each alternative is protective of human health and the environment. Alternatives 3 and 5 would satisfy RAOs by completely removing all soil containing lead and copper at concentrations that pose a potentially unacceptable risk to human health and the environment. Alternative 3 would also include treatment of the material. Alternative 2 satisfies the RAOs by limiting the possibility of direct contact with the waste. Alternative 4 satisfies the RAOs by stabilizing the COCs in soil, reducing the toxicity of the contaminated material, and limiting the possibility of direct contact with the waste. Alternatives 3 and 4 include stabilization to treat the soil; however, groundwater data indicate that stabilization is not necessary to reduce mobility of the metals since the metals do not appear to be leaching. Therefore, stabilization is not a necessary component for the remedy to meet ARARs.

2.29.8.2 Compliance with ARARs

There are no chemical-specific ARARs for COCs in soil, but there are location- and action-specific ARARs identified in **Appendix B**. Alternatives 2 through 5 can be designed to comply with the location- and action-specific ARARs.

2.29.8.3 Long-Term Effectiveness and Permanence

Alternatives 3 and 5 provide long-term effectiveness by completely removing all soil containing lead and copper at concentrations that exceed cleanup levels. No long-term monitoring and maintenance requirements are necessary for Alternatives 3 and 5. Alternative 2 provides long-term effectiveness as long as the LUCs and vegetative cover are maintained. Alternative 4 provides long-term effectiveness by stabilizing the soil and decreasing the toxicity of the COCs in soil. Alternatives 2 and 4 require long-term monitoring and maintenance and LUCs. All Alternatives include a LUC to maintain the site as industrial.

2.29.8.4 Reduction of Mobility, Toxicity, and Volume through Treatment

Only Alternatives 3 and 4 involve treatment of the soil. Under Alternative 3, contaminated soils excavated from Area 30 would be stabilized/solidified prior to off-site disposal. Under Alternative 4, contaminated soils

would be stabilized or solidified in place prior to being covered. The stabilization/solidification processes would reduce the mobility and toxicity of contaminants but not the volume.

2.29.8.5 Short-Term Effectiveness

The timeframe until RAOs would be achieved is similar for Alternatives 2 through 5, as each of the alternatives can be conducted in approximately 12 months. Construction activities associated with Alternatives 2, 3, 4, and 5 can potentially generate fugitive emissions, which may present a short-term inhalation risk for site workers and have an adverse impact on the environment; however, fugitive emissions can be minimized using dust control measures and proper health and safety procedures to reduce airborne migration of dust and limit exposures. The construction work associated with Alternative 2 is less intrusive than that associated with Alternatives 3, 4, and 5, minimizing the potential for production of fugitive emissions and limiting the short-term risks posed to both the community and workers. Risks to the community and environment are minimal, for Alternatives 2 and 4, as these Alternatives do not involve excavation and transportation of contaminated materials.

2.29.8.6 Implementability

Alternatives 2 through 5 can be completed with conventional construction equipment, and each is readily implementable.

2.29.8.7 Cost

The estimated present-worth costs for each of the alternatives are as follows:

Alternative 1: $0
Alternative 2: $640,000
Alternative 3: $3,834,000
Alternative 4: $2,420,000
Alternative 5: $4,806,000

Table 8 provides further information regarding cost.

2.29.8.8 State Agency Acceptance

The State of Missouri has expressed its support for the U.S. Army's selected alternative as described in Section 2.29.10 of this document (Selected Remedy).

2.29.8.9 Community Acceptance

Comments offered by the public were used to assess whether the proposed alternatives were acceptable to the community. The Army received four written comments during the public comment period. One of the written comments supported the Preferred Remedies, one did not support the Preferred Remedies, one was in the form of a question, and one was neutral towards the Preferred Remedies. Questions were posed to the Army regarding the proposed remedies for the IWOU during the public meeting held on 23 January 2007. Questions about the remedies posed during the public meeting appeared to be satisfactorily addressed during the meeting.

During the meeting, Mr. Greg Perry read a written statement that he opposed the remedial actions that were presented for the IWOU. Mr. Leonard Heman and other members of the public seemed to be supportive of the remedial actions at the IWOU. The questions and concerns of the community are discussed in the Responsiveness Summary, which is **Appendix C** of this ROD.

2.29.9 Principal Threat Wastes

The NCP establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable (NCP §300.430[a][1][iii][A]). Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure.

There are no existing principal threat wastes at Area 30. Low-level threat wastes have been identified in surface and subsurface soil at Area 30. Containment strategies were selected to provide sustained isolation of contaminants and to limit direct contact over long periods of time.

2.29.10 Selected Remedy for Area 30

Based on the requirements of CERCLA, comparative analysis using the nine criteria, public comments, and in consultation with the USEPA and the state, the USEPA and Army have selected the following remedies for Area 30. For all of the Selected Remedies, the LUCs will be imposed to ensure the site remains industrial use only. The Selected Remedy for Area 30 is Alternative 2 - Placement of a Vegetative Cover and LUCs.

2.29.10.1 Summary of the Rationale for the Selected Remedy for Area 30

The Selected Remedy includes placement of a vegetative cover and implementation of LUCs. Vegetative cover and LUCs is the Selected Remedy because exposure of COCs to human and ecological receptors is mitigated, and the cost differential between this remedy and the other alternatives is significant, with the cost of the selected remedy being more than one order of magnitude lower than the cost of the other alternatives. Alternatives 3 and 5 include removal of the material, which appears to contain solid waste and would therefore be difficult and costly to remove. In addition, Alternative 4 includes in-situ stabilization which would also be difficult due to the presence of solid waste in the subsurface. Performance objectives, including confirmation sampling, would be difficult to achieve for Alternative 4. The Selected Remedy provides protection to human and ecological receptors by eliminating direct contact with the impacted soil through the installation and maintenance of a vegetative soil cover. The Selected Remedy can be implemented quickly to eliminate any risk to human health or the environment, and provides long-term effectiveness and implementability with minimal cost. The Selected Remedy does not reduce the toxicity, mobility, or volume of the contaminated media. The COCs in soil at Area 30 have been shown to be immobile, as no impacts to groundwater have been observed under the current subsurface conditions.

2.29.10.2 Description of the Selected Remedy for Area 30

The Selected Remedy for Area 30 includes placement of a vegetative soil cover over impacted soil. Under the Selected Remedy, contaminants will be left in place at the site, and it will be necessary to limit the potential for exposure and minimize any environmental impacts. As surficial contaminants generally pose a more immediate risk than those in the subsurface, the vegetative cap will act as a barrier between the soil of concern and the surrounding environment to limit the potential for direct exposure and minimize the associated risk. The engineered cover will be made up of a minimum 18-inch-thick compacted protective layer and a 6-inch-thick topsoil layer. This will be sufficient cover to be protective of human health and ecological receptors. A vegetation layer will be installed to control erosion at the site, and erosion control matting will be installed where necessary in the shallow drainage swale that runs across AOI 30A (East) to prevent erosion of the cover. The cover will be designed to meet action-specific ARARs (Appendix B) to provide long-term minimization of the migration of liquids through the cover; function with minimum maintenance; promote drainage and minimize erosion or abrasion of the final cover; accommodate settling and subsidence; and maintain the integrity and effectiveness of the cover, including making repairs to the cover as necessary to correct the effects of settling or erosion. **Figure 69** shows the extent of remedial action.

This alternative will not pose significant impacts to human health or the environment during either the construction or operational period, with minimal disturbance of the overall operational activities of the surrounding LCAAP facilities. Minimal long-term maintenance will be required to prevent excess erosion of the cover or ponding. LUCs will also be implemented to restrict activities such as building, filling, grading, and excavating, ensuring the integrity of the protective cover.

The implementation of LUCs is a component of the Selected Remedy for Area 30. The LUCs for Area 30 will be designed to prohibit excavation, construction, and any other activities that would compromise the integrity of the vegetative cover and ensure that routine maintenance activities are performed to preserve the integrity of the vegetative cover. LUCs will remain in place until UUUE is achieved. The performance of the LUCs will be evaluated in regular monitoring reports.

2.29.10.3 Summary of the Estimated Remedy Costs for Area 30

The information in the cost estimate summary provided in **Table 19** is based on the best available information regarding the anticipated scope of the remedial alternative. Cost elements are likely to change as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD amendment. The cost provided in **Table 19** is an order-of-magnitude engineering cost estimate that is expected to be within 30 to 50 percent of the actual project cost.

2.29.10.4 Expected Outcomes of the Selected Remedy at Area 30

The purpose of the response action for this Area is to control risks posed by direct contact with impacted surface soil through engineering and LUCs only. Exposure will be controlled by providing a barrier to contaminated soil. Long-term LUCs (via LUCIP) and site inspections will be used to ensure that the vegetative cover remains an effective barrier to direct contact. LUCs will remain in place at IWOU as long as concentrations in soil do not meet UUUE.

- The current and future land use for LCAAP has been determined to be industrial, so the land use must remain consistent with this determination.

- The beneficial socio-economic and community revitalization impacts include the containment of identified contamination at this Area. Due to the nature of the operations at LCAAP and the long-term management that will be required in the IWOU, the remaining benefits are not applicable.

- Environmental and ecological benefits will occur by containing impacted surficial soil and preventing direct contact with ecological receptors.

2.29.10.5 Selected Remedy Performance Objectives and Performance Criteria for Area 30

Through installation and maintenance of a vegetative soil cover, the Selected Remedy achieves the following RAOs:

- Prevent exposure to lead in soil at concentrations exceeding an average of 1,197 mg/kg to achieve a predicted blood-lead level lower than 10 ug/dL with a 95 percent probability

- Prevent exposure of ecological receptors to soils containing COCs at levels that would result in adverse population-level impacts through elimination of direct contact via vegetative soil cover.

The performance objectives of the vegetative cover and LUCs for this Area are to prevent exposure to COCs above cleanup levels and to prevent exposure of ecological receptors to COCs in soil. Additionally, long-term viability and integrity of the vegetative cover is a performance objective for Area 30. In addition to proper construction and maintenance of the cover, LUCs are provided for Area 30 to ensure that the integrity of the vegetative cover is maintained. Upon completion of the active remedy for Area 30, the Area will be available for industrial/commercial use. The performance evaluation criteria to determine that these objectives have been achieved are to ensure that the vegetative cover meets appropriate specifications and that a 2-foot cover is maintained by performing regular visual inspections and to ensure that the cover is sufficient by surveying the location and extent of the cover. The vegetative cover will be repaired if necessary. An additional performance evaluation criterion is to collect confirmation samples outside the limits of the vegetative cover to determine that no COCs remain in soil above cleanup levels presented in **Table 7**. Confirmation sampling procedures will be detailed in the RD/RAWP. Cleanup levels were not calculated for the COCs driving an ecological risk at Area 30. LUCs will be provided indefinitely or until UUUE is achieved.

2.29.11 Statutory Determinations

Section 121 of CERCLA and the NCP establish several statutory requirements and preferences. These specify that, when complete, the selected remedy must achieve adequate protection of human health and the environment and comply with ARARs unless a statutory waiver is justified. The selected remedy must also be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment (as a principal element) that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes, with a bias against off-site disposal of untreated wastes. The following sections describe how the Selected Remedy satisfies or does not satisfy the statutory requirements of CERCLA Section 121.

2.29.11.1 Protection of Human Health and the Environment

The Selected Remedy addresses health and environmental issues that were identified in the IWOU Remedial Investigation and Risk Assessments in the media of soil. Specifically, the remedial actions:

- Prevent exposure to COCs in soil at Area 30 exceeding the cleanup levels by installing a vegetative cover and implementing LUCs.

- Prevent exposure of ecological receptors to soils and sediments containing COCs at Area 30 by installing a vegetative cover.

The selected soil remedies will achieve RAOs for soil result in a blood-lead level lower than 10 ug/dL with a 95 percent probability.

2.29.11.2 Compliance with ARARs

The Selected Remedy for Area 30 complies with location- and action-specific ARARs. In the absence of chemical-specific ARARs for soil, cleanup levels have been established for soil COCs at Area 30 to ensure protectiveness of human health and the environment.

2.29.11.3 Cost Effectiveness

The Selected Remedy is cost-effective and represents a reasonable value for the money to be spent. The following definition was used in making this determination: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (NCP §300.430[f][1][ii][D]). Overall effectiveness was compared to costs to determine cost effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence, this alternative represents a reasonable value for the money to be spent. The estimated present-worth cost of the Selected Remedy is $640,000, and it will satisfy CERCLA requirements.

2.29.11.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Extent Possible

The Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at Area 30. Of those alternatives that are protective of human health and the environment and comply with ARARs, the Selected Remedy provides the best balance of trade-offs in terms of the five balancing criteria while also considering the statutory preference for treatment as a principal element, bias against off-site treatment and disposal, and considering state and community acceptance.

2.29.11.5 Preference for Treatment as a Principal Element

The NCP establishes an expectation that USEPA will use treatment to address the principal threats posed by a site wherever practicable (NCP §300.430[a][1][iii][A]). No principal threat wastes have been identified at Area 30.

Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment

should exposure occur. Conversely, non-principal wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure. Groundwater data demonstrate that chemicals are not leaching at a rate sufficient to adversely impact groundwater. Because of the immobile nature of chemicals in surface and subsurface soil as demonstrated by the groundwater data, they are considered a low-level threat waste.

Five-Year Review Requirements

Five-year reviews of the selected remedy will be performed because contaminants will remain in soil and groundwater at concentrations that do not allow for UUUE. These reviews will be conducted at least every 5 years after commencement of the remedial action, until concentrations of contaminants are reduced to levels that allow for UUUE, to ensure that the remedy continues to adequately protect human health and the environment.

2.29.12 Documentation of Significant Changes

All written and verbal comments submitted during the January 2007 public meeting and comment period were reviewed, and it was determined that no significant changes to the remedy, as outlined in the 2007 Proposed Plan, were necessary or appropriate.

2.30 Area 31 - Firebreak Waste Disposal Areas

2.30.1 Site Characteristics

Area 31 occupies approximately 9 acres and is located in the northeast portion of the facility just south of the Perimeter North Road. This Area contains the remnants of two shallow open pit dumps. The waste is assorted household debris, empty drums, and empty ammunition boxes. There is also evidence of some burning in the Area. The Area was probably sporadically active between the 1940s and 1960s. Some material may also have been added after that time.

The suspected sources of potential contamination are the disposal areas. **Figure 70** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. AOI 31A was investigated as part of the Phase II RI program in 1990 and 1992. Twenty surficial soil samples (31SS01through 31SS20) and one sample from a depth of 1 foot bgs (31SS01A) were collected in 1990 and analyzed for metals. In 1992, five soil borings (31B01through 31B05) were drilled to a depth of 10 feet bgs. One sample, collected from boring 31B05 at a depth of 2.5 feet bgs, was also analyzed for explosives (EA 1994).

A removal action was conducted in 2005 through 2007 to remove the waste material at Area 31. During excavation activities, UXO and DU rounds were observed. Excavation activities were halted, and the Army hired a contractor (Pica) to screen the debris and soil for any UXO. The debris and soil were also screened for radiological materials based on the presence of the DU rounds. Results of this screening produced several more DU rounds; however, the soil and debris had not been impacted by the uranium. Approximately 7,000 CY of soil and debris were removed from AOI 31A and disposed of as non-hazardous waste in an appropriate facility off site. During the excavation, approximately 330 81 millimeter UXO and eight 20 millimeter DU rounds were uncovered. These rounds were appropriately managed and disposed of off-site by the UXO contractor.

Details of the excavation and the results of the Area 31 confirmation sampling are documented in the *IWOU Housekeeping Removal Action Completion Report,* which is scheduled to be submitted to the FFA parties in July 2007 (ARCADIS 2007).Results of sampling conducted after completion of this removal indicate that these contaminants are not present in soil at concentrations above screening levels. No further action is proposed for soil or groundwater in this Area. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.30.2 Current and Potential Future Land and Water Use

Area 31 is located in the uplands along the northern border of LCAAP east of the NECOU and was used for the disposal of assorted debris. Area 31 is currently unused, and no inhabitable buildings are present. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Current land use of Area 31 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.30.3 Summary of Human Health and Ecological Risk Assessment – Area 31

As all contaminated material containing metals, VOCs, PAHs, or explosives at concentrations which exceed screening levels (USEPA Region 9 Industrial PRGs for soil) were removed as part of the removal action, a site-specific HHRA and ERA were not conducted for Area 31. Confirmation sampling was conducted to demonstrate that the soil remaining at the base of the excavated area has not been impacted at concentrations exceeding the screening levels; therefore, all constituents in soil which presented an unacceptable risk to human health or the environment under the current site conditions and exposure scenarios considered for Area 31 were removed. Controls will be necessary to ensure that land use is restricted to industrial use only.

2.31 Area 32 - Abandoned Houses

2.31.1 Site Characteristics

Scattered throughout the eastern wooded area of the Installation are the remnants of several houses that existed prior to 1940 when the Installation was founded. A survey of the Area revealed five intact houses or house basements. One of the basements contained empty drums and a tarry residue. Another one had a domestic waste dump adjacent to the foundation.

