

FOCUSED FEASIBILITY STUDY

Site 3 – Former Base Landfill Buckley Air Force Base, Colorado

DRAFT FINAL

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LIST OF ACRONYMS

µg/L	Micrograms per Liter
amsl	Above Mean Sea Level
AFB	Air Force Base
AFI	Air Force Instruction
AMR	Annual Monitoring Report
ARAR	Applicable or Relevant and Appropriate Requirement
AVGAS	Aviation Gasoline
BAFB	Buckley Air Force Base
BGP	BAFB General Plan
bgs	Below Ground Surface
CBSGW	Colorado Basic Standards for Ground Water
CCR	Colorado Code of Regulations
CDPHE	Colorado Department of Public Health and Environment
CDOT	Colorado Department of Transportation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
C.R.S.>	Colorado Revised Statutes
DCB	Dichlorobenzene
DCE	Dichloroethene
ERP	Environmental Restoration Program
ERS	Environmental Remediation Services
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FFS	Focused Feasibility Study
FSCR	Final Supplemental Characterization Report
ft/min	Feet per Minute
HSP	Health and Safety Plan
ITSI	Innovative Technical Solutions, Inc.
LF1	Landfill Alternative 1
LF2	Landfill Alternative 2
LF3	Landfill Alternative 3
LF4	Landfill Alternative 4
LUC	Land Use Control
mph	Miles per Hour
msl	Mean Sea Level
NCP	National Contingency Plan
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethene
ppmv	Parts per Million by Volume
RAO	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision

SAIC	Science Applications International Corporation
SVOC	Semi-Volatile Organic Compound
TBC	To Be Considered
TCE	Trichloroethene
TO	Task Order
TOX	Total Organic Halogens
TWG	Technical Working Group
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USEPA	U.S. Environmental Protection Agency
Versar	Versar, Inc.
VOC	Volatile Organic Compound

EXECUTIVE SUMMARY

Site 3, the Former Base Landfill at Buckley Air Force Base, Colorado, is described as a series of landfill areas that were used between 1942 and 1982 for municipal refuse disposal. Waste oil and other flammable materials have been used during active disposal to burn refuse in order to reduce wind-blown debris. Fuel tank and aviation gas sludge were placed in the landfill from the 1940s until the late 1960s. The general method of operation was to dig a trench, fill the trench with waste material, and cover the material with earth. This was repeated as needed.

This Focused Feasibility Study (FFS) is based on the U.S. Environmental Protection Agency (USEPA) *Presumptive Remedy approach for Comprehensive Environmental Response, Compensation, and Liability Act Municipal Landfill Sites* (USEPA, 1993) and on guidance provided by the Colorado Department of Public Health and Environment (CDPHE) remedial action approach for closed landfills. The CDPHE summarized the minimum requirements for landfills that stopped receiving waste prior to October 9, 1991, in a memorandum dated August 16, 1999.

Previous site investigations have been performed at the landfill since 1982. The investigations, summarized in the *Final Supplemental Characterization Report (FSCR) for Site 3–Former Base Landfill, Buckley Air Force Base, Colorado* (Versar Inc. [Versar], 2007b), found the general area of waste disposal to encompass approximately 24 acres, located in several discrete areas. Low levels of chlorinated volatile organic compounds (VOCs) have been detected in groundwater. During the 2006 sampling, all detections of VOCs were less than the Colorado Basic Standards for Ground Water (CBSGW) with the exception of one well that was slightly above the CBSGW of 5 µg/L for trichloroethene with a reported value of 5.07 µg/L.

Based on an assessment of risk, presented in the *FSCR*, response actions for locations outside the Site 3 landfill areas are not warranted. Neither landfill leachate nor landfill gas production has been identified as a risk, and therefore will not be addressed within the containment design process. Applying the presumptive remedy of containment will adequately address exposure pathways of concern for Site 3. Based on Human Health Risk Evaluation, Ecological Risk Evaluation, and potentially complete exposure pathways presented in the *Remedial Investigation Report* (Science Applications International Corporation, 1995) and the *FSCR*, the following remedial action objectives have been developed for protection of human health and the environment:

- Prevent direct or indirect contact with landfill materials;
- Demonstrate continued protection of human health and the environment, and existing groundwater conditions, during and after cover construction.
- Minimize erosion of the landfill cover.

Municipal landfill-type wastes were observed during the assessment described in the *FSCR*.

Trenches excavated during the assessment exposed debris from the former landfill that included ash, asphalt, batteries, bricks, cardboard, ceramic pipe, concrete blocks, fiberglass insulation, glass, metal (including wire and pipe), milk jugs, newspaper, paper, plastic, possible drywall, soda cans, telephone poles, tiles, and wood. These items have been observed in locations where inadequate cover exists and where surface debris lies atop the former disposal areas.

Additional cover is needed over about 12 acres of Site 3, based on the *FSCR*. An area where debris has been recently unearthed at the extreme northwestern corner of Site 3 comprises approximately 4 additional acres, which brings the approximate total acreage requiring additional cover to 16 acres and increases the total area of the former disposal area to approximately 28 acres. A conservative depth-to-bottom-of-waste of 12 feet below ground surface was used in conjunction with the total area of 28 acres to derive a total approximate volume of waste of 542,000 cubic yards.

Development of Alternatives

Four alternatives were considered for analysis and comparison for this FFS, as summarized below:

Alternative LF1: No Action. A No Action alternative is required to be considered in all remedy comparisons since it provides a general baseline against which active remedial approaches can be judged. At Site 3, this alternative means that no further action will be taken as it relates to the existing disposal waste and the site will remain in its current configuration. The No Action alternative does not implement any remedial action alternative to lower the potential exposure to the landfill contents.

Alternative LF2: Removal and Disposal. This alternative involves the complete excavation of all landfill debris at Site 3 and the subsequent disposal of this waste in a permitted off-site landfill. This alternative also includes the continued monitoring of the existing groundwater monitoring well network for 5 years. However, as the waste will be completely removed, the alternative does not require land use controls to the areas encompassed by Site 3.

Alternative LF3: Soil Cover. This alternative involves augmentation of the existing soil cover to ensure that the waste areas have been covered with a minimum of 24 inches of clean soil, pursuant to the Colorado Solid Waste Disposal Sites and Facilities Act (Title 30, Article 20, Part 1, Colorado Revised Statutes). This alternative will also include the removal and relocation of waste debris in select locations throughout the site where capping is not practical, including along the East Toll Gate Creek drainage bottom. This alternative also includes land use controls, a long-term maintenance program for the soil cover, and monitoring of the groundwater at the site.

Alternative LF4: Soil Cover with Biota Barrier. Alternative LF4 is similar to LF3, with the addition of an engineered biota barrier constructed over the landfill waste areas to prevent

burrowing animals from digging into the waste. The entire 28 acres constituting Site 3 will be covered with the biota barrier and a 24 inch layer of soil will be placed over the biota barrier.

This alternative will also include the removal and relocation of waste debris in select locations throughout the site where capping is not practical. This alternative also includes land use controls, cover maintenance and groundwater monitoring. This alternative is also in compliance with the Colorado Waste Disposal Sites and Facilities Act (Title 30, Article 20, Part 1, Colorado Revised Statutes).

Summary of Comparative Analysis

Alternative LF1: The No Action alternative was evaluated in accordance with the National Contingency Plan and USEPA guidance. However, this alternative is not protective of human health and the environment, and does not achieve applicable or relevant and appropriate requirements.

Alternative LF2: Removal and Disposal involves excavation and off-site disposal of the waste materials. The cost for this alternative is significantly higher than the two containment alternatives at \$21,978,406. Similar alternatives have been conducted in the Denver area in support of property redevelopment, but the land use of Site 3 is anticipated to remain open space.

Alternatives LF3 and LF4: Involve containment of the landfill wastes and follow the USEPA *Presumptive Remedy for Municipal Landfills*. These two alternatives meet the requirements outlined in the Colorado Solid Waste Regulations (6 Colorado Code of Regulations 1007-2). Alternative LF3 involves augmenting the existing cover and addresses burrowing animals through maintenance activities. Alternative LF4 provides a biota barrier over the landfill materials, with a 24 inch soil cover installed over the barrier. The cost of Alternative LF4 (\$8,857,346) is significantly higher than augmenting the soil cover under Alternative LF3 (\$2,620,145).

1.0 INTRODUCTION AND BACKGROUND

This report presents the focused feasibility study (FFS) conducted by Innovative Technical Solutions, Inc. (ITSI), for Site 3, Former Base Landfill (Site 3), also referred to as the Base Dump, at Buckley Air Force Base (BAFB), in Aurora, Colorado. ITSI conducted this FFS under Task Order (TO) DK06 of the United States Army Corps of Engineers, Omaha District (USACE), Environmental Remediation Services (ERS) Small Business Contract No. W91238-06-D-0022 for remediation of BAFB Environmental Restoration Program (ERP) Sites. TO DK06 requires ITSI to optimally achieve required Performance Objectives for five identified BAFB ERP sites within the TO Period of Performance, in compliance with Colorado Department of Public Health and the Environment (CDPHE) and U.S. Environmental Protection Agency (USEPA) requirements.

1.1 Purpose and Organization of Report

This FFS is based on guidance provided by the CDPHE and USEPA. Several guidance documents have been reproduced in **Appendix A**. Applicable guidance documents include:

- CDPHE memorandum (August 16, 1999) *Old Landfill Closure Requirements and Post-Closure Care and Maintenance* (NOTE: “old landfills” refers to landfills that stopped receiving waste prior to October 9, 1991);
- USEPA. *Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills*, EPA/540/F-96/020 (USEPA, 1996);
- USEPA. *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites*, EPA/540/P-91-001 (USEPA, 1991); and
- USEPA. *Presumptive Remedy for CERCLA Municipal Landfill Sites*, EPA 540-F-93-035 (USEPA, 1993).

The USEPA provides for the use of presumptive remedies for preferred technologies for common categories of environmental sites based on historical patterns of remedy selection and the USEPA’s evaluation of performance data. The USEPA has established that containment is the presumptive remedy for municipal landfills, including military landfills. As such, containment adequately addresses the exposure pathways of concern for the Site 3 source areas. Containment will prevent direct contact with landfill contents and also meets the minimum CDPHE requirements for old landfills. Landfills that stopped receiving waste prior to October 9, 1991 (old landfills) are covered under the regulations pertaining to solid waste disposal sites and facilities (Colorado solid waste regulations pursuant to the Solid Waste Disposal Sites and Facilities Act, Title 30, Article 20, Part 1, Colorado Revised Statutes).

This FFS report is divided into five sections:

- Section 1.0 provides background information and summarizes the findings of previous site investigations and reports.

- Section 2.0 develops the site-specific remedial requirements and objectives.
- Section 3.0 develops comprehensive analysis of site alternatives.
- Section 4.0 provides a summary of the presumptive remedy; and
- Section 5.0 provides a list of cited references.

1.2 Site Description and Location

BAFB occupies approximately 3,250 acres within the City of Aurora, Arapahoe County, Colorado, and is located approximately 4.5 miles east of Denver, Colorado (**Figure 1-1**). BAFB is bounded by 6th Avenue on the north, E-470 to the east, East Jewell Avenue on the south, and Airport Boulevard/Buckley Road on the west.

Site 3 is located in the southwestern portion of BAFB, north of Mississippi Avenue and east of Alameda Parkway (**Figure 1-2**). A portion of Site 3 is crossed by South Aspen Way. Site 3 is also located along East Toll Gate Creek, an intermittent tributary to Sand Creek (**Figure 1-3**).

1.3 Site History

A detailed summary of the history of BAFB and Site 3 was presented in the *Final Supplemental Characterization Report (FSCR) for Site 3—Former Base Landfill, Buckley Air Force Base, Colorado* (Versar, 2007b). Site 3 is described as a series of landfill areas that were used between 1942 and 1982 for municipal refuse disposal. Waste oil and other flammable material were used to burn refuse in order to reduce wind-blown debris. Fuel tank and aviation gasoline (AVGAS) sludge were placed in the landfill from the 1940s until late 1960s. The general method of operation was to dig a trench, fill the trench with waste material, and cover the material with earth. This disposal method was repeated as needed.

Portions of two additional BAFB ERP sites are within the historical boundaries of Site 3 (**Figure 1-2**). Site 2 is a former Oil Pit where the contents of waste oil were occasionally burned. The former Oil Pit was taken out of service in 1987. Through site investigations between 1982 and 2005, soil and groundwater impacts were found to not exceed regulatory levels. No further response actions were deemed acceptable for Site 2.

Site 11 is an area of approximately 10 acres that formerly consisted of a machine gun synchronization area; a base motor pool; civil engineering shops; truck maintenance and refueling operations; and support facilities. Site investigation results have determined that there are soil and groundwater impacts resulting from the activities at this site, including lead, petroleum hydrocarbons, and chlorinated hydrocarbons. Site characterization activities are currently ongoing.

1.4 Physical Setting

BAFB is located in the City of Aurora, in Arapahoe County, Colorado, and is within the Denver metropolitan area (**Figure 1-1**).

BAFB is located near the western edge of the Great Plains physiographic province, in an area of grass-covered rolling uplands, generally developed on eolian (loess) and alluvial deposits.

Topography in the vicinity of BAFB is gently rolling hills separated by broad valleys. The base is on a broad northwest-trending ridge, bordered on the southwest by a northwest trending drainage (East Toll Gate Creek) and on the northeast by a north trending drainage to Sand Creek. The ground elevation ranges from about 5,500 to 5,700 feet above mean sea level (msl). The highest point is located near the southeastern corner of the base, and the lowest areas are within the drainages near the base boundaries.

Site 3 is generally located along East Toll Gate Creek in the southwest portion of BAFB. The topography is controlled by this intermittent stream with the northern and southern sides of the site sloping toward the stream.

The *FSCR* identifies two areas that define the limits of Site 3. The Historical Site 3 Area is generally the area of waste located along East Toll Gate Creek and is subdivided into six sub-areas based on the disposal locations. The Northern Site 3 investigation area is an area located northwest of the intersection of Aspen Street and Aspen Way.

The Historical Site 3 Area includes the Main Landfill (East and West), encompassing the original landfilling areas at BAFB, which were located on both sides of East Toll Gate Creek. Aspen Street bisects these two landfilling areas. The Main Landfill (South) area is a disposal trench that trends northwest-southeast, south of and parallel to East Toll Gate Creek. Two additional trench areas (North Trench and South Trench) are located parallel to East Toll Gate Creek along the north side of the stream. The East Landfill area is an area located east of the Main Landfill areas, north of East Toll Gate Creek, in the northeastern portion of Site 3.

1.4.1 Climate

The climate at BAFB is classified as dry continental and is typical of high plains areas, with low humidity, light precipitation, and abundant sunshine. Prevailing winds are from the south and average 9 miles per hour (mph). Precipitation is generally sporadic, with more than 75 % of precipitation occurring between March and September. Average annual rainfall is 16.65 inches and average monthly precipitation ranges from 0.47 inches during January to 2.68 inches during May. Average annual snowfall is 51.8 inches, with peak snowfall typically occurring in March. Average daily maximum temperatures range from 43 in January to 88 in July.

1.4.2 Surface Water

There are two primary surface water drainage areas within the vicinity of BAFB: Toll Gate Creek and Sand Creek. The drainage divide between East Toll Gate Creek and Sand Creek corresponds to the main northwest-southeast runway at the base. Sand Creek maintains a small base flow throughout most of the year, and discharges to the South Platte River.

East Toll Gate Creek flows toward the northwest, and is a tributary to Sand Creek, discharging northwest of the base. Flow in East Toll Gate Creek is intermittent. It primarily drains agricultural and residential areas. The Federal Emergency Management Agency (FEMA) has designated the East Toll Gate Creek drainage as a 100-year floodplain (Versar, 2007b). The regulatory floodplain has been defined east and south of BAFB and is being updated downstream of BAFB. In addition, BAFB recently has delineated the 100-year and 500-year floodplains for East Toll Gate Creek through BAFB, continuing from off base FEMA-mapped areas (Versar, 2007b). Wetlands were delineated following the standard US Army Corps of Engineers (USACE) delineation methodology along East Toll Gate Creek.

Based on the configuration of the 100-year floodplain, approximately one third of the Site 3 area of waste lies within the 100-year floodplain. A portion of the waste also underlies the streambed of East Toll Gate Creek. As reported in the *FSCR*, most of the Main Landfill (East and West) area lies within the 100-year floodplain, and portions of two delineated wetlands areas extend through the disposal area. Approximately half of the Main Landfill (South) area lies within the 100-year floodplain. The North and South Trench Areas and the East Landfill all lie outside of the floodplain, and no associated wetlands are mapped in or near these disposal areas.

1.4.3 Soil

A soil survey map of Arapahoe County, including the investigation area, published by the U.S. Department of Agriculture–Natural Resource Conservation Service (formerly the Soil Conservation Service) was reviewed. The soil immediately to the north of the investigation area is generally composed of Fondis silt-loam with slopes ranging from 1 to 3 percent. South of the investigation area is a Fondis silt-loam with 3 to 5 percent slopes (Versar, 2007b). The Fondis silt-loam is described as having a surface soil about 6 to 7 inches thick, abruptly underlain by a dense high-swelling montmorillinitic clay subsoil about 18 to 20 inches thick. Depth-to-lime (caliche) is 14 to 20 inches in areas of 1 to 3 percent slope and less than 14 inches in the 3 to 5 percent slope areas, with soil pH in the range of 6.4 to 9.0. Reportedly, these soils are plastic when wet, with moderate to low permeability and a high available water-holding capacity (Versar, 2007b). The area immediately northeast of the investigation areas is composed of the Renohill-Buick loam (3 to 9 percent slope) and Renohill-Little-Thedalund Complex (9 to 30 percent slope). Both of these are shallow and have loam or clay-loam topsoil 3 to 4 inches thick, underlain by calcareous clay or clay-loam subsoil with shale beginning at 24 inches or less (Versar, 2007b).

The surface soil overlying waste areas of Site 3 is largely non-native or disturbed. The soil consists of mixed types, predominantly silty, fine-grained sand where present.

1.4.4 Geology

BAFB is located within the Denver Basin geologic structure, which primarily consists of interbedded shale, claystone, siltstone, and sandstone, ranging from Late Cretaceous to Early Tertiary in age.

Sedimentary rocks within the basin are comprised of seven geologic formations. In descending order, these formations are the Castle Rock Conglomerate; Dawson Arkose; the Denver, Arapahoe, and Laramie Formations; the Fox Hills Sandstone; and the Pierre Shale. The Castle Rock Conglomerate and the Dawson Arkose are not present in the Buckley AFB area. At Buckley AFB, the Denver Formation crops out, or is overlain by Quaternary-age unconsolidated alluvial and eolian deposits.

The Denver Formation is approximately 850 feet thick in the BAFB area, and crops out in the northeastern, eastern, and southwestern areas of the base. At BAFB, the formation consists of variable consolidated, fractured and unfractured, interbedded claystone, siltstone, and fine- to coarse-grained sandstone, with occasional coal seams, that occur in discontinuous lenticular beds. It is characterized by its brown, olive, green-gray, bluish-gray, and tan colors, derived from basaltic and andesitic source rock.

The alluvial deposits are confined to stream valleys, which generally trend southeast to northwest along the southwestern and northeastern sides of the base. The alluvial deposits have a maximum thickness in the central portions of the valleys and decrease in thickness along the flanks. Since these deposits are derived from the Denver Formation, they have characteristics similar to the Denver Formation, except the material is unconsolidated and tends to be coarser and more homogeneous. The eolian deposits are typically unconsolidated silt, sandy silt, silty clay, and fine- to medium-grained silty sand. In the central portion of BAFB, these deposits are up to 30 feet thick in the topographically high areas relative to the stream valleys.

The underlying geology associated with the various areas that make up Site 3 was evaluated based on site investigations performed for the Supplemental Site Characterization through soil borings and trench excavations. In the vicinity of Site 3, fill material and unconsolidated surficial material, consisting of silt, sandy silt, silty sand, and clay, overlie the Denver Formation (Versar, 2007b). Bedrock was encountered in 22 of the test excavations at depths ranging from 1.25 to 10 feet below ground surface (bgs). The alluvial deposits along East Toll Gate Creek, typically a coarser-grained material, were less than 10 feet thick.

The Main Landfill (East and West) area is underlain by a fill material consisting primarily of silt and sand and is generally thin (less than 2 feet) (Versar, 2007b). Bedrock, consisting of a claystone, was encountered in several of the disposal trenches at depths ranging from 2 to 7.5 feet bgs (Versar, 2007b). Bedrock also was encountered in trenches within the East Landfill area at depths ranging from 4.5 feet to 10 feet bgs. Bedrock was not encountered in any of the test excavations (dug to 13 feet bgs) within the Northern Landfill area.

1.4.5 Hydrogeology

Groundwater within the Denver Basin typically is found in the variably consolidated sandstone, conglomerate, and siltstone deposits of the Denver, Arapahoe, and Laramie Formations and the Fox Hills Sandstone.

Claystone layers within the Denver Formation are relatively impermeable, inhibiting vertical and horizontal groundwater flow and creating semi-confined groundwater conditions. In general, unconfined groundwater conditions exist in the weathered Denver Formation and overlying surficial deposits. Semi-confined/confined groundwater conditions typically exist in the southern and central portions of the Basin, where the Denver Formation is overlain by the Dawson Arkose Formation.

Aquifer recharge occurs at bedrock outcrop areas through direct infiltration of precipitation and/or irrigation and drainage ditch water. Downward leakage of surface water from upland streams and rivers through alluvial material provides additional recharge. Groundwater discharge occurs primarily through seepage at streams and as evapo-transpiration where groundwater is present at formation outcrops.

BAFB regional groundwater flow generally follows ground surface topography northwest towards the South Platte River. Because of wide variability between geologic units within the Denver Basin, aquifer characteristics (e.g., transmissivity, hydraulic gradients) vary widely. Site 3 groundwater levels vary from 9.9 to 56.4 feet bgs and flows to the northwest through coarser-grained alluvial deposits and weathered Denver Formation (Versar, 2007b). Hydraulic conductivity is measured between 1.1×10^{-2} feet per minute (ft/min) to 2.7×10^{-1} ft/min, although one well screened within Denver Formation sandstone exhibited hydraulic conductivity between 5.9×10^{-5} ft/min and 1.2×10^{-4} ft/min (Versar, 2007b).

At Site 3, groundwater generally occurs within the alluvium associated with East Toll Gate Creek for areas located along the stream and within the 100-year floodplain. In areas further north or south of the local stream, groundwater occurs within the weathered bedrock claystone/siltstone. Within the Main Landfill (East and West) areas, groundwater is estimated to occur at depths ranging from 10 to 30 feet bgs (Versar, 2007b). Groundwater in the vicinity of the Main Landfill (South) area is estimated to occur between 16 and 24 feet bgs. The North and South Trench areas have groundwater occurring between 12 feet and 25 feet bgs. Both the East Trench area and the Northern Site 3 area are further distant from East Toll Gate Creek, and thus groundwater occurs at depths estimated at between 40 and 50 feet bgs.

1.4.6 Ecology

Native habitat includes short grass prairie rangelands and a riparian strip along Toll Gate Creek. The rangelands support numerous non-game species including ground-nesting birds and small mammals. Landscaped areas are predominantly turf grasses.

Significant vegetation cover, such as dense yucca and rabbit brush stands, is present in some areas. Both stands are dominated by blue grama grassland. Crested wheatgrass has become widely established since its introduction on the Base. Weedy disturbed areas also exist in these areas.

A diversity of habitats is found in the open grass prairies, riparian corridors, and open water at Lake Williams, which is located on the eastern side of the Base east of Steamboat Avenue. Wildlife found in these areas is typical of the High Plains of Colorado. Fishery resources found at Buckley AFB are limited to Lake Williams and the small ponds along Toll Gate Creek. Lake Williams has been stocked with trout, bass, and carp, and anglers have reported catching catfish. Brook stickleback, fathead minnow, and western white sucker have been observed in Toll Gate Creek.

1.4.7 Sensitive Environments or Critical Habitats

Wetlands are the only sensitive habitats known to be present. BAFB has six areas that are designated by the U.S. Fish and Wildlife Service as wetlands. Two of these areas, classified as palustrine scrub/shrub wetlands, are within or adjacent to the East Toll Gate floodplain in the southwestern portion of the base. The Base contains at least five additional potential wetland areas; however, detailed analyses have not been conducted to determine if these areas qualify for wetland protection under Section 404 of the Clean Water Act. These areas are found along the riparian corridors and are currently designated as bottomland meadow or cottonwood/willow associations.

1.4.8 Threatened, Endangered, or Rare Species

The bald eagle, federally listed as threatened, has been observed as a frequent transient at the Base. In addition to being a federally listed species, the bald eagle is also protected under the Bald Eagle Protection Act. Due to the similar appearance of immature bald eagles and golden eagles, the golden eagle is also protected under the Act.

The golden eagle has been observed foraging at BAFB. Several breeding pairs of the western burrowing owl, state-listed as threatened, currently occupy portions of the base. The ferruginous hawk, state-listed as a special concern species, also has been observed at BAFB. Other federally listed and state-listed bird species potentially existing at the Base include the mountain plover, Baird's sparrow, and loggerhead shrike. Federally listed and state-listed mammals potentially existing at BAFB include the black-footed ferret, Preble's meadow jumping mouse, and swift fox; however, these species have not been seen on the Base. The Preble's meadow jumping mouse has a higher potential of inhabiting Buckley AFB due to the available suitable habitat. The black-tailed prairie dog, a candidate for Federal listing, also has been seen on the base.

1.5 Summary of Previous Investigations

Previous site investigations performed at the landfill since 1982 have included early Phase I site assessments, further investigations based on the installation and sampling of groundwater monitoring wells, and detailed geophysical surveys.

The investigations, summarized in the *FSCR*, found the general area of waste disposal to encompass approximately 24 acres, located in several discrete areas.

As part of a Phase II site investigation conducted in 1984 (Dames & Moore, 1986), four groundwater monitoring wells were installed (MW-1, MW-2, MW-3, and MW-4). The Phase II Report (Dames & Moore, 1986) stated that although elevated total organic halogen (TOX) levels were present and cadmium levels exceeded primary drinking water standards, the landfill did not appear to be the source.

As part of the Remedial Investigation (RI) in 1988 (Science Applications International Corporation [SAIC], 1995), four groundwater monitoring wells (LFW-5, LFW-6, LFW-7, and LFW-8) were installed and sampled; and an additional five monitoring wells (LFW-13, LFW-14, LFW-15, LFW-16, and FW-17) were installed in 1991 to complete the RI field investigation. Groundwater samples were analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), chlorinated herbicides, chlorinated pesticides/polychlorinated biphenyls (PCB)s, trace metals, cations, and anions. Soil and sediment samples were analyzed for a similar suite of compounds. The *RI Report* concluded that the results showed no stream sediment contamination. The report also stated that there were limited, random areas of low-level subsurface soil contamination, including petroleum hydrocarbons. The report also stated that minor groundwater contamination was detected in well LFW-15 (trichloroethene [TCE] at 11 micrograms per liter [$\mu\text{g/L}$]).

The *RI Report* included a baseline public health risk assessment, comparing the detected contaminants to applicable or relevant and appropriate requirements (ARARs). The *RI Report* concluded that there was no significant carcinogenic or non-carcinogenic risk associated with the presence of the limited soil and groundwater contamination at Site 3.

In June, 1998, two additional groundwater monitoring wells (LFW-18 and LFW-19) were installed. During the period between June 1998 and March 2002, five groundwater monitoring events were conducted. These sampling events identified potential site-related contaminants in groundwater that included TCE, 1,2-dichloroethene (DCE), tetrachloroethene (PCE), 1,4-dichlorobenzene (DCB), dichlorodifluoromethane, and chloroform. However, only TCE and PCE were detected above regulatory standards in two wells, LFW-13 and LFW-15.

1.5.1 Final Supplemental Characterization Report for Site 3 – Former Base Landfill

In support of the *FSCR*, field activities performed from August 2004 to July 2006 included geophysical surveys, test pit excavations, wetlands delineation, landfill gas screening and sampling, and groundwater monitoring well installation, water-level measurements, and sampling. The investigation determined that Site 3 consisted of both a historical landfill area (located largely along East Toll Gate Creek) and a northern Site 3 area, located along Aspen Street, north of Aspen Way. Investigation locations are shown on **Figure 1-3**. Several distinct locations of former disposal areas were identified and investigated.

Under the *FSCR*, a review of historical documents including historical aerial photographs was performed.

The aerial photograph review indicated that trenching operations for waste disposal were conducted on both sides of East Toll Gate Creek, from about 1942 through the late 1960s or 1970. The initial landfilling area observed on a 1942 photograph appeared to be east of the current Aspen Street and immediately north of East Toll Gate Creek. Additional trenches were located to the north and west until about 1963 or 1964, when the trenching operations gradually moved east. In about 1966 to 1970, disposal occurred in large isolated trenches to the east and south of the previous disposal areas (Versar, 2007b).

The review of historical documents guided the performance of a geophysical survey over about 145 acres. The surveys involved several types of geophysical methods, including an EM31 frequency domain electromagnetic system, an EM61-MK2 time domain electromagnetic metal detection system, and a limited-use direct current receptivity survey.

The resulting interpretation of the geophysical surveys identified disturbed and buried debris at Site 3. The EM31 survey indicated several areas with high conductivity, suggesting disposal areas.

The EM61 survey identified portions of the landfill area with possible high densities of metal that also suggested disposal areas. Within the historical Site 3 area, the EM31 survey identified 13 anomalies, and the EM61 survey identified 6 anomalies.