The suspected sources of potential contamination are the domestic waste disposal areas. Figure 71 presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. The only previous investigation in this area was the Phase II Investigation, conducted in 1990. The area was initially assessed to locate and investigate each house for possible waste sources. Of the ten houses originally specified, the remains of only three were discernible. One included the house with the removed drums and some associated out-buildings. Another consisted of a trash dump next to the faint remains of a foundation, and the last was a fairly intact building which is evidently frequented by hunters. The first two sites were selected for sampling based on the presence of visible waste. Activities consisted of the collection of three surface soil samples (32SS01, 32SS02, and 32SS03). Soil samples were collected from depths of 0 to 0.5 feet bgs. Samples 32SS01 and 32SS02 were collected at a former dwelling located approximately 900 feet north of the northern boundary of the Area. This dwelling had empty 55-gallon drums in the basement.

Sample 32SS03 was collected from the location of a former household rubbish pile located near a foundation of one of the former dwellings. Soil samples were collected to verify previous data as part of the 2004 RI conducted by ARCADIS.

2.31.2 Current and Potential Future Land and Water Use

Area 32 is located in the central and slightly eastern portion of the Installation in the thickly wooded area of the uplands within the 2,195-meter firing range. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Current land use of Area 32 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.31.3 Summary of Human Health Risk Assessment – Area 32

Potential risks and hazards to human health associated with site conditions at Area 32 are depicted in the CSEM presented on Figure 72. Under the existing conditions at Area 32, the total excess lifetime upper-bound risk estimates for current and future receptors are all lower than or within the USEPA target risk range (1×10^{-6} to 1×10^{-4}). The HIs for all receptors were lower than 1, indicating that it is unlikely that adverse effects would occur under the conditions evaluated. USEPA (1991a) guidance on the *Role* of *Risk Assessment in Superfund Remedy Selection Decisions* states that, "where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} and the noncarcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts." These results indicate that, under the current site conditions at Area 32, constituents in soil, groundwater, surface water, and sediment do not pose an unacceptable risk to human health under the exposure scenarios evaluated in this HHRA.

The total potential risks from exposure to groundwater are presented in detail (by pathway) in Appendix A. Because LCAAP is an operating industrial facility, and because the future land use is not expected to change, the HHRA evaluated industrial exposure pathways. Therefore, this Area, as with all Areas within LCAAP, will be restricted to industrial use only.

2.31.4 Summary of Ecological Risk Assessment – Area 32

In addition to an assessment of human risk, USEPA also requires that the baseline risk be evaluated for ecological receptors, such as animals, that live in and around the contaminated areas. An ERA was conducted in accordance with the Final Risk Assessment Work Plan for LCAAP (ARCADIS 2004a) to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents. An ERA was performed for Areas that are not located in the manufacturing area of the plant, including Area 32. No COCs were identified in the ERA for Area 32.

Results of the baseline risk assessment indicate that contaminants are not present in soil or groundwater at levels that pose an unacceptable human health or ecological risk. Therefore, there will be no further remedial action performed for soil or groundwater at this Area. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.32 Area 33 - Blending Pelletizing Area

2.32.1 Site Characteristics

This Area occupies approximately 19 acres, is located in the center of the facility, and contains a series of small buildings with blast deflector berms. Some of these structures were used in powder pouring operations, which were conducted to scale down bulk quantities of propellant.

The suspected sources of potential contamination are the building sumps. **Figure 73** presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. There have been two previous investigations in Area 33, which consisted of collecting surface soil samples, sampling production wells, and conducting a SCAPS survey. The Phase II Investigation performed by EA Engineering, Science, and Technology included the collection of four surface soil samples adjacent to and between on-site buildings. The Phase II program also included the collection of a sediment sample (33SD01A) and surface water samples (33SW01A, and 33SW01B) from the portion of Ditch B-1 which runs through Area 33. Production well 17JJ was sampled in June 2004 by ARCADIS as part of the Site-wide Groundwater Sampling Program. Soil, sediment, and surface water samples were collected by ARCADIS as part of the 2004 RI. Soil and groundwater samples were also collected as part of the inactive sumps investigation. An inactive sump within Area 33 scheduled for removal is located next to production buildings or areas and cannot be removed at this time without the potential for disturbance to plant infrastructure and significant disturbance of plant production. This sump requires future work and will be addressed as it becomes available through maintenance or construction activities, or at installation closure or transfer.

2.32.2 Current and Potential Future Land and Water Uses

Area 33 is located within the active manufacturing area. This area contains a series of small buildings with blast berms. The buildings in Area 33 are no longer active, and they are not used daily by Installation employees. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. In addition, Area 33 is located within the inner fence, which surrounds the currently active manufacturing area, making it difficult for unauthorized visitors or trespassers to access. Current land use of Area 33 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.32.3 Summary of Human Health Risk Assessment – Area 33

Potential risks and hazards to human health associated with site conditions at Area 33 are depicted in the CSEM presented on **Figure 74.** Under the existing conditions at Area 33, the total excess lifetime upper-bound risk estimates for current and future receptors are all lower than or within the USEPA target risk range (1×10^{-6} to 1×10^{-4}). The HIs for all receptors were lower than 1, indicating that it is unlikely that adverse effects would occur under the conditions evaluated. USEPA (1991a) guidance on the *Role* of *Risk Assessment in Superfund Remedy Selection Decisions* states that, "where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts." These results indicate that, under the current site conditions at Area 33, constituents in soil, groundwater, surface water, and sediment do not pose an unacceptable risk to human health under the exposure scenarios evaluated in this HHRA.

The total potential risks from exposure to soil and groundwater are presented in detail (by pathway) in **Appendix A.** Because LCAAP is an operating industrial facility, and because the future land use is not expected to change, the HHRA evaluated industrial exposure pathways. Therefore this Area, as with all Areas within LCAAP, will be restricted to industrial use only.

Results of the baseline risk assessment indicate that the chemicals are not present in soil or groundwater at levels that pose an unacceptable human health risk. Therefore, there will be no further remedial action performed for soil or groundwater at this Area. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.33 Area 34 - Ditch A and Ditch B

2.33.1 Site Characteristics

The Ditches consist of the surface water bodies and drainages across the central and northern portions of the Installation. Specifically, Area 34 includes the Ditch A system, which includes two minor ditches (Ditch 2 and Ditch 3) that flow into Ditch A. Ditch 3 is located on the southern border of Area 12, and Ditch 2 is located in the northwestern portion of Area 7. Also included in this group is the Ditch B system, which consists of all channelized ditches that flow into Ditch B.

Ditch A is the channelized remnant of West Fire Prairie Creek. It provides stormwater drainage for the western half of the Installation. Prior to 1990, Ditch A was the outfall receiver for the IWTP and the sanitary sewage plant. Ditch B is the channelized remnant of East Fire Prairie Creek. It provides stormwater drainage for the eastern half of the Installation. Ditch B received runoff from the firing range, the Building 139 Manufacturing Area, and from several of the Installation's main production and warehouse buildings.

The suspected sources of potential contamination are wastes from the various facility processes and disposal areas which may have infiltrated or percolated into the ditch systems. Figure 75 presents the CSM for this Area as it relates to potential sources, release mechanisms, exposure pathways, and the resulting sampling strategy. Three investigations involving the collection of sediment and surface water samples have been completed in the Ditch A and Ditch B systems. Roy F. Weston conducted a Phase I Investigation in 1988. A staged Phase II Investigation was conducted by EA Engineering, Science, and Technology in 1990 and 1992. A Supplemental Investigation was conducted by Burns and McDonnell in 1999. Soil, sediment, and surface water samples were collected from Ditch A and Ditch B to determine the vertical and horizontal extents of previous sample results as part of the 2004 RI conducted by ARCADIS.

2.33.2 Current and Potential Future Land and Water Uses

Area 34 includes Ditches A and B, which were constructed during the development of the Installation for the purpose of conveying stormwater off site. While the ditches are not used for specific Installation processes, they do carry stormwater runoff from interior areas of the Installation to off-site streams. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. Current land use of Area 34 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.33.3 Summary of Human Health Risk Assessment – Area 34

Potential risks and hazards to human health associated with site conditions at Area 34 are depicted in the CSEM presented on **Figure 77**. Under the existing conditions at Area 34, the total excess lifetime upper-bound risk estimates for current and future receptors are all lower than or within the USEPA target risk range (1×10^{-6} to 1×10^{-4}). The HIs for all receptors were lower than 1, indicating that it is unlikely that adverse effects would occur under the conditions evaluated. USEPA (1991a) guidance on the *Role* of *Risk Assessment in Superfund Remedy Selection Decisions* states that, "where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts." These results indicate that, under the current site conditions at Area 34, constituents in soil, groundwater, surface water, and sediment do not pose an unacceptable risk to human health under the exposure scenarios evaluated in this HHRA.

The total potential risks from exposure to soil, surface water, and sediment are presented in detail (by pathway) in **Appendix A.** Because LCAAP is an operating industrial facility, and because the future land use is not expected to change, the HHRA evaluated industrial exposure pathways. Therefore this Area, as with all Areas within LCAAP, will be restricted to industrial use only.

Results of the baseline risk assessment indicate that the chemicals are not present in soil or groundwater at levels that pose an unacceptable human health risk. Therefore, there will be no further remedial action performed for soil or groundwater at this Area. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.33.4 Summary of Ecological Risk Assessment – Area 34

In addition to an assessment of human risk, USEPA also requires that the baseline risk be evaluated for ecological receptors, such as animals, that live in and around the contaminated areas. An ERA was conducted in accordance with the Final Risk Assessment Work Plan for LCAAP (ARCADIS 2004a) to evaluate whether ecological receptors may be adversely impacted by exposure to site-related constituents. An ERA was performed for Areas that were not in the manufacturing area of the plant, including Area 34. A Screening-level Ecological Risk Assessment (SLERA) was also conducted for Area 34 (Ditch A and Ditch B drainage ditches).

2.33.4.1 Identification of Chemicals of Concern

The observed concentrations for the COCs, the ecological toxicity values used to identify the ecological risk drivers, and the medium-specific exposure concentrations are summarized in **Table 12** The following COCs were identified:

- Cadmium, chromium, copper, lead, and mercury in Area 34A sediment; and
- Acenaphthene, acenaphthylene, benzo(k)fluoranthene, benzo(g,h,i)perylene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, copper, and lead in Area 34B sediment.

The EPC used in risk calculation is the maximum detected concentration or the UCL for each constituent, whichever is lowest. UCLs are the 95 percent upper estimates of the mean, assuming a normal distribution (Gilbert 1987).

2.33.4.2 Exposure Assessment

The LCAAP ecosystem can be divided into three principal ecosystems: upland forest, alluvial plains/grasslands, and urban ecosystem. Slightly less than one third of the plant's 3,935 acres is forested. Of the remaining land, 326 acres are improved ground, 983 acres are semi-improved ground, and 1,452 acres are unimproved ground (Shaw 2003). Ecological exposure pathways of concern including receptors are summarized on **Table 13**.

2.33.4.3 Environmental Setting

Area 34 comprises two discrete and distinct intermittent drainage ditches that carry surface runoff from the Installation **(Figure 3).** Therefore, for the purpose of this ERA, the conditions in Ditch A and Ditch B are evaluated separately. This approach is reasonable because they are separate ditches that drain different portions of the Installation, and which exit the Installation at different locations (Ditch A to the northwest, and Ditch B to northeast).

2.33.4.3.1 Ditch A

Ditch A is an intermittent channelized, low-gradient drainage, which flows to the west-northwest from roughly the center of the Installation to the northwest fence line (**Figure 3**). This ditch is a manmade channel of West Fire Prairie Creek, which continues off site to the Little Blue River. Ditch A and its tributaries drain the east-central portion of the Installation, including Area 24 and Area 29. Most of Ditch A can be characterized as influent (i.e., losing water to the groundwater system), and flow is intermittent.

Riparian Habitat

The riparian habitat of Ditch A consists mostly of grasses and forbs. Common plants observed in this area include switch grass (*Panicum virgatum*), Johnson grass (*Sorghum halepense*), bull thistle (*Cirsium horridulum*), poison hemlock (*Conium maculatum*), bindweed (*Convolvulus arvensis*), yellow sweet clover (*Melilotus officinalis*), smooth sumac (*Rhus glabra*), and crown vetch (*Coronilla varia*). In most areas, terrestrial vegetation extended completely into the dry creek channel **(Figure 4).** The stream banks ranged from very shallow to steeply sloped but were completely vegetated throughout the stream course.

The area surrounding Ditch A appears to be used by a variety of terrestrial wildlife. Several deer tracks were observed in the ditch channel, as were plentiful songbirds.

Aquatic Habitat

Due to the highly intermittent nature of this ditch and the absence of water for much of the year, Ditch A is not expected to support a diverse assemblage of aquatic organisms, nor were any observed at Ditch A during the site reconnaissance. Even following several days of heavy rain, standing water was not present in this channel during the June 2004 reconnaissance. The absence of water for much of the year is demonstrated by the

presence of dense terrestrial vegetation (grasses and forbs) in the ditch channel for large portions of Ditch A. Aquatic wildlife is likely limited to opportunistic aquatic invertebrates and amphibians that could access isolated pools of water during wet periods. Some hydrophilic vegetation was observed growing in isolated areas of the channel that likely retain standing water longer than in other portions of the ditch.

2.33.4.3.2 Ditch B

Similar to Ditch A, Ditch B is an intermittent, channelized, low-gradient drainage with two main branches. The northern branch flows west-to-east across the northernmost portion of the Installation, originating in the southeast corner of Area 3 and crossing Areas 30, 14, and 22 before joining the southern branch in Area 18 and continuing off site as East Fire Prairie Creek. The southern branch flows south-to-north across the central portion of the Installation including Areas 4, 5, and 9. Depending on rainfall and/or groundwater levels, portions of Ditch B and its tributaries can be characterized as either effluent or influent. Historical records indicate that upland portions of Ditch B are most likely effluent with shallow groundwater base flow, while the reach within the alluvial flats is likely transitional.

Riparian Habitat

Riparian vegetation along the creek channel ranges from mowed grasses along portions of the southern branch, to natural grassland communities, and dense herbaceous and woody growth along the northern branch and at the confluence of these two main branches **(Figure 4).** Small trees, including racemose dogwood, willow, American elm, and red cedar were observed, as well as numerous grasses and forbs. Dogwood growth was especially dense. In the downstream portion, emergent vegetation lined the stream bank in spots **(Figure 4).** Elsewhere, terrestrial vegetation had completely colonized the banks and grown into the dry channel.

The riparian habitat of Ditch B appears to be frequented by diverse terrestrial wildlife. Raccoon tracks were observed in a dry portion of the creek channel, and numerous deer were seen in the general vicinity of the ditch. Red-winged blackbirds were plentiful, and several animal burrow entrances (entrance opening approximately 1 foot in diameter) were observed, as was a northern water snake.

Aquatic Habitat

Water levels varied considerably throughout Ditch B. Near the confluence with the southern branch, the stream channel widened considerably and contained approximately 10 inches of water that had little perceptible flow during the June 2004 reconnaissance (Figure 4). Near the Installation boundary, flowing water exceeded a depth of approximately 1 foot following several days of rain; however, during a brief January 2005 site visit, water levels were considerably lower (approximately 1 inch or less).

While channelized, Ditch B contained abundant aquatic vegetation, especially in the downstream portion; arrowhead (*Sagittaria sp.*) and duckweed (*Lemna sp.*) were both plentiful in portions of the channel. No fish were observed in any portion of Ditch B, nor were any fish-eating birds (e.g., herons, egrets). This lack of fish is not unexpected considering that the natural hydrologic regime for the ditch is intermittent, and the cycling of dry channel conditions with precipitation-fed wet channel periods prevents establishment of a robust aquatic community typical of a perennial water body.

The variety of wildlife observed or potentially present in these habitats was also described.

This section also provides an evaluation of potential exposures to individual organisms of threatened and endangered species at the site. A threatened and endangered species literature survey was conducted for Jackson County to identify the listed species in the vicinity of Lake City Army Ammunition Plant. A Certified Ecologist and a wildlife biologist conducted an ecological reconnaissance at Area 34 to characterize the available habitat and evaluate whether suitable habitat was present for the listed species.

Ten endangered species were listed for Jackson County (MDC 2005a). There are no known occurrences of any state or federally listed threatened or endangered species at LCAAP including Area 34 (MDC 2005b).

A complete exposure pathway is "one in which the chemical can be traced or expected to travel from the source to a receptor that can be affected by the chemicals" (USEPA 2001a). Therefore, a chemical, its release and migration from the source, a receptor, and the mechanisms of toxicity of that chemical must be demonstrated before a complete exposure pathway can be identified.

The table below summarizes the potential exposure routes for all receptors.

Organism	Possible Exposure Routes
Terrestrial animals (including soil invertebrates)	Ingestion, inhalation, surface contact, and food web
Terrestrial plants	Surface contact with soil
Aquatic or semi-aquatic animals	Ingestion, surface contact, food web
Aquatic or Semi-Aquatic plants	Uptake of surface water and surface contact with surface water and sediment

Although inhalation is listed as a possible exposure route, under most exposure conditions, inhalation pathways do not represent a significant contribution to receptor risk (USEPA 2005), and so they are not evaluated quantitatively in this ERA.

2.33.4.4 Ecological Effects Assessment

Assessment endpoints are the explicit expression of the ecological values to be protected (USEPA 1997). The selection of assessment endpoints depends on knowledge of the receiving environment, knowledge about the constituents released (including their toxicological properties and the relevant concentrations), and understanding of the values that will drive risk management decision-making (Suter et al. 1995).

"For the SLERA, assessment endpoints are any adverse effects on ecological receptors, where receptors are plant and animal populations and communities, habitats, and sensitive environments. Many of the ecotoxicity screening values are based on generic assessment endpoints and are assumed to be widely applicable to sites around the United States" (USEPA 1997). The vast majority of ecotoxicity screening values is limited to just a

few species and a limited number of studies per species. As such, their robustness and ultimate relationship to the assessment endpoint may be limited.