The geophysical survey was used to direct the selection of test excavation locations. The test excavations provided a means to delineate the lateral extent of the waste and determine the thickness of the cover over the waste. Within the historical Site 3 area, 122 test excavations were performed of which 39 trenches crossed a landfilling boundary, one crossed two landfilling boundaries, and 19 trench excavations contained subsurface waste and were within the landfilling areas. Within this historical Site 3 area, the average depth to the top of the waste was 2 feet, but ranged from 1 to 8 feet.

Within the northern Site 3 area, 22 test trenches were excavated. The results suggested that 6 of these trenches crossed a buried debris boundary and 3 trenches contained buried debris within the identified debris areas. The depth to the top of the debris was less than 2 feet at all but one of these locations.

Wetlands delineation was performed in August through September 2004 at Site 3 using the *Corps of Engineers Wetland Delineation Manual* (USACE, 1987). The delineation task involved the observation of wetland vegetation, soil testing, marking and surveying, and general observations.

The wetlands evaluation was summarized in a report entitled *Final Wetland Delineation for Supplemental Characterization of Site 3—Former Base Landfill* (Versar, 2007a) and this report was included in the *FSCR*.

The results indicated eight areas containing wetland vegetation, hydrology, and soils (**Figure 1-3**). The eight areas are confined to the banks and channel of East Toll Gate Creek.

Two wetland areas determined to be less than 0.1 acre in size are expected to be covered through application for a Nationwide Permit, and therefore will not require mitigation. Three areas between 0.1 and 0.5 acre in size are expected to be covered through application for a Nationwide Permit. These areas will require mitigation if dredge and fill impacts will occur at these locations. And three areas are equal to or greater than 0.5 acre in size. These areas will require submittal of an application for an individual Clean Water Act Section 404 permit, and will require mitigation if dredge or fill activity is planned for these areas.

Landfill gas generation was evaluated in support of the *FSCR*. Soil gas samples were collected at 10 locations to evaluate the concentration and distribution of landfill gases in and adjacent to the former waste disposal areas. Methane was detected in all of the soil gas samples, at concentrations ranging from 13.3 to 17.8 parts per million by volume (ppmv). These results were determined to be three orders of magnitude lower than the lower explosive limit of 5 percent by volume for methane. Additionally, utility manholes near or in disposal areas were screened for landfill gas. No elevated concentrations of landfill gases were detected in utility manholes (Versar, 2007b).

In support of the *FSCR*, two additional groundwater monitoring wells (LFW-20 and LFW-21) were drilled and installed in 2005. These wells were installed downgradient from the Historical Landfill area and from the East Landfill area, respectively.

The two new wells and eight existing wells (LFW-6, LFW-7, LFW-8, LFW-13, LFW-14, LFW-15, LFW-16, and LFW-19) were sampled in July 2006. All samples were analyzed for VOCs, and five of the wells also were analyzed for perchlorate. Chlorinated solvents, including PCE, TCE, and cis-1,2-DCE were detected in groundwater from three wells (LFW-13, LFW-15, and LFW-19).

With the exception of TCE in well LFW-19, all detections of VOCs in July 2006 were less than the Colorado Basic Standards for Ground Water (CBSGW). The reported value of 5.07 µg/L TCE in well LFW-19 only slightly exceeded the CBSG of 5 µg/L. Perchlorate was detected in all except one (LFW-21) of the 5 wells sampled, at concentrations ranging from 0.078 µg/L (LFW-20) to 1.4 µg/L (LFW-7). All detections were below the USEPA Interim Drinking Water Health Advisory Level of 15 µg/L (Versar, 2007b).

The *FSCR* assessed applicable exposure pathways that may be associated with the former BAFB landfill. The primary migration pathway of potential concern was identified as the off-base migration of contaminated groundwater. The results of the supplemental characterization indicated that contaminants of concern in groundwater were not detected at levels above groundwater standards.

Other potential off-site migration pathways included landfill gas migration, and migration of potentially contaminated surface water, sediment, and debris from erosion or runoff at the landfill areas that are crossed by East Toll Gate Creek. The supplemental characterization indicated that there was no indication of landfill leachate, no discharge of contaminated groundwater to surface water, and no off-site migration of the waste debris. As stated in the *FSCR*, a risk assessment under the presumptive remedy of containment (USEPA, 1993) is required only for surface water and sediment in surface water bodies and wetlands and for downgradient groundwater. A quantitative risk assessment for the landfill source (such as the refuse and debris that makes up the former BAFB landfill) is not required, because the source is addressed by the containment remedy.

Based on the site characterization data and an assessment of risk (Versar, 2007b), a response action for areas outside the Site 3 landfill source is not warranted. Neither landfill leachate nor landfill gas production has been identified as a risk and therefore will not be addressed within the containment design process. A presumptive remedy of containment would adequately address exposure pathways of concern for the Site 3, as outlined in the *FSCR*.

The *FSCR* also indicates that an ecological risk assessment was not performed because the chemicals of concern were detected at low levels. Additionally, the presumptive remedy of containment will prevent contact with the soil, sediment, and debris in the landfill source areas and will minimize the potential release of contaminants to downgradient surface water. The *FSCR* concludes that the risk for ecological populations would be negligible.

The CDPHE reviewed the *FSCR* and concluded that the presumptive remedy of waste containment with a soil cover was appropriate and was consistent with the CDPHE guidance (Minutes of September 29, 2006, Technical Working Group [TWG] Meeting). The TWG also agreed there are no explosive gas concerns for Site 3 and, with the exception of perchlorate detected in some groundwater sampling, the site is adequately characterized. The TWG indicated that perchlorate sampling could be deferred to and performed under the post-closure groundwater monitoring program.

1.5.2 Additional Landfill Area Discovery

A construction effort at BAFB in 2008 uncovered a previously unidentified area of debris and waste northwest of the general extents of known contiguous waste areas at Site 3. The area encompasses approximately 4 acres in the most northwestern portion of the Site. The triangular-shaped area is bounded by Aspen Way on the northeast, the Base perimeter road on the west, and East Toll Gate Creek on the south. Trenching and characterization of this area has not been conducted, however; the construction activities exposed debris that is common to other areas of the landfill, and the area is defined by topography.

2.0 SITE-SPECIFIC REMEDIAL REQUIREMENTS AND OBJECTIVES

Remedial Action Objectives (RAOs) are specific goals for protecting human health and the environment. Establishing RAOs is the first phase of the FFS process for a site. For each medium of interest at BAFB Site 3, RAOs that will protect both human health and the environment have been established. The National Contingency Plan (NCP) specifies that RAOs be developed to address: (1) contaminants of concern (COC); (2) media of concern; (3) potential exposure pathways; and (4) preliminary remediation goals. The RAOs are developed by evaluating the applicable or relevant and appropriate requirements (ARARs). General response actions describing measures that will satisfy the RAOs are then developed. Finally, remedial technologies applicable to each action are identified and discussed with respect to their effectiveness and implementability. The applicable technologies are then assembled into medium-specific remedial alternatives in **Section 3.0**.

2.1 Contaminants of Concern

Identifying the COCs is necessary for screening remedial technologies and designing remedial alternatives that will allow for RAOs to be met.

The *FSCR* identified the maximum detections of contaminants in groundwater and identified those contaminants that exceeded regulatory standards for groundwater. **Figure 2-1** summarizes the areal extent of waste disposal areas identified within Site 3 and **Figures 2-2** and **2-3** present the most recent groundwater sampling results from July 2006 and historic groundwater results.

The only two COCs identified during these sampling events were perchlorate and TCE. However, no chemicals associated with previous site operations were found in areas of potential contaminant migration from the landfill at levels that may pose an unacceptable risk (Versar, 2007b). As discussed in the *FSCR*, the very low concentration of TCE detected in the single well appears to be anomalous and not representative of a continuous plume or consistent source. Perchlorate was detected at varying concentrations throughout the landfill areas, suggesting the possibility that non-landfill sources may be responsible for the presence of this compound. The supplemental characterization determined that site-related chemicals were not present at levels of concern in groundwater underlying the landfill. Additionally, neither elevated levels of landfill gas nor contaminated landfill leachate was observed during the Supplemental Characterization at the site. Therefore, landfill leachate and landfill gas collection and control systems are not required within a containment remedy.

The TWG also agreed there are no explosive gas concerns for Site 3 and, with the exception of perchlorate detected in select groundwater samples, the site is adequately characterized. The TWG indicated that perchlorate sampling could be deferred to and performed under the post-closure groundwater monitoring program.

2.2 *Extent and Types of Contaminated Media*

Previous site investigations have identified areas associated with the former landfill operations at Site 3. These areas have been delineated, and debris and landfill contents have been identified and characterized.

Based on the observations made during the RI and the Supplemental Characterization at Site 3, chemicals associated with the landfill activities have not been reported in areas of potential contaminant migration from the former landfill areas at levels that may pose unacceptable risks to either current or future populations. Also, neither chemicals at levels of concern nor elevated levels of landfill gas are present in the groundwater underlying the landfill areas, indicating that the landfill waste is not generating leachate. While historical groundwater sampling has indicated low-level concentrations of TCE and perchlorate, these detections were not determined to pose a risk to human health or the environment.

As previous investigations have indicated, the only potential risks at Site 3 are associated with exposure pathways to landfill debris and surrounding potentially impacted soil. The presumptive remedy of containment will eliminate these pathways.

As described in the *FSCR*, detailed characterization of the contents of the former landfill during the assessment indicate that debris at Site 3 meets the definition of municipal-landfill-type wastes. Municipal landfills are those facilities in which a combination of household, commercial, (e.g., hospital wastes, grease, and construction debris), and to a lesser extent, industrial wastes (e.g., solvents, and paints) have been co-disposed (USEPA, 1996). Previous investigations have shown that Site 3 received municipal refuse from 1942 until about 1968, with continuing operations conducted until 1982 (Simons, Li, and Associates, Inc., 1982). As a result, the closure requirements for landfills that stopped receiving waste prior to October 9, 1991, pursuant to the Colorado Solid Waste Disposal Sites and Facilities Act, are applicable to Site 3.

Municipal landfill-type wastes were observed during the assessment described in the *FSCR*. Trenches excavated during the assessment exposed debris from the former landfill that included ash, asphalt, batteries, bricks, cardboard, ceramic pipe, concrete blocks, fiberglass insulation, glass, metal (including wire and pipe), milk jugs, newspaper, paper, plastic, possible drywall, soda cans, telephone poles, tiles, and wood (Versar, 2007b). These items have been observed in locations where inadequate cover exists and where surface debris lies atop the former disposal areas.

As stated in the *FSCR*, additional cover is needed over about 12 acres of Site 3, or approximately half of the estimated 28 total acres of former disposal area (**Figure 2-1**). Additionally, a recommendation was made to remove or cover areas where surface and subsurface debris exists along East Toll Gate Creek (Versar, 2007b).

The additional areas along the creek coupled with an area where debris has been recently unearthed at the extreme northwestern extent of Site 3, comprise approximately 4 additional acres, bringing the approximate total acreage requiring additional cover to 16 acres and increasing the total extent of the former disposal areas to approximately 28 acres. A conservative depth-to-bottom of-waste of 12 feet bgs was used in conjunction with the total area of 28 acres to derive a total approximate volume of waste of 542,080 cubic yards.

The extents of the Site 3 landfill areas (including the newly discovered area of landfill waste in the northwestern portion of the site) and the observed depth of the existing soil cover are shown on **Figure 2-1**.

2.3 Preliminary Remedial Action Objectives

The FFS for Site 3 follows the *Presumptive Remedy for CERCLA Municipal Landfill Sites* and focuses on containment as a means to eliminating exposure pathways. Relevant guidance documents have been reproduced in **Appendix A**. The following preliminary RAOs are applicable to Site3:

- Prevent direct or indirect contact with landfill materials;
- Demonstrate continued protection of human health and the environment, and existing groundwater conditions, during and after cover construction; and
- Minimize erosion of the landfill cover.

2.4 Applicable or Relevant and Appropriate Requirements

Site 3 is being closed in accordance with the USEPA Presumptive Remedy approach for municipal and military landfill sites under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). However, before this remedial action can be implemented, the federal, state, and local regulatory requirements that may be pertinent to such action must be identified. These ARARs are used to create a framework for determining the health-based and risk-based limits for remedial action and developing remedial action alternatives.

2.4.1 Types of ARARs

Based on CERCLA guidance, there are three categories of ARARs to be considered: chemical-specific, location-specific, and action-specific. Chemical-specific ARARs set health or risk-based exposure concentration limits or ranges in various environmental media for specific hazardous substances. Chemical-specific ARARs are used to establish site cleanup levels or to provide a basis for calculating cleanup levels for the media of interest. Location-specific ARARs set restrictions on the types of remedial activities that can be performed based on site-specific characteristics or location. Location-specific ARARs may restrict remediation activities at sensitive or hazard-prone locations such as active fault zones, wildlife habitat, and flood plains.

Action-specific ARARs are applied to particular remedial activities that are selected to complete a site cleanup. Most action-specific ARARs address treatment, transportation, and disposal of hazardous waste. Action-specific ARARs may specify performance levels, actions, or technologies, as well as specific levels for discharge of residual chemicals, and provide a basis for assessing the feasibility and effectiveness of the remedies.

2.4.2 To Be Considered Criteria

Conditions may occur where ARARs may not be sufficient to protect human health or the environment. Should these conditions exist, non-promulgated standards, criteria, guidance, and advisories must be evaluated along with the selected ARARs to help provide protective target cleanup levels and to develop CERCLA remedies. These types of standards are commonly referred to as “To Be Considered” (TBC) requirements and are not legally binding.

Three types of TBC requirements are identified:

- Health effects information;
- Technical information regarding site investigations or remedial actions; and
- Policy.

Identified TBCs are included in the ARAR discussions that follow.

2.4.3 Chemical-Specific ARARs and TBCs

A list of potential chemical-specific ARARs and TBCs for the Site 3 is provided in **Table 2-1**. Chemical-specific ARARs include regulations and guidance that pertain to cleanup goals and include Colorado regulations and guidance, solid waste management regulations, Clean Water Act regulations, air regulations for landfill gas, and the Safe Drinking Water Act for the existing groundwater impacts. For areas where waste will be removed, chemical-specific ARARs include levels that pertain to cleanup goals, to determine that sufficient material has been removed and remaining soil does not pose significant risks to human health or the environment.

2.4.4 Location-Specific ARARs and TBCs

A list of potential location-specific ARARs and TBCs for the Site 3 is provided in **Table 2-2**. Location-specific ARARs include regulations and guidance that pertain to the protection of wetlands, floodplain, fish and wildlife, and historic and archeological sites. Location-specific ARARs would relate to the surface water bodies located in the vicinity of Site 3. Site 3 is located adjacent to designated wetland areas. Additionally, portions of Site 3 are located within the 100 year floodplain along East Toll Gate Creek.

The Federal Endangered Species Act (ESA) requires action to avoid jeopardizing the continued existence of listed threatened and endangered species, or destroying or adversely modifying critical habitat. Several threatened and endangered species have been identified or have the potential to be found at Buckley AFB, as discussed in **Section 1.5.8**.

2.4.5 Action-Specific ARARs and TBCs

A list of potential action-specific ARARs and TBCs for the Site 3 is provided in **Table 2-3**. Action-specific ARARs include regulations and guidance that pertain to safety standards, permitting and monitoring of air emissions, and solid-waste landfill requirements.

Construction health and safety standards would be associated with action-specific ARARs. Action-specific ARARs would also include final cover requirements, Occupational Safety and Health Administration (OSHA) regulations, National Pollution Discharge Elimination System (NPDES) requirements (40 CFR 122), discharge of stormwater runoff (40 Code of Federal Regulations [CFR] 122.26), and Colorado State requirements for closure of historical landfills (6 CCR 1007-2).

2.4.6 Waiver of ARARs

The CERCLA regulations (40 CFR Part 300.430(f)(3)) provide conditions under which an ARAR may be waived with respect to remedial activities. These are noted since the preferred remedy, containment, may not meet all ARARs. Several criteria that allow the waiver of an ARAR are provided by CERCLA (Section 121(d)(4)):

- The remedial action selected is only part of a total remedial action that will attain such level or standard of control when completed;
- Compliance with such requirements at the facility will result in greater risk to human health than alternative options;
- Compliance with such requirements is technically impractical from an engineering perspective; and
- The remedial action selected will attain a standard of performance that is equivalent to what is required under the otherwise applicable standard, requirement, criteria, or limitation, through use of another method of approach.

With respect to a State standard, requirement, criteria, or limitation, a waiver can be obtained in instances where the State has not consistently applied (nor demonstrated the intention to consistently apply) the standard, requirement, criteria, or limitation in similar circumstances at other remedial actions.

2.4.7 Cleanup Goals

The final step in the development of the RAOs is to establish cleanup goals based on chemical-specific ARARs, TBCs, and COCs. The aim of the remedial action objectives is to meet ARARs and eliminate exposure to COCs such that human health and the environment are adequately protected. This can be achieved by eliminating exposure pathways or reducing contaminant concentrations to levels that are accepted to be adequately protective of human health and the environment. The FFS for Site 3 follows the *Presumptive Remedy for CERCLA Municipal Landfill Sites* and focuses on containment as a means to eliminating exposure pathways.

2.5 Remedial Action Goals for Site 3

Based on the Human Health Risk Evaluation, Ecological Risk Evaluation, and potentially complete exposure pathways presented in the *RI* and the *FSCR*, the following RAOs have been developed for protection of human health and the environment:

- Prevent direct or indirect contact with landfill materials;
- Demonstrate continued protection of human health and the environment, and existing groundwater conditions, during and after cover construction.
- Minimized erosion of the landfill cover.

There are no specific remedial action goals for groundwater, leachate, or landfill gas based on the evaluation of impacted media, COCs, and ARARs for Site 3. Therefore, landfill leachate and landfill gas collection and control systems are not required within the presumptive remedy of containment.

2.6 Presumptive Remedies for Landfills

The USEPA states in *Presumptive Remedies: Policies and Procedures*, “presumptive remedies are expected to be selected at all appropriate sites except under unusual site specific circumstances.” The presumptive remedy for municipal landfills is intended to ensure consistency in the selection of the remedy, and reduction in the time and cost required to clean up similar types of sites. Although the use of presumptive remedies does not affect the need to identify the COCs and the RAOs at Site 3, the presumptive remedy approach allows BAFB to streamline the feasibility process and perform a FFS. It also does the following:

- Eliminates the step of identifying and performing a preliminary screening of potential treatment technologies and containment/disposal requirements. The identification of general response actions is associated with this step, and is therefore eliminated.
- Eliminates the need to assemble retained technologies into “complete alternatives.”
- Eliminates the need to screen the retained “complete alternatives,” which is normally performed in order to reduce the number of alternatives that will be evaluated in detail.
- Streamlines the identification of alternatives to be evaluated in detail to justify the presumptive remedy and the No Action alternative.
- Streamlines the detailed evaluation of the retained alternatives to the set of nine criteria against which remedial actions are judged (**Section 3.1**), and to each other.

In order to use a presumptive remedy at a specific site, sufficient site characterization must be performed to show that the site conditions match those specified for the presumptive remedy.

As stated in the *Presumptive Remedy for CERCLA Municipal Landfill Sites*, “Consistent with the NCP, the USEPA’s expectation was that containment technologies generally would be appropriate for municipal landfill waste because the volume and heterogeneity of the waste generally make treatment impracticable.”

The USEPA’s guidance document *Application of the CERCLA Municipal Landfill Presumptive Remedy Guidance to Military Landfills* lists six questions that should be addressed to evaluate if the presumptive remedy can apply to military landfills such as Site 3 at BAFB. An evaluation of these questions as they pertain to Site 3 is discussed below:

- What information should be collected? The guidance indicates that information about the source material and volume of landfill wastes should be sufficient to determine whether source containment is the appropriate remedy for the landfill.

Evaluation: Based on the *FSCR*, an evaluation of historic records, aerial photographs, and test pit logs (**Section 1.3**) provided sufficient information to determine if source containment is an appropriate remedy for Site 3.

- How may land reuse plans affect remedy selection? The guidance indicates that for smaller landfills, (generally less than two acres), excavation could be considered as an option in addition to containment, depending upon land reuse plans.

Evaluation: There are currently no plans to use the land at Site 3 for anything but its current purpose. In addition, the size of the landfill (28 acres) is in excess of what the guidance indicates is suitable for excavation.

- Do landfill contents meet municipal landfill-type waste definition? To determine whether a specific military landfill is appropriate for application of the containment presumptive remedy, compare the characteristics of the wastes present in the landfill to typical municipal landfill wastes listed in the guidance.

Evaluation: As detailed in the *FSCR*, only household wastes and construction debris were found during excavation of test pits.

- Are military-specific wastes present? Military wastes (such as explosively configured munitions or chemical warfare materiel), may possess unique safety, risk, and toxicity characteristics.

Evaluation: No wastes of a military nature were found at Site 3 during the supplemental investigation.

- Is excavation of contents practical? Although no set excavation volume limit exists, landfills with a content of more than 100,000 cubic yards (approximately two acres, 30 feet deep) would normally not be considered for excavation.

Evaluation: The estimated volume of waste (542,080 cubic yards) may not be considered practical. The removal of landfill materials is further evaluated under Alternative LF2 (**Section 3.2.2**).

- Can the presumptive remedy be used?

Evaluation: The available information indicates that the presumptive remedy is appropriate and should be used at Site 3.

The USEPA's presumptive remedy guidance program expectations, which are applicable to landfill sites, can be used to define the following components of the landfill presumptive remedy:

- Landfill cover;
- Source area groundwater control to contain contaminant migration;
- Leachate collection and treatment;
- Landfill gas collection and treatment; and
- Institutional controls (such as access controls, land use controls in the Base General Plan, etc.) to supplement engineering controls (such as landfill capping, drainage control, etc.).

Not all components listed above are required in all cases.

2.7 Formulation of Remedial Alternatives

There are several general response actions available to address the components of source containment as presented in the presumptive remedy guidance. These general response actions are listed in **Table 2-4**. Also included in this summary is the option of disposal through excavation as a comparative analysis. A preliminary screening of the technologies is presented, and based on these general response options and their associated retained technologies, a number of alternatives is considered, ranging from the No Action alternative to removal and disposal of landfill waste and containment of the landfill materials with a soil cover. The waste areas to be addressed by the proposed remedial alternatives are shown on **Figure 2-4**.

A No Action alternative (LF1) is required to be considered in all remedy comparisons. It provides a general base-line from which active remedial approaches can be judged. In this case, a No Action approach to Site 3 means that no further action will be taken with respect to the existing disposal waste, and the site will remain in its current configuration.

Alternative (LF2), a removal alternative, considers the complete excavation of all debris and waste within Site 3 (**Figure 2-4**) and the subsequent disposal of this waste in a permitted off-site landfill. Since the waste will be completely removed, it will not be necessary to apply land use controls to the areas encompassed by Site 3. This alternative is considered to determine whether excavation of the landfill materials practical. The remaining alternatives focus on the presumptive remedy of containment.

The containment alternatives (LF3, LF4) have common institutional controls including access restrictions, long-term maintenance and monitoring, and land use controls. The main objectives of the containment alternatives are to prevent human and ecological contact with the hazards associated with the former landfill contents, minimize infiltration of water to preclude future impacts to groundwater, and control surface water runoff and erosion. These alternatives also include the removal and relocation of waste debris from select locations throughout the site where capping is not practical (such as along the existing East Toll Gate Creek drainage bottom).

3.0 ANALYSIS OF ALTERNATIVES

This section presents a detailed analysis of the remedial action alternatives needed for remedy selection. The alternatives are described and evaluated with respect to the nine evaluation criteria that encompass statutory requirements: technical criteria, cost criteria, and public acceptance. The analytic approach is designed to provide sufficient information to allow an adequate comparison of the alternatives, support selection of the most appropriate remedy, and demonstrate compliance with statutory requirements as detailed in USEPA guidance (USEPA, 1988).

3.1 Description of Evaluation Criteria

Alternatives were evaluated based on criteria established by the NCP (USEPA, 1988). Nine evaluation criteria encompass the statutory requirements and technical, cost, and institutional considerations. The criteria are categorized as threshold criteria, balancing criteria, or modifying criteria.

Threshold Criteria

- **Overall Protection of Human Health and the Environment**: This describes how the remedial alternative achieves and maintains protection of human health and the environment. This protection can be accomplished by eliminating, reducing, or controlling exposures to contaminants to levels established during the development of remedial action objectives.
- **Compliance with ARARs**: This describes how the remedial alternative complies with the identified ARARs and TBCs. The determination that a requirement is relevant and appropriate is a two-step process. The relevance of a requirement is first determined, and relevant requirements are then evaluated for appropriateness.

Balancing Criteria

- **Long-term Effectiveness and Permanence**: This describes how the remedial alternative will continue to be effective in maintaining protection of human health and the environment after response objectives have been met. Factors that are considered include the magnitude of residual risk that may remain from untreated waste and the adequacy and reliability of controls to manage treatment of residuals and untreated waste.
- **Reduction of Toxicity, Mobility, and Volume through Treatment**: This describes how the remedial alternative addresses the anticipated performance of the specific treatment technologies. Factors that are considered include the treatment processes; amount of hazardous substances that will be destroyed; degree of expected reduction in toxicity and mobility due to the treatment; degree to which the treatment is irreversible; type and quantity of residuals that will remain following treatment; and the degree to which the treatment reduces the inherent hazards posed by the principal threats at the site.

- **Short-term Effectiveness**: This describes how the remedial alternative will maintain protection of human health and the environment during the construction and implementation of the remedy until a final response objective has been met. Short-term effectiveness may include evaluating the short-term risks posed to the community during the implementation of an alternative; the potential impacts on workers during remedial action; potential environmental impacts of the remedial action; and the time required until remedial action objectives are achieved.
- **Implementability**: This describes the remedial alternative in terms of technical and administrative feasibility and the availability of required goods and services toward final response objective. Technical feasibility will consider the reliability of the technology. Administrative feasibility will consider coordination with state agencies and the time it may take to obtain necessary approvals.
- **Cost**: This describes the evaluation of the remedial alternative in terms of capital and operational costs and long-term maintenance costs.

Modifying Criteria

- **Regulatory Acceptance**: This describes how the remedial alternative reflects regulatory (e.g., federal, state, and local governmental) support of and preference for alternatives. This criterion will be addressed in the Proposed Plan after comments on this FFS are received and reviewed.
- **Community Acceptance**: This describes how the remedial alternative reflects the community's support of and preference for the alternatives. Community input regarding the Proposed Plan will be solicited during the public comment period, during which time the Proposed Plan will be available for public review.

The CERCLA regulations specify requirements that should be addressed for each remedial action alternative. These requirements include:

- Protectiveness of human health and the environment;
- Compliance with ARARs;
- Cost-effectiveness;
- Use of permanent solutions and alternative treatment technologies when possible; and
- Satisfaction of the preference for treatment that reduces toxicity, mobility, or volume as a principal element.

3.2 Analysis of Alternatives

Based on USEPA guidance, the detailed analysis of alternatives presents a description and assessment for each alternative. An analysis of the four Site 3 alternatives, as they relate to the nine NCP evaluation criteria, is provided in **Table 3-1**.

The following subsections describe each alternative, provide major activities and estimated costs for implementing the alternative, and summarize the analyses, including principal limitations and benefits.

The surface area and boundaries of Site 3 were determined during the preparation of the *FSCR*. These boundaries are shown on **Figure 1-2**. Based on the *FSCR* and recent findings, areas of waste at Site 3 are estimated to encompass approximately 28 acres. Approximately 16 acres of Site 3 do not currently have sufficient cover material atop the landfill debris adequate to prevent exposure and control runoff. The estimated total landfill volume of waste that would require removal is 542,080 in-place cubic yards.

3.2.1 Alternative LF1: No Action

Description of Alternative: Under this alternative, no action would be taken to remove, treat, or contain waste at Site 3. Additionally, no institutional controls would be implemented to prevent intrusive activities into the waste materials. The No Action alternative is the baseline condition assuming no further remedial measures will be implemented and the site remains in its current configuration. This No Action alternative is required by the NCP to be carried forward to detailed analysis.

Analysis of Alternative: “No Action” does not meet the RAOs. As determined by the *FSCR*, adequate cover does not exist on approximately 16 acres of the former landfill, and the risk of exposure to the waste in these areas remains under this alternative. This alternative does not improve on the minimal protection already provided by the existing soil cover, nor is it considered a permanent remedy because it does not reduce the toxicity, volume, or mobility of the waste on the site. Further analysis is provided below:

Overall Protection of Human Health and the Environment

The No Action alternative does not provide adequate protection of human health and the environment. Waste is not contained adequately in approximately 16 acres, thus posing a threat of exposure to the landfill contents. The landfill cover materials in their current condition do not provide adequate protection against direct contact with the landfill contents. The No Action alternative would not include any access restrictions to BAFB personnel or visitors.

Additionally, the existing landfill cover in its current state is vulnerable to erosion from surface run-on and runoff in several portions of the site. The existing cover materials are vegetated in areas, but the vegetation is generally inadequate to provide protection from surface water erosion.

The No Action alternative also does not provide requirements for monitoring of groundwater to ensure that contaminants that may remain within the waste areas do not further disperse and impact groundwater beneath the landfill.

Compliance with ARARs

The chemical-specific ARARs are generally numerical standards that establish acceptable concentrations of a chemical found or discharged to the environment. The No Action alternative is in compliance with the chemical-specific ARARs since the *Final Supplemental Site Characterization Report* reported that chemical compounds, with the exception of TCE in well LFW-19, were detected in groundwater at concentrations less than the CBSGW. Chemicals associated with previous site operations have not been found at levels that may pose an unacceptable risk to current and future populations. Site-related chemicals are not present at levels of concern in groundwater, elevated levels of landfill gas were not present, and contaminated leachate has not been observed.

The location-specific ARARs, requirements related to the location of the landfill, generally relate to the location of the Site 3 with respect to the 100-year floodplain and the designated wetlands along East Toll Gate Creek. Under the No Action alternative, these areas are not disturbed; therefore, actions under these location-specific ARARs would not need to be taken.

The No Action alternative is not in compliance with the action-specific ARARs. The principal action-specific ARAR is the Colorado Solid Waste Regulations (6 CCR 1007-2). Although portions of Site 3 have adequate cover to comply with this ARAR, approximately 16 acres have been identified as requiring additional soil cover. In addition, portions of the existing landfill surface are relatively flat and allow some ponding of surface water.

Long-term Effectiveness and Permanence

Because no actions are implemented under the No Action alternative, the current configuration of the former landfill would remain as it is today. Because the landfill is only partially contained, risk of exposure to the landfill contents would continue to exist. Also, a No Action alternative does not control surface water runoff and erosion, and there are no controls in place to prevent the continued degradation of the existing cover. Therefore, the No Action alternative is not effective, nor is it permanent.

Reduction of Toxicity, Mobility, and Volume through Treatment

Since no treatment or removal of the waste is proposed for the No Action alternative, there is no reduction in toxicity, mobility, or volume of waste. There are no assurances that the waste will remain contained since the cover is not augmented and erosion is not controlled under the No Action alternative.

Short-term Effectiveness

There are no short-term impacts associated with the implementation of the No Action alternative, because no construction or monitoring activities will be performed. Because no remedial actions would occur with the No Action alternative, there would be no risks posed to either site workers or BAFB personnel during implementation of this alternative.

Implementability

Since no actions are undertaken in this alternative, there is no design, construction, or technical difficulties in the implementation of the No Action alternative.

Costs

No capital or annual operation and maintenance (O&M) costs are expected with this alternative.

Regulatory Acceptance

This criterion is generally addressed in the Proposed Plan and Record of Decision (ROD) after agency review of the FFS. However, it is anticipated that CDPHE would not accept the No Action Alternative since the Colorado Solid Waste Regulations (6 CCR 1007-2) and guidance on landfill covers would not be followed.

Community Acceptance

This criterion is generally addressed in the Responsiveness Summary of the ROD, which is the summary of all written and oral comments received from the public on the Proposed Plan. Community acceptance of the No Action alternative is not expected since the waste materials are not adequately covered.

3.2.2 Alternative LF2: Removal and Disposal

Description of Alternative: Alternative LF2 is the complete removal and off-site disposal of all debris and waste associated with Site 3. The material would be segregated and characterized. Depending on the characteristics of the waste, disposal would be at a Resource Conservation and Recovery Act (RCRA) Subtitle D (solid waste) disposal facility. Dewatering may be required during a portion of the excavation activities because some of the waste may be buried below the groundwater table, particularly along the creek bottom. The methods for treatment and disposal of the dewatered waste would be dependent upon the results of the laboratory characterization. The landfill materials would be disposed of in an off-site approved and permitted disposal facility.

The excavations would be backfilled with clean fill material to return the site to an original, stable grade and minimize any potential erosion. With the removal of all the landfill contents, no institutional controls would be needed.

Groundwater monitoring is included as a component of the maintenance program for this alternative. It is expected that four groundwater monitoring wells would be replaced due to site activities and a total of 10 monitoring wells would comprise the groundwater monitoring network. The wells would be sampled annually for 5 years after implementation of the remedy, and analyzed for VOCs using standard USEPA laboratory methods. The groundwater monitoring is defined for cost estimating purposes in **Table 3-2**; the specific groundwater monitoring program would be developed in the long-term monitoring plan.

Implementation of this alternative would allow unrestricted use and development of the Site 3 area. Below is a summary of anticipated scheduled activities and estimated costs.

Alternative LF2 would require disturbance of areas defined as wetlands and areas within the 100-year floodplain. Waste would be excavated and removed from these ecologically sensitive areas. As such, appropriate federal permits under the Clean Waters Act and Section 404 would be obtained and managed. Where required, wetlands would be re-established.

Schedule of Activities and Estimated Costs: Alternative LF2 is expected to require the following principal site activities:

- Prepare a Remedial Design Report including a Quality Assurance Project Plan, Site-Specific Health and Safety Plan (HSP), and Contractor Quality Control Plan;
- Submit a BAFB Civil Engineering Clearance Request;
- Prepare a Stormwater Pollution Prevention Plan;
- Site preparation including construction of temporary stormwater runoff controls;
- Excavate all waste and debris from all areas identified as Site 3;
- Conduct continuous air monitoring during excavation to evaluate air emissions and specify appropriate personal protective equipment for worker safety;
- Segregate and characterize all landfill contents and associated soil;
- Dewater excavations; treat and dispose of water as needed;
- Transport all waste for off-site treatment and disposal (assuming 100 percent of the excavated waste and debris will be disposed of at a RCRA Subtitle D facility);
- Restore the site (import and emplace clean fill to replace the removed waste and debris, replace topsoil, re-vegetate disturbed areas);
- Stabilize and re-construct surface water drainage features;
- Construct erosion control features on the former landfill, particularly adjacent to East Toll Gate Creek;
- Install groundwater monitoring wells (4 replacement wells will be constructed);
- Prepare completion report and engineering as-builts; and
- Conduct annual groundwater monitoring (10 wells) for 5 years.

Costs associated with Alternative LF2: The principal costs of this alternative are associated with the physical excavation of all wastes, transportation of the waste to a disposal facility, and the disposal fees. A summary of the cost items is presented in **Table 3-2**, and the cost development assumptions are included in **Appendix B**.

Analysis of Alternative: Alternative LF2 satisfies the RAOs since the removal of all debris and waste from Site 3 will effectively eliminate any risk posed by the waste. Elimination of the waste allows for unrestricted future use of the area, and no institutional controls will be imposed.

Overall Protection of Human Health and the Environment

Alternative LF2: Removal and Disposal would provide protection of human health and the environment. Total removal of all landfill waste and debris would prevent future exposure to the landfill contents. During implementation of this alternative, the work activities associated with excavation and site restoration may pose health and safety issues prior to completion of the remedy. The excavation of the debris may pose complications and risks to workers exposed to the waste and to BAFB personnel.

Compliance with ARARs

Implementation of Alternative LF2 would eliminate any potential sources of surface water contamination by removing all potential contaminant sources. Although groundwater impacts do not currently exist, the excavation of the waste would eliminate any potential for groundwater contamination. Therefore, LF2 would be in compliance with the chemical-specific ARARs.

Since LF2 will require work within the 100-year floodplain and within areas designated as wetlands, specific location-specific ARARs would be a concern. Compliance with these location-specific ARARs could be achieved during the implementation through mitigation efforts such as erosion control practices.

Compliance with action-specific ARARs would be associated with the construction safety of alternative LF2. All site work, including excavation and earthwork, would be conducted in accordance with general industry and construction safety standards and the site-specific HSP. Alternative LF2 would require compliance with federal, state, and local air emissions regulations and a fugitive dust and odor emission control plan would be required during site work. Water generated by any dewatering activities would require treatment and disposal under several state and federal regulations.

Long-term Effectiveness and Permanence

Because all waste and landfill contents would be removed under this alternative LF2, all potential sources for future surface water or groundwater degradation would be eliminated.

Although this alternative may result in the complete remediation of Site 3 and the long-term effectiveness is high, the Air Force would still retain liability for the waste at any off-site disposal site.

Should the waste contribute to an environmental problem, the Air Force would retain some responsibility for any cleanup actions.

Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative LF2 does not include waste treatment as part of the remedy. Depending on the final characterization of the waste, portions of the landfill contents may be segregated and handled separately. As discussed above, Alternative LF2 would not reduce the inherent hazards of the landfill material, but would transfer those hazards to a new location with more robust engineering controls.

Short-term Effectiveness

The implementation of Alternative LF2 would pose additional risks to site workers, BAFB personnel, and the adjacent community due to the excavation activities and the transportation of large volumes of waste material. The high truck traffic on the Base and in the adjacent community would result in increased risks to the public in the vicinity of the landfill, near the entrance gates, and along the traffic routes to the off-site disposal location. Additionally, dust and odor control technologies would need to be implemented to minimize the migration of fugitive emissions to nearby neighborhoods.

Site workers might also be exposed to contaminants during implementation of Alternative LF2. The risks to site workers could be minimized through an effective health and safety program. Air monitoring could be implemented to assess requirements for respiratory protection. Workers implementing Alternative LF2 would also incur risk of injuries that are routinely encountered with the operation of heavy equipment and high truck traffic.

Short-term risks to the environment may also be expected during implementation of Alternative LF2. Although the *FSCR* provides some details about the contents of the landfill, current knowledge of the site is not complete. Releases of chemicals or substances to the environment could occur during excavation of the waste. Also, the existing wetlands environment along East Toll Gate Creek could be impacted temporarily by diversion of surface water or a lowering of the groundwater table through dewatering efforts.

Implementability

In general, Alternative LF2 would be technically feasible. The excavation, dewatering, and backfilling activities at the former landfill would be implemented using conventional practices and would use standard materials and equipment. The excavation construction would be performed in accordance with detailed engineered construction plans and specifications. From a technical feasibility standpoint, the greatest complications occur with the staging of the operations, and the segregation of different material types (soil versus debris).

The administrative feasibility of Alternative LF2 is lower than the technical feasibility. As the contents of the landfill are not fully known, a potential risk of uncovering hazardous materials and substances exists with this alternative, and the handling of any RCRA hazardous wastes would require permits under RCRA.

Additionally, the large volume of waste involved, and the complexity of the transportation system required to bring the waste to a disposal site, would require coordination with CDPHE, USEPA, Colorado Department of Transportation (CDOT) and other state and local regulatory agencies.

Costs

The budgetary cost estimate summary for LF2 is shown in **Table 3-2**. Capital costs include all costs required for the implementation of Alternative LF2. This cost would be substantially higher if any RCRA hazardous materials are encountered during the removal activities. Periodic sampling costs are adjusted for present worth at a seven percent discount factor. The estimated capital and total project costs of LF2 are:

Capital Cost:	\$21,786,760
Total Project Cost (present value):	\$21,978,406

Regulatory Acceptance

This criterion is generally addressed in the Proposed Plan and ROD after agency review of the FFS. However, it is anticipated that CDPHE would accept Alternative LF2: Removal and Disposal. Several former landfills in the Denver area have been removed and disposed at commercial Subtitle D landfills in order to allow redevelopment of commercial and residential properties.

Community Acceptance

This criterion is generally addressed in the Responsiveness Summary of the ROD, which is the summary of all written and oral comments received from the public on the Proposed Plan. However, community acceptance of the Alternative 2 is expected to be low based on the high cost of the alternative and the risks associated with the transportation of large volumes of landfill wastes and backfill materials.

3.2.3 Alternative LF3 Soil Cover and Institutional Controls including Long-Term Monitoring and Land Use Controls

Description of Alternative: A Soil Cover is a containment technology that involves the placement of a soil cover over areas of the landfill that do not meet the minimum standards of the Colorado Solid Waste Regulations. This alternative is intended to meet this minimum standard by augmenting the soil cover in areas that do not currently meet this requirement, supplementing the soil in these areas as necessary. This alternative also includes institutional controls and monitoring to ensure the long-term integrity and post-closure care of the final remedy.

Alternative LF3 is based on the Colorado Solid Waste Regulations applicable to sites that ceased accepting wastes prior to October 9, 1991. For landfills in Colorado that did not receive waste after October 9, 1991, closure requirements are in accordance with the previous version of 6 CCR 1007-2, and dated January 10, 1983.

These regulations and guidance documents are reproduced in **Appendix A**.

The CDPHE has established minimum closure requirements for old landfills, summarized as follows:

- At least two feet of cover soil should be placed over the entire landfill area (**Figure 3-1**);
- Surface drainage should be implemented to prevent ponding that could lead to infiltration or erosion that could remove the soil cover over time;
- The completed covered landfill should present an orderly and good aesthetic appearance and should blend into the surrounding area;
- The concentration of explosive gases should not exceed 5 percent in air at the site boundary;
- Water pollution should not occur at or beyond the site boundary;
- Nuisance conditions should not exist at or beyond the site boundary;
- A post-closure monitoring, care, and maintenance program should be developed and followed. (NOTE: The CDPHE guidance for old landfills states that post-closure care is generally for 5 to 10 years, though the current regulations specify a 30 year care period.)

Following completion of the closure remedy, Buckley AFB as the landfill owner/operator must implement an inspection plan and program to accomplish the following:

- Maintain the integrity and effectiveness of the final landfill cover, including making repairs to correct effects of settlement, subsidence, erosion, vegetation failure, etc., and prevent water run-on and runoff from eroding or otherwise damaging the final containment cover;
- Maintain groundwater and gas monitoring systems, and test according to an approved plan;
- Provide the name, address, and telephone number of the responsible party during the post-closure care period.

Activities comprising this alternative include site preparation/grading, placement of the cover material, and site restoration (including re-vegetation with native plants and grasses).

Groundwater monitoring is included as a component of the maintenance program for this alternative. It is expected that four groundwater monitoring wells would be replaced due to site activities and a total of 10 monitoring wells would comprise the groundwater monitoring network. The wells would be sampled annually and analyzed for VOCs using standard USEPA laboratory methods.

The groundwater monitoring is defined in **Table 3-3** for cost-estimating purposes; the specific groundwater monitoring program would be developed in the long-term monitoring plan.

The CDPHE requires that an owner or operator will record a notation on the deed to the facility property that the land has been used as a landfill and that its use is restricted under the solid waste regulations. An alternate vehicle for performing this land use notation would be the BAFB General Plan (BGP).

The State regulations (6 CCR 1007-2) stipulate that post-closure use of the property shall not disturb the integrity of the final cover, components of the containment system, or function of the monitoring system. Containment of the waste under a soil cap eliminates many of the risks posed by the presence of the waste. Alternative LF3 would also include long-term groundwater monitoring at wells within the former waste piles and downgradient from the capped waste areas. The groundwater monitoring is included as a component of the operation and maintenance for this alternative.

Containment of the former landfill would also include institutional controls to maintain and enforce restrictions on the current and future use of the Site 3 areas.

These institutional controls would limit the development and use of the property in order to maintain the integrity of the landfill cover and prevent direct exposure to the waste.

Provisions for managing and monitoring for explosive gases (landfill gases) are not included in Alternative LF3 since such gases are not currently being detected, as detailed in the *FSCR*. Methane was detected in soil well below the threshold level of 5% in air within the landfill areas. The soil cover included in Alternative LF3 would not contain landfill gases and allow concentrations to accumulate within the waste debris piles, thereby reducing any risks of explosive gas buildup. Additionally, the TWG agreed that there are no explosive gas concerns at Site 3.

Alternative LF3 consists of adding soil to areas of the landfill in order to achieve the required 24 inches of cover and to provide drainage in currently shallow or flat areas. A generalized cross-sectional view of the soil cover is illustrated on **Figure 3-1**. Based on the *FSCR*, approximately 12 acres of the former landfill do not have adequate cover to meet the State requirements of 24 inches. Additionally, an area where debris has been recently unearthed at the extreme northwestern extent of Site 3 comprises approximately 4 additional acres, which increases the total acreage requiring additional cover to 16 acres. The remaining 12 acres of Site 3 have sufficient cover and would only need some limited grading to improve the surface drainage. **Figure 2-1** displays the existing cover thickness. Soil from the site would be used, when practical, for the supplemental cover material, and additional clean soil would be brought in from off-base for the additional soil cover. The soil cover would be graded and contoured to provide positive drainage toward the creek.

For Alternative LF3, waste occurring along East Toll Gate Creek would be excavated and relocated away from the creek bottom, consolidating the material toward the center areas of the landfill and incorporating the material into the existing waste.

The debris occurring along East Toll Gate Creek currently performs a function as rip-rap, and may have been purposely placed to prevent erosion. This debris would be replaced with engineered material that blends into the surrounding features of the site.

Alternative LF3 would require disturbance of areas defined as wetlands and areas within the 100-year floodplain. Waste would be excavated and relocated from these ecologically sensitive areas. Appropriate federal permits under the Clean Waters Act and Section 404 would be obtained and managed. Where required, wetlands would be re-established.

Schedule of Activities and Estimated Costs: Alternative LF3 is expected to require the following principal site activities:

- Prepare a Remedial Design Report including Quality Assurance Project Plan, Site-Specific HSP, and Contractor Quality Control Plan;
- Submit a BAFB Civil Engineering Clearance Request;
- Prepare a Stormwater Pollution Prevention Plan;
- Remove and relocate waste and debris from areas along East Toll Gate Creek (displayed on **Figure 1-3** as Surface Debris Along Creek);
- Remove waste and debris along the western portion of Site 3, along the perimeter road;
- Import fill material to replace the removed waste and debris;
- Place additional soil cover over 16 acres to ensure that a minimum of 2 feet of cover overlies landfill waste;
- Stabilize and re-construct adequate surface water drainage and erosion control features;
- Site restoration (replacement of topsoil in disturbed areas and re-vegetation to minimize wind and water erosion);
- Install signs notifying the public and BAFB personnel of the presence of the landfill;
- Install groundwater monitoring wells (up to 4 replacement wells);
- Implement land use controls (plan development, registry filings);
- Conduct annual monitoring at 10 groundwater wells (10 years);
- Implement long-term, annual inspections of the landfill surface for approximately 30 years, with maintenance and repairs performed as needed; and
- Perform 5-year reviews of the remedial action.

Site preparation would be performed before any disturbance of the existing surface is initiated. The purpose of the site preparation is to grade existing surfaces and remove vegetation that would affect the cover construction, and to control and collect storm water runoff during construction. Storm water controls would be constructed including silt fences and placement of straw fiber rolls.

Also, access restrictions (including installation of perimeter fencing) would be implemented to limit access.

Following completion of the site preparation, additional soil cover would be placed on 16 acres, and the site would be regraded, to establish a 24 inch soil cover over the entire landfill and attain the final site contour. **Figure 2-1** highlights areas that require additional cover material to meet the 24 inch minimum requirement. Areas associated with existing roadways would not require additional fill. Perimeter waste may need to be excavated and consolidated on site to move it away from surface drainage features or the site boundaries. Additional fill material would be imported and placed to develop acceptable slopes for proper drainage. The soil cover would not have specific engineering properties for low permeability or specified hydraulic conductivity value(s).

The site grading plan would be designed to manage surface water run-on, runoff, and control erosion of the cover soil. The final grading design for the site would also eliminate surface water ponding that can lead to excessive infiltration of precipitation within the landfill areas. The grading plan would be designed to maintain the natural drainage slopes toward East Toll Gate Creek. Native grasses would be used for revegetation of the site based on low maintenance requirements and compatibility.

The landfill cover would require long-term maintenance, including inspections and repair of damage that may occur through erosion or borrowing animals. The existing network of groundwater monitoring wells would be used to monitor the groundwater quality in the vicinity of the capped landfill. Groundwater monitoring would continue for approximately 10 years.

A summary of the cost items is presented in **Table 3-3**, and the cost development assumptions are included in **Appendix B**.

Land Use Controls

Land use controls (LUCs) would be instituted and enforced to control access and prevent potential exposure to the waste material. The LUCs would prohibit the construction of buildings within areas of the former landfill.

LUCs are kept in place until unrestricted use and unlimited exposure can be allowed. The LUCs are made part of the BGP and relate to the planning and development process to prevent exposure. The United States Air Force (USAF) would not modify or terminate LUCs or implementation actions, or modify land use, without approval by CDPHE. The USAF would be required to seek prior concurrence before any anticipated action that may disrupt the effectiveness of the LUCs or any action that may alter or negate the need for LUCs.

The specific LUC performance objectives and the mechanisms for achieving these objectives are as follows:

1. Prohibit the use of groundwater underlying Site 3, other than for environmental monitoring or testing. Due to the presence of perchlorate in groundwater, the BAFB well permitting system will be utilized to prevent any use of groundwater within the boundaries of Site 3.
2. Prohibit disturbing any components of the groundwater monitoring network that will be used for the long term monitoring. All groundwater monitoring wells will be permitted with the state, and records of the wells and well locations will be included with the BAFB excavation and digging permit system.
3. Prohibit new construction in areas identified as containing waste from the former Site 3. The BAFB excavation and digging permit system will maintain an access restriction that will prevent excavations within the LUC boundaries. The BAFB construction review process will also maintain data that will ensure no new construction will take place within the LUC boundaries.
4. Classify the property as 'Restricted Open Space' to ensure protection of human health and the environment. This property is subject to a 'Notice of Environmental Use Restrictions' imposed by the CDPHE pursuant to Colorado Revised Statutes (C.R.S.) 25-15-321.5 and is enforceable by CDPHE. The Notice will be submitted to CDPHE for approval.
5. Perform annual inspections of the biota populations within the extents of the landfill areas. Should the native burrowing animals create a nuisance and evidence of waste disturbance occurs, an animal relocation program will be instituted, relocating nuisance animals to areas outside of Site 3.

The USAF employs administrative procedures to track all development activity at BAFB that requires excavation, so that no project violates use restrictions. Existing procedures are included in Air Force Instruction (AFI) 32-1021, Planning and Programming of Facility Projects, and work request procedures under AFI 32-1001, Operations Management. AFIs and procedures require coordination with and prior approval by environmental personnel if a proposed project is located on or near an ERP site. Base personnel would verify locations of potentially contaminated sites via the available information (maps, documents, databases, GIS, etc.). The USAF will ensure that these or equivalent instructions, processes, and/or requirements will be complied with for all proposed construction or surface soil disturbing activities.

The BGP implements zoning-like requirements at BAFB. The BGP is one of the first and primary documents to be reviewed when installation personnel are proposing projects on the installation. AFI 32-7062 requires this comprehensive planning document for the establishment and maintenance of administrative and physical controls.

The BGP resides in the office of the Base Community Planner. The USAF would develop a detailed map to be included in the BGP showing the extent of waste and landfill material associated with Site 3. This information as well as LUCs, boundaries, and expected durations would be added to the existing LUC section of the BGP within 90 days of ROD signature. This section of the BGP includes a comprehensive listing and map of all LUCs on the installation. The specific LUCs would be incorporated into the BGP and cross-referenced to this map.

The USAF will not modify or terminate LUCs or modify land use within the affected area without approval by the CDPHE, and will seek prior concurrence before any anticipated action that may disrupt the effectiveness of the LUCs.

For proposed land use changes which do not include transfer of the property, the USAF would notify the CDPHE at least 30 days in advance of any anticipated Base proposal inconsistent with the use restriction and assumptions described for this alternative, any anticipated action which may disrupt the effectiveness of the LUCs, or any action which may alter or negate the need for the LUCs.

The USAF would conduct periodic monitoring of the LUCs, and provide notice to the CDPHE within 10 business days if it discovers any activity that is inconsistent with the LUC requirements, objectives, or controls, or any action that may interfere with the effectiveness of the LUCs. The USAF would include in such notice a list of corrective actions taken or planned to address such deficiency or failure.

The USAF would fully comply with and be accountable for the LUCs identified for this alternative and would timely submit to the CDPHE an Annual Monitoring Report (AMR) summarizing the status of the LUCs, including the operation, maintenance, and monitoring of LUCs, and describing the means by which any LUC deficiency or inconsistent use has been addressed.

Analysis of Alternative: Alternative LF3 satisfies the USEPA Presumptive Remedy guidance and also satisfies the Colorado Solid Waste Regulations (6 CCR 1007-2) that apply to older landfills. The containment option of a soil cover with institutional controls and a post-closure maintenance program effectively prevents exposure to the waste. An analysis of this alternative as it compares to the nine NCP criteria follows.

Overall Protection of Human Health and the Environment

The soil cover proposed by Alternative LF3 prevents direct contact with the landfill waste and reduces the infiltration of surface water. Therefore, Alternative LF3 would reduce and control the primary threats to human health and the environment and provide a reasonable level of long-term protection. The soil cover coupled with land-use restrictions would fulfill the RAOs and provide a remedy that would be protective of human health and the environment.

The landfill soil cover would prevent direct contact with the landfill contents and reduce erosion and control surface water run-on and runoff by including an adequate slope to promote positive drainage. The soil cover would be vegetated with native grasses and maintain control of erosion, thereby reducing the potential for future exposure to the waste.

Though impacted groundwater is not currently a problem at Site 3, groundwater monitoring would provide for early detection of contaminated groundwater before any migrate from the landfill boundary.

Alternative LF3 employs the use of added soil cover and the existing cover as the containment option for the landfill. This cover alternative may not prevent all burrowing animals from digging into the landfill cover and potentially digging into the waste contents. The 24 inch minimum thickness of the soil cover may exclude most common burrowing animals. Provisions in the institutional controls will include management of burrowing animals through a periodic deterrence or re-location program. Currently, BAFB performs regular biota management in other areas around BAFB, and this program would include the Site 3 areas.

Compliance with ARARs

Implementation of Alternative LF3 would reduce any potential surface water contaminant sources by fully containing the potential contaminant sources. Though groundwater impacts do not currently exist, the containing of the waste would greatly reduce any potential for groundwater contamination. Therefore, LF3 would be in compliance with the chemical-specific ARARs.

Since LF3 would require work within the 100-year floodplain and within areas designated as wetlands, specific location-specific ARARs would be a concern. Compliance with these location-specific ARARs could be achieved during the implementation of the soil cover through mitigation efforts such as erosion control practices.

Action-specific ARARs apply to the implementation of the proposed remedial actions at the landfill and follow the State of Colorado landfill closure requirements (6 CCR 1007-2) and general health and safety requirements. Alternative LF3 activities would be conducted in compliance with these action-specific ARARs.

Long-term Effectiveness and Permanence

The sources of the residual risks following the soil cover installation include the potential for direct contact with landfill materials and potential leaching of contaminants to surface water and groundwater. Therefore, the evaluation of the long-term adequacy and reliability of the controls considers the ability of the landfill cover to maintain its integrity and the long-term reliability of the institutional controls.

After construction of the soil cover, long-term human health and environmental risks from the landfill contents would be prevented by a physical barrier of at least 24 inches.

Grading of the soil cover and vegetation of the cover should prevent erosion and exposure of surface water to the landfill contents over the long term.

The low levels of VOCs in groundwater do not currently present an unacceptable human health risk. Effective institutional controls should prevent the use of groundwater in the future, thus eliminating any potential risks.

The long-term effectiveness of Alternative LF3 is expected to be acceptable because the soil cover would prevent contact with the waste contents and reduce infiltration of surface water. The long-term permanence of the remedy will be dependent upon the effectiveness of the cover inspection and periodic maintenance, the effectiveness of the institutional controls including the prevention of groundwater use, restrictions on land use, and limitations on intrusive activities.

Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative LF3 does not include waste treatment as part of the remedy. Portions of the landfill contents may be excavated and relocated, particularly along East Toll Gate Creek. However, Alternative LF3 would not reduce the inherent hazards of the landfill material, but rather depend upon containment and reducing the exposure risk through restricting access to the landfill area.

Short-term Effectiveness

The implementation of Alternative LF3 would pose some additional risks to BAFB personnel and to the adjacent community during implementation of the remedy due to the need to transport additional cover soil to the site. The increase in truck traffic on the base and in the adjacent community would result in increased risks to the public traveling in the vicinity of the landfill and near the entrance gates. Additionally, dust and odor control technologies would need to be implemented to minimize the migration of fugitive emissions to the nearby neighborhoods.

Site workers may also be exposed to contaminants during implementation of Alternative LF3. The risks to site workers could be minimized through an effective health and safety program. Air monitoring could be implemented to assess requirements for respiratory protection. Workers implementing Alternative LF3 would also incur risk of injuries that are routinely encountered with the operation of heavy equipment and high truck traffic.

Short-term risks to the environment may also be expected during implementation of Alternative LF3. Although the *FSCR* provides some information as to the contents of the landfill, the landfill contents are not completely known. Releases of known or unidentified chemicals or substances to the environment could occur during excavation of waste along the creek for purposes of relocating and consolidation. Also, the existing wetlands environment along East Toll Gate Creek could be temporarily impacted by either a diversion of the surface water or a lowering of the groundwater table through dewatering efforts.

Implementability

Alternative LF3 would be technically feasible. The soil cover construction activities at the former landfill would be implemented using conventional practices and would use standard materials and equipment. The soil cover would be constructed in accordance with engineered construction plans and specifications. Few aspects of the implementation are considered technically complex. Also, the institutional controls and monitoring would be expected to be easy to implement.

Alternative LF3 would be administratively feasible; but significant coordination with federal, state, and local agencies would be expected. Permits may be required to work within the 100 year floodplain and within the designated wetlands. These permits are not likely to impact the administrative feasibility.

Materials, services, and equipment required to implement Alternative LF3 are readily available. The landfill soil cover construction would involve the use of common materials since the soil cover would not have specific engineering parameters.

Costs

The budgetary cost estimate summary for LF3 is shown in **Table 3-3**. Capital costs include all costs that are required for the construction of the soil cover for Alternative LF3 and the long-term costs associated with groundwater monitoring and landfill cover maintenance. Annual and periodic sampling costs are adjusted for present worth at a seven percent discount factor. The estimated capital and total project costs of LF3 are:

Capital Cost:	\$2,228,268
Total Project Cost (present value):	\$2,620,145

Regulatory Acceptance

This criterion is generally addressed in the Proposed Plan and ROD after agency review of the FFS. However, it is anticipated that CDPHE would accept Alternative LF3, Soil Cover, since the installation of the cover and the LUCs would be conducted in accordance with CDPHE requirements.

Community Acceptance

This criterion is generally addressed in the Responsiveness Summary of the ROD, which is the summary of all written and oral comments received from the public on the Proposed Plan. Community acceptance of the Alternative LF3 is expected to be high based on the low cost of containment and the lower risks (in comparison with Alternative 2) associated with the transportation of smaller volumes of soil cover.