Because direct measurement of assessment endpoints is often difficult (or impossible), surrogate endpoints (called measurement endpoints) are used to provide the information necessary to evaluate whether the values associated with the assessment endpoint are being protected. A measurement endpoint is a measurable ecological characteristic and/or response to a stressor (USEPA 1998). Measurement endpoints are also referred to as measures of potential effect (USEPA 1998). Measurement endpoints, such as mortality, reproductive effects, and reduced growth, are considered for the ERA; however, they are not directly measured. These measurement endpoints are indirectly evaluated in the ERA through the use of HQs. An HQ is the ratio of a constituent concentration to an associated ecotoxicity screening value. The assessment and measurement endpoints used to evaluate the ecological risk drivers are summarized for ecological risk drivers in Table 13.

2.33.4.5 Ecological Risk Characterization – Area 34

Risks were characterized for terrestrial ecological receptors at Area 34 based on HQs (direct contact exposure and food web modeling) and TUs (additive with conservative assumptions regarding alkylated PAHs and nondetected PAHs), with emphasis on the weight of evidence (such as conservatism of the ESV, ESL, EcoSSLs, National Oceanic and Atmospheric Administration [NOAA] values, and other screening values), the spatial extent of elevated HQs, background levels relative to site-related concentrations, and the quality of the available habitat. An HQ less than or equal to a value of 1 indicates that adverse impacts to wildlife are considered unlikely (USEPA, 2001b). However, there is no clear guidance for interpreting the HQs that exceed a value of 1, except that this point of departure indicates that adverse effects of some kind may have occurred in the past or may occur in the future. The conclusions drawn based on the HQs and analysis of supporting information are summarized below.

Risks to terrestrial ecological receptors from exposure to soil and sediment (when dry) are not likely to occur via direct contact or via the food web for the majority of the COPECs evaluated in this ERA. For Ditch A, the refined HQs based on direct contact exposure for antimony, copper, and lead exceeded the target HQ of 1. For Ditch B, the refined HQs based on direct contact exposure for copper and lead exceeded the target HQ of 1. These exceedances were discussed for both Ditch A and Ditch B, including common issues such as the basis for the ecological screening values and the limited occurrence of samples with HQs above 1. The ERA indicates that potentially unacceptable direct contact risks may result from exposure to soil and sediment impacted with antimony, copper, and lead at a few locations in Ditch A, and from exposure to copper and lead at a few locations in Ditch B.

For both Ditch A and Ditch B, food web modeling was conducted for the American robin and for the short-tailed shrew because habitat suitable for both of these species is present at or adjacent to the ditches, both species are known to be susceptible to many of the constituents present at the site, both species have relatively small home ranges, and both species are likely to be exposed to constituents via the food web, as they can consume a large quantity of earthworms.

Results from Ditch A and Ditch B indicate that concentrations of thallium resulted in HQs based on food web modeling that exceed 1 for the short-tailed shrew. These results indicate that maximally exposed short-

tailed shrew (and other insectivorous mammals) could experience reduced reproductive success due to thallium, if all exposure assumptions are met.

For aquatic organism exposure to sediment in Ditch A, refined HQs for several PAHs, cadmium, chromium, copper, lead, and mercury exceeded the target HQ of 1. The HQ exceedances for the PAHs were confined to a single sample collected from an intermittent roadside ditch immediately south of Area 19, and for the metals (cadmium, chromium, copper, lead, and mercury), the exceedances were limited to a few samples (from one to three samples in most cases). The roadside ditch located immediately south of Area 19 is not considered a viable aquatic habitat due to its lack of water except during stormwater conveyance. For the most part, the elevated concentrations for the metal COPECs were collected from very small ditches in the vicinity of Area 7 that drain into Ditch A. HQs above 1 indicate that the potential exists that maximally exposed individuals could experience adverse effects, if all exposure assumptions are met. The results indicate that potentially unacceptable risks may result if sediment-dwelling organisms are exposed to these sediments impacted by cadmium, chromium, copper, lead, and mercury.

For aquatic organism exposure to sediment in Ditch B, refined HQs for several PAHs, copper, and lead exceeded the target HQ of 1. Similar to conditions in Ditch A, the exceedances for the PAHs were confined to a single sample, and for the metals (copper and lead), the exceedances were limited to a few samples (from one to three samples in most cases). The PAHs, copper and lead were detected at an unnamed ditch immediately north of Area 33 (34A-17). In addition, copper and lead were detected in Ditch B in the southern portion of Area 18 (34B-10). HQs above 1 indicate that the potential exists that maximally exposed individuals could experience adverse effects, if all exposure assumptions are met. The results indicate that potentially unacceptable risks may result if sediment-dwelling organisms are exposed to these sediments impacted by PAHs, copper, and lead.

For surface water in Ditch A and in Ditch B, there is sufficient information to conclude that adverse impacts are unlikely for aquatic organisms that may be exposed to the surface water in Ditch A or Ditch B.

2.33.5 Area 34 Remedial Action Objectives

The RAOs are site-specific cleanup objectives established for protecting human health and the environment. The RAOs are intended to be specific to the affected media, but sufficiently broad so as not to unreasonably restrict the potential remedial technology available. The RAOs developed for the IWOU include the COCs, media of concern, and potential exposure pathways identified during the risk assessment. Because of the industrial nature of the LCAAP, the exposure scenarios evaluated in the HHRA were primarily limited to industrial exposure frequencies and durations. Because of the use restriction imposed by the industrial exposure scenarios, LUCs will be a required component of the Selected Remedies at the IWOU to be protective of sensitive populations and the higher exposure frequencies and durations that would be associated with a UUUE scenario. Therefore, use restrictions would be implemented by the Army at the IWOU to limit future use of the site to industrial only. The RAOs for Area 34 are to:

- Prevent contaminant migration of RDX to groundwater from soil above the cleanup levels identified in Table 7.

- Prevent exposure of ecological receptors to sediments containing COCs at levels that would result in adverse population-level impacts through removal of sediments contributing to the potential ecological risk via excavation.

The rationale for the first RAO is to prevent migration of RDX above cleanup levels from the soil to surrounding groundwater that could cause exceedances of drinking water standards (i.e., via leaching). The rationale for the second RAO is to protect ecological receptors from contaminated media at unacceptable potential risk levels. Achieving this RAO will eliminate the potential risk by removing the impacted soil that may pose a risk to ecological receptors, thus eliminating exposure to contaminated soil.

The proposed actions for soil remediation would successfully meet the RAOs and comply with ARARs.

2.33.6 Description of Area 34 Alternatives

RDX has been detected from 0 to 1 foot bgs at concentrations exceeding the industrial screening level in soil and sediments in an unnamed ditch located in the vicinity of Area 7 (**Figure 76**). RDX has also been detected at concentrations exceeding the tap water screening level in groundwater in the vicinity of the locations where there was a soil exceedance. The site-specific HHRA determined that risks associated with exposure to RDX in sediment and surface water are within the acceptable range as defined by the USEPA target risk range; however, RDX in the ditch in the vicinity of Area 7 appears to be contributing to groundwater contamination.

The results of the ERA indicate that potentially unacceptable risks for terrestrial wildlife and sediment-dwelling organisms may result from exposure to sediments impacted by antimony, cadmium, chromium, copper, mercury, lead, and thallium in Ditch A and from exposure to sediments impacted with PAHs, copper, lead, and thallium in Ditch B. Remedial action is necessary to prevent exposure to contaminated soils. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

The remedial alternatives for each Area in the IWOU are presented in **Table 8**, along with their estimated present-worth life-cycle costs. A narrative description of these remedial alternatives is given in the following section.

Due to the limited extent of waste material at Area 34 and the limited applicability of appropriate technologies for the treatment of isolated contaminated soil locations, alternatives of no action and excavation and off-site disposal were the only remedial alternatives considered for Area 34; as such, the technology screening process for the general response actions was not conducted. Excavation and off-site disposal was the only active remedy considered because it is the most conservative and practical approach to removal of contaminants in soil at isolated locations.

Alternative 1: No Further Remedial Action

Estimated Capital Cost: $0
Estimated Annual O&M Cost: $0
Estimated Present Value: $0

The NCP and USEPA's guidance for conducting RI/FS investigations requires that the "No Action" option be developed and examined as a potential remedial action for all sites. The "No Action" option is retained and examined as a baseline with which other remedial actions are compared. The "No Action" alternative does not address the baseline conditions associated with unacceptable risk to potential future site worker and construction/utility worker exposures and does not achieve the RAOs established at the IWOU.

Alternative 2: Excavation and Off-Site Disposal

Estimated Capital Cost: $236,400
Estimated Annual O&M Cost: $0
Estimated Present Value: $236,400

The ERA indicates that potentially unacceptable risks for terrestrial wildlife and sediment-dwelling organisms may result from exposure to sediments impacted by antimony, cadmium, chromium, copper, mercury, lead, and thallium in Ditch A and from exposure to sediments impacted with PAHs, copper, lead, and thallium in Ditch B. In addition, RDX has been detected at concentrations exceeding the industrial screening level in soil and sediments in an unnamed ditch in the vicinity of Area 7. RDX has also been detected at concentrations exceeding the tap water screening level in groundwater in the vicinity of the locations where there were soil exceedances. The site-specific HHRA determined that risks associated with exposure to RDX in sediment and surface water are within the acceptable range as defined by the USEPA target risk range. Removing the soil and sediments from the unnamed ditch in the vicinity of Area 7 will, however, reduce potential future risks to groundwater. The aerial extent of sediment identified as having RDX concentrations in Ditch A (in the vicinity of Area 7) in exceedance of cleanup levels is approximately 12,000 square feet (**Figure 78**). The RDX is in the surface sediment. The aerial extent of sediment identified as having metals concentrations in Ditch B (north of Area 33) in exceedance of cleanup levels is approximately 8,700 square feet (**Figure 79**). The metals are in the surface sediment.

Excavation and off-site disposal of the waste materials and impacted soil is proposed as Alternative 2. Under this alternative, the waste materials will be excavated and disposed of at an appropriate off-site facility.

LUCs will be implemented as described in Section 2.7.5. LUCs will be selected as part of this ROD and implemented in accordance with the LUCIP. The Army will enforce these LUCs and maintain the integrity of the remedial technologies at Area 34. LUCs must be enforced to maintain industrial land use.

2.33.7 Principal Threat Wastes

The NCP establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable (NCP §300.430[a][1][iii][A]). Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure.

There are no existing principal threat wastes at Area 34. Low-level threat wastes have been identified in sediment at Area 34. Removal strategies were selected to completely remove contaminants.

2.33.8 Selected Remedy for Area 34

Based on the requirements of CERCLA, comparative analysis using the nine criteria, public comments, and in consultation with the USEPA and the state, the USEPA and Army have selected the following remedies for

Area 34. For all of the Selected Remedies, the LUCs will be imposed to ensure that the site remains industrial use only. The Selected Remedy for Area 34 is Alternative 2 - Soil Excavation and Off-site Disposal.

2.33.8.1 Summary of the Rationale for the Selected Remedy for Area 34

The Selected Remedial action for the contaminated soil at Area 34 is excavation and off-site disposal because it:

- Eliminates the potential for future migration of contaminants from soil to groundwater permanently, minimizing the potential threat to groundwater from RDX-impacted soil.
- Mitigates risk to ecological receptors associated with contaminants in soil and sediment by removing the COCs in soil and thus the potential for contact with the COCs.

Alternative 1 (No Action) does not meet ARARs. Excavation and off-site disposal, which is the only other alternative that was evaluated, is conservatively protective of human health and the environment and is cost-effective. This remedial action also satisfies the RAOs within a reasonable timeframe. There are no chemical-specific ARARs for soil, so CERCLA requirements are satisfied by the Selected Remedy. Excavation and off-site disposal is cost-effective, implementable, permanent, and effective.

2.33.8.2 Description of the Selected Remedy for Area 34

The Selected Remedy includes removal and off-site disposal of approximately 1,000 CY of impacted soil. Under this remedy, the waste materials will be excavated and disposed of at an appropriate off-site facility. LUCs will be imposed to ensure that the site remains industrial use only. **Figure 32** shows the extent of remedial action.

Confirmation samples will be collected, as necessary, from the bases of the excavations to verify that the contaminated material has been removed, eliminating the potential for ongoing groundwater impacts related to RDX contamination in soil and decreasing population-level effects for ecological receptors.

Chemical-specific cleanup levels were not calculated for the COCs driving an ecological risk at Area 34.

Upon completion of the excavation activities, residual ecological risk will be re-calculated to verify that soil contributing to a population-level ecological risk has been removed (**Figures 78 and 79**).

The excavation activities associated with the sediments in the unnamed drainage ditch in Area 7 will be conducted subsequent to the removal action for the inactive sumps. While the entire ditch has been included in the remedial action extent (**Figure 78**), it is assumed that some or all of the sediments in the unnamed ditch that are posing an unacceptable risk to ecological receptors and groundwater have already been removed as part of the removal action for the inactive sumps. The remaining sediments identified in the remedial action extent will be excavated.

2.33.8.3 Summary of the Estimated Remedy Costs for Area 34

The information in the cost estimate summary provided in **Table 20** is based on the best available information regarding the anticipated scope of the remedial alternative. Cost elements are likely to change as a result of

new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD amendment. The cost provided in **Table 20** is an order-of-magnitude engineering cost estimate that is expected to be within 30 to 50 percent of the actual project cost.

2.33.8.4 Expected Outcomes of the Selected Remedy at Area 34

The purpose of the response action for Area 34 is to remove impacted soil with concentrations of RDX higher than cleanup levels (**Table 7**). Exposure for these Areas is controlled through off-site disposal of residuals. No concentrations of COCs higher than cleanup levels will remain on site.

- The current and future land use for LCAAP has been determined to be industrial, so the land use must remain consistent with this determination. There are no additional restrictions on land use following the remedial response action.

- The cleanup level for RDX at IWOU is provided in **Table 7**. This cleanup level was determined based on the USEPA Region 9 Industrial PRG of 16 mg/kg, which is more conservative than the calculated soil screening value for protection of groundwater of RDX for the site. Therefore, the Industrial PRG is protective of groundwater. It is estimated that the cleanup level will be achieved within approximately 1 year. Cleanup levels were not calculated for the COC's driving an ecological risk at Area 34. As a result, residual ecological risk will be re-calculated, as necessary, using the results of the confirmation samples to verify that soil contributing to population-level ecological risk has been removed. It is estimated that the RAOs will be achieved within approximately 1 year.

- The beneficial socio-economic and community revitalization impacts include elimination of identified contamination at this particular Area. Due to the nature of the operations at LCAAP and the long-term management that will be required in the IWOU, the remaining benefits are not applicable.

- Environmental and ecological benefits will occur as a result of removing impacted surface soil in this Area.

2.33.8.5 Selected Remedy Performance Objectives and Performance Criteria

The Selected Remedy provides protectiveness by applying immediate mass removal through excavation of metals and RDX in sediment. Through excavation of impacted sediment, the Selected Remedy achieves the following RAOs:

- Prevent contaminant migration of RDX to groundwater from soil at concentrations above the cleanup levels identified in Table 7.
- Prevent exposure of ecological receptors to sediments containing COCs at levels that would result in adverse population-level impacts through removal of sediments contributing to the potential ecological risk via excavation.

The performance objectives of the excavation and off-site disposal for this Area are to prevent exposure of ecological receptors to COCs, prevent contaminant migration to groundwater from soil above cleanup levels, prevent exposure of RDX above cleanup levels, and to achieve cleanup levels for RDX as verified through

confirmation sampling. Upon completion of the active remedy for Area 34, the Area will be available for industrial/commercial use. The performance evaluation criterion to determine that these objectives have been achieved is to collect confirmation samples, if necessary, from Ditch A within the excavation area and perimeter to determine that no RDX remains in soil at concentrations above cleanup levels presented in **Table 7**, and that the Hazard Quotient for all constituents driving an ecological risk are less than 1. Confirmation sampling procedures will be detailed in the RD/RAWP. LUCs will be provided indefinitely or until UUUE is achieved.

2.33.9 Statutory Determinations

Section 121 of CERCLA and the NCP establish several statutory requirements and preferences. These specify that, when complete, the selected remedy must achieve adequate protection of human health and the environment and comply with ARARs unless a statutory waiver is justified. The selected remedy must also be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment (as a principal element) that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes, with a bias against off-site disposal of untreated wastes. The following sections describe how the Selected Remedy satisfies or does not satisfy the statutory requirements of CERCLA Section 121.

2.33.9.1 Protection of Human Health and the Environment

The Selected Remedy addresses health and environmental issues that were identified in the Area 34 Remedial Investigation and Risk Assessments in the media of soil. Specifically, the remedial actions:

- Prevent exposure to COCs in soil at Area 34 exceeding the cleanup levels by excavating.
- Prevent exposure of ecological receptors to soils and sediments containing COCs at Area 34 by excavating.
- Prevent migration of RDX from soil to groundwater.

2.33.9.2 Compliance with ARARs

The Selected Remedy for Area 34 will comply with location- and action-specific ARARs. There are no chemical-specific ARARs for soil. Cleanup levels have been established for the RDX in soil at Area 34 based on the Region 9 Industrial PRG to ensure protectiveness of human health and the environment (**Table 7**). This alternative complies with the action-specific and location-specific ARARs for this alternative (action-specific ARARs in **Table B-12** and location-specific ARARs in Table B-13). The ARARs for this alternative include 40 CFR 261 A, B, C, and D, which ensure proper handling and disposal of excavated material.