3.2.4 Alternative LF4 – Soil Cover and Engineered Biota Barrier, Institutional Controls including Long-Term Monitoring and Land Use Controls

Description of Alternative: Alternative LF4, Soil Cover and Engineered Biota Barrier, is a containment technology that includes installing a soil cover with a biota barrier followed by long-term monitoring and land use controls. Alternative LF4 is similar to Alternative LF3 with the exception of the installation of a barrier layer covering the entire Site 3 former landfill area. The additional biota barrier would be a 16 inch layer of crushed/recycled concrete placed over the waste. The soil cover would consist of an additional 24 inches of soil overlying the biota barrier. A generalized cross-sectional view of the landfill cover is illustrated on

Figure 3-2. The purpose of the biota barrier is to deter burrowing animals from digging into the waste. The principal burrowing animal at BAFB is the native prairie dog. The biota barrier material is designed to an aggregate size sufficient to deter these animals from digging into the waste material that the barrier covers. The biota barrier will not prevent the animals from digging into the soil cover. However, provisions in the institutional controls will include management of burrowing animals through a periodic deterrence or re-location program. Alternative LF4 meets the closure requirements for a solid waste landfill under the Colorado Solid Waste Regulations (6 CCR 1007-2).

The general activities that comprise Alternative LF4 include site preparation/grading, placement of the biota barrier, placement of the soil cover, site restoration, and re-vegetation with native plants and grasses. Groundwater monitoring is included as a component of the maintenance program for this alternative. It is expected that four groundwater monitoring wells would need to be replaced, and a total of 10 monitoring wells would comprise the groundwater monitoring network. The wells would be sampled and analyzed for VOCs using standard USEPA laboratory methods. The groundwater monitoring is defined in **Table 3-4** for cost estimating purposes; the specific groundwater monitoring program would be developed in the long-term monitoring plan.

The CDPHE requires that an owner or operator record a notation on the deed to the facility property that the land has been used as a landfill and that its use is restricted under the solid waste regulations. An alternate vehicle for performing this land use notation would be the BGP.

The State regulations [6 CCR 1007-2] stipulate that post-closure use of the property shall not disturb the integrity of the final cover, components of the containment system, or function of the monitoring system. Containment of the waste under a soil cap eliminates many of the risks posed by the presence of the waste. Alternative LF4 also would include long-term groundwater monitoring from groundwater wells within the former waste and downgradient from the capped waste areas. The groundwater monitoring is included as a component of the operation and maintenance for this alternative.

Containment of the former landfill would include institutional controls (described in detail below) to maintain and enforce current and future use of the Site 3 areas. These institutional controls would limit the development and use of the property and maintain the integrity of the landfill cover to prevent direct exposure to the waste.

The biota barrier would be composed of an aggregate of crushed or recycled concrete imported from off base. For the soil cover, existing site soil would be used as far as possible, and additional clean soil would be brought in from off base (**Figure 3-2**). The soil cover would be graded and contoured to provide positive drainage toward the creek.

As with Alternative LF3, waste occurring along the East Toll Gate Creek would be excavated and relocated away from the creek bottom. This debris would be replaced with engineered material that blends into the surrounding features of the site.

Schedule of Activities and Estimated Costs: Alternative LF4 is expected to require the following principal site activities:

- Prepare a Remedial Design Report including a Design Report, Quality Assurance Project Plan, Site-Specific HSP, and Contractor Quality Control Plan;
- Submit a BAFB Civil Engineering Clearance Request;
- Prepare a Stormwater Pollution Prevention Plan;
- Remove waste and debris from areas along East Toll Gate Creek (displayed on **Figure 1-3** as Surface Debris Along Creek);
- Remove waste and debris along the western portion of Site 3, along the perimeter road;
- Import aggregate for the biota barrier;
- Import fill material to replace the removed waste and debris;
- Place a 16 inch layer of concrete aggregate over the entire landfill area;
- Place a 24 inch soil cover over the biota barrier;
- Stabilize and re-construct adequate surface water drainage and erosion control features;
- Restore the site (replace topsoil and re-vegetate);
- Install signs notifying public and BAFB personnel of the presence of the landfill;
- Install groundwater monitoring wells (up to 4 replacement wells);
- Implement land use controls (plan development, registry filings);
- Initiate annual monitoring of 10 groundwater wells (10 years);
- Conduct annual inspections of the landfill surface for approximately 30 years, with maintenance and repairs performed as needed; and
- Perform 5-year reviews of the remedial action.

Site preparation would be performed before any disturbance of the existing surface is initiated.

The purpose of the site preparation is to grade existing surfaces and remove vegetation that would affect the cover construction, and to control and collect runoff during construction.

Stormwater controls including silt fences and straw fiber rolls would be installed as appropriate. Also, access restrictions including perimeter fencing would be enacted to limit access.

Following site preparation, the site would be regraded to attain the final site contour and the 16 inch thick layer of aggregate would be installed to act as the biota barrier. Upon completion of the emplacement of the biota barrier, soil would be placed overlying the aggregate to a depth of 24 inches (**Figure 3-2**). **Figure 2-1** highlights all the areas that would require the biota barrier and soil cover. Areas associated with existing roadways would not require cover material. Perimeter waste may need to be excavated and consolidated on-site to move it away from surface drainage features or the site boundaries. Additional fill material will be imported and placed to develop acceptable slopes for proper drainage. The soil cover would not have specific engineering properties for low permeability or specified hydraulic conductivity value(s). The site grading plan would be designed to manage surface water run-on and runoff, to control erosion of the cover soil. The final grading design also would eliminate surface water ponding and infiltration of precipitation within the landfill areas. Native grasses would be used for vegetation of the site, based on low maintenance requirements and compatibility.

The landfill cover would require long-term maintenance including inspections and repair of damage that may occur through erosion or burrowing animals. The existing network of groundwater monitoring wells would be used to monitor the groundwater quality in the vicinity of the capped landfill. Groundwater monitoring would continue for approximately 10 years.

A summary of cost items is provided in **Table 3-4**, and the cost development assumptions are included in **Appendix B**.

Land Use Controls

The LUCs for this alternative would be consistent with those presented in Alternative LF3 (**Section 3.2.3**). The LUCs would rely on the BGP to enforce access and future use restrictions. The LUCs would prohibit use of groundwater underlying Site 3 and prohibit disturbing any components of the groundwater monitoring network. Construction in areas identified as containing waste would be prohibited and the area would be classified as “Restricted Open Space” to ensure continued protection of human health and the environment. The USAF would manage the BGP and provide notices to the CDPHE when any changes occur to Site 3.

Analysis of Alternative: Alternative LF4 also satisfies the USEPA Presumptive Remedy guidance and also satisfies the Colorado Solid Waste Regulations (6 CCR 1007-2) that apply to older landfills. The containment option of a soil cover with a biota barrier, along with institutional controls and a post-closure maintenance program, effectively prevents exposure to the waste. An analysis of this alternative as it compares to the nine NCP criteria follows.

Overall Protection of Human Health and the Environment

The soil cover and biota barrier proposed for Alternative LF4 would prevent direct contact with the landfill waste, reduce the infiltration of surface water, and prevents burrowing animals from direct contact with the waste. Therefore, Alternative LF4 would reduce and control the primary threats to human health and the environment, including prevention of biota intrusion, and provide a reasonable level of long-term protection. The soil cover and biota barrier coupled with land-use restrictions would fulfill the RAOs and provide a remedy that would be protective of human health and the environment.

The landfill soil cover would reduce erosion and control surface water run-on and runoff by including an adequate slope to promote positive drainage. The soil cover would be vegetated with native grasses and maintain control of erosion thereby reducing the potential for future exposure to the waste.

The engineered biota barrier would prevent burrowing animals, such as the common prairie dog or other small mammals, from digging into the underlying waste. Prairie dog burrows can commonly reach 5 to 6 feet deep. The construction of a biota barrier will prevent the burrowing animals from digging any deeper than 2 feet, which would make these animals less likely to colonize, breed, or raise their young in these areas.

Though impacted groundwater is not currently a problem at Site 3, groundwater monitoring would allow for early detection of contaminated groundwater before any migrate from the landfill boundary.

Although provisions in the institutional controls for the management of burrowing animals will be required, these provisions would be eased with the use of the biota barrier.

Compliance with ARARs

Implementation of Alternative LF4 would reduce any potential surface water contamination by fully containing the potential contaminant sources. Though groundwater impacts do not currently exist, the containing of the waste would greatly reduce any potential for groundwater contamination. Therefore, LF4 would be in compliance with the chemical-specific ARARs.

Since LF4 would require work within the 100-year floodplain and within areas designated as wetlands, specific location-specific ARARs would be a concern. Compliance with these location-specific ARARs could be achieved during the implementation through mitigation efforts such as erosion control practices.

Action-specific ARARs apply to the implementation of the proposed remedial actions at the landfill and follow the State of Colorado landfill closure requirements (6 CCR 1007-2) and general health and safety requirements. Alternative LF4 would be in compliance with these action-specific ARARs.

Long-term Effectiveness and Permanence

The sources of the residual risks following the soil cover installation include the potential for direct contact with landfill materials and the potential leaching of contaminants to surface water and groundwater. Therefore, the evaluation of the long-term adequacy and reliability of the controls considers the ability of the landfill cover to maintain its integrity and the long-term reliability of the institutional controls.

After constructing the biota barrier and soil cover, long-term human health and environmental risks from the landfill contents would be prevented by a 16 inch barrier of crushed concrete and a 24 inch soil cover. The biota barrier will prevent burrowing animals from coming into contact with the waste. Grading of the soil cover and vegetation of the cover should prevent erosion and exposure of surface water to the landfill contents over the long term.

The low levels of VOCs in groundwater do not currently present an unacceptable human health risk. Effective institutional controls should prevent the use of groundwater in the future, thus eliminating any potential risks.

The long-term effectiveness of Alternative LF4 is expected to be acceptable because the soil cover and biota barrier would prevent contact with the waste contents and reduce infiltration of surface water. The long-term permanence of the remedy will be dependent upon the effectiveness of institutional controls including the prevention of groundwater use, restrictions on land use, and limitations on intrusive activities.

Reduction of Toxicity, Mobility, and Volume Through Treatment

Alternative LF4 does not include waste treatment as part of the remedy. Portions of the landfill contents may be excavated and relocated, particularly along East Toll Gate Creek. However, Alternative LF4 would not reduce the inherent hazards of the landfill material, but rather would depend upon containment and reduction of the exposure risk by restricting access to the landfill area.

Short-term Effectiveness

The implementation of Alternative LF4 would pose some additional risks to BAFB personnel and to the adjacent community during implementation of the remedy due to need to transport concrete aggregate and additional cover soil to the site. The increased truck traffic on the base and in the adjacent community would result in increased risks to the public traveling in the vicinity of the landfill and near the entrance gates. Additionally, dust and odor control technologies would need to be implemented to minimize the migration of fugitive emissions to the nearby neighborhoods.

Site workers might also be exposed to contaminants during implementation of Alternative LF4. The risks to site workers could be minimized through an effective health and safety program. Air monitoring could be implemented to assess requirements for respiratory protection.

Workers implementing Alternative LF4 would also incur risk of injuries that are routinely encountered with the operation of heavy equipment and high truck traffic.

Short-term risks to the environment may also be expected during implementation of Alternative LF4. Although the *FSCR* provides some information as to the contents of the landfill, the landfill contents are not completely known. Releases of known or unidentified chemicals or substances to the environment could occur during excavation of the waste along the creek for purposes of relocating and consolidation. Also, the existing wetlands environment along East Toll Gate Creek could be temporarily impacted diversion of the surface water or a lowering of the groundwater table through dewatering efforts.

Implementability

Alternative LF4 would be technically feasible. The biota barrier construction and the soil cover construction activities at the former landfill would be implemented using conventional practices and would use standard materials and equipment. The soil cover would be constructed in accordance with engineered construction plans and specifications. Very few aspects of the implementation are considered technically complex. Also, the institutional controls and monitoring would be expected to be easy to implement.

As with LF3, alternative LF4 would be administratively feasible; but significant coordination with federal, state, and local agencies would be expected. Permits may be required to work within the 100-year floodplain and within the designated wetlands. These permits are not likely to impact the administrative feasibility.

Materials, services, and equipment required to implement Alternative LF4 are generally readily available. The landfill soil cover construction would involve the use of common materials. The aggregate, crushed or recycled concrete would be slightly more complicated to acquire in the quantities needed, but the material would be available.

Costs

The budgetary cost estimate summary for LF4 is shown in **Table 3-4**. Capital costs include all costs that are required for the implementation of Alternative LF4 and the long-term costs associated with groundwater monitoring and landfill maintenance. Annual and periodic sampling costs are adjusted for present worth at a seven percent discount factor. The estimated capital and total project costs of LF4 are:

Capital Cost:	\$8,462,419
Total Project Cost (present value):	\$8,857,346

Regulatory Acceptance

This criterion is generally addressed in the Proposed Plan and ROD after agency review of the FFS.

However, it is anticipated that CDPHE would accept Alternative LF4: Soil Cover and Engineered Biota Barrier, since the installation of the cover and the LUCs would be conducted in accordance with CDPHE requirements.

Community Acceptance

This criterion is generally addressed in the Responsiveness Summary of the ROD, which is the summary of all written and oral comments received from the public on the Proposed Plan. Community acceptance of the Alternative LF4 is expected to be high based on the low cost of containment and the manageable risks associated with the transportation of soil cover and biota barrier material (with an increased volume of material as compared to Alternative LF3).

3.3 Comparative Analysis of Alternatives

A comparative analysis is conducted to evaluate the relative performance of each of the four alternatives at Site 3 in relation to six of the nine evaluation criteria. The reduction of toxicity, mobility, or volume through treatment criterion is not included in this comparative analysis because active treatment was not proposed for any of the alternatives. Also, community and regulatory acceptance will be evaluated during the formal state and public comment on the Proposed Plan. The relative merits of the alternatives provide the rationale for selecting a preferred alternative and provide a transition between the RI and the Decision Document. The analysis of the four Site 3 alternatives is also summarized in **Table 3-1**.

3.3.1 Overall Protection of Human Health and the Environment

Alternative LF1: No Action would not be protective of human health and the environment because no attempt to manage risk would be undertaken. Under this alternative, existing waste areas that currently may be exposed to the elements would continue to pose risks.

Alternative LF2: Remove and Dispose is protective of human health and the environment through the complete removal of the waste debris, and thus the sources of potential contaminants, from Site 3. This alternative increases short-term risk to the public due to the heavy equipment traffic associated with its implementation and the risks posed by the uncovering and handling of the waste debris.

Alternative LF3: Soil Cover and Alternative LF4: Soil Cover with Engineered Biota Barrier are both protective of human health and the environment through containment of the landfill materials and the associated LUCs. The placement of a soil cover under both alternatives will prevent exposure to landfill materials and control further spreading of the waste material associated with erosion. The biota barrier associated with Alternative LF4 additionally will prevent burrowing animals from digging into the waste contents through a physical barrier.

3.3.2 Compliance with ARARs

Chemical-specific ARARs would be met by all four alternatives since groundwater currently below the existing landfill has been found to be in compliance with State standards.

In addition, chemical-specific ARARs for surface water are achieved since surface water has not been impacted by the presence of the former landfill.

Location-specific ARARs would be met by all four alternatives. Location-specific ARARs are generally related to the floodplains and wetlands in the site area. All of the alternatives will contain provisions to minimize the destruction, loss, or degradation of the wetlands.

Alternative LF1 is the only alternative that does not meet the action-specific ARARs. Action-specific ARARs are primarily associated with closure and post-closure requirements under the Colorado Solid Waste Regulations, and these would be met by Alternatives LF2, LF3, and LF4.

3.3.3 Long-Term Effectiveness and Permanence

Alternative LF1: No Action would not provide long-term effectiveness and permanence because only a portion of the landfill has adequate cover. Also, this alternative does not address surface water runoff and erosion control.

The excavation and removal of all the waste under Alternative LF2 would have a high long-term effectiveness and permanence. However, liability for the waste would be retained by the Air Force at any off-site disposal facility.

The long-term effectiveness and permanence of the containment option under Alternative LF3 and Alternative LF4 would both be dependent on the adequacy and reliability of the institutional controls to maintain the integrity of the landfill cover system. The amount of maintenance required is low for a soil cover, and these two alternatives are expected to have a high long-term effectiveness.

3.3.4 Short-Term Effectiveness

Alternative LF1 has no short-term impacts since no action is undertaken.

The implementation of Alternative LF2 would pose elevated risks to site workers and BAFB personnel due to the large volume of material that would need to be excavated and transported both off and onto the Base. Site workers could be exposed to contaminants during site work, although personal protective equipment would be worn by site workers to minimize any risk. There may also be short-term risks to the environment depending on the materials encountered during the excavation activities.

The short-term risks posed by the implementation of Alternative LF3 and Alternative LF4 would involve the increased traffic during transportation of site materials onto the Base. A much greater volume of material would be hauled under Alternative LF4 than Alternative LF3. Under both alternatives, site workers may be subject to health and safety concerns associated with the excavation of portions of the waste from along East Toll Gate Creek and the use of heavy equipment.

3.3.5 Implementability

Alternative LF1 has no technical implementability or administrative feasibility considerations since no action is undertaken.

Alternative LF2: Removal and Disposal would be technically feasible. The administrative feasibility would be more difficult and involve greater federal, state, and local regulatory participation.

Alternative LF3 and Alternative LF4 are both technically feasible and administratively feasible. Materials and services are readily available for the soil cover for both alternatives, but the crushed concrete for the biota barrier may be more difficult to obtain in the required quantities making the LF4 alternative more technically complex than Alternative LF3. As with Alternative LF2, administrative feasibility would be more difficult, and would involve significant coordination with federal, state, and local regulatory entities.

3.3.6 Cost

The costs for Alternatives LF2, LF3 and LF4 are summarized in **Tables 3-2, 3-3, and 3-4** (detailed cost assumptions are provided in **Appendix B**). For purposes of comparison, present net worth costs assume a 7 percent discount rate and no inflation factor. Total Project Costs for each alternative are as follows:

- Alternative LF1: No cost
- Alternative LF2: \$21,978,406
- Alternative LF3: \$2,620,145
- Alternative LF4: \$8,857,346

4.0 SUMMARY

This FFS was prepared for Site 3, Former Base Landfill at Buckley Air Force Base, Colorado. Four alternatives were developed to address the existing landfill contents, based on previous investigations that have determined that the groundwater beneath the landfill contains low levels of volatile organic compounds, but that elevated levels of soil gas have not been detected.

Alternative LF1: No Action was evaluated in accordance with the NCP and USEPA guidance. However, this alternative is not protective of human health and the environment, and does not achieve ARARs.

Alternative LF2: Removal and Disposal involves excavation and off-site disposal of the waste materials. The cost for this alternative is significantly higher than the two containment alternatives. Similar alternatives have been conducted in the Denver area in support of property redevelopment, but the land use of Site 3 is anticipated to remain open space.

Alternatives LF3 and LF4 involve containment of the landfill wastes and follow the USEPA *Presumptive Remedy for Municipal Landfills*. These two alternatives achieve the Colorado Solid Waste Regulations (6 CCR 1007-2) closure requirements. Alternative LF3 involves augmenting the existing cover and addresses burrowing animals through maintenance activities. Alternative LF4 provides a biota barrier over the landfill materials, and a 24 inch soil cover is installed over the barrier. The cost of Alternative LF4 is significantly higher than augmenting the soil cover under Alternative LF3.

5.0 REFERENCES

Colorado Department of Public Health and Environment (CDPHE), 1999. *Old Landfill Closure Requirements and Post-Closure Care and Maintenance*. Memorandum from Peter Laux, Solid Waste Unit, Colorado Department of Public Health and Environment, Hazardous Materials and Waste Management Division. August 16.

CDPHE, 2005. *The Basic Standards for Ground Water, Regulation No. 41, 5 CCR 1002-41*. Water Quality Control Commission. Denver, Colorado. March 22.

Dames & Moore, 1986. *Phase II – Confirmation/Qualification Stage 1, Buckley Air National Guard Base, Colorado*. March.

Science Applications International Corporation (SAIC), 1995. *Remedial Investigation Report, Colorado Air National Guard, Buckley Air National Guard Base, Aurora, Colorado*. August.

Simons, Li & Associates, Inc., 1982. *Phase I Records Search Buckley Air National Guard Base, Colorado*. Fort Collins, Colorado. September.

U.S. Army Corps of Engineers (USACE), 1987. *Corps of Engineers Wetlands Delineation Manual*, Environmental Laboratory Technical Report Y-87-1. Vicksburg, MS. January.

United States Environmental Protection Agency (USEPA), 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, Interim Final, EPA/540/G-89/002. Office of Emergency and Remedial Response. Washington, D.C.. October.

USEPA, 1991. *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites*, EPA/540/P-91/001. February.

USEPA, 1993. *Presumptive Remedy for CERCLA Municipal Landfill Sites*, EPA Directive No. 9355.0-49FS. Office of Solid Waste and Emergency Response. Washington, D.C. September.

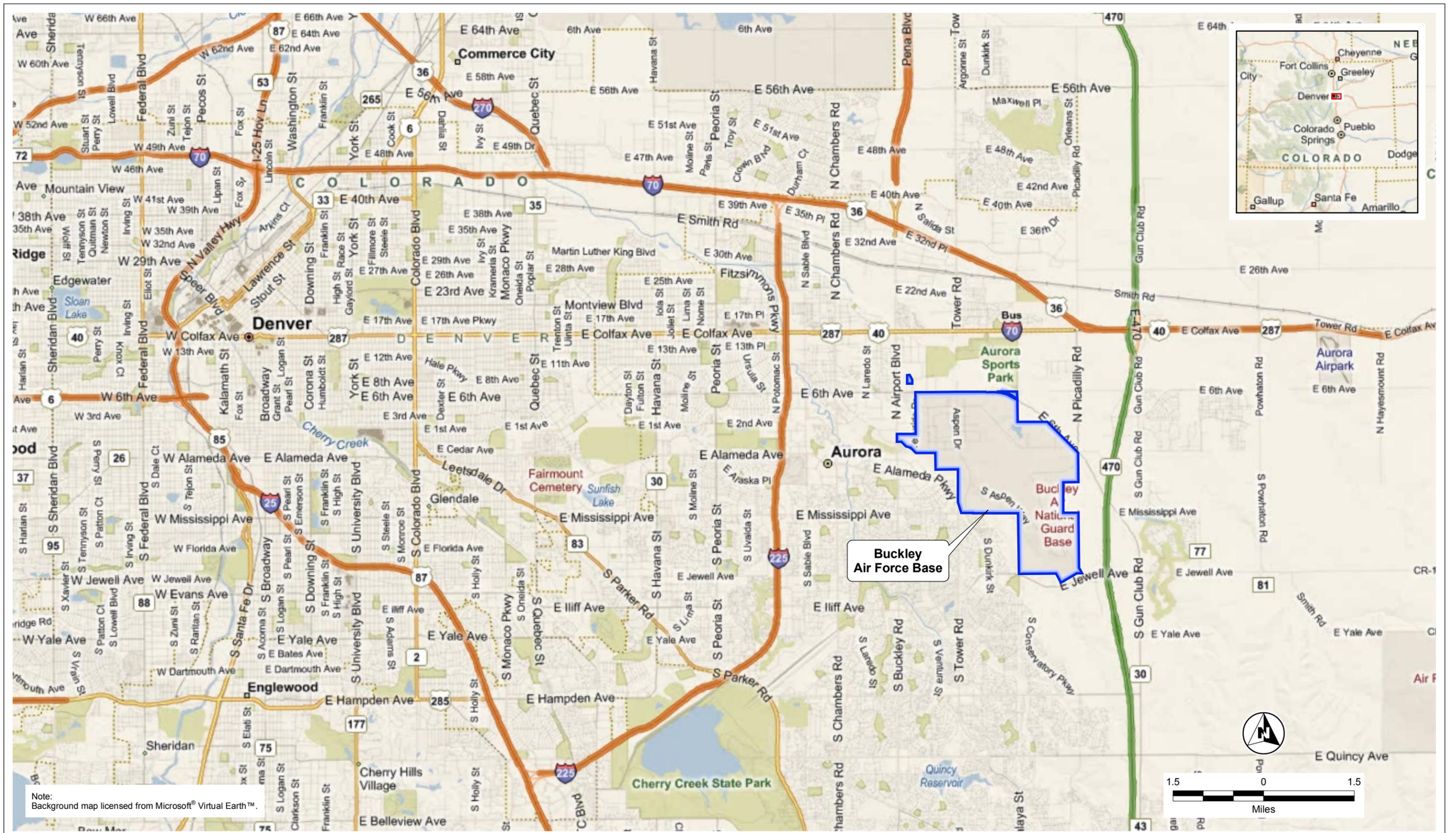
USEPA, 1996. *Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills*, EPA/540/F-96-020. Office of Solid Waste and Emergency Response. Washington, D.C. December.

Versar, Inc. (Versar), 2006. *Final Second Addendum to the Final Quality Program Plan for Supplemental Characterization for Site 3–Former Base Landfill, Buckley Air Force Base, Colorado*. Westminster, Colorado. July.

Versar, 2007a. *Final Wetland Delineation for Supplemental Characterization for Site 3–Former Base Landfill, Buckley Air Force Base, Colorado*. Westminster, Colorado. June.

Versar, 2007b. *Final Supplemental Characterization Report for Site 3–Former Base Landfill, Buckley Air Force Base, Colorado*. Westminster, Colorado. June.

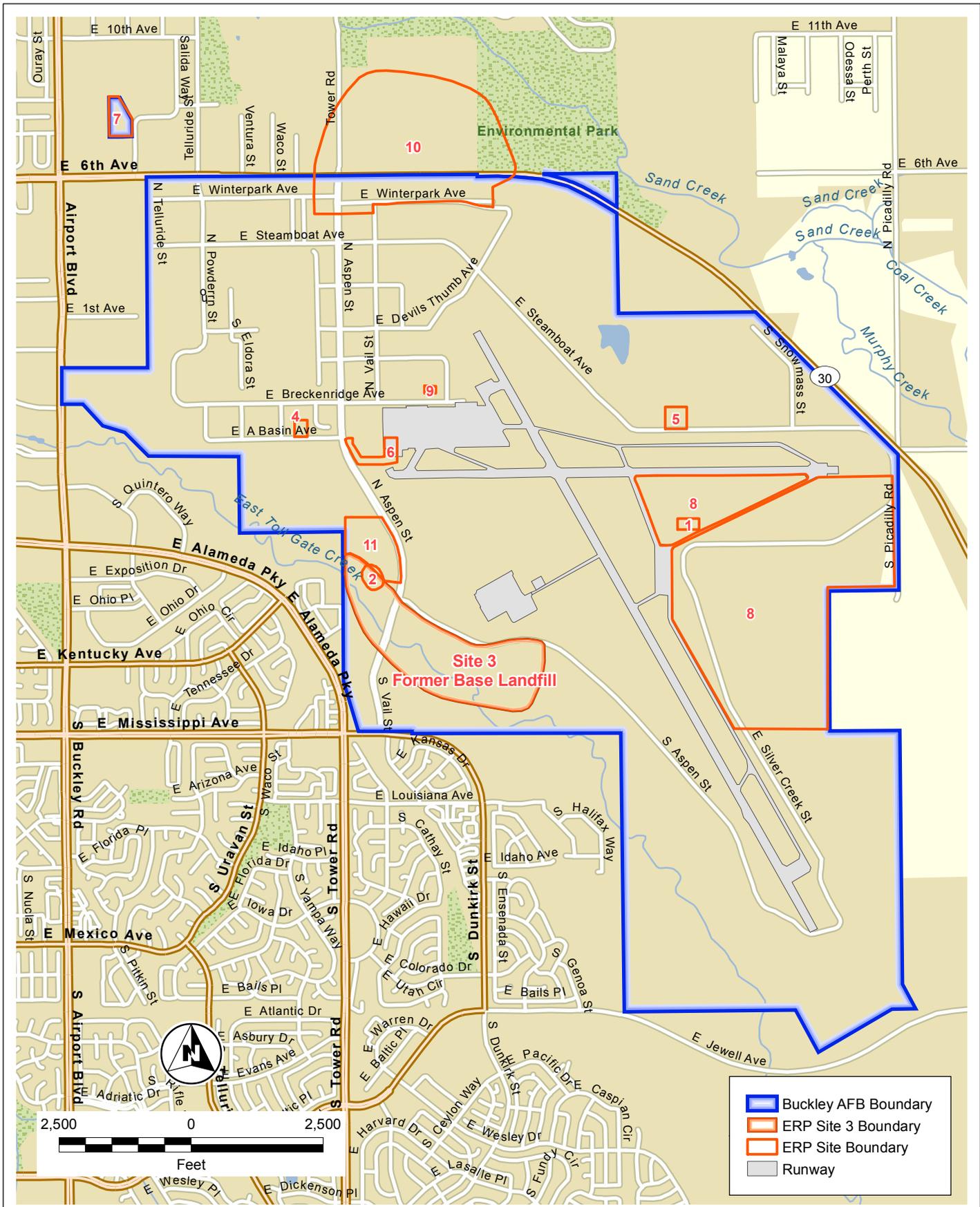
FIGURES



Note:
Background map licensed from Microsoft® Virtual Earth™.