2.33.9.3 Cost-Effectiveness

The Selected Remedy is cost-effective and represents a reasonable value for the money to be spent. The following definition was used in making this determination: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (NCP §300.430[f][1][ii][D]). Overall effectiveness was compared to costs to determine cost effectiveness. Because of the limited amount of waste and limited applicability of appropriate technologies, only two alternatives were evaluated for this Area (No Action and Excavation and

Off-Site Disposal). The "No Action" alternative does not address the baseline conditions associated with unacceptable risk to potential future site worker and construction/utility worker exposures and does not achieve the RAOs. Therefore, only excavation and off-site removal is effective. The estimated present-worth cost of the Selected Remedy is $236,400, and it will satisfy CERCLA requirements.

2.33.9.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Extent Possible

The Selected Remedy meets the statutory requirement to utilize permanent solutions and treatment technologies to the maximum extent practicable for Area 34 because focused excavation will permanently remove contaminated soil at Area 34.

2.33.9.5 Preference for Treatment as a Principal Element

The NCP establishes an expectation that USEPA will use treatment to address the principal threats posed by a site wherever practicable (NCP §300.430[a][1][iii][A]). No principal threat wastes have been identified at Area 34.

Five-Year Review Requirements

Five-year reviews of the Selected Remedy will be performed because contaminants will remain in soil and groundwater at concentrations that do not allow for UUUE. These reviews will be conducted at least every 5 years after commencement of the remedial action, until concentrations of contaminants are reduced to levels that allow for UUUE, to ensure that the remedy continues to adequately protect human health and the environment.

2.33.10 Documentation of Significant Changes

All written and verbal comments submitted during the January 2007 public meeting and comment period were reviewed, and it was determined that no significant changes to the remedy, as outlined in the 2007 Proposed Plan, were necessary or appropriate.

2.34 Area 00 – Pyrotechnics Area West of Area 13

2.34.1 Site Characteristics

This Area consists of the Pyrotechnics Manufacturing Area west of Area 13. There are 15 inactive sumps in this Area that were investigated as part of the Inactive Sumps Removal Action. The sumps in the Pyrotechnics Manufacturing Area are not located within any of the previously assigned LCAAP Areas that comprise the IWOU. This Area has been designated by the Army as "Area 00." Although the sumps in Area 00 are not part of Area 13, the results of the inactive sump investigation at Area 00 were presented in the Area 13 RI/FS document based on the proximity of the two areas.

The suspected sources of potential contamination are the building sumps. Area 00 was part of the Inactive Sumps Removal Action that included removal of sumps and surface soil associated with VOC, PAH, and metals contamination in this Area.

2.34.2 Current and Potential Future Land and Water Uses

Area 00 is located within the active manufacturing area. Many of the buildings in Area 00 are currently used on a regular basis. People using this area would include LCAAP site employees working in Building 35 or one of the other complexes and employees responsible for maintaining the area or utilizing the adjacent areas. A fence currently surrounds the facility, and the perimeter is regularly patrolled. Access by authorized personnel is limited to guarded entrances, and public access is restricted. In addition, Area 00 is located within the inner fence, which surrounds the currently active manufacturing area, making it difficult for unauthorized visitors or trespassers to access.

Current land use of Area 00 is classified as industrial for the purpose of identifying plausible human receptors and exposure pathways for evaluation in the HHRA.

2.34.3 Summary of Human Health Risk Assessment – Area 00

The Area 00 - Pyrotechnics Area HHRA characterized potential risks in a manner consistent with the risk assessment principles and practices established by the USEPA Risk Assessment Guidance for Superfund (USEPA 1989). The HHRA is discussed further in the Final IWOU RI/FS (ARCADIS 2006) and is summarized in the following sections.

2.34.3.1 Identification of Chemicals of Concern

The observed concentrations of the human health risk drivers and the calculated and exposure concentrations are summarized in **Table 2.** The 95th Upper Confidence Limit of the mean was calculated and used as the exposure concentration following USEPA guidance. Carbon tetrachloride, chloroform, TCE, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene were identified as COCs in groundwater in Area 00.

2.34.3.2 Exposure Assessment

The assessment of exposure includes characterization of the physical environment, identification of exposure pathways (including migration pathways, exposure points, and exposure routes), and identification of potentially exposed individuals and populations. Due to the industrial nature of the LCAAP and the IWOU in particular, the exposure scenarios evaluated in the HHRA were limited to industrial exposure frequencies and durations. Based on the current and reasonably anticipated future land uses for Area 00, the following complete or potentially complete exposure pathways and receptors were identified:

- Current and future site workers may be exposed to COPCs in surface soil via incidental ingestion and inhalation of wind-blown fugitive dust. Current and future site workers may also be exposed to volatile COPCs in groundwater migrating to indoor air via inhalation. In addition, future site workers may also be exposed to COPCs in groundwater via ingestion of groundwater used as potable water and dermal contact while washing hands.

- Future construction/utility workers may be exposed to COPCs in combined surface and subsurface soil via incidental ingestion, dermal contact, and inhalation of dust during excavation activities.

- Current and future maintenance workers may be exposed to COPCs in surface soil via incidental ingestion, dermal contact, and inhalation of wind-blown fugitive dust.

- Current and future adult and youth visitors/trespassers may be exposed to COPCs in surface soil via incidental ingestion and dermal contact.

Note that no sediments or surface water are present at Area 00; therefore, exposure pathways are not presented here. **Table 3** tabulates key exposure assumptions and intake parameters used in the evaluations.

2.34.3.3 Toxicity Assessment

The toxicity assessment results in the selection of appropriate toxicity values to use in estimating potential health risks associated with exposure. This is accomplished by reviewing the available information on the toxicity of the COCs and summarizing the factors pertinent to the exposures being assessed.

Chemical-specific CSFs and weight-of-evidence classifications were compiled for cancer endpoints. The weight-of-evidence classification describes the likelihood that a chemical is a human carcinogen, based on the supporting evidence of carcinogenicity in human and animal studies (USEPA 1999b). Cancer toxicity values are summarized in **Table 4.**

Chemical-specific RfDs were compiled for non-cancer health effects. Chronic RfDs were used to assess long-term exposures ranging from 7 years to a lifetime. Subchronic RfDs were used to evaluate the potential for adverse health effects associated with exposure to constituents over a period of 2 weeks to 7 years. Subchronic RfDs were used to evaluate the short-term construction worker hazards. Non-cancer toxicity values are summarized in **Table 5.**

The primary organ/system affected by COCs is the liver (TCE). TCE and the remaining COCs elicit cancer effects. The primary source for toxicity values, such as CSFs and RfDs, is USEPA's IRIS. In addition, the following provisional or draft toxicity values were utilized in the HHRA:

- Provisional toxicity values were obtained for TCE from the NCEA.

- CSFs for PAHs, with the exception of benzo(a)pyrene, were estimated using USEPA's relative potency approach (1993). This approach utilizes TEFs to adjust the CSF for benzo(a)pyrene for a particular PAH based on its relative potency.

2.34.3.4 Risk Characterization

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time with a reference dose derived for a similar exposure period. The ratio of the exposure to toxicity is an HQ. An HQ lower than 1 indicates that a receptor's dose of a single contaminant is lower than the RfD, and that toxic noncarcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all COCs that affect the same target organ or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI lower than 1 indicates that, based on the sum of all HQs from different COCs and exposure routes, toxic noncarcinogenic effects from all

contaminants are unlikely. An HI higher than 1 indicates that site-related exposure may present a potential risk to human health.

Potential carcinogenic (cancer) risks are classified by the increased probability of a person getting cancer in his or her lifetime (i.e., excess lifetime cancer risks) from being exposed to known or suspected cancer-causing chemicals at the site. Excess lifetime cancer risks are determined by multiplying the exposure with the slope factor. These risks are probabilities that are generally expressed in scientific notation (e.g., 1×10^{-6}). An excess lifetime cancer risk of 1×10^{-6} indicates that, as a plausible upper bound, an individual has a one in 1,000,000 chance of developing cancer over a 70-year lifetime as a result of site-related exposure to a carcinogen under the specific exposure conditions at a site. USEPA's generally acceptable carcinogenic risk range is between 1×10^{-4} and 1×10^{-6}. This means there is an increased probability of one additional case in 10,000 to one case in 1,000,000 that an individual will develop cancer above the expected normal rate of 250,000 per 1,000,000 (or one in four).

Table 6 summarizes risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of exposure, as well as the toxicity of the COCs. The total risk for a site worker's exposure to groundwater used as a potable water supply is 8×10^{-4}, and the HI is 2. Additionally, total risks from exposure to impacted soil and groundwater are presented in detail (by pathway) in Appendix A. These risk levels indicate that, if no cleanup action is taken, an individual would be exposed to an unacceptable probability of adverse health effects as a result of site-related exposure to carbon tetrachloride, chloroform, TCE, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene in groundwater used as a potable water supply in Area 00. Remedial action associated with COCs in groundwater is included in Section 2.35.

Results of sampling associated with the Inactive Sumps Removal Action indicate that contaminants are not present in soil at concentrations above human health or ecological risk levels; therefore, there will be no remedial action performed for soil at this Area. However, carbon tetrachloride, chloroform, TCE, benzo(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, benzo(a)pyrene, and indeno(1,2,3-cd)pyrene are present in groundwater at concentrations above screening levels as shown on Figure 80. Groundwater at Area 00 will be addressed as part of the IWOU-Wide Groundwater program. Controls will be necessary to ensure that land and resource use remain consistent with the assumptions used to evaluate potential risk.

2.35 IWOU-Wide Groundwater

2.35.1 Site Characteristics

A Site-wide groundwater strategy has been implemented at LCAAP which addresses groundwater as a holistic system as opposed to addressing groundwater at specific OUs or AOIs. The site characteristics of the LCAAP are presented in Sections 2.5 and 2.5.1.

Groundwater samples have been collected during various investigations from monitoring wells at the IWOU and analyzed for a combination of VOCs, SVOCs, PAHs, explosives, and total and dissolved metals. Documentation of groundwater remedial investigation activities was provided in the following reports:

- AEHA, August and December 1982, Groundwater Quality Assessment 38-26-0234-83, LCAAP

- AEHA, December 1985, *Groundwater Potential Contamination Survey No. 38-26-0901-86, LCAAP*
- USEPA, May 1986, *Geohydrologic Study No. 38-26-0922-86, LCAAP*
- EA Engineering, Science, and Technology, January 1989, *LCAAP Preliminary Assessment/Site Investigation (PA/SI) Report*
- Roy F. Weston, Inc., 1990, *Final Remedial Investigation Report, LCAAP*
- EA Engineering, Science, and Technology, February 1994, *Draft Final Remedial Investigation Report of the Installation Wide Operable Unit, LCAAP*
- USACE, July 1999, *Installation-Wide Site Characterization and Analysis Penetrometer System (SCAPS) Data Report, LCAAP*
- Burns and McDonnell, August 1999, *Installation-Wide Supplemental Field Investigation, LCAAP*

An IWOU Site-wide RI/FS was prepared to evaluate impacts to groundwater on a holistic basis. The results of the RI activities indicate that there are potentially unacceptable risks associated with groundwater contamination in Areas 1, 5, 7, 12, 13, 15, 24, and 00. Areas 1, 7, and 15 are contaminated with arsenic; Areas 5, 12, and 13 are contaminated with TCE; Areas 15 and 00 are contaminated with PAHs; and Area 24 is contaminated with PCE and vinyl chloride. In addition, there are other chemicals present in groundwater at Area 2 (lead), Area 5 (vinyl chloride), Area 7 (vinyl chloride, RDX), Area 12 (vinyl chloride), Area 20 (carbon tetrachloride), Area 24 (TCE), and Area 00 (carbon tetrachloride) at concentrations above their respective MCLs. Although these chemicals do not pose a potentially unacceptable risk based on the results of the HHRA, these chemicals will be monitored in groundwater to ensure that natural attenuation is occurring, concentrations continue to decrease over time, and that COCs are not leaching from soil. In accordance with CERCLA, a response action is generally warranted if chemical-specific standards or other measures that define acceptable risk levels are exceeded for groundwater when groundwater is a current or potential source of drinking water. A response action is necessary to ensure that MCLs are achieved.

Post-closure monitoring for Areas 1, 2, 4, 5, 6, 7, and 8 will be included as part of the long-term monitoring for IWOU-Wide Groundwater. Details of the post-closure monitoring will be presented in the RD/RAWP.

Current conditions at the IWOU are such that 1) the groundwater at IWOU does not appear to be impacted continuously by a soil source, and contaminated plumes are diminishing or stable in size and concentration; 2) contaminated groundwater is completely contained within the boundaries of the IWOU under current groundwater pumping activities at LCAAP; 3) contaminated groundwater is not migrating off site; and 4) all potable water is treated before use either via wellhead treatment (air strippers) or through the potable water treatment system.

2.35.2 Current and Potential Future Land and Water Uses

Groundwater is the principal source of water supply for LCAAP. The Lake City Aquifer serves as the principal aquifer of the Lake City area and is used extensively by LCAAP for all of its industrial and drinking water needs. There are 12 production wells screened in the lower portion of the Lake City Aquifer beneath LCAPP. In 2007, the production wells at LCAAP provide approximately 1.7 million gallons per day (gpd) of water on

average. Production wells 17AA (Area 20) and 17CC (Area 12) produce approximately 50 percent of the facility's potable water supply, with the remaining production wells supplying the rest. Many of the production wells have air strippers associated with them, and the groundwater is treated prior to delivery to the water supply system. Three extraction wells (17R, 17S, and 17FF) are pumped, and the water is treated as part of a groundwater containment system within the Area 18 OU. These three wells extract an additional 571,000 gpd and discharge the treated water to the Little Blue Valley Sewer District (LBVSD).

Currently, there are no production wells screened in the silt and clay water-bearing unit or the bedrock aquifer. There are no known restrictions on the use of water from any of these units, and these units are classified as potential sources of drinking water unless otherwise demonstrated as not being viable sources; however, groundwater occurring in the clay water-bearing and bedrock units is considered a negligible component of the overall hydrologic budget at Lake City (ARCADIS 2006). It should be noted the Army family housing residences on site do not use the LCAAP water system, but are supplied potable water by the City of Independence instead.

2.35.3 Summary of Human Health Risk Assessment – IWOU-Wide Groundwater

The IWOU-Wide Groundwater HHRA characterized potential risks in a manner consistent with the risk assessment principles and practices established by the USEPA Risk Assessment Guidance for Superfund (USEPA 1989). The HHRA is discussed further in the Final IWOU RI/FS (ARCADIS 2006) and is summarized in the following sections.

The HHRA was prepared to evaluate potential risks and hazards for three hypothetical future scenarios for the IWOU: 1) that a new production well is installed in one of 23 Areas within the IWOU, and groundwater is used as a potable water supply; 2) that untreated groundwater from the current production wells is used for potable purposes; and 3) that all production wells within LCAAP are shut down, allowing impacted groundwater beneath the installation to migrate off site. Under the third hypothetical scenario, where production wells are shut down, the Site-Wide Groundwater Evaluation/Model predicted that only impacted groundwater beneath Area 12 has the potential to migrate off site. Therefore, the HHRA specifically evaluates potential off-site residential exposure to groundwater beneath Area 12. Note that hypothetical future site worker risks and hazards associated with exposure to groundwater as a potable source were added to risks and hazards associated with exposure to groundwater and soil under existing conditions for each IWOU area.

The HHRA also discusses the cumulative risk and hazard for the current and future maintenance worker exposure to soil, sediment, and surface water throughout the IWOU. Maintenance worker risks associated with exposure to lead in soil on an IWOU-wide basis was also evaluated using a time-weighted average approach.

2.35.3.1 Identification of Chemicals of Concern

Under the three hypothetical groundwater exposure scenarios evaluated in this HHRA, future site workers and off-site adult and child residents would be exposed to chemicals in potable groundwater resulting in potential risks and/or hazards higher than an excess lifetime cancer risk greater than 1×10^{-4} to 1×10^{-6} and/or an HI is higher than 1. COCs are identified in the following section because USEPA benchmarks for acceptable risks and/or hazards were exceeded. The evaluation of potential remedial actions provided in the FS will focus on the COCs identified in the HHRA. Note that maintenance worker cumulative exposure to chemicals in soil did

not result in an unacceptable cancer risk and noncancer hazard. Thus, no COCs were identified based on maintenance worker exposure to IWOU-wide soil.

In Areas where the cumulative risk exceeded 1 x 10^{-4}, COCs are identified as individual COPCs resulting in an excess lifetime cancer risk (ELCR) exceeding the 10^{-6} level. In Areas were the target organ HI is higher than 1, COPCs contributing to the HI are identified as COCs. The following COCs have been identified in potable groundwater by Area (refer to Area-specific risk assessments for COCs in media other than potable groundwater):

- Area 1: arsenic
- Area 5: PCE, TCE, vinyl chloride, RDX, 2-nitrotoluene, and arsenic
- Area 7: vinyl chloride, RDX, and arsenic
- Area 12: TCE
- Area 13: TCE and benzo(b)fluoranthene
- Area 15: benzo(a)anthracene, benzo(a) pyrene, benzo(b)fluoranthene, and arsenic
- Area 24: PCE, TCE, vinyl chloride, and manganese
- Area 00: carbon tetrachloride, chloroform, TCE, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene

Lead in potable groundwater in Area 2 is also identified as a COC.

2.35.3.2 Exposure Assessment

The assessment of exposure includes characterization of the physical environment, identification of exposure pathways (including migration pathways, exposure points, and exposure routes), and identification of potentially exposed individuals and populations. Due to the industrial nature of the LCAAP and the IWOU in particular, the exposure scenarios evaluated in the HHRA were limited to industrial exposure frequencies and durations. Based on the current and reasonably anticipated future land uses of LCAAP, the following complete or potentially complete exposure pathways and receptors were identified:

- Future site workers may be exposed to COPCs in groundwater via ingestion of drinking water, dermal contact during hand washing and showering, and inhalation of VOCs during showering. Note that showering occurs daily in Areas 4, 5, 13, and 15; in all other Areas, showering occurs weekly. Inhalation of volatile COPCs in groundwater migrating to indoor air was not evaluated in this HHRA, as this exposure pathway was quantified in the Area-specific HHRAs.
- Future adult and child off-site residents may be exposed to COPCs in groundwater that may migrate from Area 12 via ingestion of drinking water, dermal contact during showering, and inhalation of volatile COPCs migrating to indoor air and during showering. Note that exposure to COPCs in groundwater via

hand washing was not evaluated for the off-site resident, as this is not a major exposure pathway compared with other pathways (i.e., showering).

Table 3 tabulates key exposure assumptions and intake parameters used in the evaluations. The migration pathways and receptors developed from the CSEM are shown on **Figure 81**.

2.35.3.3 Toxicity Assessment

The toxicity assessment results in the selection of appropriate toxicity values to use in estimating potential health risks associated with exposure. This is accomplished by reviewing the available information on the toxicity of the COCs and summarizing the factors pertinent to the exposures being assessed.

Chemical-specific CSFs and weight-of-evidence classifications were compiled for cancer endpoints. The weight-of-evidence classification describes the likelihood that a chemical is a human carcinogen based on the supporting evidence of carcinogenicity in human and animal studies (USEPA 1999b). Cancer toxicity values are summarized in Table 4.

Chemical-specific RfDs were compiled for non-cancer health effects. Chronic RfDs were used to assess long-term exposures ranging from 7 years to a lifetime. Subchronic RfDs were used to evaluate the potential for adverse health effects associated with exposure to constituents over a period of 2 weeks to 7 years. Subchronic RfDs were used to evaluate the short-term construction worker hazards. Non-cancer toxicity values are summarized in Table 5.

2.35.3.4 Risk Characterization

The following table summarizes the cumulative ELCRs and HIs for each of the receptors evaluated in this HHRA. Note that the hypothetical future risks and hazards presented below are cumulative for all exposure scenarios. In other words, future exposure to groundwater as a potable source was added to risks and hazards associated with exposure to groundwater as a non-potable source and soil under existing conditions.

Area	Exposure Medium	Total Risk	Total Hazard Index
1	Soil, groundwater	1×10^{-4}	2 (a)
2	Groundwater	6×10^{-5}	1 (a)
3	Soil (b), groundwater	2×10^{-4}	0.8
4	Soil, groundwater	4×10^{-5}	0.5
5	Groundwater	4×10^{-4}	7
6	Groundwater	2×10^{-6}	0.9
7	Soil, groundwater	3×10^{-4}	3 (a)
8	Soil, groundwater	1×10^{-5}	0.8
9	Soil, groundwater	2×10^{-4}	1 (a)
12	Groundwater	9×10^{-5}	2
13	Soil, groundwater	6×10^{-4}	8
14	Soil, groundwater	4×10^{-5}	2 (a)
15	Soil, groundwater	6×10^{-4}	4
19	Soil, groundwater	6×10^{-5}	0.7

Area	Exposure Medium	Total Risk	Total Hazard Index
20	Soil, groundwater	3×10^{-5}	0.5
21	Soil, groundwater	9×10^{-5}	0.2
22	Groundwater	8×10^{-6}	0.1
24	Soil, groundwater	6×10^{-4}	6
28	Groundwater	2×10^{-7}	0.003
29	Groundwater	5×10^{-5}	1 (a)
30	Soil, groundwater	8×10^{-6}	0.8
33	Soil, groundwater	3×10^{-5}	0.09
00	Soil, groundwater	8×10^{-4}	2 (a)
Production Wells	Groundwater	4×10^{-5}	1 (a)
Off-Site Adult Resident	Area 12 Groundwater	5×10^{-4}	6
Off-Site Child Resident	Area 12 Groundwater	5×10^{-4}	20
Maintenance Worker	IWOU-wide soil, sediment, and surface water	2×10^{-5}	0.1

(a) The HIs for each target organ/effect were lower than or equal to 1, indicating that adverse non-cancer effects are unlikely.

(b) The cumulative risk presented in this table is for exposure to Area-wide soil and groundwater.

2.35.4 IWOU-Wide Groundwater Remedial Action Objectives

The RAOs are site-specific cleanup objectives established for protecting human health and the environment. The RAOs are intended to be specific to the affected media, but sufficiently broad so as not to unreasonably restrict the potential remedial technology available. The RAOs developed for the IWOU include the COCs, media of concern, and potential exposure pathways identified during the risk assessment. Because of the industrial nature of the LCAAP, the exposure scenarios evaluated in the HHRA were primarily limited to industrial exposure frequencies and durations. Because of the use restriction imposed by the industrial exposure scenarios, LUCs will be a required component of the Selected Remedies at the IWOU to be protective of sensitive populations and the higher exposure frequencies and durations that would be associated with a UUUE scenario. Therefore, use restrictions would be implemented by the Army at the IWOU to limit future use of the site to industrial only. The RAOs for IWOU-Wide Groundwater are to:

- Achieve cleanup levels presented in **Table 21** for COCs in groundwater.
- Prevent off-site migration of COCs in groundwater exceeding cleanup levels in **Table 21**.

The rationale for the first RAO is to return the groundwater to beneficial use in a reasonable timeframe. The rationale for the second RAO is to prevent migration of COCs in groundwater off the Installation. This will eliminate risk to off-site receptors by also eliminating contact with groundwater exceeding cleanup levels.

As discussed previously, the exposure scenarios evaluated in the HHRA were primarily limited to industrial exposure frequencies and durations. The RAOs will result in a return of IWOU groundwater to beneficial uses, as cleanup levels account for uses such as drinking. Beneficial uses for IWOU groundwater (within the paleochannel) include water supply and drinking due to the large production capacity. Groundwater in the silty

clay, weathered bedrock, and bedrock do not yield enough water for a reliable and consistent water supply, although monitoring wells at a few locations could yield enough water for beneficial uses such as drinking.

The proposed actions for groundwater remediation would successfully meet the RAOs and comply with ARARs.

2.35.5 Description of IWOU-Wide Groundwater Remedial Action Alternatives

The remedial alternatives for each Area in the IWOU are presented in **Table 8** along with their estimated present-worth life-cycle costs. A narrative description of these remedial alternatives is given in the following section.

Five remedial action alternatives were developed for IWOU-Wide Groundwater. COCs in IWOU-Wide Groundwater include arsenic, manganese, PCE, TCE, vinyl chloride, chloroform, carbon tetrachloride, RDX, 2-nitrotoluene, benzo(b)fluoranthene, benzo(a)pyrene, benzo(a)anthracene, dibenz(a,h)anthracene, and indeno(1,2,3-cde)pyrene.

Detailed cost estimates for each of the IWOU-Wide Groundwater remedial alternatives are provided in the Final IWOU RI/FS (ARCADIS 2006).

Alternative 1: No Action

Estimated Capital Cost: $0
Estimated Annual O&M Cost: $0
Estimated Present Value: $0

The NCP and USEPA's guidance for conducting RI/FS investigations requires that the "No Action" option be developed and examined as a potential remedial action for all sites. The "No Action" option is retained and examined as a baseline with which other remedial actions are compared. The "No Action" alternative does not assume that current conditions at the IWOU, as described above, are sustained. The "No Action" alternative does not address the baseline conditions associated with unacceptable risk to potential future site worker and construction/utility worker exposures and does not achieve the RAOs established at the IWOU.

Overall Protection

This alternative provides no controls to limit exposure or future use of the contaminated groundwater and will not reduce the risks to human health or the environment. COCs will remain in IWOU groundwater at levels that exceed the allowable levels for exposure, as determined in the HHRA. Pumping in Area 12 may be terminated at any time under this scenario, allowing potential off-site migration of dissolved COCs from Area 12. Natural attenuation processes will eventually reduce COC concentrations at all Areas identified in the HHRA to below PRGs; however, these trends would not be confirmed, as this alternative includes no monitoring of IWOU groundwater.

Compliance with ARARs

Alternative 1 would not comply with chemical-specific ARARs for groundwater, as no action would be taken to address identified COCs. Alternative 1 would not comply with all location-specific ARARs. There are no action-specific ARARs for Alternative 1.

Long-term Effectiveness

This alternative does not include any controls for exposure to mitigate risk associated with COCs in IWOU groundwater. Although natural attenuation processes would eventually result in the permanent reduction of COC concentrations in IWOU groundwater to levels that meet the PRGs, this can not be confirmed without regular groundwater monitoring. In addition, based on the results of the groundwater model, off-site migration of groundwater containing COCs at Area 12 could occur if active pumping on production well 17AA is terminated. This alternative is considered ineffective in the long term, as RAOs will not be achieved.

Reduction of Mobility, Toxicity, and Volume through Treatment

This alternative includes no active remediation, and therefore will not actively reduce the toxicity, mobility, or volume of contamination in IWOU groundwater. Natural attenuation mechanisms can collectively result in permanent reduction of COC mobility, toxicity, and volume in groundwater; however, without groundwater monitoring, such reductions cannot be confirmed. In addition, pumping in Area 12 will lead to mass reduction and plume control; however, if groundwater extraction in Area 12 is terminated, the TCE plume could migrate off site.

Short-term Effectiveness

Alternative 1 does not incorporate any on-site activities that would present risks to the community, workers, or the environment; in the short term, it does not present an unacceptable risk for human receptors.

Implementability

Due to the lack of technical and administrative components, the no action alternative is implementable and will not limit or interfere with the ability to perform future remedial actions. However, it is unlikely that the no action alternative would be accepted by government agencies or the public.

Cost

Because no remedial actions are performed in connection with this alternative, there are no associated O&M or capital costs.

Alternative 2: Monitored Natural Attenuation and Land Use Controls

Estimated Capital Cost: $31,900
Estimated Annual O&M Cost: $385,000
Estimated Present Value: $520,000
Estimated Remedial Timeframe: See ***Table 22***

Alternative 2 would be MNA and LUCs, as described in the IWOU-Wide Groundwater RI/FS. Monitoring would be required to monitor natural attenuation parameters and trends of chemicals in groundwater until cleanup levels have been achieved. In addition, Alternative 2 would include the implementation of LUCs to prohibit the access to or use of untreated contaminated groundwater except for limited use for remedial activities and investigative monitoring only; and prohibit direct contact with untreated groundwater. Alternative 2 does not include any constraints that require well 17AA to continue pumping. Therefore, no active remediation would occur under Alternative 2.

LUCs will be implemented as described in Section 2.7.5. Specific LUCs will be selected and implemented in accordance with the LUCIP. The Army will enforce these LUCs and maintain the integrity of the remedial technologies associated with the IWOU-Wide Groundwater.

Overall Protection

Under Alternative 2, LUCs will be implemented to limit exposure and future use of the contaminated groundwater, reducing the risk to human receptors while COCs attenuate naturally. Monitoring of natural attenuation processes will demonstrate that COC concentrations are reduced to below PRGs in all Areas identified in the HHRA to drive a risk to human health receptors. Under Alternative 2, pumping in Area 12 may be terminated at any time, creating the potential for off-site migration of dissolved COCs from Area 12. RAOs associated with Areas 00, 1, 2, 5, 7, 13, 15, 20, and 24 would be achieved under Alternative 2; however, this alternative does not comply with the RAOs, as COCs at Area 12 could migrate off site.

Alternative 2 would comply with chemical-specific ARARs for groundwater, which are included in 40 CFR Part 141 (MCLs and maximum contaminant level levels [MCLGs]) and more stringent standards found in 10 CSR 20-7.031 (MWQS) (and specifically identified on **Table 9 and Table 21**). The chemical-specific ARARs for COCs in IWOU Site-Wide groundwater are based on a combination of MCLGs (if non-zero), MCLs, and MWQSs depending on what is the lowest concentration for a particular COC (**Table 21**). The COCs that have chemical-specific ARARs are PCE (MWQS), TCE (MCL), vinyl chloride (MCL), carbon tetrachloride (MCL), chloroform (MWQS), benzo(a)anthracene (MWQS), benzo(a)pyrene (MWQS), benzo(a)fluoranthene (MWQS), indeno(1,2,3-cd)pyrene (MWQS), dibenz(a,h)anthracene (MWQS), benzo(k)fluoranthene (MWQS), arsenic (MCL), and lead (MCL) (**Table 21**). The other key ARARs for Alternative 2 include 40 CFR 264.97, which sets requirements for the groundwater monitoring program that there be sufficient wells, proper casings that do not spread contamination, consistent sampling techniques, and consistent measurement of the water table. Other ARARs for this alternative are found in Appendix B (action-specific ARARs in Table B-14 and location-specific ARARs in B-15).

Long-term Effectiveness

MNA would result in the permanent reduction of COC concentrations in groundwater to attain the PRGs. Attainment of PRGs would be confirmed through regular monitoring. However, based on the results of the groundwater model, if pumping in Area 12 is terminated at any time under this scenario, dissolved COCs from Area 12 could potentially migrate off site. Therefore, this alternative is considered ineffective in the long term, as the RAO associated with the prevention of off-site migration will not be achieved.

Reduction of Mobility, Toxicity and Volume through Treatment

Treatment via natural attenuation mechanisms can collectively result in permanent reduction of COC toxicity, mobility, and volume in groundwater. The extent to which this occurs at the IWOU would be confirmed through regular groundwater monitoring. Alternative 2 would result in the permanent reduction of mobility, toxicity, and volume of COCs in IWOU groundwater. Installation production well pumping will lead to mass reduction and plume control in Area 12; however if groundwater extraction in Area 12 is terminated, the TCE plume could migrate off site.

Short-term Effectiveness

Implementation of Alternative 2 would result in minimal risk to site workers or the environment. All of the wells associated with the long-term and attenuation monitoring are currently installed with the exception of wells in Areas 00, 15, 19, 20, and 21; therefore, Alternative 2 could be implemented in a short timeframe. LUCs in the form of groundwater use restrictions and protective measures to limit the potential for direct exposure to groundwater in Areas 5, 12, and 13 would prevent exposure to groundwater while concentrations of COCs attenuate naturally.

Implementability

Implementation of the long-term and attenuation monitoring program is feasible, as the monitoring network is currently in place with the exception of monitoring wells in Areas 00, 15, 19, 20, and 21. Materials necessary for the collection and analysis of groundwater samples are readily available. LUCs to limit the groundwater use and the potential for direct exposure to groundwater in Areas 5, 12, and 13 are implementable.

Alternative 2 does not rely on the continued operation of the existing pump-and-treat system at Area 12; however, as production well 17AA contributes approximately 21 percent of the overall water that is treated and distributed for use at the facility, it is anticipated that continued extraction from this well will be required for manufacturing operations. To the extent that production well 17AA operates, it will provide a positive effect on the groundwater system.

Cost

The capital cost to implement LUCs for Alternative 2 is approximately $31,900 based on current year dollars. The present-worth cost for Alternative 2 is approximately $520,000 based on the implementation of LUCs and 30 years of long-term monitoring and maintenance activities.

Alternative 3: Monitored Natural Attenuation, Land Use Controls, Groundwater Extraction, and Ex-situ Treatment via Air Stripping

Estimated Capital Cost: $93,100
Estimated Annual O&M Cost: $1,046,900
Estimated Present Value: $1,430,000
Estimated Remedial Timeframe: See ***Table 22***

Alternative 3 would include the MNA of COCs associated with Areas 00, 1, 2, 5, 7, 12, 13, 15, 20, and 24 as well as the implementation of LUCs as described in Alternative 2. Alternative 3 would also include the operation of a groundwater extraction system to ensure on-site containment of impacted groundwater associated with Area 12. As previously discussed, all COC plumes are contained on site with the current extraction systems in operation; however, based on the groundwater model, impacted groundwater in the vicinity of Area 12 may flow off site under non-pumping or reduced pumping conditions. Alternative 3 incorporates the continued operation of a groundwater extraction system to contain the groundwater in Area 12.

Groundwater is currently extracted from production well 17AA in the vicinity of the VOC plume in Area 12 as part of the facility operations. Alternative 3 incorporates the continued operation of production well 17AA to contain the impacted groundwater at Area 12, followed by ex-situ treatment or natural attenuation. With continued extraction of groundwater from the IWOU associated with facility ammunition production, the existing attenuation process is expected to continue for the foreseeable future. In the event that sufficient extraction rates are not maintained at well 17AA by the Installation due to a decrease in production, Alternative 3 includes the installation of a new extraction well and associated equipment as well as the routine operation and maintenance of the extraction well.

LUCs will be implemented as described in Section 2.7.5. LUCs will be selected as part of this ROD and implemented in accordance with the LUCIP. The Army will enforce these LUCs and maintain the integrity of the remedial technologies associated with the IWOU-Wide Groundwater.