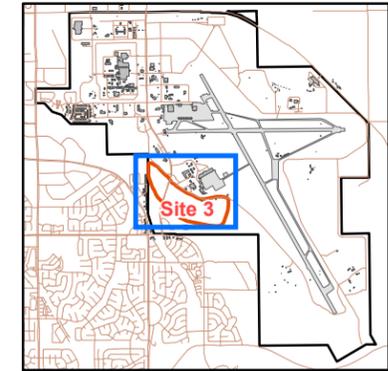
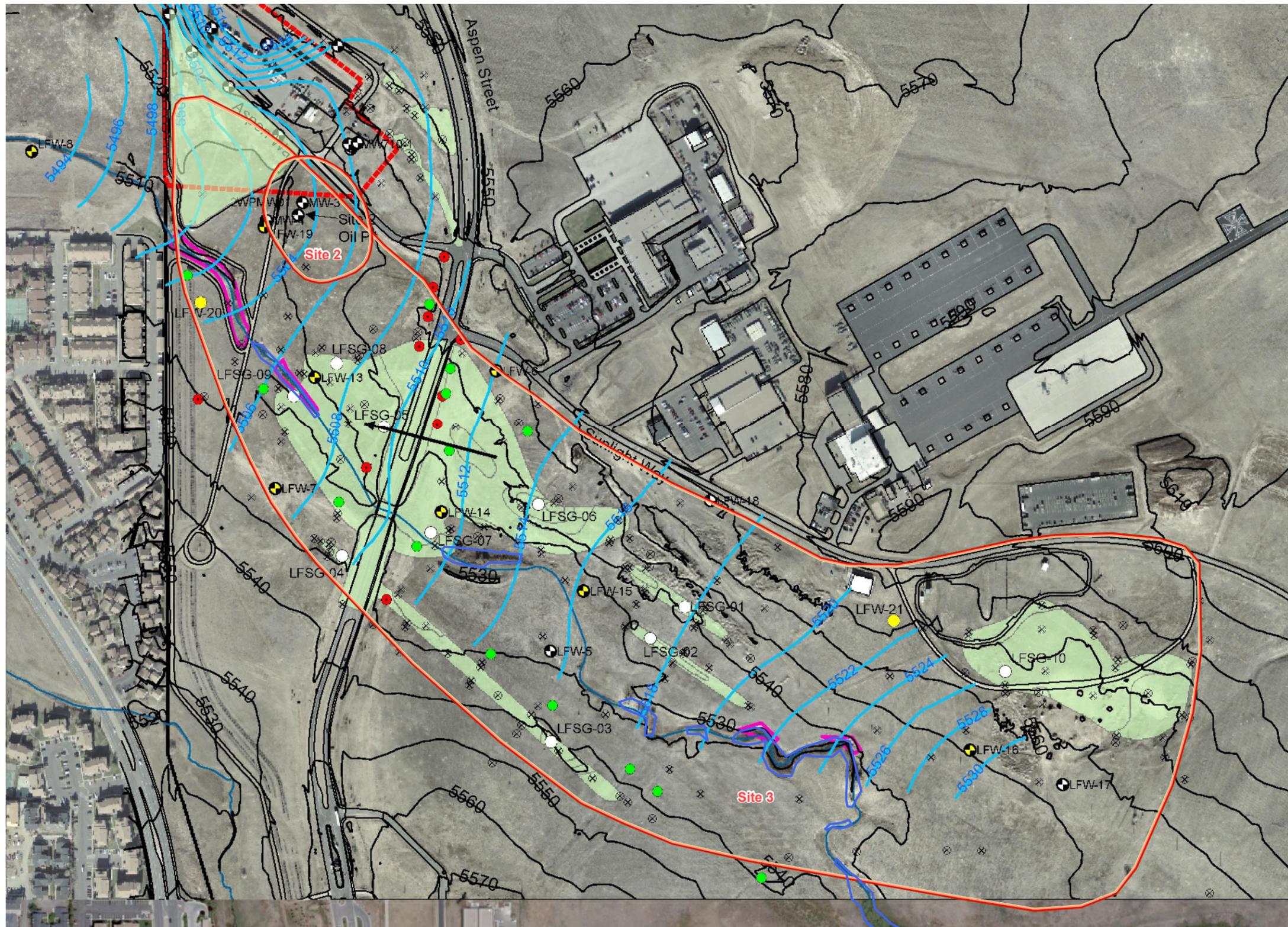
Site 3 – Former Base Landfill,
Buckley Air Force Base,
Aurora, Colorado

FIGURE 1-1
Vicinity Map



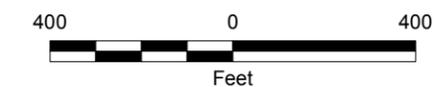
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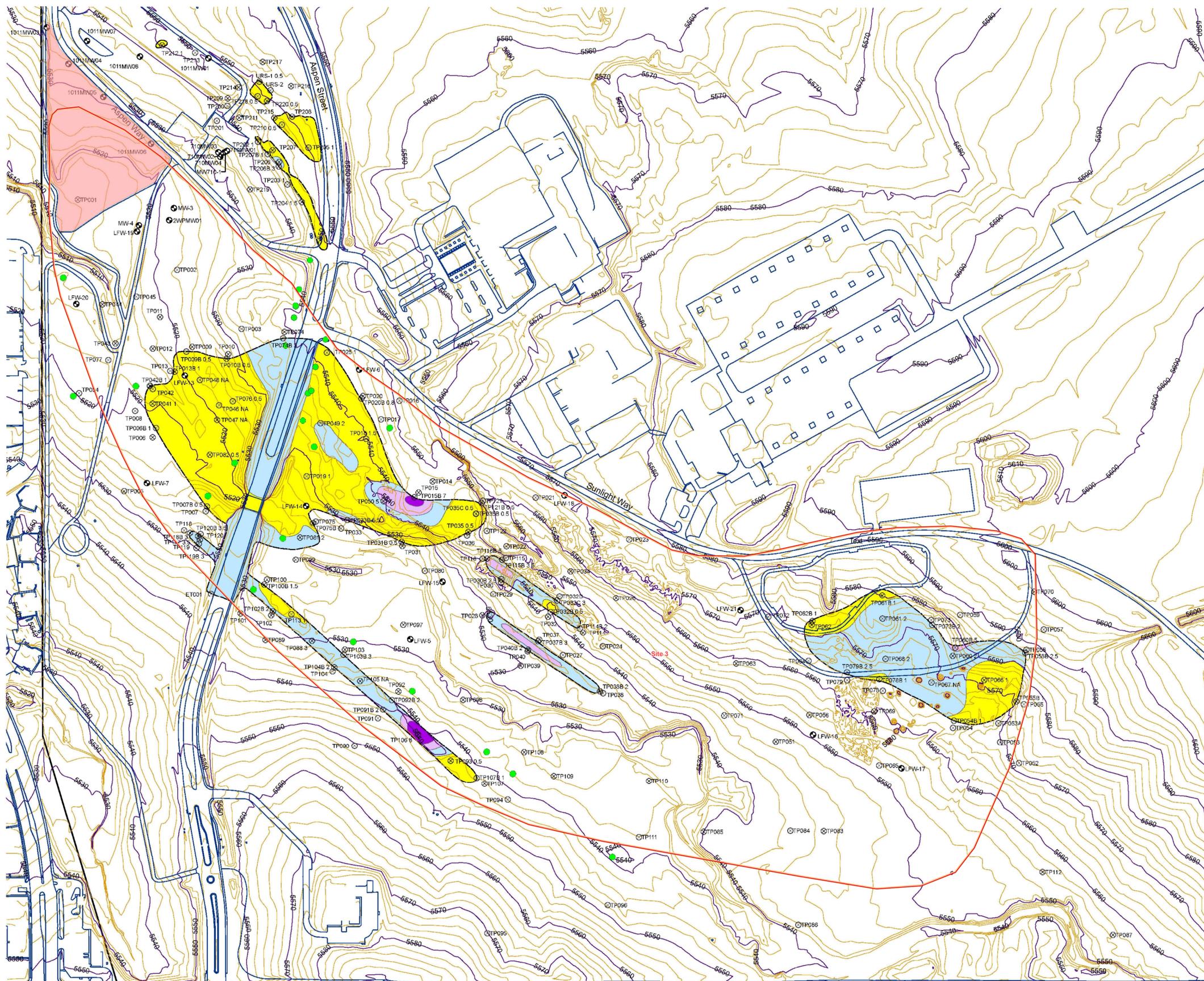
FIGURE 1-2
 Site 3 Location



- ERP Site Boundary
- Roads
- Stream
- Buckley Boundary
- Existing Monitoring Well Not Sampled July 2006
- Existing Monitoring Well Sampled July 2006
- New Monitoring Well
- Manhole Screened for Explosive Gases
- Manhole Not Screened
- ⊗ Test Pit/Trench
- Soil Gas Sample
-
 Site 3 Landfill Areas
-
 Surface Debris Along Creek
- Topographic Contours
- Potentiometric Contour (June 06)
- Preliminary Site 11 Boundary
- Groundwater Flow Direction
- Wetland Area Delineated in 2004

Credit: Figure is based on Figure 2-2, Supplemental Characterization Report for Site 3 Base Landfill, Versar 2007





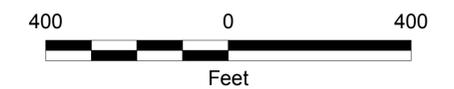
- ERP Site 3 Boundary
 - Undetermined Cover Thickness
 - Topographic Index Contour
 - Topographic Intermediate Contour
 - Buckley AFB Boundary
 - Waste Disposal Area
 - Trench/Test Pit
 - Well
 - Manhole/Utility Box
- Existing Cover**
- <2 Feet
 - 2-4 Feet
 - >4-8 Feet
 - >6-8 Feet

Notes:

Cover thickness is shown in feet where waste was found.

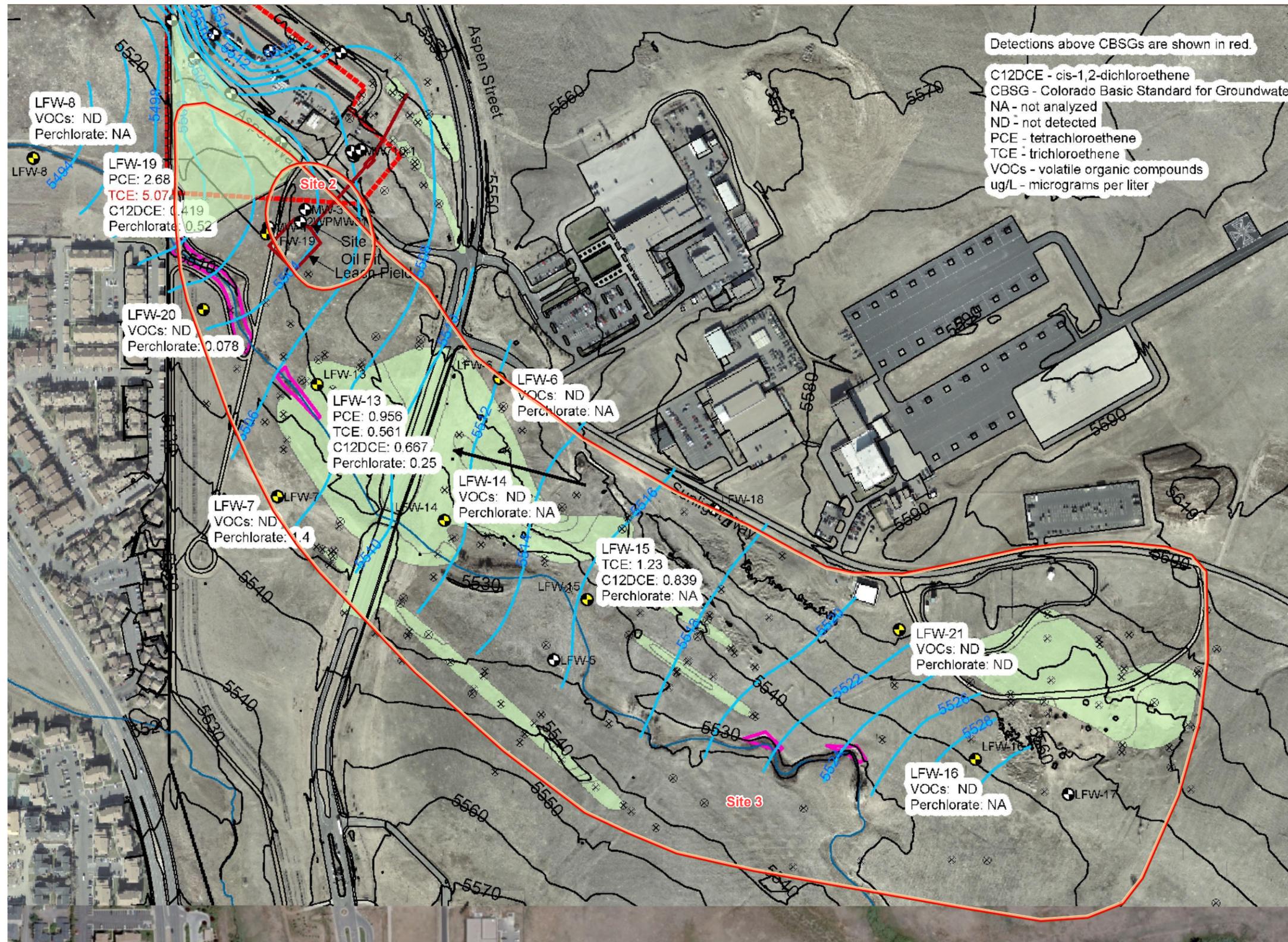
"NA" indicates no waste was found in trench/test pit in landfill area.

Credit: Figure is based on Plate 3-1, Supplemental Characterization Report for Site 3 Base Landfill, Versar 2007



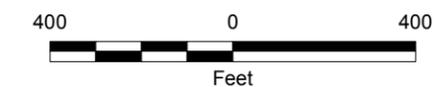
Site 3 – Former Base Landfill,
Buckley Air Force Base,
Aurora, Colorado

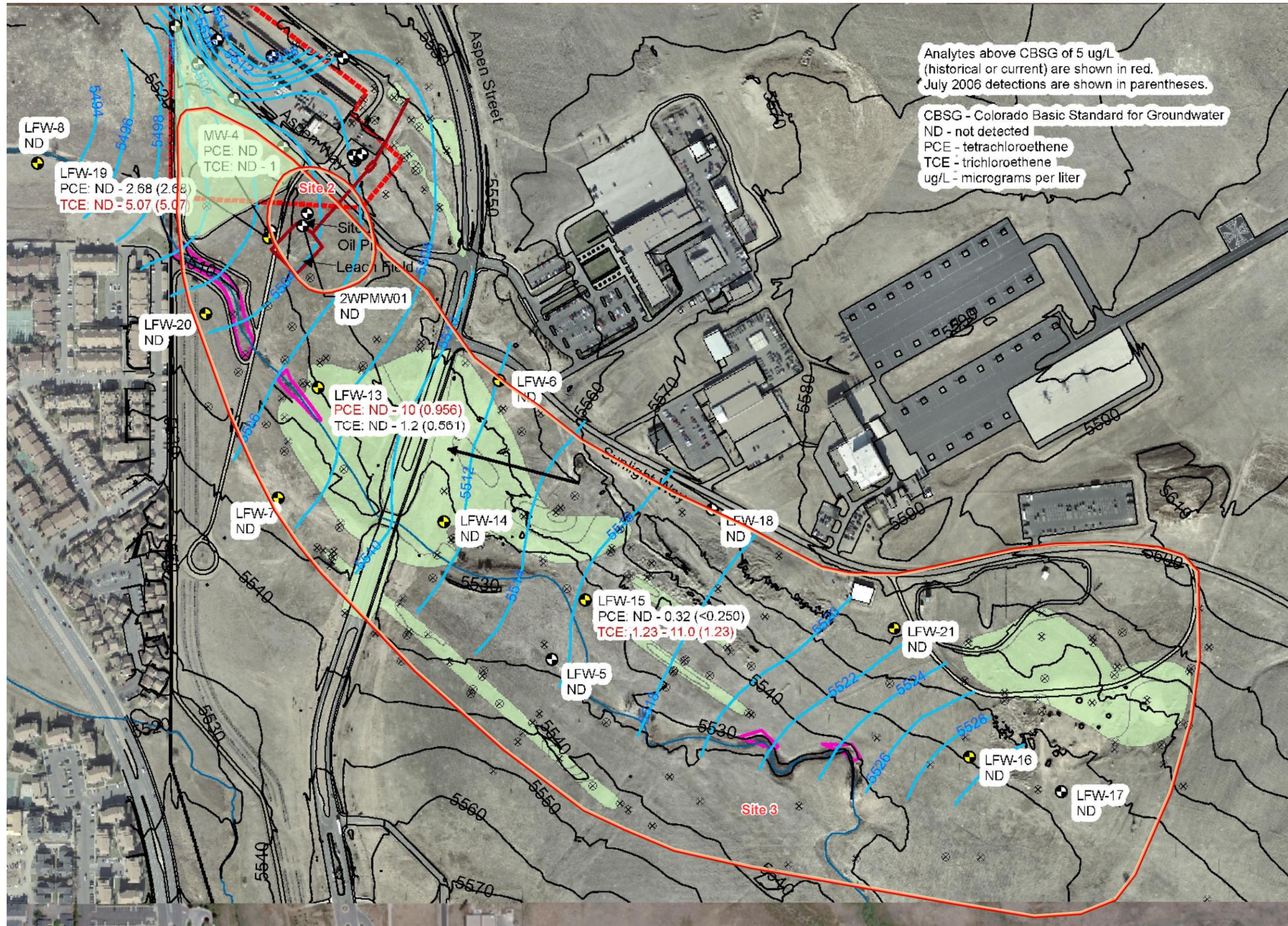
FIGURE 2-1
Horizontal Extent of Waste Disposal
and Cover Thickness



- ERP Site Boundary
- Roads
- Stream
- Buckley Boundary
- Monitoring Well Not Sampled July 2006
- Monitoring Well Sampled July 2006 and Concentrations in ug/L
- Test Pit/Trench
- Site 3 Landfill Areas
- Surface Debris Along Creek
- Topographic Contours
- Potentiometric Contour (June 06)
- Preliminary Site 11 Boundary
- Leach Field
- Groundwater Flow Direction

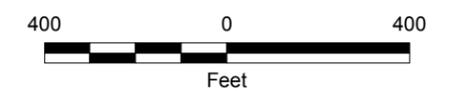
Credit: Figure is based on Figure 3-2, Supplemental Characterization Report for Site 3 Base Landfill, Versar 2007.

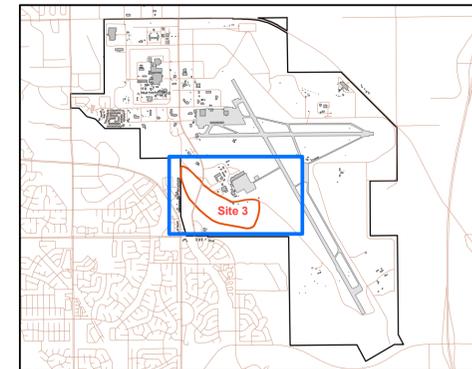
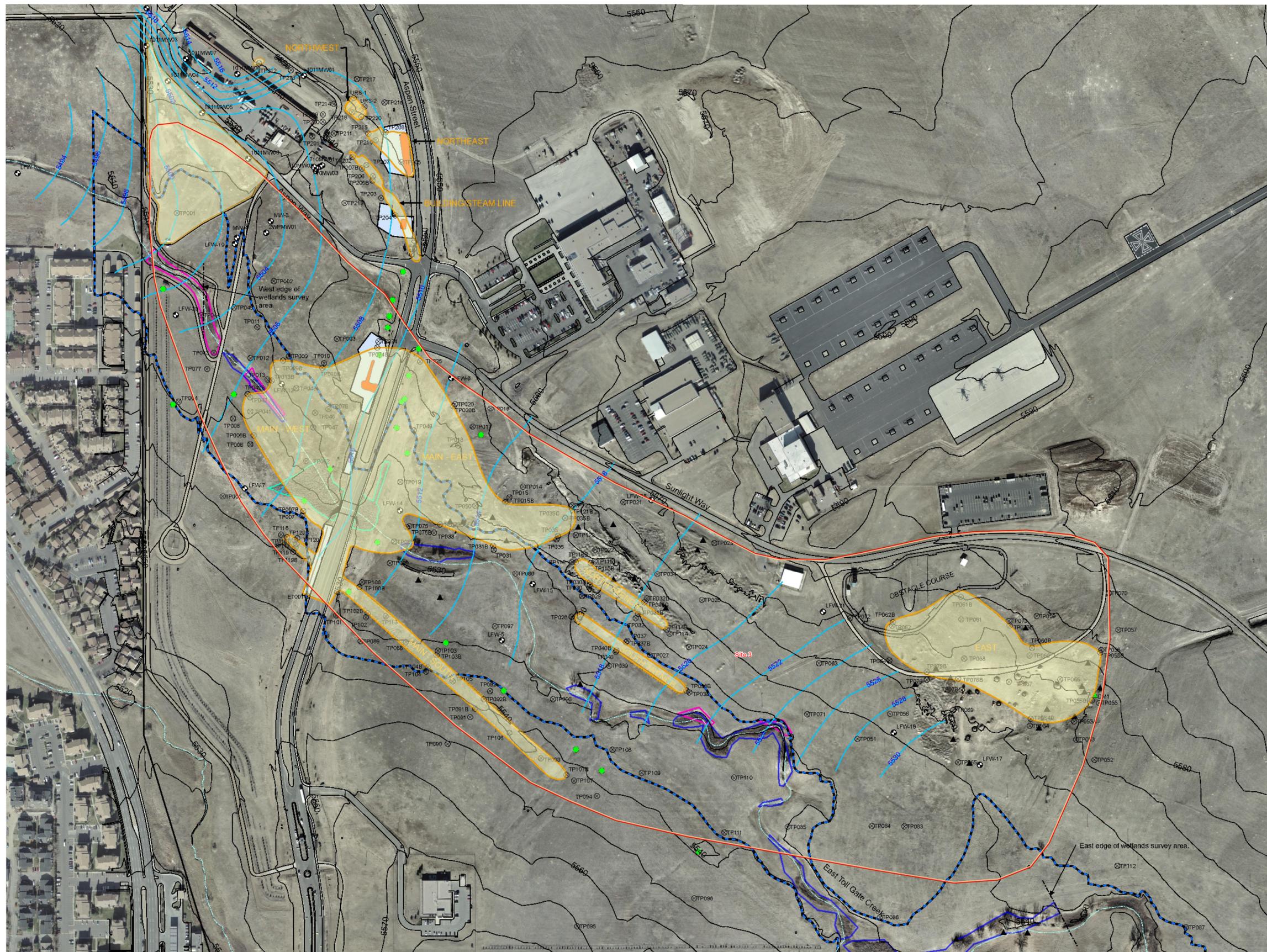




- ERP Site Boundary
- Roads
- Stream
- Buckley Boundary
- Monitoring Well Not Sampled July 2006
- Monitoring Well Sampled July 2006 and Concentrations in ug/L
- Test Pit/Trench
- Site 3 Landfill Areas
- Surface Debris Along Creek
- Topographic Contours
- Potentiometric Contour (June 06)
- Preliminary Site 11 Boundary
- Leach Field
- Groundwater Flow Direction

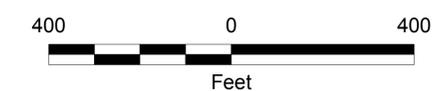
Credit: Figure is based on Figure 3-3, Supplemental Characterization Report for Site 3 Base Landfill, Versar 2007





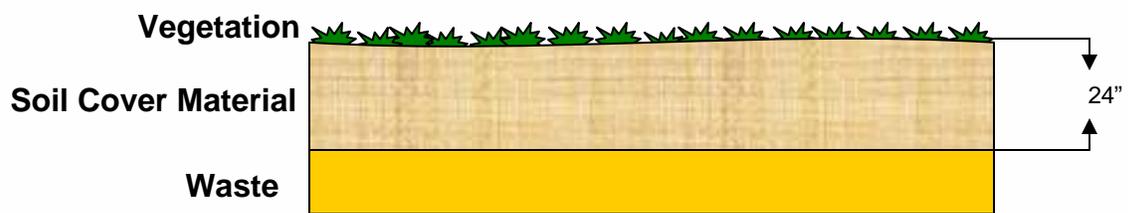
- ⊙ Monitoring Well
- ▲ Surface Debris
- Manhole/Utility Box
- ⊗ Trench/Test Pit
- ▲ Crushed Drum
- Existing Ground Contour (10' Interval)
- Potentiometric Contour (June 06)
- Streams
- ▭ Utility Trench with Debris
- ▭ Removed Waste Disposal Area
- ▭ As-built Cover (COE)
- ▭ Wetlands (Summer 04)
- ▭ Riprap
- ▭ Subsidence Area
- ▭ Surface Debris Along Creek
- ▭ Buckley Boundary
- ▭ 100 Year Flood Plain
- ▭ ERP Site 3 Boundary
- ▭ Area of Waste

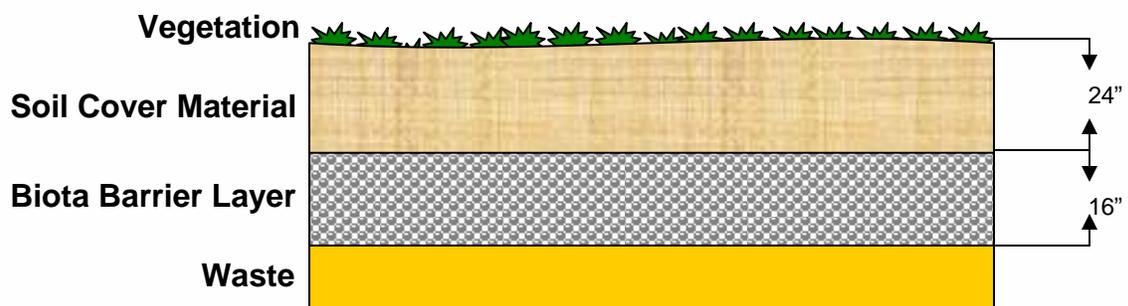
Credit: Figure is based on Plate 3-2, Supplemental Characterization Report for Site 3 Base Landfill, Versar 2007.



Site 3 – Former Base Landfill,
Buckley Air Force Base,
Aurora, Colorado

FIGURE 2-4
Areas of Waste





TABLES

**Table 2-1
Chemical-Specific Applicable or Relevant and Appropriate Requirements
Site 3 Former Base Landfill
Buckley Air Force Base, Colorado**

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable	Relevant and Appropriate	To Be Considered	Comments
FEDERAL REQUIREMENTS						
National Primary and Secondary Ambient Air Quality Standards	40 CFR 50 and 53	National primary ambient air quality standards define levels of air quality to protect the public health. National secondary ambient air quality standards define levels of air quality protect the public welfare from any known or anticipated adverse effects of a pollutant.	X			Site 3 activities for remedial alternatives could generate significant air or fugitive emissions. The standards are applicable.
National Emission Standards for Hazardous Air Pollutants (NESHAP)	40 CFR 61	Provides emission standards for 8 contaminants. Identifies 25 additional contaminants as having serious health effects but does not provide emission standards for these contaminants.		X		Hazardous pollutants are not expected to be generated as part of Site 3 activities for remedial alternatives. However, in the event that hazardous pollutants are encountered during activities at the Site, the standards are relevant and appropriate.
National Emission Standards for Hazardous Air Pollutants for Affected Source Categories	40 CFR 63	Establishes standards for hazardous air pollutants for specific categories of stationary sources that emit (or have the potential to emit) one or more listed hazardous air pollutants listed.		X		Hazardous pollutants are not expected to be generated as part of Site 3 activities for remedial alternatives. However, in the event that hazardous pollutants are encountered during activities at the Site, the standards are relevant and appropriate.
Water Quality Criteria (WQC)	40 CFR 131	Sets criteria for water body and surface water quality based on toxicity to aquatic organisms and human health.		X		Surface water is intermittently present in East Toll Gate Creek adjacent to the Site 3 boundaries. It is not expected that elevated levels of pollutants will occur in East Toll Gate Creek as a result of activities on the Site. However, in the event that elevated levels of pollutants in surface water occurs at the Site the criteria will be relevant and appropriate.
National Primary Drinking Water Standards	40 CFR 141 and 142	Establishes national health-based standards (MCLs) for specific contaminants. MCLs are applicable for drinking water as supplied to the end users of public water supplies.	X			Shallow groundwater has not been used as a source of drinking water and is not part of a public drinking water supply system. There is potential for groundwater to be encountered during Site 3 activities for remedial alternatives therefore, the standards are applicable.
Maximum Contaminant Levels (MCLs)	40 CFR 141, Subpart G	Establishes drinking water quality goals set at levels of no known or anticipated adverse health effects with an adequate margin of safety.	X			Shallow groundwater has not been used as a source of drinking water and is not part of a public drinking water supply system. There is potential for groundwater to be encountered during Site 3 activities for remedial alternatives therefore, the standards are applicable.
Maximum Contaminant Level Goals (MCLG)	40 CFR 141, Subpart F	Establishes non-enforceable drinking water quality goals set at levels of no known or anticipated adverse health effects with an adequate margin of safety.			X	The MCLGs are not legally enforceable. However, the goals are to be considered as Site 3 activities for remedial alternatives may encounter groundwater.
National Secondary Drinking Water Standards	40 CFR 143	Establishes welfare-based standards (secondary maximum contaminant levels [SMCLs]).	X			Shallow groundwater has not been used as a source of drinking water and is not part of a public drinking water supply system. There is potential for groundwater to be encountered during Site 3 activities for remedial alternatives therefore, the standards are applicable.