Overall Protection

LUCs in the form of groundwater use restrictions will protect against human exposure to groundwater while COCs in the groundwater attenuate naturally over time. Groundwater in Area 12 will be contained on site through pumping, and the COCs in groundwater will be removed, eliminating the risk associated with the COCs in groundwater. COC concentrations in impacted groundwater will be monitored to demonstrate attenuation. Alternative 3 will achieve the RAOs.

Compliance with ARARs

Alternative 3 would comply with chemical-specific ARARs for groundwater, which are included in 40 CFR Part 141 (MCLs and MCLGs) and 10 CSR 20-7.031 (MWQS) (and specifically identified on **Table 9 and Table 21**). The chemical-specific ARARs for COCs in IWOU Site-Wide groundwater are based on a combination of MCLGs (if non-zero), MCLs, and MWQSs depending on what is the lowest concentration for a particular COC (**Table 21**). The COCs that have chemical-specific ARARs are PCE (MWQS), TCE (MCL), vinyl chloride (MCL), carbon tetrachloride (MCL), chloroform (MWQS), benzo(a)anthracene (MWQS), benzo(a)pyrene (MWQS), benzo(a)fluoranthene (MWQS), indeno(1,2,3-cd)pyrene (MWQS), dibenz(a,h)anthracene (MWQS), benzo(k)fluoranthene (MWQS), arsenic (MCL), and lead (MCL) (**Table 21**). The other key ARARs for Alternative 3 include 40 CFR 264.97, which sets requirements for the groundwater monitoring program that there be sufficient wells, proper casings that do not spread contamination, consistent sampling techniques, and consistent measurement of the water table. Other ARARs for this alternative are found in **Appendix B** (action-specific ARARs in **Table B-14** and location-specific ARARs in **B-15**).

Long-Term Effectiveness

MNA at Areas 00, 1, 2, 5, 7, 13, 15, 20, and 24 will result in permanent reduction of COC concentrations in groundwater to achieve PRGs, which will be confirmed through regular monitoring. In addition, the VOC plume present in Area 12 will continue to be successfully contained through groundwater extraction and treatment until the RAOs are met.

Reduction of Mobility, Toxicity, and Volume through Treatment

Alternative 3 permanently reduces the mobility, toxicity, and volume of COCs in groundwater through natural attenuation mechanisms. The mobility and volume of VOCs in groundwater is also limited by extraction and treatment of groundwater in Area 12. Reduction of the mobility, toxicity, and volume of COCs will be confirmed through regular groundwater monitoring.

Short-Term Effectiveness

Implementation of this alternative would result in minimal risks to the community, workers, and the environment. Purge water from monitoring well sampling would be handled using approved methods. Air stripping of VOCs from groundwater extracted from Area 12 is a high-efficiency process, and stripped VOCs will be emitted at levels that do not require treatment. LUCs in the form of groundwater use restrictions and protective measures to limit the potential for direct exposure to groundwater in Areas 5, 12, and 13 would prevent exposure to groundwater until the concentrations of COCs are reduced to below cleanup levels. A groundwater extraction and treatment system is already in place and operated by the Army. It is anticipated that minimal work will be required to change or modify its operation. In the event that the production rate from well 17AA is decreased to a rate that is not sufficient for groundwater containment, an additional recovery well will be installed to ensure groundwater capture.

Implementability

Implementation of this alternative is both technically and administratively feasible. The existing groundwater extraction and treatment system will not be significantly modified, and only monitoring wells in Areas 00, 15, 19, 20, and 21 are required for the long-term and natural attenuation monitoring program. The services and materials necessary for the collection and analysis of groundwater samples are readily available.

Cost

The capital cost to implement Alternative 3 is approximately $93,100 based on current year dollars. The present-worth cost for Alternative 3 is approximately $1,430,000 based on installation of extraction wells, implementation of LUCs, operation of the extraction system for 22 years, and 30 total years of long-term maintenance activities.

Alternative 4: Monitored Natural Attenuation, Land Use Controls, Groundwater Extraction and Ex-situ Treatment via Air Stripping, and In-Situ Treatment at Area 12 via Enhanced Reductive Dechlorination.

Estimated Capital Cost: $126,200

Estimated Annual O&M Cost: $1,099,100
Estimated Present Value: $1,530,000
Estimated Remedial Timeframe: See ***Table 22***

Alternative 4 includes MNA, which includes long-term monitoring requirements for Areas 00, 1, 2, 5, 7, 12, 13, 15, 20, and 24, implementation of LUCs as described in Alternative 2, and the operation of the groundwater extraction and treatment system in Area 12 as described in Alternative 3. Alternative 4 also includes the implementation of an ERD system to enhance the mass removal associated with the TCE-impacted groundwater in Area 12.

LUCs will be implemented as described in Section 2.7.5. LUCs will be selected as part of this ROD and implemented in accordance with the LUCIP. The Army will enforce these LUCs and maintain the integrity of the remedial technologies associated with the IWOU-Wide Groundwater.

Overall Protection

LUCs in the form of groundwater use restrictions and limitations on excavation activities in Areas 5, 12, and 13 will protect against human exposure to groundwater while COCs in the groundwater attenuate naturally over time. Groundwater in Area 12 will be contained on site through pumping, and the COCs in groundwater will be removed, eliminating the risk associated with the COCs in groundwater. ERD will be implemented through the installation of an IRZ in the higher concentration zone at Area 12 to reduce the overall remediation duration at Area 12 from 22 years to 17 years. COC concentrations in impacted groundwater in the various AOCs will be monitored to demonstrate attenuation. Alternative 4 will achieve the RAOs.

Compliance with ARARs

Alternative 4 would comply with chemical-specific ARARs for groundwater, which are included in 40 CFR Part 141 (MCLs and MCLGs) and 10 CSR 20-7.031 (MWQS) (and specifically identified on **Table 9 and Table 21**). The chemical-specific ARARs for COCs in IWOU Site-Wide groundwater are based on a combination of MCLGs (if non-zero), MCLs, and MWQSs depending on what is the lowest concentration for a particular COC (**Table 21**). The COCs that have chemical-specific ARARs are PCE (MWQS), TCE (MCL), vinyl chloride (MCL), carbon tetrachloride (MCL), chloroform (MWQS), benzo(a)anthracene (MWQS), benzo(a)pyrene (MWQS), benzo(a)fluoranthene (MWQS), indeno(1,2,3-cd)pyrene (MWQS), dibenz(a,h)anthracene (MWQS), benzo(k)fluoranthene (MWQS), arsenic (MCL), and lead (MCL) (**Table 21**). The other key ARARs for Alternative 4 include 40 CFR 264.97, which sets requirements for the groundwater monitoring program that there be sufficient wells, proper casings that do not spread contamination, consistent sampling techniques, and consistent measurement of the water table and 10 CSR 20-6, which regulates the construction and operation of injection wells and the substantive requirements including identifying the reagents to be injected, volume, and frequency. Other ARARs for this alternative are found in **Appendix B** (action-specific ARARs in **Table B-14** and location-specific ARARs in **B-15).**

Long-Term Effectiveness

MNA at Areas 00, 1, 2, 5, 7, 13, 15, 20, and 24 will result in permanent reduction of COC concentrations in groundwater to achieve PRGs, which will be confirmed through regular monitoring. In addition, the VOC plume present in Area 12 will continue to be successfully contained through groundwater extraction and

treatment until the RAOs are met. The implementation of ERD to target the higher concentration zone at Area 12 will reduce the overall remediation duration in this Area to 17 years.

Reduction of Mobility, Toxicity, and Volume through Treatment

Alternative 4 permanently reduces the mobility, toxicity, and volume of COCs in groundwater through natural attenuation mechanisms. The mobility and volume of VOCs in groundwater are also limited by extraction and treatment of groundwater in Area 12. The implementation of ERD through the installation of an IRZ in the higher concentration zone in Area 12 will accelerate the reduction in volume and toxicity. Reduction of the mobility, toxicity, and volume of COCs will be confirmed through regular groundwater monitoring.

Short-Term Effectiveness

Implementation of this alternative would result in minimal risks to the community, workers, and the environment. Purge water from monitoring well sampling would be handled using approved methods. Air stripping of VOCs from groundwater pumped in Area 12 is a high-efficiency process, and stripped VOCs will be emitted at levels that do not require treatment. LUCs in the form of groundwater use restrictions and protective measures to limit the potential for direct exposure to groundwater in Areas 5, 12, and 13 would prevent exposure to groundwater while the concentrations of COCs exceed standards. A groundwater extraction and treatment system is already in place and operated by the Army. It is anticipated that minimal work will be required to change or modify its operation. In the event that the production rate from well 17AA is decreased to a rate that is not sufficient for groundwater containment, an additional recovery well will be installed to ensure groundwater capture. Degradable carbon that would be used to create the IRZ would be in the form of molasses, corn syrup, whey, or other similar products that would not result in additional risks to the community, workers, and the environment. The injection wells are spaced upgradient from well 17AA with sufficient spacing to allow groundwater to return to ambient conditions, eliminating the potential for bio-fouling of the extraction well.

Implementability

Implementation of this alternative is both technically and administratively feasible. The existing groundwater extraction and treatment system will not be significantly modified, and only monitoring wells in Areas 00, 15, 19, 20, and 21 are required for the long-term and natural attenuation monitoring program. Injection wells will be required to implement the IRZ. Wells would be installed using standard well-drilling methods and materials. These services are readily available, as are the services and materials necessary for the collection and analysis of groundwater samples.

Cost

The capital cost to implement Alternative 4 is approximately $126,200 based on current year dollars. The present-worth cost for Alternative 4 is approximately $1,530,000 based on installation of extraction wells, implementation of LUCs, in-situ ERD, operation of the extraction system for 17 years, and 30 years of long-term maintenance.

Alternative 5: Monitored Natural Attenuation; Land Use Controls; Groundwater Extraction; Ex-situ Treatment via Air Stripping; and In-Situ Treatment at Areas 5, 12, and 13 via Enhanced Reductive Dechlorination.

Estimated Capital Cost: $424,500
Estimated Annual O&M Cost: $2,022,500
Estimated Present Value: $3,060,000
Estimated Remedial Timeframe: See ***Table 22***

Alternative 5 includes MNA, which includes long-term monitoring requirements for Areas 00, 1, 2, 5, 7, 12, 13, 15, 20, and 24 as well as the implementation of LUCs as described in Alternative 2; the operation of the groundwater extraction and treatment system in Area 12 as described in Alternative 3; and the in-situ treatment of groundwater in Area 12 via ERD. In addition, Alternative 5 includes the implementation of additional ERD treatment to enhance the mass removal associated with the VOC-impacted groundwater in Areas 5 and 13.

LUCs will be implemented as described in Section 2.7.5. LUCs will be selected as part of this ROD and implemented in accordance with the LUCIP. The Army will enforce these LUCs and maintain the integrity of the remedial technologies associated with the IWOU-Wide Groundwater.

Overall Protection

LUCs in the form of groundwater use restrictions and limitations on excavation activities in Areas 5, 12, and 13 will protect against human exposure to groundwater while COCs in the groundwater attenuate naturally over time. Groundwater in Area 12 will be contained on site through pumping, and the COCs in groundwater will be removed, eliminating the risk associated with the COCs in groundwater. ERD will be implemented through the installation of an IRZ in the higher concentration zone at Areas 5, 12, and 13 to reduce the overall remediation duration in these areas. COC concentrations in impacted groundwater in the various AOCs will be monitored to demonstrate attenuation. Alternative 5 will achieve the RAOs.

Compliance with ARARs

Alternative 5 would comply with chemical-specific ARARs for groundwater, which are included in 40 CFR Part 141 (MCLs and MCLGs) and 10 CSR 20-7.031 (MWQS) (and specifically identified on **Table 9 and Table 21**). The chemical-specific ARARs for COCs in IWOU Site-Wide groundwater are based on a combination of MCLGs (if non-zero), MCLs, and MWQSs depending on what is the lowest concentration for a particular COC **(Table 21)**. The COCs that have chemical-specific ARARs are PCE (MWQS), TCE (MCL), vinyl chloride (MCL), carbon tetrachloride (MCL), chloroform (MWQS), benzo(a)anthracene (MWQS), benzo(a)pyrene (MWQS), benzo(a)fluoranthene (MWQS), indeno(1,2,3-cd)pyrene (MWQS), dibenz(a,h)anthracene (MWQS), benzo(k)fluoranthene (MWQS), arsenic (MCL), and lead (MCL) **(Table 21)**. The other key ARARs for Alternative 5 include 40 CFR 264.97 which sets requirements for the groundwater monitoring program that there be sufficient wells, proper casings that do not spread contamination, consistent sampling techniques, and consistent measurement of the water table and 10 CSR 20-6, which regulates the construction and operation of injection wells and the substantive requirements including identifying the reagents to be injected, volume, and frequency. Other ARARs for this alternative are found in **Appendix B** (action-specific ARARs in **Table B-14** and location-specific ARARs in **B-15**).

Long-Term Effectiveness

MNA at Areas 00, 1, 2, 5, 7, 13, 15, 20, and 24 will result in permanent reduction of COC concentrations in groundwater to achieve PRGs, which will be confirmed through regular monitoring. In addition, successful containment of the VOC plume present in Area 12 will continue through groundwater extraction and treatment until the RAOs are met. The implementation of ERD to target the higher-concentration zone at Areas 5, 12, and 13 will reduce the overall remediation duration in these areas.

Reduction of Mobility, Toxicity, and Volume through Treatment

Alternative 5 permanently reduces the mobility, toxicity, and volume of COCs in groundwater, through natural attenuation mechanisms. The mobility and volume of VOCs in groundwater is also limited by extraction and treatment of groundwater in Area 12. The implementation of ERD through the installation of an IRZ in the higher-concentration zone in Areas 5, 12, and 13 will accelerate the reduction in volume and toxicity. Reduction of the mobility, toxicity, and volume of COCs will be confirmed through regular groundwater monitoring.

Short-Term Effectiveness

Implementation of this alternative would result in minimal risks to the community, workers, and the environment. Purge water from monitoring well sampling would be handled using approved methods. Air stripping of VOCs from groundwater pumped in Area 12 is a high-efficiency process, and stripped VOCs will be emitted at levels that do not require treatment. LUCs in the form of groundwater use restrictions and protective measures to limit the potential for direct exposure to groundwater in Areas 5, 12, and 13 would prevent exposure to groundwater while the concentrations of COCs exceed standards. A groundwater extraction and treatment system is already in place and operated by the Army. It is anticipated that minimal work will be required to change or modify its operation. In the event that the production rate from well 17AA is decreased to a rate that is not sufficient for groundwater containment, an additional recovery well will be installed to ensure groundwater capture. Degradable carbon that would be used to create the IRZ in Areas 5, 12, and 13 would be in the form of molasses, corn syrup, whey, or other similar products that would not result in additional risks to the community, workers, and the environment.

Implementability

Implementation of this alternative is both technically and administratively feasible. The existing groundwater extraction and treatment system will not be significantly modified, and monitoring wells in Areas 00, 15, 19, 20, and 21 are required for the long-term and natural attenuation monitoring program. Injection wells will be required to implement the IRZ. Wells would be installed using standard well-drilling methods and materials. These services are readily available, as are the services and materials necessary for the collection and analysis of groundwater samples.

Cost

The capital cost to implement Alternative 5 is approximately $424,500 based on current year dollars. The present-worth cost for Alternative 5 is approximately $3,060,000 based on installation of extraction wells,

implementation of LUCs, in-situ ERD at Areas 5, 12, and 13, operation of the extraction system for 17 years, and 30 years of long-term monitoring and maintenance.

2.35.6 Summary of Comparative Analysis of Alternatives

Each alternative must undergo detailed analysis based on the threshold, primary, and modifying criteria discussed in Section 2.7.6.

2.35.7 Comparative Analysis of IWOU-Wide Groundwater Alternatives

The comparative analysis of the IWOU-Wide Groundwater alternatives is provided in the following sections and summarized in **Table 23. Table 8** summarizes cost associated with each groundwater alternative.

Attenuation rates were calculated for the existing groundwater plumes at Areas 5, 7, 12, 13, 15, and 24 in order to understand the potential for natural attenuation within the various groundwater plumes at the IWOU. This process is summarized in more detail in the Final IWOU RI/FS (ARCADIS 2006), and the remedial timeframes estimated for IWOU-Wide Groundwater are summarized in **Table 22**. The primary uncertainties associated with the calculation of the attenuation rates include the geologic heterogeneity and quantification of current and future source attenuation rates.

Remediation timeframes were not calculated for inorganic compounds. This is because MNA timeframes for the organic compounds were calculated assuming the source of the organics would be cut off, followed by physical flushing, which would eventually eliminate the organics from the system (which resulted in the MNA timeframe). For the inorganics, the same assumptions cannot be made, as they are complicated by the geochemistry and will precipitate out or solubilize given different redox conditions. In the instance of arsenic, the source of arsenic is from the formation itself (naturally occurring) and is present in the aqueous phase due to the redox conditions. Since physical flushing is not a mechanism to deplete the arsenic, trend analysis was used instead to show that the plumes are either stable or decreasing.

2.35.7.1 Overall Protection of Human Health and the Environment

Alternative 1 - No Action would not be protective. Alternative 2 also would not be protective because 17AA would not be pumping and, as a result, dissolved COCs from Area 12 could potentially migrate off site. Thus, Alternative 2 would not comply with the RAOs, as off-site migration of COCs could occur, presenting a risk to the community. Alternatives 3, 4, and 5 would not present additional risks to the community, workers, or the environment. Alternatives 3, 4, and 5 would satisfy the RAOs by restricting extraction and potable use of contaminated groundwater and limiting the potential for direct exposure to groundwater in Areas 5, 12, and 13 while COCs present in IWOU groundwater are reduced. Alternatives 4 and 5 would reduce the concentration of VOCs in groundwater at Area 12 to at or below cleanup levels in a shorter timeframe than Alternative 3 due to the implementation of an IRZ to support ERD in the area of higher TCE concentration in Area 12. Implementation of additional IRZ treatment in Areas 5 and 13 (Alternative 5) would further reduce the remedial timeframe for remediation of VOCs in these Areas.

Alternatives 2, 3, 4, and 5, which include MNA, would satisfy the RAOs because concentrations of COCs present in IWOU groundwater would be reduced over time to meet the cleanup levels presented in **Table 7.** Overall, the contaminant concentrations in groundwater at the individual Areas have significantly decreased or

are stable. Based on the historical data trends and calculated remediation timeframes that are presented in Alternative 2, natural attenuation will occur for COCs in groundwater.

2.35.7.2 Compliance with ARARs

Alternative 1 would not comply with chemical-specific ARARs. Alternatives 2, 3, 4, and 5 would comply with the chemical-specific ARARs presented in **Table 9**. The natural attenuation processes would be monitored to verify that COC concentrations were being reduced to the cleanup levels presented in **Table 7**. However, if extraction and treatment in Area 12 are terminated (as in Alternative 2), COCs may migrate off site, potentially impacting off-site receptors. Alternatives 2, 3, 4, and 5 would comply with action- and location-specific ARARs as identified in the Final IWOU RI/FS.

2.35.7.3 Long-Term Effectiveness and Permanence

Although MNA would result in the permanent reduction of COC concentrations in groundwater to attain the PRGs in most Areas, Alternative 2 is considered ineffective, as the RAO associated with the prevention of off-site migration may not be achieved. Alternatives 3, 4, and 5 would achieve RAOs and are considered effective in the long term. Alternatives 4 and 5 would require less long-term monitoring and maintenance of the groundwater extraction system, because the concentration of VOCs in Area 12 would be reduced to cleanup levels in a shorter timeframe than Alternative 3. Implementation of IRZ treatment in Areas 5 and 13 (Alternative 5) would further reduce the remedial timeframe for remediation of VOCs in these Areas.

2.35.7.4 Reduction of Mobility, Toxicity, and Volume

Alternative 2 would result in the permanent reduction of mobility, toxicity, and volume of COCs in groundwater for all Areas except Area 12, where COCs could migrate off site if groundwater extraction is terminated. Alternatives 3, 4, and 5 permanently reduce the mobility, toxicity, and volume of COCs in groundwater through natural attenuation mechanisms and active treatment in Area 12, as IRZ and natural attenuation processes would result in permanent removal or destruction of COCs. In Alternatives 3, 4, and 5, the mobility and volume of VOCs in groundwater are limited by the current groundwater extraction and treatment system, which is successfully containing the plume in Area 12. Reduction of the mobility, toxicity, and volume of COCs would be confirmed through regular groundwater monitoring. Alternatives 4 and 5 would reduce the mobility, toxicity, and volume of COCs in Area 12 in a shorter timeframe through the implementation of ERD for the treatment of VOCs. Implementation of IRZ treatment in Areas 5 and 13 (Alternative 5) would further reduce the remedial timeframe for remediation of VOCs in these Areas.

2.35.7.5 Short-Term Effectiveness

Implementation of Alternative 2, 3, 4, or 5 would result in minimal short-term risk to site workers, the environment, or the community. In all alternatives (except the no action alternative), LUCs in the form of groundwater use restrictions and protective measures to limit the potential for direct exposure to groundwater in Areas 5, 12, and 13 would be necessary to prevent groundwater use while the concentrations of COCs are reduced to achieve RAOs. For Alternatives 3, 4, and 5, a groundwater extraction and treatment system is already in place and operated by the Army. It is anticipated that minimal work would be required to change or modify its operation. The current treatment system in place releases low levels of VOC to the air; however, concentrations are monitored and are lower than regulatory standards protective of human health and the

environment.

In the event that the production rate from well 17AA is decreased to a rate that is insufficient for groundwater containment, an additional recovery well would be installed to ensure groundwater capture. Potential exposure to contaminated groundwater by workers could occur during installation; however, proper health and safety procedures would be implemented in the form of PPE to reduce exposure. Degradable carbon that would be used to create the IRZ would be in the form of molasses, corn syrup, whey, or similar products that would not result in additional risks to the community, workers, and the environment in Alternatives 4 and 5. In-situ groundwater treatment results in insignificant releases, thus minimizing potential risks to the community and the environment.

2.35.7.6 Implementability

Implementation of the long-term and attenuation monitoring program in all alternatives is feasible, as the monitoring network is currently in place. Injection wells would be installed to support the implementation of the IRZ in Alternatives 4 and 5, and monitoring wells would be installed to support MNA at Areas 00 and 20 and monitoring associated with the inactive sumps at Areas 15, 19, and 21. These services are readily available, as are the services and materials necessary for the collection and analysis of groundwater samples. LUCs to limit the groundwater use are readily implementable in each alternative, but would require administrative support. For Alternatives 3, 4, and 5, extraction well 17AA would not be significantly modified. If an additional extraction well is incorporated in Alternatives 3, 4, and 5, the well would be installed using standard drilling methods and materials.

2.35.7.7 Cost

The estimated present-worth costs for each of the alternatives are as follows:

Alternative 1: $0
Alternative 2: $520,000
Alternative 3: $1,430,000
Alternative 4: $1,530,000
Alternative 5: $3,060,000

2.35.7.8 State Agency Acceptance

The State of Missouri has expressed its support for the U.S. Army's selected alternative as described in Section 2.35.9 of this document (Selected Remedy).

2.35.7.9 Community Acceptance

Comments offered by the public were used to assess whether the proposed alternatives were acceptable to the community. The Army received four written comments during the public comment period. One of the written comments supported the Preferred Remedies, one did not support the Preferred Remedies, one was in the form of a question, and one was neutral towards the Preferred Remedies. Questions were posed to the Army regarding the proposed remedies for the IWOU during the public meeting held on 23 January 2007. Questions about the remedies posed during the public meeting appeared to be satisfactorily addressed during the meeting.

During the meeting, Mr. Greg Perry read a written statement that he opposed the remedial actions that were presented for the IWOU. Mr. Leonard Heman and other members of the public seemed to be supportive of the remedial actions at the IWOU. The questions and concerns of the community are discussed in the Responsiveness Summary, which is **Appendix C** of this ROD.

2.35.8 Principal Threat Wastes

The NCP establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable (NCP §300.430[a][1][iii][A]). Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure.

There are no existing principal threat wastes in IWOU-Wide Groundwater; however, low-level threat wastes have been identified in groundwater. Remedial strategies were selected to partially remove contaminants.

2.35.9 Selected Remedy for IWOU-Wide Groundwater

Based on the requirements of CERCLA, comparative analysis using the nine criteria, public comments, and in consultation with the USEPA and the state, the USEPA and Army have selected the following remedies for IWOU-Wide Groundwater. For all the Selected Remedies, the LUCs will be imposed to ensure that the site remains industrial use only. The Selected Remedy for IWOU-Wide Groundwater is Alternative 4 - Monitored Natural Attenuation including Long-Term Monitoring, LUCs, Groundwater Extraction and Ex-situ Treatment via Air Stripping, and In-situ Treatment at Area 12 via Enhanced Reductive Dechlorination.

2.35.9.1 Summary of the Rationale for the Selected Remedy for IWOU-Wide Groundwater

Alternative 4 is the Selected Remedy, as it provides the best balance of the evaluation criteria and satisfies the RAOs. Alternative 4 is protective by ensuring that environmental and health concerns associated with the COCs in the IWOU-Wide Groundwater are minimized. This will be accomplished by monitoring the attenuation processes that are currently being demonstrated in groundwater at Areas 00, 1, 2, 5, 7, 12, 13, 15, 20, and 24, as well as continuing the containment of the impacted groundwater associated with Area 12 through the operation of an extraction well at Area 12. The COCs would be removed through ex-situ treatment using an air stripper to remove VOCs from the impacted groundwater associated with Area 12, eliminating the risk associated with the COCs in groundwater. In addition, ERD would be implemented through the installation of an IRZ in the higher-concentration zone at Area 12 to reduce the overall remediation duration and to more rapidly reduce the overall mass associated with the impacted groundwater (**Figure 82**). Alternative 4 achieves RAOs, has a high degree of short-term effectiveness and would provide long-term effectiveness and implementability at half the cost of Alternative 5.

2.35.9.2 Description of the Selected Remedy for IWOU-Wide Groundwater

The Selected Remedy includes the long-term and attenuation monitoring requirements associated with Areas 00, 1, 2, 5, 7, 12, 13, 15, 20, and 24; the implementation of LUCs; the operation of the groundwater extraction

and treatment system in Area 12; and the implementation of an ERD system to enhance the mass removal associated with the TCE-impacted groundwater in Area 12.

As part of the Selected Remedy for site-wide groundwater at IWOU, and to provide adequate confirmation of the effectiveness of the Selected Remedies proposed at IWOU, it will be necessary to perform short- and long-term monitoring of water levels and groundwater chemistry analysis from various well networks at IWOU in the vicinity of known historical groundwater and soil contamination. Monitoring wells associated with the Areas will be used to: 1) provide a sufficient monitoring well network to ensure that any closed RCRA lagoons are not contributing to groundwater contamination; 2) verify the performance and effectiveness of various groundwater and soil remedies; 3) confirm that trends in groundwater contamination are stable or declining, demonstrating that natural attenuation is active; and 4) determine if sufficient hydraulic control is maintained. The details of the proposed long-term groundwater monitoring program for each Area at IWOU will be provided as part of the RD/RAWP.

LUCs will be implemented to restrict future uses of the site to industrial uses and prevent the potable use of untreated groundwater extracted from the Lake City Aquifer. In addition, LUCs will be implemented to protect direct contact of groundwater containing COCs at levels contributing to an unacceptable risk to construction workers at Areas 5, 12, and 13.

Regularly scheduled inspections would be performed to confirm compliance with the restrictions. The frequency and key elements of the compliance inspections will be outlined as part of the LUCIP. It is assumed that the elements of the on-site inspection would verify that there is no evidence of land use change. Interviews with the site property owner would include reviewing the owner's familiarity with the restrictions imposed upon the property; documentation of these restrictions; and plans for property sale, development for residential use, or construction at the site. It is assumed that these inspections would occur annually. As previously discussed, a LUCIP will be developed to ensure LUC enforcement throughout the remedial timeframe. The LUCIP for the site would remain in effect regardless of changes in future land use or future site management.

In addition, the selected remedy includes the operation of a groundwater extraction system to ensure that impacted groundwater associated with Area 12 is contained on site. As previously discussed, all COC plumes are contained on site; however, based on the groundwater model, impacted groundwater in the vicinity of Area 12 may flow off site under non-pumping or reduced pumping conditions. The Selected Remedy incorporates the continued operation of a groundwater extraction system to contain the groundwater in Area 12.

Groundwater is currently extracted from production well 17AA in the vicinity of the VOC plume in Area 12 as part of the facility operations. Groundwater modeling and monitoring results indicate that the operation of production well 17AA is effectively containing the VOC plume in Area 12. Under current operating parameters, production well 17AA is extracting groundwater at an average rate of 180 gpm. Currently, the flow for production well 17AA is combined with production well 17CC, and is treated through a packed tower air stripper prior to being sent to the on-site water treatment plant, where it is treated and distributed for facility use. Based on the extraction rate data from 2005, production well 17AA contributes approximately 21 percent of the overall water that is treated and distributed for use at the facility.

The Selected Remedy incorporates the continued operation of production well 17AA at Area 12 to contain the impacted groundwater on site, followed by ex-situ treatment or natural attenuation. With continued extraction of groundwater from the IWOU associated with facility ammunition production, the existing attenuation

process is expected to continue for the foreseeable future. The current production rates, on a well-by-well basis, have demonstrated effectiveness at limiting off-site migration of groundwater in the area of existing contaminant plumes. Groundwater modeling for the facility has further shown that modifications to the pumping regime can be affected for production purposes and still be effective at groundwater control. It is anticipated that the combination of the long-term monitoring, and continued overall (facility-wide) extraction of groundwater for production will allow for sufficient control of the existing contaminant plume at Area 12. The 5-year review process can then be used to measure the effectiveness of the factors discussed above, and changes, if necessary, can be effected at that time. Based on this scenario, the Army retains sufficient flexibility to address groundwater production needs, while maintaining sufficient control of the groundwater system to ensure that no off-site impacts occur.

For the purposes of estimating remedial costs, it is assumed that the rate of extraction in the vicinity of Area 12 would be decreased to a rate that does not support groundwater containment. Groundwater modeling has been conducted to demonstrate that a reduced extraction rate of 50 gpm will effectively contain the VOC plume and eliminate the potential for off-site migration. As such, the Selected Remedy includes the installation of a new extraction well in Area 12 in the event that sufficient extraction rates are not maintained at well 17AA by the Installation for production purposes. Operation of the existing air stripper would continue for the treatment of VOC-impacted groundwater. The Selected Remedy includes the installation of the new extraction well and associated equipment as well as the routine operations and maintenance of the extraction well.

The extraction and treatment system will be operated until RAOs for IWOU site-wide groundwater are achieved. It is assumed that it will take 22 years of operation under the current operating parameters to achieve cleanup levels for the COCs in Area 12 based on remediation duration modeling.

In addition, the selected remedy includes the implementation of an ERD system to enhance the mass removal associated with the TCE-impacted groundwater in Area 12. The conceptual design assumptions for the IRZ installation associated with the Selected Remedy are Installation of at least one IRZ injection line, consisting up to five wells, located in the higher-concentration zone in Area 12 as approximately depicted on **Figure 82**. The number and exact location of the wells will be documented in the RD/RAWP. It is anticipated that operation of the IRZ injection line will take approximately 3 years for mass removal.

Implementation of an IRZ in the higher-concentration areas will decrease the overall operation timeframe of the extraction and treatment system by approximately 5 years. This will be accomplished by reducing TCE concentrations in the portion of the plume featuring the higher (greater than 100 ug/L) concentrations to levels consistent with the distal portion of the plume (approximately 50 ug/L). This represents approximately 40 percent of the dissolved mass plume. The remaining VOC mass will attenuate naturally or will be treated through the ex-situ treatment system to below cleanup levels.

*2.35.9.3 **Summary of the Estimated Remedy Costs for IWOU-Wide Groundwater***

The information in the cost estimate summary provided in **Table 24** is based on the best available information regarding the anticipated scope of the remedial alternative. Cost elements are likely to change as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or a ROD amendment. The cost provided in **Table 24** is an order-of-magnitude engineering cost estimate that is expected to be within 30 to 50 percent of the actual project cost.

2.35.9.4 Expected Outcomes of the Selected Remedy for IWOU-Wide Groundwater

The purpose of the response action for IWOU-Wide Groundwater is to control risks posed by direct contact with groundwater, prevent migration of contaminants to groundwater, and prevent off-site migration of impacted groundwater. Exposure for the IWOU-Wide Groundwater is controlled through the use of groundwater treatment by ERD, natural attenuation processes, ex-situ treatment, and LUCs.

- Groundwater restrictions for IWOU-Wide Groundwater will remain in effect until groundwater concentrations of COCs achieve cleanup levels. Groundwater is not to be used as a drinking water source until cleanup levels are achieved. Groundwater at the IWOU will be available for unrestricted drinking water use as a result of the Selected Remedy.

- The cleanup levels for groundwater at IWOU are provided in **Table 21**. These cleanup levels were determined based on an evaluation of ARARs and risk-based cleanup levels. LUCs will remain in place at IWOU as long as concentrations in soil and groundwater do not meet UUUE. It is estimated that the cleanup levels will be achieved as shown in **Table 21**. Treatment shall be monitored to ensure that cleanup levels are achieved.

- The beneficial socio-economic and community revitalization impacts include the elimination of identified contamination in groundwater. Due to the nature of the operations at LCAAP and the long-term management that will be required in the IWOU, the remaining benefits are not applicable.

- Environmental and ecological benefits will occur as a result of protecting and remediating groundwater.

2.35.9.5 Selected Remedy Performance Objectives and Performance Criteria for IWOU-Wide Groundwater

The RAOs for IWOU-Wide Groundwater are to:

- Achieve cleanup levels presented in Table 21 for COCs in groundwater.

- Prevent off-site migration of COCs in groundwater exceeding cleanup levels in **Table 21**.

The Selected Remedy for IWOU-Wide Groundwater is Monitored Natural Attenuation including Long-Term Monitoring, LUCs, Groundwater Extraction and Ex-situ Treatment via Air Stripping, and In-situ Treatment at Area 12 via Enhanced Reductive Dechlorination. The performance objectives and performance criteria for the individual components are discussed in the following sections.

IWOU-Wide Groundwater Monitored Natural Attenuation

The performance objectives of the MNA program are:

1) Verify that contaminant concentrations are declining with time at a rate and in a manner that cleanup levels will be achieved in the estimated timeframes presented in **Table 21.**

2) Ensure that lateral migration does not extend beyond the current area of impact.

3) Monitor hydrologic conditions at the Areas over time in order to identify any changes in groundwater flow direction that might affect the protectiveness of the Selected Remedy.