**Table 2-1
Chemical-Specific Applicable or Relevant and Appropriate Requirements
Site 3 Former Base Landfill
Buckley Air Force Base, Colorado**

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable	Relevant and Appropriate	To Be Considered	Comments
STATE REQUIREMENTS						
Colorado Air Quality Regulations	5 CCR 1001-2 to 5	Requires the use of all available practical methods that are technologically feasible and economically reasonable so as to reduce, prevent, and control air pollution throughout the state of Colorado;	X			Site 3 activities for remedial alternatives could generate significant air or fugitive emissions. The standards are applicable.
Regulation of Particulates, Smokes, Carbon Monoxide, and Sulfur Oxides	5 CCR 1001-3	Regulates the emissions of particulates (including dust), carbon monoxide, and sulfur oxides from stationary sources. Establishes opacity limits.	X			Site 3 activities for remedial alternatives could generate significant air or fugitive emissions. The standards are applicable.
Ambient Air Quality Standards	5 CCR 1001-14	Sets ambient standards for total suspended particulates.	X			Site 3 activities for remedial alternatives could generate significant air or fugitive emissions. The standards are applicable.
Basic Standards and Methodologies for Surface Water	5 CCR 1002-31	Provides classification that establishes use categories for surface water, sets anti-degradation rules, and assigns water quality standards for surface water.		X		Surface water is intermittently present in East Toll Gate Creek adjacent to the Site 3 boundaries. It is not expected that elevated levels of pollutants will occur in East Toll Gate Creek as a result of activities on the Site. However, in the event that elevated levels of pollutants in surface water occurs at the Site the criteria will be relevant and appropriate.
Classification and Numeric Standards for South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin	5 CCR 1002-38 Section 38.1 to 38.6	Designates Clear Creek and its tributaries in the vicinity of the Site as use-protected and sets specific numeric standards.		X		Surface water is intermittently present in East Toll Gate Creek adjacent to the Site 3 boundaries. It is not expected that elevated levels of pollutants will occur in East Toll Gate Creek as a result of activities on the Site. However, in the event that elevated levels of pollutants in surface water occurs at the Site the criteria will be relevant and appropriate.
Basic Standards for Groundwater	5 CCR 1002-41	Sets non-degradation standards (Colorado Groundwater Standards [CGSI]) and welfare-based standards (Safe Drinking Water Standards [SDWS]) for groundwater, and establishes a "point of compliance" at impacted sites.	X			Shallow groundwater has not been used as a source of drinking water and is not part of a public drinking water supply system. There is potential for groundwater to be encountered during Site 3 activities for remedial alternatives therefore, the standards are applicable.
Regulations for the State Discharge System	5 CCR 1002-61	Regulates effluent discharges to waters of the State of Colorado from point sources and sets effluent limitations.		X		It is not anticipated that Site 3 activities for remedial alternatives will require discharge of effluent to waters of the state. However, in the event that discharge does become a requirement, this regulation is relevant and appropriate.
Regulations for Effluent Limitations	5 CCR 1002-62	Sets effluent limitations of specifically identified pollutants discharged to specific classes of State of Colorado waters.		X		It is not anticipated that Site 3 activities for remedial alternatives will require discharge of pollutants to waters of the state. However, in the event that discharge does become a requirement, this regulation is relevant and appropriate.
Regulations for Controlling Discharges to Storm Sewers	5 CCR 1002-65	Requires a Colorado Discharge Permit System (CDPS) permit to discharge to storm sewers non-stormwater wastewater containing pollutants.		X		It is not anticipated that Site 3 activities for remedial alternatives will require discharge to a storm sewer. However, in the event that discharge to a storm sewer does become a requirement, this regulation is relevant and appropriate.
Primary Drinking Water Regulations	5 CCR 1003-1	Establishes health-based standards (MCLs) for public drinking water systems.	X			Shallow groundwater has not been used as a source of drinking water and is not part of a public drinking water supply system. There is potential for groundwater to be encountered during Site 3 activities for remedial alternatives therefore, the standards are applicable.
Colorado Hazardous Waste Act, Waste Characterization	6 CCR 1007-3, Subparts 260 to 265	Standards for owners and operators of hazardous waste treatment, storage, and disposal facilities.		X		Activities conducted for Site 3 remedial alternatives are not anticipated to generate hazardous waste. However, in the event that hazardous wastes are encountered at the Site, and require characterization these restrictions relevant and appropriate.
Land Disposal Restrictions	6 CCR 1007-3 Part 268	Establishes numeric concentration limits for land disposal of selected hazardous wastes.		X		Activities conducted for Site 3 remedial alternatives are not anticipated to generate hazardous waste. However, in the event that hazardous wastes are encountered at the site, these restrictions are relevant and appropriate.
LOCAL/MUNICIPAL REQUIREMENTS						
Tri-County Health or Aurora		Control of fugitive dust during construction.	X			Site 3 activities for remedial alternatives could generate significant air or fugitive emissions. The standards are applicable.

**Table 2-2
Location-Specific Applicable or Relevant and Appropriate Requirements
Site 3 Former Base Landfill
Buckley Air Force Base, Colorado**

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable	Relevant and Appropriate	To Be Considered	Comments
FEDERAL REQUIREMENTS						
Guidelines for Specification of Disposal Sites for Dredged or Fill Material	40 CFR 230	Requires that chemical, physical, and biological integrity of waters of the United States are maintained through the control of discharges of dredged or fill material.	X			These regulations are applicable as Site 3 activities for remedial alternatives will be conducted adjacent to a designated wetlands.
Requirements for Dredging or Filling of Wetlands	33 CFR 320, 323, 328, and 330	Provides requirements including permit requirements for possible discharges from construction activities that could impact surface water quality and wetlands pursuant to the Clean Water Act (CWA).	X			Discharges to the adjacent designated wetlands are not anticipated during Site 3 activities for remedial alternatives. However, in the event that discharges become required, these regulations applicable.
Criteria for Classification of Solid Waste Disposal Facilities	40 CFR Part 257.3-1	Facilities or practices in floodplains shall not restrict the flow of the base flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste, so as to pose a hazard to human life, wildlife, or land or water resources.		X		Activities conducted for Site 3 are not anticipated to require operation of a waste treatment, storage or disposal unit (TSD) facility. However, in the event that storage of hazardous wastes becomes a requirement at the site and as activities will be conducted in a designated 100-year floodplain, this regulation is relevant and appropriate.
Executive Order on Floodplain Management	E.O. 11988	Requires federal agencies to evaluate the potential effect of actions taken in a floodplain and to avoid adverse impact associated with direct and indirect development of a floodplain.	X			This executive order is applicable as Site 3 activities for remedial alternatives will be conducted adjacent to a designated wetlands.
Executive Order on Protection of Wetlands	E.O. 11990	Sets forth direction for avoidance of adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative.	X			This executive order is applicable as Site 3 activities for remedial alternatives will be conducted adjacent to a designated wetlands.
National Historic Preservation Act (NHPA)	36 CFR Part 63, Part 65	Requires the preservation of historic properties included in or eligible for the National Register of Historic Places and to minimize harm to National Historic Landmarks.		X		There are no Historic Landmarks and Registered National Historic Places at Site 3. However, in the event that historic properties are encountered this regulation is relevant and appropriate.
The Historic and Archeological Data Preservation Act of 1974	16 USC 469	Establishes procedures to provide for preservation of historic and archeological data which might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity program.		X		Historical and/or archeological data have not been found at Site 3. However, in the event that historical and/or archeological data is encountered, this act is relevant and appropriate.
The Archeological Resources Protection Act of 1979	16 USC 470aa-470ll	Requires a permit for any excavation or removal of archeological resources from public lands or Indian lands.		X		The existence or removal of archeological resources is not anticipated for remedial activities at Site 3. However, if archeological resources are discovered at the Site, this act is relevant and appropriate.
Endangered Species Act	50 CFR 17 and 50 CFR 402	Protects endangered species and threatened species and preserves their habitat. Requires coordination with federal agencies for migration of impacts.		X		Threatened and endangered species or critical habitats have not been found at Site 3. However, in the event that threatened or endangered species or critical habitats are found at the Site, this act is relevant and appropriate.
Endangered Species Habitat	U.S. Fish and Wildlife Service - Mountain - Prairie Region - Colorado	Lists endangered species in Colorado.		X		Endangered species or critical habitats have not been found at Site 3. However, if endangered species were encountered at the Site, this criteria is relevant and appropriate.
Fish and Wildlife Coordination Act	16 USC 661	Establishes provisions for protection of fish and wildlife resources and requires consultation with federal authorities if modifications of streams or other water bodies are required.	X			Activities conducted for Site 3 are not anticipated to impact fish or wildlife resources or modify streams or other water bodies. However, as the activities will be conducted adjacent to a designated wetlands this act is applicable.
Migratory Bird Treaty Act	16 USC 703-712	Provides protection for migratory bird species, including many passerines. Prohibits killing or taking of any bird or any part, nest, or egg of any such bird.		X		Migratory birds have not been found at Site 3. However, in the event that migratory birds are encountered, this act is relevant and appropriate.
STATE REQUIREMENTS						
Colorado Non-game, Endangered, or Threatened Species Act	C.R.S. 33-2-103 through 108	Protects endangered and threatened species and preserves their habitats. Requires coordination with the Division of Wildlife if remedial activities impact on state-listed endangered/threatened species or their habitat.		X		State threatened and endangered species or critical habitats have not been found at Site 3. However, if threatened or endangered species or critical habitats are found at the Site, this act is relevant and appropriate.
Colorado Species of Special Concern and Species of Undetermined Status	Colorado Division of Wildlife Administrative Directive E-1, 1985, modified	Protects animals listed on the Colorado Division of Wildlife generated list. Coordination with Division of Wildlife is strongly urged if animal species are to be impacted.			X	Animal species listed as special concern have not been found at Site 3. However, if species listed as special concern are found at the Site, this directive will be considered.
Colorado Natural Areas	No State citation.	The Colorado Natural Areas Program maintains a list of plant species of special concern for the State. Coordination with Division of Parks and Outdoor Recreation is recommended if activities will impact listed species.			X	Plant species of special concern have not been found at Site 3. However, in the event that plant species of special concern are found at the Site, this criteria will be considered.
Colorado State Cultural Properties Act	C.R.S. 24-80-401 through 411	Establishes procedures and requires a permit for investigation, excavation, gathering, or removal from the natural state of any historical, prehistorical, or archeological resources on state lands for the benefit of recognize scientific or educational institutions. Also requires an excavation permit and notification if human remains are found on state land.		X		The existence or removal of archeological resources is not anticipated for remedial activities at Site 3. However, considering that the Site is a portion of the contiguous property for Buckley AFB, this act is relevant and appropriate.

**Table 2-3
Action-Specific Applicable or Relevant and Appropriate Requirements
Site 3 Former Base Landfill
Buckley Air Force Base, Colorado**

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable	Relevant and Appropriate	To Be Considered	Comments
FEDERAL REQUIREMENTS						
Clean Air Act (CAA)	40 CFR 50 and 52	Implements and sets rules for a regional air pollution control program. Establishes National Ambient Air Quality Standards (NAAQS).	X			Site 3 activities for remedial alternatives could generate significant air or fugitive emissions. This regulation is applicable.
National Pollutant Discharge Elimination System (NPDES)	40 CFR 122	Requires permits for the discharge of pollutants from any point source into waters of the United States and establishes criteria and standards for technology-based treatment of discharges.		X		Site 3 activities for remedial alternatives are not expected to require discharge of pollutants into water bodies. However, in the event that discharge of pollutants is required at the Site, this regulation is a relevant and appropriate.
Resource Conservation and Recovery Act (RCRA) Hazardous Materials Regulations	40 CFR Parts 260-265	Regulates the generation, transportation, and treatment, storage and disposal of hazardous materials. Also regulates construction, design, monitoring, operation and closure of hazardous waste facilities.		X		Site 3 activities for remedial alternatives are not expected to generate hazardous materials requiring transportation or require the operation of a TSD facility. However, in the event that hazardous materials are generated that require transportation, storage, or disposal this regulation is relevant and appropriate.
RCRA Subtitle D	40 CFR 258	Establishes minimum national criteria for management of non-hazardous waste.		X		Subtitle D is not applicable to landfills closed prior to 1991 as is the case at Site 3. However, this regulation may be relevant and appropriate to remedial alternatives that are considered.
Occupational Safety and Health Administration (OSHA)	29 USC Sect. 651-678	Regulates worker health and safety.	X			Requirements of the Act apply to response actions under the National Contingency Plan (NCP). OSHA exposure limits are developed for 8-hour worker exposures. OSHA HAZWOPER requirements also apply to field crews conducting remedial action activities. This regulation is applicable for Site 3 activities for remedial alternatives.
STATE REQUIREMENTS						
Observation/Monitoring Water Well Permit Requirements	2 CCR 402-2, Rules 6, 10, 11, 13, 15, and 16	Establishes rules applicable to the construction and abandonment of recovery, monitoring, and observation wells.	X			Construction of monitoring wells may be part of Site 3 activities for remedial alternatives. These requirements are applicable.
Regulations for Effluent Limitations	5 CCR 1002-62	Limits effluent for specifically identified pollutants that may be discharged into any specified class of state waters.		X		It is not anticipated that Site 3 activities for remedial alternatives will require discharge of pollutants to waters of the state. However, in the event that discharge does become a requirement, this regulation is relevant and applicable.
Pretreatment Regulations	5 CCR 1002-63	Standards and requirements for discharge to a publicly operated treatment works (POTW).		X		It is not anticipated that Site 3 activities for remedial alternatives will require discharge to a POTW. However, in the event that discharge to a POTW does become a requirement, this regulation is relevant and applicable.
Discharge to Storm Sewers Regulation	5 CCR 1002-65	Prohibits discharges to storm sewer unless Colorado Discharge Permit System (CDPS) permit has been obtained.		X		It is not anticipated that Site 3 activities for remedial alternatives will require discharge to a storm sewer. However, in the event that discharge to a storm sewer does become a requirement, this regulation is relevant and applicable.
Colorado Hazardous Waste Act	6 CCR 1007-3, Part 100	Establishes procedures for notification of hazardous waste activities, identification and listing of hazardous wastes, generators, and operators of treatment, storage, and disposal facilities.		X		Activities conducted for Site 3 remedial alternatives are not anticipated to require operation of a TSD facility. However, in the event that storage of hazardous wastes becomes a requirement at the site, this regulation is applicable and relevant.
Hazardous Waste Management Systems, General (Subtitle C)	6 CCR 1007-3, Part 260	Establishes procedures and criteria for modification or revocation of any provision in 6 CCR 1007-3, Part 260-265.		X		Activities conducted for Site 3 remedial alternatives are not anticipated to generate hazardous waste. However, in the event that hazardous wastes are encountered at the site, this regulation is applicable and relevant.
Identification and Listing of Hazardous Wastes (Subtitle C)	6 CCR 1007-3, Part 261	Defines those solid wastes which are subject to regulation as hazardous wastes under 6 CCR 1007-3, Parts 262-265, 268 and Parts 270 and 271 of RCRA.		X		Activities conducted for Site 3 remedial alternatives are not anticipated to generate hazardous waste. However, in the event that hazardous wastes are encountered at the site, this regulation is applicable and relevant.
Standards Applicable to Generators of Hazardous Waste (Subtitle C)	6 CCR 1007-3, Part 262	Establishes standards for generators of hazardous waste.		X		Activities conducted for Site 3 remedial alternatives are not anticipated to generate hazardous waste. However, in the event that hazardous wastes are encountered at the site, the standards are applicable and relevant.
Standards Applicable to Transporters of Hazardous Waste	6 CCR 1007-3, Part 263	Establishes standards which apply to persons transporting hazardous waste within the U.S. if the transportation requires a manifest under 6 CCR 1007-3, Part 262.		X		Activities conducted for Site 3 remedial alternatives are not anticipated to generate hazardous waste. However, in the event that transportation of hazardous wastes are required at the site, the standards are applicable and relevant.
Colorado Environmental Covenant	C.R.S. 25-15-320	Requires an environmental covenant to ensure continuance of land use restriction if remedy is on-site with restricted uses.	X			Activities conducted for Site 3 remedial alternatives will likely include institutional controls. Therefore, the Act is applicable.

**Table 2-4
General Response Actions and Remedial Technologies
Site 3 Former Base Landfill
Buckley Air Force Base, Colorado**

General Response Action	Technology Type	Technology Category	Technology Process Option	Description	Screening Results (Retained or Not Retained)
No Action	No Action	No Action	No Action	No Action	Retain. Required under NCP for comparative purposes.
Institutional Controls	Access Restrictions	Administrative	Land-Use Controls	Covenants attached to a property deed to restrict uses of the property that may negatively affect the integrity or effectiveness of the	Retain. Applicable technology to be used in conjunction with selected remedial option.
		Physical	Fencing	A physical barrier that restricts access to the site.	Retain. Applicable technology to be used in conjunction with selected remedial option.
			Signage	Signs or postings that decrease the risk of access to the site.	Retain. Applicable technology to be used in conjunction with selected remedial option.
	Monitoring	Monitoring	Groundwater Monitoring	Monitoring of groundwater quality to ensure that contaminants are not migrating through waste.	Retain. Applicable as groundwater monitoring is necessary to ensure effectiveness of selected remedial option.
			Landfill Gas Monitoring	Monitoring of commonly produced methane gas from the decomposition of the waste to reduce the risk of exposure.	Not Retained. There is no risk of landfill gas and no need for monitoring.
			Leachate Monitoring	Monitoring of leachate from the infiltration of surface water, through the waste pile, which could carry off waste constituents.	Not Retained. There is no production of leachate and no need for monitoring.
Containment	Containment	Capping	Soil Cap	A 24-inch soil cover layer placed atop the landfill material.	Retain. Applicable remedial technology option.
			Biota Barrier	Emplaced barrier to minimize digging into waste by burrowing animals.	Retain. Applicable technology to be used in conjunction with selected remedial option.
		Surface Control	Grading/Revegetation	Grading and revegetation of surficial soils to ensure surface water drainage and minimize erosion.	Retain. Applicable technology to be used in conjunction with selected remedial option.
Disposal	Excavation	Removal	Off-Base Disposal	Excavate waste and remove from site to a permitted facility for permanent disposal.	Retain. Although this technology is not practical, it is retained for comparative purposes.
			On-Site Relocation/Burial	Excavate waste and remove and dispose at an alternate location at BAFB. Re-establish an alternate engineered landfill elsewhere at BAFB.	Not Retained. Technology is not practical as there are no appropriate locations elsewhere at BAFB.

Notes:
BAFB = Buckley Air Force Base
NCP = The National Oil and Hazardous Substances Pollution Contingency Plan

**Table 3-1
Remedial Technology and Option Screening Analysis
Site 3 Former Base Landfill
Buckley Air Force Base, Colorado**

Remedial Alternative	Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, and Volume Through Treatment	Short-Term Impacts and Effectiveness
LF1: No Action	Provides no increased protection.	Is not in compliance with the action-specific ARAR as it does not comply with the Colorado Solid Waste regulations.	Provides no long-term effectiveness.	No waste treatment is part of this remedy.	Entails no short-term changes or impacts.
LF2: Removal and Disposal	This remedy would be protective of the public health and environment through complete removal of all waste material. The short-term risks are high due to the large volume of material that will be transported through BAFB and the community.	Alternative is compliant with ARARs.	This remedy would have a high effectiveness and would be very permanent alternative.	No waste treatment is part of this remedy.	This remedy will require greater upfront preparations to implement. There are elevated risks associated with the complete removal and offsite disposal of waste and the additional truck traffic and heavy equipment operation. There may also be short-term risks to the environment depending on the material encountered during the excavation.
LF3: Soil Cover (including Long-Term Monitoring and Land-Use Controls)	Alternative LF3 is protective of human health and the environment through ensuring the complete containment of the waste debris. Control of the existing waste material through the placement of a soil cover will prevent contact with landfill waste and reduce infiltration through the waste material. Land use controls prevent exposure through controlling access and future use of the former landfill.	Alternative is compliant with ARARs.	Effectiveness and permanence will be dependent on the adequacy and reliability of the institutional controls to maintain the integrity of the landfill cover.	No waste treatment is part of this remedy.	The short-term risks posed by the implementation of Alternative LF3 would involve the increased traffic to transport site materials on-base. Site workers may be subject to health and safety concerns associated with the excavation of portions of the waste from along East Toll Gate Creek and the use of heavy equipment. There may also be short-term risks to the environment depending on the material encountered during the excavation.
LF4: Soil Cover with Biota Barrier (including Long-Term Monitoring and Land-Use Controls)	Alternative LF4 is protective of human health and the environment through ensuring the complete containment of the waste debris. Control of the existing waste material through the placement of a soil cover will prevent contact with waste materials and reduce infiltration through the landfill waste. The biota barrier will prevent burrowing animals from digging into the waste contents. Land use controls prevent exposure through controlling access and future use of the former landfill.	Alternative is compliant with ARARs.	Effectiveness and permanence will be dependent on the adequacy and reliability of the institutional controls to maintain the integrity of the landfill cover system.	No waste treatment is part of this remedy.	The short-term risks posed by the implementation of Alternative LF4 would involve the increased traffic to transport site materials on-base. A much greater volume of material would be hauled on-base compared to Alternative LF3. Site workers may be subject to health and safety concerns associated with the excavation of portions of the waste from along East Toll Gate Creek and the use of heavy equipment. There may also be short-term risks to the environment depending on the material encountered during the excavation.

**Table 3-1
Remedial Technology and Option Screening Analysis
Site 3 Former Base Landfill
Buckley Air Force Base, Colorado**

Remedial Alternative	Implementability	Cost	Regulatory Acceptance	Community Acceptance
LF1: No Action	There are no technical implementability or administrative feasibility considerations.	None	This criterion will be addressed in the Proposed Plan and Record of Decision (ROD) after agency review of the FFS. Regulatory acceptance of Alternative LF1 is not anticipated since no action is undertaken.	This criterion will be addressed in the Record of Decision (ROD) after public review of the Proposed Plan. Community acceptance of Alternative LF1 is not anticipated since no action is undertaken.
LF2: Removal and Disposal	Alternative LF2 would be technically feasible. The administrative feasibility would be much higher and involve greater federal, state, and local regulatory participation. Permits and approvals could be difficult to obtain.	\$21,978,406	This criterion will be addressed in the Proposed Plan and ROD after agency review of the FFS. Regulatory acceptance of this alternative is anticipated based on similar landfill removal projects.	This criterion will be addressed in the ROD after public review of the Proposed Plan. Community acceptance of the Alternative LF2 is expected to be low based on the high cost and the risks associated the transportation of large volumes of landfill wastes.
LF3: Soil Cover (including Long-Term Monitoring and Land-Use Controls)	Alternative LF3 is both technically feasible and administratively feasible. Materials and services are readily available.	\$2,620,145	This criterion will be addressed in the Proposed Plan and ROD after agency review of the FFS. Regulatory acceptance of this alternative is anticipated.	This criterion will be addressed in the ROD after public review of the Proposed Plan. Community acceptance of the Alternative LF3 is anticipated.
LF4: Soil Cover with Biota Barrier (including Long-Term Monitoring and Land-Use Controls)	Alternative LF4 is both technically feasible and administratively feasible. Materials and services are readily available. The larger area of concern and greater volume of material make this alternative somewhat more technically complex than Alternative LF3.	\$8,857,346	This criterion will be addressed in the Proposed Plan and ROD after agency review of the FFS. Regulatory acceptance of this alternative is anticipated.	This criterion will be addressed in the ROD after public review of the Proposed Plan. Community acceptance of the Alternative LF4 is anticipated.

Table 3-2
LF 2 Remedial Alternative Estimated Cost Summary
Site 3 Former Base Landfill
Buckley Air Force Base, Colorado

Removal and Disposal - Alternative LF 2						
Site: Site 3		Cost Estimate Summary			Date: 7/16/10	
Location : Buckley AFB, Aurora, Colorado						
Phase: Feasibility Study (-30% to +50%)						
Base Year: 2010						
Description: Alternative LF2 consists of excavation and off-site disposal of waste debris. Also includes installation of replacement monitoring wells, groundwater monitoring, and a five-year review. Capital costs occur in Year 0. Periodic monitoring costs occur in Years 1 through 5.						
Capital Costs:						
	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Site Preparation						
	Mob/Demob	1	LS	\$25,741	\$25,741	Excavators, loaders
	Strip and Stockpile Topsoil	1	LS	\$55,048	\$55,048	
	Install Erosion Controls	1	LS	\$24,202	\$24,202	
	SUBTOTAL				\$104,991	
Excavation						
	Stormwater Management - Riprap	1	LS	\$97,378	\$97,378	
	Stormwater Management - Drainage Features	1	LS	\$19,538	\$19,538	
	Excavate and Load Landfill Debris	1	LS	\$1,161,193	\$1,161,193	Removal of approx 542,080 cy of debris
	Excavation Dewatering	1	LS	\$53,262	\$53,262	Disposal cost is included in T&D cost
	Deliver and Emplace Clean Fill	1	LS	\$6,329,671	\$6,329,671	Import and placement of clean fill
	Replace Topsoil and Reseed	1	LS	\$133,690	\$133,690	Revegetate former waste debris area
	SUBTOTAL				\$7,794,731	
Removal & Disposal						
	Transportation & Disposal of Landfill Debris	1	LS	\$7,408,892	\$7,408,892	Disposal of 542,080 cy
	Transportation & Disposal of Dewatering Liquids	1	LS	\$151,091	\$151,091	Assumed 30,000 gallons
	Transportation & Disposal of Well Development Water	1	LS	\$3,590	\$3,590	
	Transportation & Disposal of Well Cuttings	1	LS	\$5,146	\$5,146	
	SUBTOTAL				\$7,568,720	
Monitoring Well Installation						
		1	LS	\$12,003	\$12,003	Replacement of 4 monitoring wells
	SUBTOTAL				\$12,003	
	Subtotal - Direct Capital Costs				\$15,480,445	
	Bid Contingency (25%)				\$3,870,111	10% scope + 15% bid
	Total - RA Cost				\$19,350,556	
	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Planning & Reporting						
	ROD/Proposed Plan	1	LS	\$103,518	\$103,518	
	RD Field Activities	1	LS	\$74,783	\$74,783	
	Remedial Design/Remedial Action WP	1	LS	\$127,413	\$127,413	
	Completion Report	1	LS	\$91,575	\$91,575	Post construction submittal
	SUBTOTAL				\$397,289	
	Other Capital Costs (PM, Overhead, Fringe, G&A, Fee)				\$2,038,914	
	Total - Direct Capital Costs (RA Costs, Planning & Reporting, Other Capital Costs)				\$21,786,760	
Periodic Costs:						
GW Monitoring						
	GW Sampling - Year 1	1	LS	\$20,212	\$20,212	Sampling of 10 wells
	GW Sampling Report - Year 1	1	LS	\$27,780	\$27,780	
	GW Sampling - Years 2-5	4	EA	\$16,522	\$66,087	Annual sampling of 10 wells
	GW Sampling Report- Years 2-5	4	EA	\$21,137	\$84,549	
	SUBTOTAL				\$198,628	
Five-Year Review						
		1	LS	\$4,254	\$4,254	Report at the end of year five
	SUBTOTAL				\$4,254	
	Other Costs (PM, Overhead, Fringe, G&A, Fee)				\$30,782	
	Total - Periodic Costs				\$233,664	
	Total Alternative Cost				\$22,020,424	
Present Value Analysis:						
COST TYPE	YEAR	TOTAL COST	TOTAL COST PER YEAR	DISCOUNT FACTOR(%)	PRESENT VALUE	NOTES
Capital Cost	0	\$21,786,760	\$21,786,760	1.000	\$21,786,760	
Periodic Cost	1	\$52,856	\$52,856	0.935	\$49,420	GW Sampling - Year 1
Periodic Cost	2	\$42,523	\$42,523	0.873	\$37,123	GW Sampling
Periodic Cost	3	\$42,523	\$42,523	0.816	\$34,699	GW Sampling
Periodic Cost	4	\$42,523	\$42,523	0.763	\$32,445	GW Sampling
Periodic Cost	5	\$42,523	\$42,523	0.713	\$30,319	GW Sampling
Periodic Cost	5	\$10,716	\$10,716	0.713	\$7,641	Five-Year Review
		\$22,020,424			\$21,978,406	
Total Present Value of Alternative					\$21,978,406	

Table 3-3
LF 3 Remedial Alternative Estimated Cost Summary
Site 3 Former Base Landfill
Buckley Air Force Base, Colorado