4) Verify that there are no unacceptable impacts to downgradient receptors.

The groundwater monitoring program will be developed using existing monitoring wells to evaluate contaminant behavior over time. Any new well installation or plugging of wells will follow the Missouri requirements for drilling (10 CSR 23-4.040), well construction (10 CSR 23-4.060), and decommissioning (10 CSR 23-4.080). The details of the program will be provided in the RD/RAWP and will be based on Use of *Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* (OSWER 9200.4-17P).

The program will likely evolve over time, but will be designed to meet the RAOs. The program will be designed to verify that natural attenuation processes are performing as expected and provide a mechanism for evaluating performance. Moreover, the monitoring program will identify additional monitoring and related activities that may be implemented if it appears that the MNA remedy is not meeting the performance objectives. The specific monitoring locations and performance evaluation criteria will be defined in the RD/RAWP that implements the ROD.

Land Use Controls

The implementation of LUCs is a component of the Selected Remedy for all IWOU-Wide Groundwater and will be designed to primarily prohibit the access or use of untreated contaminated groundwater except for its limited use for remedial activities and monitoring only. LUCs will remain in place until cleanup levels are met. The performance of the LUCs will be evaluated in regular monitoring reports.

Enhanced Reductive Dechlorination Via IRZ For Area 12

The performance objectives of the monitoring program for Area 12 are:

1) Verify that contaminant concentrations are declining with time at a rate and in a manner that cleanup levels will be achieved in the estimated timeframe of 17 years;

2) Ensure that lateral migration does not extend beyond the current area of impact;

3) Monitor hydrologic conditions at Area 12 over time in order to identify any changes in groundwater flow direction that might affect the protectiveness of the Selected Remedy; and

4) Verify that there is no unacceptable impact to downgradient/off-site receptors.

The groundwater monitoring program will be developed using existing monitoring wells to evaluate contaminant behavior over time. Any new well installation or plugging of wells will follow the Missouri requirements for well construction as identified in 10 CSR 23-4.050. The details of the program will be provided in the RD/RAWP and will be based on Use of *Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* (OSWER 9200.4-17P).

The monitoring program will likely evolve over time, but will be designed to verify that the remedy is meeting the RAOs. The program will be designed to verify that natural attenuation processes are performing as expected and provide a mechanism for evaluating performance. Moreover, the monitoring program will identify additional monitoring and related activities that may be implemented if it appears that the MNA remedy is not meeting the performance objectives. The specific monitoring locations and performance evaluation criteria will be defined in the RD/RAWP that implements the ROD.

The performance objectives for enhanced reductive dechlorination via IRZ are to:

1) Ensure optimum IRZ operation through the use of operational monitoring;

2) Demonstrate chlorinated ethene treatment within the limits of the IRZ;

3) Demonstrate decreasing chlorinated ethene concentrations in groundwater and decreasing mass flux downgradient of the IRZ;

4) Reduce contaminant concentrations to levels that will ensure that they are declining throughout Area 12 with time at a rate and in a manner that cleanup levels will be achieved in the estimated timeframe of 17 years; and

5) Ensure cost-effective operation of the IRZ technology.

ERD performance monitoring wells will be located strategically within the IRZ treatment area to allow for the collection of the data necessary to control ERD system operation and demonstrate treatment performance (**Figure 82**). Monitoring wells within the injection radius of influence will be located to evaluate the adequate concentration and distribution of reagent. Data collected from the radius of influence wells will be used to adjust the volume and concentration of the injected solution as necessary. Wells located further downgradient will demonstrate the extent of chlorinated VOC treatment obtained within the IRZ.

Performance and operational data will be collected with the following objectives:

- During development and through maturation of the IRZ, evaluate the amount of dilution that occurs immediately following injection to select an injection total organic carbon (TOC) concentration that results in an in-situ TOC concentration of approximately 2,000 mg/L.

- Monitor the depletion (i.e., degradation and dilution) of TOC within the injection wells to determine the injection frequency required to maintain an in-situ TOC concentration of greater than approximately 200 mg/L in monitoring wells located approximately 70 to 100 days downgradient.

- Confirm that the presence of excess organic carbon does not result in pH levels that inhibit microbial activity within the IRZ – a pH of greater than 5 will be maintained within the IRZ.

- Observe IRZ propagation at monitoring wells located approximately 70 to 100 days travel time downgradient of the injection radius of influence, which is the maximum approximate distance that suitable TOC concentrations can be sustained through organic carbon injections.

- Collect periodic (i.e., quarterly) data to evaluate progress of the ERD process and to monitor the level of methanogenesis (i.e., dissolved methane concentrations) occurring within the IRZ.

To evaluate performance of the IRZ treatment line, trends in molar concentrations of parent compounds (i.e., TCE) and degradation products (i.e., cis-1,2-dichloroethene, vinyl chloride, ethene, and ethane) will be assessed over time within the IRZ.

Initially, the total molar concentration of chlorinated ethenes in groundwater is expected to increase as a result of desorption and dissolution of sorbed mass, respectively. As this mass enters the aqueous phase, it becomes available for biodegradation and treatment through the ERD process. An increase in parent compound concentrations may not be observed and is usually seen in dense non-aqueous phase liquids (DNAPL) source zone ERD systems where the rate of NAPL dissolution can exceed the rate of reductive dechlorination; however, an increase in molar concentrations of total ethenes (sum of tetra- and trichloroethenes, cis-1,2-dichloroethene, ethene, and ethane) is almost always seen in both source and non-source area ERD systems. At some time after injection, the partial dechlorination of parent compounds results in the generation of dechlorination products. Eventually, the rate of parent compound reductive dechlorination will exceed the rate of desorption and dissolution, resulting in a plateau and decrease in parent compound concentrations. As the rate of mass desorption and dissolution continues to decrease and the rate of dechlorination product biodegradation increases, a peak in the total ethene molar concentration will develop, followed by decreasing concentration trends in both dechlorination products and total ethenes.

To evaluate the performance of the IRZ technology, performance monitoring will be conducted at monitoring locations within the treatment area and at a location greater than 100 days groundwater travel time downgradient of the treatment line. The IRZ treatment line will be operated until concentrations within the 100 ug/L contour have decreased to concentrations consistent with the distal portion of the plume (approximately 50 ug/L). This represents approximately 40 percent of the dissolved mass plume. The VOC plume in this area will be treated by a combination of ERD, groundwater pump and treat, and MNA. It is anticipated that the IRZ treatment line will operate for approximately 3 years to achieve this goal. Following the operation of the IRZ treatment line, chlorinated ethene mass remaining in groundwater will be treated by MNA and will be contained via the extraction at well 17AA and treated through the ex-situ treatment system. Natural attenuation monitoring will be conducted to confirm that concentrations continue to decrease at a rate and in a manner that cleanup levels will be achieved in the estimated timeframe of 17 years throughout Area 12.

Groundwater data collected in accordance with the IWOU long-term monitoring plan will be used to verify that natural attenuation processes continue to reduce chlorinated ethene concentrations at an acceptable rate following active IRZ remediation. These systems will be completely reviewed and evaluated regularly and during the 5-year review to ensure that performance objectives and criteria are being achieved.

Groundwater Extraction With Ex-Situ Treatment Via Air Stripping For Area 12

The performance objectives for groundwater extraction and ex-situ treatment via air stripping are to:

1) Maintain a minimum groundwater extraction rate of 50 gpm to contain the groundwater plume within the boundaries of the site;

2) Ensure that the contaminated groundwater is contained within the boundaries of LCAAP;

3) Verify that there are no unacceptable impacts to downgradient/off-site receptors;

4) Verify that contaminant concentrations are declining with time; and

5) Ensure cost-effective operation of the groundwater extraction system.

2.35.10 Statutory Determinations

Section 121 of CERCLA and the NCP establish several statutory requirements and preferences. These specify that, when complete, the selected remedy must achieve adequate protection of human health and the environment and comply with ARARs unless a statutory waiver is justified. The selected remedy must also be cost-effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment (as a principal element) that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes, with a bias against off-site disposal of untreated wastes. The following sections describe how the Selected Remedy satisfies or does not satisfy the statutory requirements of CERCLA Section 121.

2.35.10.1 Protection of Human Health and the Environment

The selected remedy for IWOU-Wide Groundwater addresses health and environmental issues that were identified in the IWOU Remedial Investigation and Risk Assessments in the medium of groundwater. Specifically, the Selected Remedies:

- Reduce potential exposures to off-site receptors by containing Area 12 contaminated groundwater with COC concentrations at levels exceeding cleanup levels within LCAAP boundaries;
- Reduce risk by reducing the concentrations of contaminants in the groundwater to levels below cleanup levels;
- Prevent the use of untreated, contaminated groundwater extracted from within LCAAP boundaries; and
- Provides for long-term monitoring of groundwater to identify potential future risks associated with the IWOU and to monitor the effectiveness of the remedial action.

The selected groundwater remedy will meet remedial action goals for groundwater. Exposure levels for potential on-site and off-site receptors will be reduced either to protective ARAR levels or to within USEPA's generally acceptable risk range of 10^{-4} to 10^{-6} for carcinogenic risk and below the HI of 1 for noncarcinogenic effects..

2.35.10.2 Compliance with ARARs

The Selected Remedies for the IWOU will comply with chemical-specific ARARs for COCs in groundwater. The Selected Remedies for the IWOU comply with location- and action-specific ARARs (Tables B-14 and B-15).

2.35.10.3 Cost-Effectiveness

The Selected Remedy is cost-effective and represents a reasonable value for the money to be spent. The following definition was used in making this determination: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." (NCP §300.430[f][1][ii][D]). This was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (i.e., were both protective of human health and the environment and ARAR-compliant). Overall effectiveness was compared to costs to determine cost effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence, this alternative represents a reasonable value for the money to be spent. The estimated present-worth cost of the Selected Remedy is $1,530,000. Although Alternative 5 will reduce the time to achieve cleanup levels at Areas 5 and 13, it is approximately two times more expensive, and the groundwater plumes in these Areas do not pose a risk to off-site receptors.

2.35.10.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Extent Possible

The Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner for IWOU-Wide Groundwater. Of those alternatives that are protective of human health and the environment and comply with ARARs, the Selected Remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element and bias against off-site treatment and disposal and considering state and community acceptance.

The Selected Remedy treats the low-level threat wastes in IWOU-Wide Groundwater, achieving significant reductions in chlorinated solvents in groundwater. The Selected Remedy satisfies the criteria for long-term effectiveness by degrading low-level threats in groundwater. ERD via IRZ will effectively reduce the mobility of contaminants. The Selected Remedy does not present short-term risks that are different from the other treatment alternatives. There are no special implementability issues that set the Selected Remedy apart from any of the other alternatives evaluated.

2.35.10.5 Preference for Treatment as a Principal Element

The NCP establishes an expectation that USEPA will use treatment to address the principal threats posed by a site wherever practicable (NCP §300.430[a][1][iii][A]). No principal threat wastes have been identified in IWOU-Wide Groundwater.

By treating the contaminated groundwater by ERD via IRZ and natural attenuation processes, the Selected Remedy addresses impacted groundwater through the use of treatment technologies. By utilizing treatment as a significant portion of the remedy, the statutory preference for remedies that employ treatment as a principal element is satisfied.

Five-Year Review Requirements

Five-year reviews of the Selected Remedy will be performed because the Selected Remedy will require an extended timeframe to meet cleanup levels, and contaminants will remain in soil and groundwater at concentrations that do not allow for UUUE. These reviews will be conducted at least every 5 years after

commencement of the remedial action, until concentrations of contaminants are reduced to levels that allow for UUUE, to ensure that the remedy continues to adequately protect human health and the environment.

2.35.11 Documentation of Significant Changes

All written and verbal comments submitted during the January 2007 public meeting and comment period were reviewed, and it was determined that no significant changes to the remedy, as outlined in the 2007 Proposed Plan, were necessary or appropriate.

3. Responsiveness Summary

3.1 Stakeholder Issues and Lead Agency Response

The modifying criteria (Section 2.7.6.3) addressed following submission of the Proposed Plan are used to evaluate the acceptability of the selected remedies to regulatory agencies and the community. The following is an evaluation of regulatory agency and community acceptance of the selected remedies for IWOU. The Responsiveness Summary is presented in detail in **Appendix C.**

During the public meeting on January 23, 2007 at LCAAP, representatives of the Army were available to answer questions from the public and to briefly describe the proposed remedial actions for IWOU. Most of the questions received during the public meeting were related to the investigation findings and the remedial actions (i.e., what remedial actions would be taken, how they would be implemented, and what effects the actions would have). The responses to these questions are in the written transcript from the meeting provided in the information repository. The public notices published in local newspapers are also included in the information repository.

Five written comments were received during the public comment period. A written comment from the Co-Chair of the RAB, Mr. Greg Perry, was received during the public meeting. Mr. Perry objected to the proposed remedial actions. A second written comment from Mr. Greg Perry was received in a letter to the Army on February 12, 2007. In his letter, Mr. Perry requested inclusion of a statement regarding access to the site by RAB members. A written comment was received during the public meeting from another member of the RAB, Mr. Leonard Heman. Mr. Heman stated that he had made numerous visits to IWOU, accompanied by qualified personnel, to answer his questions. He stated his agreement with the selected remedial alternatives for IWOU. A written comment was received from another member of the RAB, Ms. Georgia Saunders, in a letter to the Army dated February 6, 2007. In the letter, Ms. Saunders expresses her objection to the IWOU proposed remedies, stating that she does not believe cleaning the area to what is defined as suitable for industry will be good enough for the future. Finally, a written comment was received from a member of the public, Mr. Greg Davison. Mr. Davison presents a question regarding health screening of employees and local residents. All of the written comments and the corresponding responses related to IWOU are summarized in **Appendix C.**

There were no other outstanding comments or questions from the public during the public meeting or the public comment period. The USEPA and MDNR accepted the Final IWOU RI/FS and Proposed Plan, and communicated their respective concurrence of the selected remedies during the IWOU public meeting. No technical or administrative issues regarding the selected remedial alternatives have been identified.

4. ACRONYMS AND ABBREVIATIONS

AEHA	U.S. Army Environmental Hygiene Agency
ALM	Adult Lead Model
AOC	Area of Concern
AOI	Area of Interest
ARAR	Applicable or Relevant and Appropriate Requirement
Area 18 OU	Area 18 Operable Unit
bgs	below ground surface
BNA	base/neutral and acid extractable organic compound
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
COC	chemical of concern
COD	chemical oxygen demand
COPC	chemical of potential concern
COPEC	chemical of potential environmental concern
CRP	Community Relations Plan
CSF	cancer slope factor
CSEM	Conceptual Site Exposure Model
CSM	conceptual site model
CY	cubic yards
DAF	dilution attenuation factor
DERP	Defense Environment Restoration Program
DNAPL	dense non-aqueous phase liquid
DQO	data quality objective
DU	depleted uranium
EcoSSL	USEPA Ecological Soil Screening Level
EE/CA	Engineering Evaluation/Cost Analysis

ELCR	Excess Lifetime Cancer Risk
EP	extraction procedure
EPC	exposure point concentration
ERA	ecological risk assessment
ERD	enhanced reductive dechlorination
ESD	explanation of significant differences
ESL	Ecological Screening Level
ESV	Ecological Screening Value
FFA	Federal Facilities Agreement
FS	Feasibility Study
GOCO	government-owned/contractor-operated
gpd	gallons per day
gpm	gallons per minute
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
HSU	hydrostratigraphic unit
IRA	Interim Remedial Action
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
IRZ	in-situ reactive zone
IWOU	Installation-Wide Operable Unit
IWTP	industrial wastewater treatment plant
LBVSD	Little Blue Valley Sewer District
LCAAP	Lake City Army Ammunition Plant
LOAEL	Lowest-Observed Adverse Effect Level
LUC	Land Use Control
LUCIP	Land Use Control Implementation Plan

MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MDNR	Missouri Department of Natural Resources
mg/kg	milligrams per kilogram
MNA	monitored natural attenuation
MOWQC	Missouri Water Quality Criteria
MPE	multi-phase extraction
NAPL	non-aqueous phase liquid
NCEA	National Center for Environmental Assessment
NCP	National Contingency Plan
NECOU	Northeast Corner Operable Unit
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No-Observed Adverse Effect Level
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
NRC	Nuclear Regulatory Commission
O&M	operations and maintenance
OU	operable unit
PAH	polynuclear aromatic hydrocarbon
PA/SI	Preliminary Assessment/Site Inspection
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PPE	personal protective equipment
PRG	preliminary remediation goal
PRW	permeable reactive wall
RAB	Restoration Advisory Board
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act

RD/RAWP	Remedial Design/Remedial Action Work Plan
RDX	cyclonite
RfD	reference dose
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act of 1986
SCAPS	Site Characterization and Soil Vapor Containment System
SLERA	Screening Level Ecological Risk Assessment
SSL	soil screening level
SVCA	soil vapor contaminant assessment
SVE	soil vapor extraction
SVOC	semi-volatile organic compound
SWMU	solid waste management unit
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TEF	Toxicity Equivalency Factor
TKN	Total Kjeldahl Nitrogen
TNR	trinitroresorcinol
TOC	total organic carbon
TU	Toxicity Unit
UCC	upper confidence limit
ug/dL	micrograms per deciliter
ug/L	micrograms per liter
USACE	U.S. Army Corps of Engineers
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USEPA	United States Environmental Protection Agency
UST	underground storage tank

UULE	unlimited use and unrestricted exposure
UXO	unexploded ordinance
VOC	volatile organic compound

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