Landfill Containment - Alternative LF 3						
Single Layer Soil Cover and Institutional Controls including LTM and LUCs						
Site: Site 3	Cost Estimate Summary				Date: 7/16/10	
Location : Buckley AFB, Aurora, Colorado						
Phase: Feasibility Study (-30% to +50%)						
Base Year: 2010						
Description: Alternative LF3 consists of emplacement of cover, LTM sampling, LUCs, O&M of the cover, and five-year reviews. Capital costs occur in Year 0. Periodic LTM sampling costs occur in Years 1 through 10. O&M costs occur in years 1 through 30.						
Capital Costs:						
	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Site Preparation						
	Mob/Demob	1	LS	\$25,741	\$25,741	Excavators, loaders
	Strip and Stockpile Topsoil	1	LS	\$55,048	\$55,048	
	Install Erosion Controls	1	LS	\$24,202	\$24,202	
	SUBTOTAL				\$104,991	
Landfill Containment						
	Address Settlement/Erosion	1	LS	\$58,319	\$58,319	
	Stormwater Management - Riprap	1	LS	\$79,172	\$79,172	
	Stormwater Management - Drainage Features	1	LS	\$19,538	\$19,538	
	Removal of Debris and Consolidation	1	LS	\$79,624	\$79,624	
	Augment Soil Cover	1	LS	\$731,918	\$731,918	Cover 16 acres with 2 feet of soil
	Replace Topsoil and Reseed	1	LS	\$128,376	\$128,376	Reseed 16 acres
	SUBTOTAL				\$1,096,947	
	Subtotal - Direct Capital Costs				\$1,201,938	
	Bid Contingency (25%)				\$300,484	10% scope + 15% bid
	Total - RA Cost				\$1,502,422	
	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Planning & Reporting						
	ROD/Proposed Plan	1	LS	\$94,637	\$94,637	
	RD Field Activities	1	LS	\$70,449	\$70,449	
	Remedial Design/Remedial Action WP	1	LS	\$114,785	\$114,785	
	Completion Report	1	LS	\$83,381	\$83,381	Post construction submittal
	SUBTOTAL				\$363,251	
Land Use Controls						
	Land Use Controls Plan	1	LS	\$13,223	\$13,223	Describe controls/implementation
	Groundwater Use Restrictions	1	LS	\$6,606	\$6,606	Includes registry filings
	Provide Update for Base General Plan	1	LS	\$6,493	\$6,493	
	SUBTOTAL				\$26,322	
	Other Capital Costs (PM, Overhead, Fringe, G&A, Fee)				\$336,273	
	Total - Direct Capital Costs (RA Costs, Planning & Reporting, LUCs, Other Capital Costs)				\$2,228,268	
Periodic Costs:						
LTM Sampling						
	LTM Sampling - Year 1	1	LS	\$19,371	\$19,371	Sampling of 10 wells
	LTM Sampling Report - Year 1	1	LS	\$27,780	\$27,780	
	LTM Sampling - Years 2-10	9	EA	\$15,680	\$141,123	Annual sampling of 10 wells
	LTM Sampling Report- Year 2-10	9	EA	\$21,137	\$190,235	
	SUBTOTAL				\$378,508	
	Five-Year Review	6	LS	\$4,254	\$25,527	6, 5-yr reviews over 30-yr period
	SUBTOTAL				\$25,527	
O&M Costs:						
Landfill Cover Inspection and Maintenance						
	Landfill Cover Inspection	30	EA	\$2,383	\$71,501	Annual inspection for 30 years
	Landfill Cover Maintenance	6	EA	\$6,968	\$41,807	Maintenance every 5 years
	SUBTOTAL				\$113,308	
	Other Periodic and O&M Costs (PM, Overhead, Fringe, G&A, Fee)				\$119,359	
	Total - Periodic and O&M Costs				\$636,702	
	Total Alternative Cost				\$2,864,970	

**Table 3-3
LF 3 Remedial Alternative Estimated Cost Summary
Site 3 Former Base Landfill
Buckley Air Force Base, Colorado**

Present Value Analysis:							
COST TYPE	YEAR	TOTAL COST		DISCOUNT FACTOR(7%)	PRESENT VALUE	NOTES	
		TOTAL COST	PER YEAR				
Capital Cost	0	\$2,228,268	\$2,228,268	1.000	\$2,228,268		
Periodic Cost	1	\$54,981	\$54,981	0.935	\$51,407	LTM Sampling - Year 1 - 10 Wells	
Periodic Cost	2	\$44,640	\$44,640	0.873	\$38,970	Annual LTM Sampling - 10 Wells	
Periodic Cost	3	\$44,640	\$44,640	0.816	\$36,426	Annual LTM Sampling - 10 Wells	
Periodic Cost	4	\$44,640	\$44,640	0.763	\$34,060	Annual LTM Sampling - 10 Wells	
Periodic Cost	5	\$44,640	\$44,640	0.713	\$31,828	Annual LTM Sampling - 10 Wells	
Periodic Cost	6	\$44,640	\$44,640	0.666	\$29,730	Annual LTM Sampling - 10 Wells	
Periodic Cost	7	\$44,640	\$44,640	0.623	\$27,810	Annual LTM Sampling - 10 Wells	
Periodic Cost	8	\$44,640	\$44,640	0.582	\$25,980	Annual LTM Sampling - 10 Wells	
Periodic Cost	9	\$44,640	\$44,640	0.544	\$24,284	Annual LTM Sampling - 10 Wells	
Periodic Cost	10	\$44,640	\$44,640	0.508	\$22,677	Annual LTM Sampling - 10 Wells	
Periodic Cost	5	\$10,224	\$10,224	0.713	\$7,290	Five-Year Review	
Periodic Cost	10	\$10,224	\$10,224	0.508	\$5,194	Five-Year Review	
Periodic Cost	15	\$10,224	\$10,224	0.362	\$3,701	Five-Year Review	
Periodic Cost	20	\$10,224	\$10,224	0.258	\$2,638	Five-Year Review	
Periodic Cost	25	\$10,224	\$10,224	0.184	\$1,881	Five-Year Review	
Periodic Cost	30	\$10,224	\$10,224	0.131	\$1,339	Five-Year Review	
O&M Cost	5	\$7,380	\$7,380	0.713	\$5,262	Cover Maintenance	
O&M Cost	10	\$7,380	\$7,380	0.508	\$3,749	Cover Maintenance	
O&M Cost	15	\$7,380	\$7,380	0.362	\$2,671	Cover Maintenance	
O&M Cost	20	\$7,380	\$7,380	0.258	\$1,904	Cover Maintenance	
O&M Cost	25	\$7,380	\$7,380	0.184	\$1,358	Cover Maintenance	
O&M Cost	30	\$7,380	\$7,380	0.131	\$967	Cover Maintenance	
O&M Cost	1-30	\$74,340	\$2,478	12.409	\$30,750	Annual Cover Inspection - 30 years	
		<u>\$2,864,970</u>			<u>\$2,620,145</u>		
Total Present Value of Alternative					\$2,620,145		

Table 3-4
LF 4 Remedial Alternative Estimated Cost Summary
Site 3 Former Base Landfill
Buckley Air Force Base, Colorado

Landfill Containment - Alternative LF 4						
Composite Cover of Soil and Engineered Biota Barrier, Institutional Controls including LTM and LUCs						
Site: Site 3		Cost Estimate Summary			Date: 7/16/10	
Location : Buckley AFB, Aurora, Colorado						
Phase: Feasibility Study (-30% to +50%)						
Base Year: 2010						
Description: Alternative LF4 consists of emplacement of cover and biota barrier, LTM sampling, LUCs, O&M of the cover and biota barrier, and five-year reviews. Capital costs occur in Year 0. Periodic LTM sampling costs occur in Years 1 through 10. O&M costs occur in years 1 through 30.						
Capital Costs:						
	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Site Preparation						
	Mob/Demob	1	LS	\$25,741	\$25,741	Excavators, loaders
	Strip and Stockpile Topsoil	1	LS	\$55,048	\$55,048	
	Install Erosion Controls	1	LS	\$24,202	\$24,202	
	SUBTOTAL				\$104,991	
Landfill Containment						
	Address Settlement/Erosion	1	LS	\$58,319	\$58,319	
	Stormwater Management - Riprap	1	LS	\$79,172	\$79,172	
	Stormwater Management - Drainage Features	1	LS	\$19,538	\$19,538	
	Removal of Debris and Consolidation	1	LS	\$79,624	\$79,624	
	Augment Soil Cover	1	LS	\$1,200,236	\$1,200,236	Cover 28 acres with 2 feet of soil
	Emplace Biota Barrier	1	LS	\$4,048,299	\$4,048,299	Emplace 16 inches of biota barrier
	Replace Topsoil and Reseed	1	LS	\$160,294	\$160,294	Reseed 28 acres
	SUBTOTAL				\$5,645,482	
	Subtotal - Direct Capital Costs				\$5,750,473	
	Bid Contingency (25%)				\$1,437,618	10% scope + 15% bid
	Total - RA Cost				\$7,188,091	
	DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Planning & Reporting						
	ROD/Proposed Plan	1	LS	\$94,637	\$94,637	
	RD Field Activities	1	LS	\$70,449	\$70,449	
	Remedial Design/Remedial Action WP	1	LS	\$114,785	\$114,785	
	Completion Report	1	LS	\$83,381	\$83,381	Post construction submittal
	SUBTOTAL				\$363,251	
Land Use Controls						
	Land Use Controls Plan	1	LS	\$13,223	\$13,223	Describe controls/implementation
	Groundwater Use Restrictions	1	LS	\$6,606	\$6,606	Includes registry filings
	Provide Update for Base General Plan	1	LS	\$6,493	\$6,493	
	SUBTOTAL				\$26,322	
	Other Capital Costs (PM, Overhead, Fringe, G&A, Fee)				\$884,755	
	Total - Direct Capital Costs				\$8,462,419	
Periodic Costs:						
LTM Sampling						
	LTM Sampling - Year 1	1	LS	\$19,371	\$19,371	Sampling of 10 wells
	LTM Sampling Report - Year 1	1	LS	\$27,780	\$27,780	
	LTM Sampling - Years 2-10	9	EA	\$15,680	\$141,123	Annual sampling of 10 wells
	LTM Sampling Report- Year 2-10	9	EA	\$21,137	\$190,235	
	SUBTOTAL				\$378,508	
Five-Year Review						
		6	LS	\$4,254	\$25,527	6, 5-yr reviews over 30-yr period
	SUBTOTAL				\$25,527	

Table 3-4
LF 4 Remedial Alternative Estimated Cost Summary
Site 3 Former Base Landfill
Buckley Air Force Base, Colorado

O&M Costs:							
Landfill Cover Inspection and Maintenance							
Landfill Cover Inspection	30	EA	\$2,383			\$71,501	Annual inspection for 30 years
Landfill Cover Maintenance	6	EA	\$8,361			\$50,168	Maintenance every 5 years
SUBTOTAL						\$121,669	
Other Periodic and O&M Costs (PM, Overhead, Fringe, G&A, Fee)						\$119,470	
Total - Periodic and O&M Costs						\$645,175	
Total Alternative Cost						\$9,107,593	
Present Value Analysis:							
COST TYPE	YEAR		TOTAL COST	PER YEAR	DISCOUNT FACTOR(7%)	PRESENT VALUE	NOTES
Capital Cost	0		\$8,462,419	\$8,462,419	1.000	\$8,462,419	
Periodic Cost	1		\$54,981	\$54,981	0.935	\$51,407	LTM Sampling - Year 1 - 10 Wells
Periodic Cost	2		\$44,640	\$44,640	0.873	\$38,970	Annual LTM Sampling - 10 Wells
Periodic Cost	3		\$44,640	\$44,640	0.816	\$36,426	Annual LTM Sampling - 10 Wells
Periodic Cost	4		\$44,640	\$44,640	0.763	\$34,060	Annual LTM Sampling - 10 Wells
Periodic Cost	5		\$44,640	\$44,640	0.713	\$31,828	Annual LTM Sampling - 10 Wells
Periodic Cost	6		\$44,640	\$44,640	0.666	\$29,730	Annual LTM Sampling - 10 Wells
Periodic Cost	7		\$44,640	\$44,640	0.623	\$27,810	Annual LTM Sampling - 10 Wells
Periodic Cost	8		\$44,640	\$44,640	0.582	\$25,980	Annual LTM Sampling - 10 Wells
Periodic Cost	9		\$44,640	\$44,640	0.544	\$24,284	Annual LTM Sampling - 10 Wells
Periodic Cost	10		\$44,640	\$44,640	0.508	\$22,677	Annual LTM Sampling - 10 Wells
Periodic Cost	5		\$10,224	\$10,224	0.713	\$7,290	Five-Year Review
Periodic Cost	10		\$10,224	\$10,224	0.508	\$5,194	Five-Year Review
Periodic Cost	15		\$10,224	\$10,224	0.362	\$3,701	Five-Year Review
Periodic Cost	20		\$10,224	\$10,224	0.258	\$2,638	Five-Year Review
Periodic Cost	25		\$10,224	\$10,224	0.184	\$1,881	Five-Year Review
Periodic Cost	30		\$10,224	\$10,224	0.131	\$1,339	Five-Year Review
O&M Cost	5		\$8,773	\$8,773	0.713	\$6,255	Cover Maintenance
O&M Cost	10		\$8,773	\$8,773	0.508	\$4,457	Cover Maintenance
O&M Cost	15		\$8,773	\$8,773	0.362	\$3,176	Cover Maintenance
O&M Cost	20		\$8,773	\$8,773	0.258	\$2,264	Cover Maintenance
O&M Cost	25		\$8,773	\$8,773	0.184	\$1,614	Cover Maintenance
O&M Cost	30		\$8,773	\$8,773	0.131	\$1,149	Cover Maintenance
O&M Cost	1-30		\$74,451	\$2,482	12.409	\$30,795	Annual Cover Inspection - 30 years
			\$9,107,593			\$8,857,346	
Total Present Value of Alternative						\$8,857,346	

APPENDIX A
LANDFILL CLOSURE REFERENCES

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT
Hazardous Materials and Waste Management Division

M E M O R A N D U M

TO: Concerned Parties

FROM: Peter Laux, Solid Waste Unit (phone 303-692-3455)

DATE: August 16, 1999

SUBJECT: Old Landfill Closure Requirements and Post-Closure Care and Maintenance

Reference: Regulations Pertaining to Solid Waste Disposal Sites and Facilities, 6 CCR 1007-2
(Colorado solid waste regulations pursuant to the Solid Wastes Disposal Sites and Facilities Act,
Title 30, Article 20, Part 1, Colorado Revised Statutes)

Minimum requirements for old landfills that stopped receiving waste prior to October 9, 1991:

A. Closure Requirements

1. At least two feet of soil over the entire fill area.
2. Surface drainage to prevent ponding and erosion, and to control run-on and run-off.
3. Orderliness, good aesthetic appearance and capable of blending with surrounding area.
4. Concentration of explosive gases not to exceed 5% volume in air in soil at site boundary.
5. Water pollution shall not occur at or beyond site boundary.
6. Nuisance conditions (litter, dust, odors, vectors) shall not exist at or beyond site boundary.
7. Post-closure monitoring, care and maintenance program.

The thrust of current solid waste landfill regulations is to keep the wastes dry and isolated from water. Wastes accepted for landfill disposal are to contain no free liquid, and then they are placed between liner and cover systems with very low hydraulic conductivity. Additionally, surface water is to be diverted away from the landfill. Most old landfills have no bottom liner and wastes may have been placed in contact with ground water. As long as there is no severe impact to ground water, surface measures to reduce waste exposure to water are usually deemed adequate after closure of old landfills. A good vegetative cover serves to protect the cover soil from erosion as well as presenting a pleasing aesthetic appearance. If the post-closure use of the landfill area includes irrigation, or planting of vegetation with deeply penetrating root systems, special measures may be required to prevent exposure of the buried wastes to excess moisture.

The minimum cover system prescribed in old regulations consisted of two feet of soil. This was generally applied as eighteen inches of unspecified soil plus six inches of topsoil. The minimum cover system prescribed in current regulations consists of an engineered barrier layer (eighteen inches thick; maximum permeability 1×10^{-5} cm/sec) and earthen material capable of sustaining native plant growth (topsoil, six inches thick). However, to protect the integrity of the barrier layer, it is recommended that additional soil (generally eighteen inches) be placed as frost protection and to provide adequate root zone for the vegetative cover. The cover system is to be monitored and maintained.

B. Post-Closure Care and Maintenance

Following closure, the landfill operator must implement an inspection plan and program to:

1. Maintain the integrity and effectiveness of the final cover, including making repairs to correct effects of settlement, subsidence, erosion, vegetation failure, etc., and preventing water run-on and run-off from eroding or otherwise damaging the final cover;
2. Maintain ground water and gas monitoring systems, and test according to an approved sampling and analysis plan;
3. Provide name, address, and telephone number of responsible party during post-closure care period.

The post-closure care period for old municipal solid waste landfills generally was 5 or 10 years, and for numerous old landfills it was unspecified. The current regulations specify 30 years. Regardless of post-closure care plan length, a landowner is always responsible to address nuisance conditions and threats to health and environment that occur on the property.

C. Deed Notation

Following closure, the owner or operator shall record a notation on the deed to the facility property that the land has been used as a landfill and that its use is restricted under solid waste regulations, currently Section 3.6.1(A)(7). This section stipulates that post-closure use of the property shall not disturb the integrity of the final cover, components of the containment system, or function of the monitoring systems. Any proposed disturbance would require demonstration that it would not increase the potential threat to the environment, and review and approval by the Department would be necessary prior to construction.



Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills

Federal Facilities Restoration and Reuse Office
Mail Code 5101

Quick Reference Fact Sheet

Presumptive remedies are preferred technologies for common categories of sites based on historical patterns of remedy selection and the U.S. Environmental Protection Agency's (EPA's) scientific and engineering evaluation of performance data on technology implementation. By streamlining site investigation and accelerating the remedy selection process, presumptive remedies are expected to ensure the consistent selection of remedial actions and reduce the cost and time required to clean up similar sites. Presumptive remedies are expected to be used at all appropriate sites. Site-specific circumstances dictate whether a presumptive remedy is appropriate at a given site.

EPA established source containment as the presumptive remedy for municipal landfill sites regulated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) in September of 1993 (see the directive *Presumptive Remedy for CERCLA Municipal Landfill Sites*). The municipal landfill presumptive remedy should also be applied to all appropriate military landfills. This directive highlights a step-by-step approach to determining when a specific military landfill is an appropriate site for application of the containment presumptive remedy. It identifies the characteristics of municipal landfills that are relevant to the applicability of the presumptive remedy, addresses characteristics specific to military landfills, outlines an approach to determining whether the presumptive remedy applies to a given military landfill, and discusses administrative record documentation requirements.

PURPOSE

This directive provides guidance on applying the containment presumptive remedy to military landfills. Specifically, this guidance:

- Describes the relevant characteristics of municipal landfills for applicability of the presumptive remedy;
- Presents the characteristics specific to military installations that affect application of the presumptive remedy;
- Provides a decision framework to determine applicability of the presumptive remedy to military landfills; and
- Provides relevant contacts/specialists in military wastes, case histories, administrative record documentation requirements, and references.

BACKGROUND

Municipal landfills are those facilities in which a combination of household, commercial and, to a lesser

extent, industrial wastes have been co-disposed. The presumptive remedy for municipal landfills – source containment – is described in detail in the directive *Presumptive Remedy for CERCLA Municipal Landfill Sites*. Highlight 1 outlines the components of the containment presumptive remedy. Highlight 2 lists the characteristics of municipal landfills that are compatible with the presumptive remedy of containment.

Highlight 1

Components of the Containment Presumptive Remedy

- Landfill cap
- Source area groundwater control to contain plume
- Leachate collection and treatment
- Landfill gas collection and treatment
- Institutional controls to supplement engineering controls

Highlight 2
Appropriate Municipal Landfill Characteristics for Applicability of the Presumptive Remedy

- Risks are low-level, except for "hot spots"
- Treatment of wastes is usually impractical due to the volume and heterogeneity of waste
- Waste types include household, commercial, nonhazardous sludge, and industrial solid wastes
- Lesser quantities of hazardous wastes are present as compared to municipal wastes
- Land application units, surface impoundments, injection wells, and waste piles are not included

The presumptive remedy process involves streamlining of the remedial investigation/feasibility study (RI/FS) or, for non-time-critical removals, an Engineering Evaluation/Cost Analysis (EE/CA) by:

- Relying on existing data to the extent possible rather than characterizing landfill contents (limited or no landfill source investigation unless there is information indicating a need to investigate hot spots);
- Conducting a streamlined risk assessment; and
- Developing a focused feasibility study that analyzes only alternatives consisting of appropriate components of the presumptive remedy and, as required by the National Contingency Plan, the no action alternative.

Several directives, including *Presumptive Remedy for CERCLA Municipal Landfill Sites*, *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites*, and *Streamlining the RI/FS for CERCLA Municipal Landfill Sites*, provide a complete discussion of these streamlining principles.

USE OF THIS GUIDANCE

EPA anticipates that the containment presumptive remedy will be applicable to a significant number of landfills found at military facilities. Although waste types may differ between municipal and military landfills, these differences do not preclude use of source containment as the primary remedy at appropriate military landfills.

Additionally, EPA continues to seek greater consistency among cleanup programs, especially in the process of

selecting response actions for sites regulated under CERCLA and corrective measures for facilities regulated under the Resource Conservation and Recovery Act (RCRA). In general, even though the Agency's presumptive remedy guidances were developed for CERCLA sites, they should also be used at RCRA Corrective Action sites to focus RCRA Facility Investigations, simplify evaluation of remedial alternatives in the Corrective Measures Study, and influence remedy selection in the Statement of Basis. For more information, refer to the *RCRA Corrective Action Plan*, the proposed *Subpart S regulations*, and the *RCRA Corrective Action Advance Notice of Proposed Rule-making*.

CHARACTERISTICS OF MILITARY LANDFILLS

The size of the landfill and the presence, proportion, distribution, and nature of wastes are fundamental to the application of the containment presumptive remedy to military landfills.

An examination of 31 Records of Decisions (RODs) that document the remedial decisions for 51 landfills at military installations revealed that no action was chosen for 10 landfills and remedial actions were chosen at 41 landfills (see Appendix). Of these 41 landfills, containment was selected at 23 (56 percent). For the remaining 18 landfills where other remedies were selected, institutional controls only were selected at three landfills, excavation and on-site consolidation were selected at four landfills, and excavation and off-site disposal were selected for 11 landfills.

The military landfills examined in the 51 RODs mentioned above ranged in size from 100 square feet to 150 acres and contained a wide variety of waste types. Of the 41 landfills for which remedial actions were chosen, 14 (34 percent) were one acre or less in size; containment was not selected for any of these landfills. Containment was chosen at 23 (85 percent) of the 27 landfills that were greater than one acre in size. This information suggests that the size of the landfill area is an important factor in determining the use of source containment at military landfills.

The wastes most frequently deposited at these military landfills were municipal-type wastes: household, commercial (e.g., hospital wastes, grease, construction debris), and industrial (e.g., process wastes, solvents, paints) wastes. Containment was the remedy selected at the majority of these sites. Military-specific wastes (e.g., munitions) were found at only 5 of the 51 landfills (10 percent).

Highlight 3 lists typical municipal and military wastes, including:

- (1) Wastes that are common to both municipal landfills and military landfills;
- (2) Wastes that are usually specific to military bases but that do not necessarily pose higher risks than other industrial wastes commonly found in municipal landfills (i.e., low-hazard military-specific wastes), depending on the volume and heterogeneity of the wastes; and
- (3) High-hazard military wastes that, because of their unique characteristics, would require special consideration (i.e., high-hazard military-specific wastes).

The proportion and distribution of hazardous wastes in a landfill are important considerations. Generally, municipal landfills produce low-level threats with occasional hot spots. Similarly, most military landfills present only low-level threats with pockets of some high-hazard waste. However, some military facilities (e.g., weapons fabrication or testing, shipbuilding, major aircraft or equipment repair depots) have a high level of industrial activity compared to overall site activities. In these cases, there may be a higher proportion and wider distribution of industrial (i.e., potentially hazardous) wastes present than at other less industrialized facilities.

PRACTICAL CONSIDERATIONS

Sensitive Environments

Site-specific conditions may limit the use of the containment presumptive remedy at military landfills. For example, the presence of high water tables, wetlands and other sensitive environments, and the possible destruction or alteration of existing habitats as a result of a particular remedial action could all be important factors in the selection of the remedy.

Land Use

Reasonably anticipated future land use is also an important consideration at all sites. However, at military bases undergoing base closure procedures, where expeditiously converting property to civilian use is one of the primary goals, land use may receive heightened attention. Thus, at bases that are closing, it is particularly important for reuse planning to proceed concurrently with environmental investigation and restoration activities. The local reuse group is responsible for developing the preferred reuse alternatives. The Base Realignment and Closure Team should work closely with the reuse group to integrate reuse planning into the cleanup process, where practicable (see the *Land Use in CERCLA Remedy Selection* directive).

Highlight 3 Examples of Municipal-Type and Military-Specific Wastes

Municipal-Type Wastes

Municipal landfills contain predominantly non-hazardous materials. However, industrial solid waste and even some household refuse (e.g., pesticides, paints, and solvents) can possess hazardous components. Further, hazardous wastes are found in most municipal landfills as a result of past disposal practices.

Predominant Constituents

Household refuse, garbage, and debris
Commercial refuse, garbage, and debris
Construction debris
Yard wastes

Found In Low Proportion

Asbestos
Batteries
Hospital wastes
Industrial solid waste(s)
Paints and paint thinner
Pesticides
Transformer oils
Other solvents

Military-Specific Wastes

The majority of military landfills contain primarily nonhazardous wastes. The materials listed in this column are rarely predominant constituents of military landfills.

Low-Hazard Military-Specific Wastes

These types of wastes are specific to military bases but generally are no more hazardous than some wastes found in municipal landfills.

Low-level radioactive wastes
Decontamination kits
Munitions hardware

High-Hazard Military-Specific Wastes

These wastes are extremely hazardous and may possess unique safety, risk, and toxicity characteristics. Special consideration and expertise are required to address these wastes.

Military Munitions

Chemical warfare agents
(e.g., mustard gas, tear agents)
Chemical warfare agent training kits
Artillery, small arms, bombs
Other military chemicals
(e.g., demolition charges,
pyrotechnics, propellants)
Smoke grenades

**Highlight 4
Decision Framework**

Collect Available Information

- Waste Types
- Operating History
- Monitoring Data
- State Permit/Closure
- Land Reuse Plans
- Size/Volume
- Number of Facility Landfills

Consider Effects of Land Reuse Plans on Remedy Selection

Do Landfill Contents Meet Municipal-Type Waste Definition?

NO

Military-Specific Wastes Are Present; Consult With Military Waste Experts

YES

Is Excavation of Contents Practical?

Note: Site-specific factors such as hydrogeology, volume, cost, and safety affect the practicality of excavation of landfill contents.

No Military Wastes

Military Wastes Present

NO

Is Containment the Most Appropriate Remedy?

Note: Site investigation or attempted treatment may not be appropriate; these activities may cause greater risk than leaving waste in place.

YES

NO/UNCERTAIN

YES

Don't Use Containment Presumptive Remedy
(A conventional RI/FS is required.)

NO

USE CONTAINMENT PRESUMPTIVE REMEDY
(A streamlined risk assessment and focused feasibility study are used.)

DECISION FRAMEWORK TO EVALUATE APPLICABILITY OF THE PRESUMPTIVE REMEDY TO MILITARY LANDFILLS

This Section and Highlight 4 describe the steps involved in determining whether the containment presumptive remedy applies to a specific military landfill.

1. What Information Should Be Collected? Determine the sources, types, and volumes of landfill wastes using historical records, state files, closure plans, available sampling data, etc. This information should be sufficient to determine whether source containment is the appropriate remedy for the landfill. If adequate data do not exist, it may be necessary to collect additional sampling or monitoring data. The installation point of contact (environmental coordinator, base civil engineer, or public works office) should be contacted to obtain records of disposal practices. Current and former employees are also good sources of information.

2. How May Land Reuse Plans Affect Remedy Selection? For smaller landfills (generally less than two acres), land reuse plans may influence the decision on the practicality of excavation and consolidation or treatment of landfill contents. Excavation is a remedial alternative that is fundamentally incompatible with the presumptive remedy of source containment.

3. Do Landfill Contents Meet Municipal Landfill-Type Waste Definition? To determine whether a specific military landfill is appropriate for application of the containment presumptive remedy, compare the characteristics of the wastes to the information in Highlights 2 and 3.

4. Are Military-Specific Wastes Present? Military wastes, especially high-hazard military wastes, may possess unique safety, risk, and toxicity characteristics. Highlight 3 presents examples of these types of materials. If historical records or sampling data indicate that these wastes may have been disposed at the site, special consideration should be given to their handling and remediation. Caution is warranted because site investigation or attempted treatment of these contaminants may pose safety issues for site workers and the community. Some high-hazard military-specific wastes could be considered to present low-level risk, depending on the location, volume, and concentration of these materials relative to environmental receptors. Consult specialists in military wastes (see Highlight 5) when determining whether military-specific wastes at a site fall into either the low-hazard or the high-hazard military-specific waste category found in Highlight 3.

Highlight 5 Specialists in Military Wastes

The installation point of contact will notify the major military command's specialists in military wastes (Explosive Ordnance Disposal Team) for assistance with regard to safety and disposal issues related to any type of military items.

Army chemical warfare agents specialists:

- Project Manager, Non-Stockpile Chemical Materiel, Aberdeen Proving Ground, Maryland 21010-5401, (410) 671-1083.

Navy ordnance related items specialists:

- The Navy Ordnance Environmental Support Office, Naval Surface Warfare Center, Indian Head, Maryland 20460-5035, (301) 743-4534/4906/4450.

Navy low-level radioactive wastes specialists:

- The Naval Sea Systems Command Detachment, Radiological Affairs Support Office, Yorktown, Virginia 23691-0260, (804) 887-4692.

Air Force ordnance specialists:

- The Air Force Civil Engineering Support Agency, Contingency Support Division, Tyndall AFB, Florida 32403-5319, (904) 283-6410.

Responsibilities for response are clearly spelled out in the regulation *Interservice Responsibilities For Explosive Ordnance Disposal*.

5. Is Excavation of Contents Practical? The volume of landfill contents, types of wastes, hydrogeology, and safety must be considered when assessing the practicality of excavation and consolidation or treatment of wastes. Consideration of excavation must balance the long-term benefits of lower operation and maintenance costs and unrestricted land use with the initial high capital construction costs and potential risks associated with excavation. Although no set excavation volume limit exists, landfills with a content of more than 100,000 cubic yards (approximately two acres, 30 feet deep) would normally not be considered for excavation. If military wastes are present, especially high-hazard military wastes such as ordnance, safety considerations may be very important in determining the practicality of excavation.

If excavation of the landfill contents is being considered as an alternative, the presumptive remedy should not be used. Therefore, a standard RI/FS would be required to adequately analyze and select the appropriate remedial actions.

6. Can the Presumptive Remedy Be Used? The site manager will make the initial decision of whether a particular military landfill site is suitable for the presumptive remedy or whether a more comprehensive RI/FS is required. This determination must be made before the RI/FS is initiated. This decision will depend on whether the site is a potential candidate for excavation, and if not, whether the nature of contamination is such that a streamlined risk evaluation can be conducted.* A site generally is eligible for a streamlined risk evaluation if groundwater contaminant concentrations clearly exceed chemical-specific standards or the Agency's level of risk or if other conditions exist that provide a justification for action (e.g., direct contact with landfill contents due to unstable slopes). If these conditions do not exist, a quantitative risk assessment that addresses all exposure pathways will be necessary to determine whether action is needed. Before work on the RI/FS workplan is initiated, the community and state should be notified that a presumptive remedy is being considered for the site. It is important for all stakeholders to understand completely how the presumptive remedy process varies from the usual clean-up process, and the benefits of using the presumptive remedy process.

TREATING "HOT SPOTS"

The presumptive remedy also allows for the treatment of hot spots containing military-specific (or other) waste. While the analysis, *Feasibility Study Analysis for CERCLA Municipal Landfill Sites*, that justified the selection of source containment as the presumptive remedy for municipal landfill sites did not specifically take into account high-hazard military wastes, the high-hazard materials present in some military landfills may be compared to the hazardous wastes at municipal landfills and could potentially be treated as hot spots. For further information and case studies on treatment of hot spots, see the *Presumptive Remedy for CERCLA Municipal Landfill Sites* directive.

CASE HISTORIES

The case histories below illustrate how use of the municipal landfill presumptive remedy at military landfills follows the decision framework in Highlight 4.

* See *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions*, which states that if MCLs or non-zero MCLGs are exceeded [a response] action generally is warranted.

The decision to use the presumptive remedy can be made for one landfill or as a part of a site-wide strategy (as in the Loring Air Force Base example below), depending on factors such as the nature of the wastes, size of the landfill, land reuse potential, and public acceptance.

The following case histories present examples of where the containment presumptive remedy was or was not applied, based on site-specific conditions.

Disposal of Municipal-Type Wastes

The Naval Reactor Facility (NRF) site in Idaho Falls, Idaho, was established in 1949 as a testing site for the nuclear propulsion program. The three landfill units at the site received solid wastes similar to municipal landfills. These wastes included petroleum and paint products, construction debris, and cafeteria wastes. Historical records do not indicate that any radioactive wastes were disposed of in these landfill units. The selected remedy for the landfills at the site included the installation of a 24-inch native soil cover designed to incorporate erosion control measures to reduce the effects from rain and wind. The remedy also provided for maintenance of the landfill covers, including subsidence correction and erosion control. Monitoring of the landfills will include sampling of soil gas to assess the effectiveness of the cover and sampling of the groundwater to ensure that the remedy remains protective. Institutional controls will also be implemented to prevent direct exposure to the landfill. The NRF site is an example of where the streamlining principles of the presumptive remedy process, including a streamlined risk assessment and a focused feasibility study, were successfully employed.

Co-Disposal of High-Hazard Wastes

At the Massachusetts Military Reservation, in Cape Cod, Massachusetts, anecdotal information indicated that munitions had been disposed of at an unidentified location in a landfill that primarily contained municipal-type waste. Ground penetrating radar was utilized to determine if there were any discrete disposal areas containing potential hot spots at this site and found none. Because the munitions waste was not in a known discrete and accessible area, it could not be treated as a hot spot. Consequently, without excavating or treating the munitions waste as a hot spot, the authorities decided to cap the landfill. In this case, the streamlining principles of the presumptive remedy process were applied. For example, site investigation was limited and treatment options were not considered.

Land Reuse Considerations

At Loring Air Force Base, a closing base in Limestone, Maine, base landfills 2 and 3 (9 and 17 acres, respectively) consisted primarily of municipal and flightline wastes. The selected remedy for these landfills included a multi-layer cap, passive venting system, and institutional controls. The RODs for the landfills, signed in September 1994, required placing a RCRA Subtitle C cap on the landfills. To construct the RCRA cap, the designers estimated that 400,000 to 600,000 cyds of material would have to be placed on the landfills prior to construction of the cap to ensure proper drainage and slopes.

At Loring, the streamlining principles of the containment remedy, a focused feasibility study, and a streamlined risk assessment were applied for landfills 2 and 3. Additionally, the RODs signed for these landfills specified that excavated material from other parts of the base would be used at the landfills to meet subgrade design specifications. To date, more than 500,000 cyds of contaminated soils have been excavated and used as subgrade for the landfills (after demonstrating compliance with RCRA Land Disposal Restrictions). In addition to cost savings realized by providing subgrade, other benefits have been realized, such as limiting the number of parcels requiring deed restrictions and minimizing locations requiring operation and maintenance. At this base, the landfill consolidation efforts resulted in an estimated total cost savings of \$12-20 million while incorporating future land use considerations into the decision process.

The Brunswick Naval Air Station in Brunswick, Maine, contained several landfill sites. One of the first RODs signed, for Sites 1 and 3, called for construction of a 12-acre RCRA Subtitle C cap and a slurry wall, as well as for groundwater extraction and treatment. Subsequently, during the remedy selection process for Site 8, the public objected to containment as the proposed remedy for this relatively small (0.6 acre) site on the grounds that should the base eventually close, containment would create several useless parcels of land. After public comment, the Navy reconsidered, proposing instead to excavate Site 8 and consolidate the removed materials (which consisted of construction debris and soil contaminated with nonhazardous levels of polycyclic aromatic hydrocarbons) as part of the necessary subgrade fill for the landfill cap to be constructed at Sites 1 and 3. In this case, land reuse considerations preempted the selection of a containment remedy.

PRESUMPTIVE REMEDY ADMINISTRATIVE RECORD DOCUMENTATION REQUIREMENTS

As stated earlier, it must be determined whether the military landfill in question contains military-specific wastes, as described in Highlight 3. This should be followed by a determination of whether anything about these wastes would make the engineering controls specified in the presumptive remedy for municipal landfills less suitable at that site. These determinations must be documented in the administrative record, which supports the final decision. This information, in turn, will assist the public in understanding the evaluation of the site as a candidate for use of the presumptive remedy and the advantage it provides. For further reference, the administrative record requirements for all Superfund sites including military landfills are explained in the *Final Guidance on Administrative Records for Selecting CERCLA Response Actions*.

The administrative record must contain the following generic and site-specific information, which documents the selection or non-selection of the containment presumptive remedy.

Generic Information

- A. Generic Documents.** These documents should be placed in the docket for each federal facility site where the containment presumptive remedy is selected. Each EPA Regional Office has copies of the following presumptive remedy documents:
- *Presumptive Remedy: Policy and Procedures*
 - *Presumptive Remedy for CERCLA Municipal Landfill Sites*
 - *Application of the Municipal Landfill Presumptive Remedy to Military Landfills*
 - *Feasibility Study Analysis for CERCLA Municipal Landfill Sites*
- B. Notice Regarding Backup File.** The docket should include a notice specifying the location of and times when public access is available to the generic file of backup materials used in developing the *Feasibility Study Analysis for CERCLA Municipal Landfill Sites*. This file contains background materials such as technical references and portions of the feasibility studies used in the generic study. Each EPA Regional Office has a copy of this file.

Site-specific Information

Focused FS or EE/CA. Military-specific wastes need to be addressed in site-specific analyses when determining the applicability of the containment presumptive remedy to military landfills. High-hazard military-specific waste materials (e.g., military munitions) require special consideration when applying the presumptive remedy.

As noted on pages 1 and 2 of this directive, the presumptive remedy approach allows you to streamline and focus the FS or EE/CA by eliminating the technology screening step from the feasibility study process. EPA has already conducted this step on a generic basis in the *Feasibility Study Analysis for CERCLA Municipal Landfill Sites*. Thus, the FS analyzes only alternatives comprised of components of the containment remedy identified in Highlight 1. In addition, the focused FS or EE/CA should include a site-specific explanation of how the application of the presumptive remedy satisfies the National Contingency Plan's three site-specific remedy selection criteria (i.e., compliance with state applicable or relevant and appropriate requirements, state acceptance, and community acceptance).

CONCLUSION

This directive provides guidance for the use of the containment presumptive remedy at appropriate military landfills. The remedies selected at numerous military installations indicate that source containment is applicable to a significant number of military landfills. These landfills need not be identical to municipal landfills in all regards. Key factors determining whether the containment presumptive remedy should be applied to a specific military landfill include the size of the landfill; volume and the type of landfill contents; future land use of the area; and the presence, proportion, and distribution of military-specific wastes.

REFERENCES

California Base Closure Environmental Committee, *Integrating Land Use and Cleanup Planning at Closing Bases*, December 1994.

Federal Register, 1996. Volume 61, No. 85, May 1, 1996; *Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities, Advance Notice of Proposed Rulemaking*.

Federal Register, 1990. Volume 55, No. 145, July 27, 1990; 40 CFR Parts 264, 265, 270 and 271; *Corrective Action for Solid Waste Management Units at Hazardous Waste Facilities; Proposed (proposed Subpart S regulations)*.

U.S. Environmental Protection Agency, OSWER Directive 93557-04, *Land Use in the CERCLA Remedy Selection*, May 25, 1995.

U.S. Environmental Protection Agency, OSWER Directive 9356.0-03, EPA/540/R-94/081, *Feasibility Study Analysis for CERCLA Municipal Landfill Sites*, August 1994.

U.S. Environmental Protection Agency, OSWER Directive 9902.3-2A, EPA/520/R-94/004, *RCRA Corrective Action Plan*, May 1994.

U.S. Environmental Protection Agency, OSWER Directive 9355.0-49FS, *Presumptive Remedy for CERCLA Municipal Landfill Sites*, September 1993.

U.S. Environmental Protection Agency, OSWER Directive 9355.0-47FS, EPA/540/F-93/047, *Presumptive Remedy: Policy and Procedures*, September, 1993.

U.S. Environmental Protection Agency, OSWER Publication 9380.3-06FS, *Guide to Principal Threat and Low Level Threat Wastes*, November 1991.

U.S. Environmental Protection Agency, OSWER Directive 9355.0-30, *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions*, April 22, 1991.

U.S. Environmental Protection Agency, OERR, EPA/540/P-91/001, *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites*, February 1991.

U.S. Environmental Protection Agency, OSWER Directive 9833.3A.1, *Final Guidance on Administrative Records for Selecting CERCLA Response Actions*, December 3, 1990.

U.S. Environmental Protection Agency, OSWER Directive 9355.3-11FS, *Streamlining the RI/FS for CERCLA Municipal Landfill Sites*, September 1990.

U.S. Department of Navy, *Interservice Responsibilities for Explosive Ordnance Disposal* OPNAVINST 8027.1G (also known as MCO 8027.1D, AR 75-14; or AFR 32-3002), February 14, 1992.

NOTICE

The policies set out in this document are intended solely as guidance to the EPA personnel; they are not final EPA actions and do not constitute rulemaking. These policies are not intended, nor can they be relied upon, to create any rights enforceable by any party in litigation with the United States. EPA officials may decide to follow the guidance provided in this document, or to act at variance with the guidance, based on an analysis of specific site circumstances. EPA also reserves the right to change this guidance at any time without public notice.

DATA SUMMARY TABLE FOR MILITARY LANDFILLS APPENDIX

ROD / Site Name, State, Region, ROD Sign Date	Disposal Area, Size, Volume of Waste	Type of Waste Deposited	Contaminants of Concern	Remedy
Brunswick NAS, Sites 1 and 3 (OU1), ME, Region 1 6/16/92	Site 1, 8.5 acres; Site 3, 1.5 acres. Sites are in close proximity and not easily distinguishable; the combined volume of Sites 1 and 3 is 300,000 cy	Household refuse, waste oil, solvents, pesticides, paints, isopropyl alcohol	Metals, VOCs, PAHs, PCBs, pesticides	Remedy: Capping (permanent, low-permeability, RCRA Subtitle C cap), of 12 acres with a slurry wall and pump and treat ground water within cap and slurry wall.
Brunswick NAS, Sites 5 and 6 (OU3), ME, Region 1 8/31/93	Site 5, 0.25 acres, 12 cy	Asbestos-covered pipes	Asbestos	Remedy: Excavation, containerization, and transport to landfill Sites 1 and 3 for use as fill under cap.
Brunswick NAS, Sites 5 and 6 (OU3), ME, Region 1 8/31/93	Site 6, 1.0 acre, 8,800 - 18,700 cy	Construction debris, and aircraft parts, asbestos pipes	Asbestos	Remedy: Excavation, containerization, and transport to Sites 1 and 3 landfill for use as fill under cap.
Brunswick NAS, Site 8 (OU4), ME, Region 1 8/31/93	Site 8, 0.6 acres, 5,600 - 14,000 cy	Rubble, debris, trash, and possibly solvents	Metals, pesticides, PCBs ¹	Remedy: Excavation, containerization, and transport to landfill Sites 1 and 3 for use as fill under cap.
Loring AFB, Landfills 2 and 3 (OU2), ME, Region 1 9/30/94	Landfill 2, 9 acres	Domestic waste, construction debris, flightline wastes, sewage sludge and oil-filled switches	PCBs, VOCs, SVOCs, metals, DDT ¹	Remedy: Capping (low-permeability cover system which meets RCRA Subtitle C and Maine hazardous waste landfill cap requirements), passive gas venting system and controls, and institutional controls.
Loring AFB, Landfills 2 and 3 (OU2), ME, Region 1 9/30/94	Landfill 3, 17 acres	Waste oil/fuels, solvents, paints, thinners, and hydraulic fluids	VOCs, SVOCs, DDT, PCBs, metals ¹	Remedy: Capping (low-permeability cover system which meets RCRA Subtitle C and Maine hazardous waste landfill cap requirements), passive gas venting system and controls, and institutional controls.

¹ Contaminants of Potential Concern

DATA SUMMARY TABLE FOR MILITARY LANDFILLS APPENDIX (CONT.)

ROD / Site Name, State, Region, ROD Sign Date	Disposal Area, Size, Volume of Waste	Type of Waste Deposited	Contaminants of Concern	Remedy
Newport Naval Education and Training Center, McAllister Point Landfill, RI, Region 1 9/27/93	McAllister Point Landfill, 11.5 acres	Domestic refuse, spent acids, paints, solvents, waste oils, and PCB-contaminated transformer oil	VOCs, PAHs, PCBs, pesticides, phenols, metals	Remedy: Capping (RCRA Subtitle C, multi-layer cap), landfill gas management, surface controls, and institutional controls.
Otis Air National Guard, Camp Edwards, Massachusetts Military Reservation, MA, Region 1 1/14/93	Landfill Number 1 (LF-1), 100 acres	General refuse, fuel tank sludge, herbicides, blank ammunition, paints, paint thinners, batteries, DDT, hospital wastes, sewage sludge, coal ash, possibly live ordnance	VOCs, SVOCs, inorganics	Remedy: Capping (composite-low-permeability cover system), institutional controls, soil cover inspection, and ground water monitoring.
Pease AFB (OU1), NH, Region 1 9/27/93	LF-5, 23 acres	Domestic and Industrial wastes, waste oils and solvents, and industrial wastewater treatment plant sludge	VOCs, PAHs, arsenic and other metals	Remedy: Excavation, dewatering and consolidation and regrading of waste under a composite-barrier type cap, institutional controls, and extraction and treatment of ground water with discharge to base wastewater treatment facility.
Fort Dix Landfill Site, NJ, Region 2 9/24/91	Main area, 126 acres	Domestic waste, paints and paint thinners, demolition debris, ash, and solvents	VOCs, metals	Remedy: Capping 50-acre portion (New Jersey Administrative Code 7:26 closure plan for hazardous waste), installing gas venting system and an air monitoring system, ground water, surface water, and air monitoring, and institutional controls. Remedy: Source: No action.
Naval Air Engineering Center (OU3), NJ, Region 2 9/16/91	Site 26, 1500 sq. ft., volume not reported	Oil, roofing materials, building debris	No contamination was detected	Remedy: Source: No action.
Naval Air Engineering Center (OU3), NJ, Region 2 9/16/91	Site 27, 6.4 acres	Scrap steel cable	No contamination was detected	Remedy: Source: No action.

DATA SUMMARY TABLE FOR MILITARY LANDFILLS APPENDIX (CONT.)

ROD / Site Name, State, Region, ROD Sign Date	Disposal Area, Size, Volume of Waste	Type of Waste Deposited	Contaminants of Concern	Remedy
Naval Air Engineering Center (OU17), NJ, Region 2 9/26/94	Site 29, 20 acres	Construction debris, metal, asbestos, solvents, other miscellaneous wastes	VOCs, SVOCs, metals	Remedy: Source: No action.
Plattsburgh AFB, LF-022, NY, Region 2 9/30/92	LF-022, approx. 13.7 acres, approx. 524,000 cy	Household refuse	Metals, pesticides	Remedy: Capping (NY State requirements for solid waste landfills, 12 inch soil cap), and institutional controls.
Plattsburgh AFB, LF-023, NY, Region 2 9/30/92	LF-023, approx. 9 acres, approx. 406,000 cy	Household refuse, debris, car parts	Metals, VOCs, SVOCs, PCB, pesticides	Remedy: Capping (NY State requirements for solid waste landfills, low permeability cap), and institutional controls.
U.S. Army Aberdeen Proving Grounds (OU 1), MD, Region 3 6/30/92	Michaelsville Landfill, 20 acres, greater than 100,000 cy	Household refuse, limited quantities of industrial waste, burned sludges, pesticide containers, paint, asbestos shingles, solvents, waste motor oils, grease, PCB transformer oils, possible pesticides	Metals, pesticides, VOCs, PCBs, PAHs	Remedy: Capping (multi-layer cap in accordance with MDE requirements for sanitary landfills, using a geosynthetic membrane, 0-2 feet compacted earth material), surface water controls, and gas venting system.
Marine Corps Base, Camp Lejeune (OU1), NC, Region 4 9/15/94	Site 24, 100 acres, volume not reported	Fly ash, cinders, solvents, used paint stripping compounds, sewage sludge, spiractor sludge, construction debris	Pesticides, metals, SVOCs, PCBs	Remedy: Source: No action.
Robins AFB (OU1), GA, Region 4 6/25/91	Main area (Landfill No. 4), 45 acres, greater than 100,000 cy	Household refuse, industrial waste	VOCs, metals	Remedy: Capping (to maintain a minimum 2-foot cover over the waste materials), renovation of current soil cover including clearing, filling, regrading, adding soil and clay cover material and seeding to maintain a minimum 2-foot cover over the waste material.

DATA SUMMARY TABLE FOR MILITARY LANDFILLS APPENDIX (CONT.)

ROD / Site Name, State, Region, ROD Sign Date	Disposal Area, Size, Volume of Waste	Type of Waste Deposited	Contaminants of Concern	Remedy
Twin Cities AFB Reserve, MN, Region 5 3/31/92	Main area, approx. 2 acres, volume not reported	Household refuse, small amounts of industrial; some burned waste	VOCs, metals	Remedy: Source: Institutional controls, natural attenuation, ground water and surface water monitoring.
Wright-Patterson AFB, (Source Control Operable Unit) OH, Region 5 7/15/93	LF-8, 11 acres, 187,300 cy	General refuse and hazardous materials	PAHs, pesticides, PCBs, VOCs, metals, inorganics	Remedy: Capping (low-permeability clay cap that complies with Ohio EPA regulations for sanitary landfills which meet or exceed RCRA Subtitle D requirements), institutional controls, ground water treatment and monitoring.
Wright-Patterson AFB, (Source Control Operable Unit) OH, Region 5 7/15/93	LF-10, 8 acres, 171,600 cy	General refuse and hazardous materials	PAHs, pesticides, PCBs, VOCs, metals, inorganics	Remedy: Capping (low-permeability clay cap that complies with Ohio EPA regulations for sanitary landfills which meet or exceed RCRA Subtitle D requirements), institutional controls, ground water treatment and monitoring.
Hill AFB (OU4), UT, Region 8 6/14/94	Landfill 1, 3.5 acres, 140,000 cy	Burned solid waste, small amounts of waste oils and solvents (from vehicle maintenance facility).	VOCs (TCE)	Remedy: Capping (clay or multi-media cap), pumping, treating, and discharging ground water to POTW, treating contaminated surface water, soil vapor extraction, implementing institutional controls and access restrictions.
Defense Depot, Ogden (OU1), UT, Region 8 6/26/92	Plain City Canal Backfill Area, 4,000 cy	Electrical wire, glass, ash, charcoal, asphalt, wood, concrete, plastic and metal fragments	Metals, PCBs, dioxins, furans, VOCs	Remedy: Excavation, sorting, and off-site disposal in a RCRA permitted facility.
Defense Depot, Ogden (OU3), UT, Region 8 9/28/92	Burial Site 3-A: Chemical Warfare Agent Identification Kit Burial Area, 100 cy	Vials of chemical surety agents, broken glass	Metals, chemical warfare agents	Remedy: Excavation, sorting, and off-site disposal in a RCRA permitted facility.
Defense Depot, Ogden (OU3), UT, Region 8 9/28/92	Burial Site 3-A: Riot Control and Smoke Grenade Burial Area, 90 cy	Unfused grenades and grenade fragments, as well as riot control grenades	No contaminants identified	Remedy: Excavation, sorting, and off-site disposal in a RCRA permitted facility.

DATA SUMMARY TABLE FOR MILITARY LANDFILLS APPENDIX (CONT.)

ROD / Site Name, State, Region, ROD Sign Date	Disposal Area, Size, Volume of Waste	Type of Waste Deposited	Contaminants of Concern	Remedy
9/28/92 Defense Depot, Ogden (OU3), UT, Region 8	Burial Site 3-A: Compressed Gas Cylinder Reburial Area	Two compressed gas cylinders and four smaller steel tanks removed from the Chemical Warfare Agent Identification Kit and Riot Control and Smoke Grenade burial areas	Unknown, possible chemical warfare agents	Remedy: Excavation of compressed gas cylinders and disposal by a commercial operator.
9/28/92 Defense Depot, Ogden (OU3), UT, Region 8	Burial Site 3-A: Miscellaneous Items Burial Area, 230 cy	Chemical Warfare Agent Identification Kits containing no CWAs, World War II gas mask canisters, paint, broken glass, wooden boxes, and pieces of iron	No contaminants identified	Remedy: Excavation and transportation for off-site disposal in a RCRA permitted hazardous waste landfill.
9/28/92 Defense Depot, Ogden (OU3), UT, Region 8	Water Purification Tablet Burial Area, 110 cy	Bottles containing halazone water purification tablets	No contaminants identified	Remedy: Excavation and transportation for off-site disposal in a RCRA permitted industrial waste landfill.
9/28/92 Defense Depot, Ogden (OU4), UT, Region 8	4-A, 7500, sq. ft., 3000 cy	Wood, crating materials, paper, greases, debris, medical waste, oils, some burned waste	Pesticides, VOCs, PCBs	Remedy: Excavation and transportation for off-site disposal in a RCRA permitted hazardous waste landfill.
9/28/92 Defense Depot, Ogden (OU4), UT, Region 8	4-B, (inside 4-E), less than 7,500, sq. ft.	Fluorescent tubes	No contaminants identified	Remedy: Excavation and transportation for off-site disposal in a RCRA permitted landfill.
9/28/92 Defense Depot, Ogden (OU4), UT, Region 8	4-C, 6,000 sq. ft.	Food products, sanitary landfill waste	Pesticides, VOCs, PCBs	Remedy: Excavation and transportation for off-site disposal in a RCRA permitted landfill.

DATA SUMMARY TABLE FOR MILITARY LANDFILLS APPENDIX (CONT.)

ROD / Site Name, State, Region, ROD Sign Date	Disposal Area, Size, Volume of Waste	Type of Waste Deposited	Contaminants of Concern	Remedy
Defense Depot, Ogden (OU4), UT, Region 8 9/28/92	4-D, 2,000 sq. ft.	Methyl bromide cylinders, halazone tablets (jars)	Possibly methyl bromide	Remedy: Excavation and transportation for off-site disposal in a RCRA permitted industrial landfill.
Defense Depot, Ogden (OU4), UT, Region 8 9/28/92	4-E, 7,500 sq. ft., volume not reported	Oils, spent solvents, industrial waste	PCBs, VOCs, pesticides	Remedy: Excavation and transportation for off-site disposal in a RCRA permitted hazardous landfill.
Rocky Mountain Arsenal, Shell Section 36 Trenches (OU23), CO, Region 8 5/3/90	Shell Trench Area, 8 acres	Rags, plastic and metal cans, glass jars, piping, pipe fittings, insulation, refuse, insulation, liquid and solid wastes generated from the manufacture of pesticides	VOCs, SVOCs, pesticides ²	Remedy: Capping (physical barrier with a soil and vegetative cover).
Fort Ord Landfills (OU2), CA, Region 9	Landfills, 150 acres	Household and commercial refuse, dried sewage sludge, construction debris, small amounts of chemical waste including paint, oil, pesticides, and epoxy adhesive, electrical equipment	VOCs	Remedy: Capping (California Code of Regulations for non-hazardous waste), institutional controls, extraction, treatment, and recharge of ground water.
Riverbank Army Ammunition Plant Site, CA, Region 9 3/24/94	Landfill, 4.5 acres	Paper, oils, greases, solvents, hospital wastes, construction debris, and industrial sludges	Metals	Remedy: Capping (a multi-layer cap as specified in Dispute Resolution Agreement), pump and treat ground water, discharge treated water to on-site ponds.

² Contaminants identified as emanating from the trenches but not contaminants of concern

DATA SUMMARY TABLE FOR MILITARY LANDFILLS APPENDIX (CONT.)

ROD / Site Name, State, Region, ROD Sign Date	Disposal Area, Size, Volume of Waste	Type of Waste Deposited	Contaminants of Concern	Remedy
Williams AFB (OU1), AZ, Region 9 5/18/94	Landfill LF-04, 90 acres, 59,000 cy	Dried sewage sludge, domestic trash and garbage, wood, metal, brush, construction debris, some solvents and chemicals	Soil, pesticides, SVOCs, inorganics, including beryllium, lead, zinc	Remedy: Capping (a permeable cap with a 24 inch soil cover), stormwater runoff controls, institutional actions, and soil and ground water monitoring.
Williams AFB (OU1), AZ, Region 9 5/18/94	Pesticide Burial Area (DP-13), 0.4 acre	Pesticides	Pesticides, VOCs, metals	Remedy: Source: No action.
Williams AFB (OU1), AZ, Region 9 5/18/94	Radioactive Instrumentation Burial Area (RW-11), 100 sq. ft.	Cement; radioactive instruments	Radium (background levels)	Remedy: Source: No action.
Elmendorf AFB (OU1), AK, Region 10 9/29/94	LF05, 17 acres	General refuse, scrap metal, used chemicals and other scrap material	VOCs, PCBs, metals, PAHs	Remedy: Source: No action.
Elmendorf AFB (OU1), AK, Region 10 9/29/94	LF07, 35 acres	Base generated refuse, scrap metal, construction rubble, drums of asphalt, empty pesticide containers, small amounts of shop wastes, and asbestos wastes	VOCs, PCBs, metals, PAHs	Remedy: Source: No action.
Elmendorf AFB (OU1), AK, Region 10 9/29/94	LF13, 2 acres	Empty drums, metal piping, drums of asphalt, and small quantities of quicklime	VOCs, PCBs, metals, PAHs	Remedy: Source: No action.

DATA SUMMARY TABLE FOR MILITARY LANDFILLS APPENDIX (CONT.)

ROD / Site Name, State, Region, ROD Sign Date	Disposal Area, Size, Volume of Waste	Type of Waste Deposited	Contaminants of Concern	Remedy
<p>9/29/94</p> <p>Fairchild AFB (OU1), WA, Region 10</p>	<p>LF59, 2 landfills (.5 acres each)</p>	<p>General refuse and construction debris, and tar seep</p>	<p>VOCs, PCBs, metals, PAHs</p>	<p>Remedy: Source: No action.</p>
<p>2/13/93</p> <p>Fairchild AFB (OU1), WA, Region 10</p>	<p>Southwest area, 12.6 acres, 407,300 cy</p>	<p>Coal ash, solvents, dry cleaning filters, paints, thinners, possibly electrical transformers.</p>	<p>VOCs</p>	<p>Remedy: Capping (low-permeability cap designed to meet the closure requirements of Washington State's Minimum Functional Standards for Solid Waste handling and of federal RCRA Subtitle D), SVE/ treatment system, extracting contaminated ground water and treating by air stripping and granular activated carbon, disposal off-site, monitoring off-site water supply wells.</p>
<p>2/13/93</p> <p>Fairchild AFB (OU1), WA, Region 10</p>	<p>Northeast area, 6 acres, 291,000 cy</p>	<p>Coal ash, solvents, dry cleaning filters, paints, thinners, possibly electrical transformers.</p>	<p>VOCs</p>	<p>Remedy: Capping (low-permeability cap designed to meet the closure requirements of Washington State's Minimum Functional Standards for Solid Waste handling and of federal RCRA Subtitle D), SVE/ treatment system, extracting contaminated ground water and treating by air stripping and granular activated carbon, disposal off-site, monitoring off-site water supply wells.</p>
<p>2/13/93</p> <p>Fort Lewis Military Reservation, Landfill 4 and the Solvent Refined Coal Pilot Plant, WA, Region 10</p>	<p>LF4, 52 acres</p>	<p>Domestic and light industrial solid waste (no landfill records were maintained).</p>	<p>VOCs, metals</p>	<p>Remedy: Source: Institutional controls, treat ground water and soil using SVE and air sparging system.</p>
<p>9/24/93</p> <p>Naval Air Station, Whidbey Island, Ault Field (OU1), WA, Region 10</p>	<p>Area 6 Landfill, 40 acres. Within Area 6 there are 2 distinct areas where wastes were disposed.</p>	<p>Household waste, construction debris, and yard waste</p>	<p>VOCs</p>	<p>Remedy: Capping (low-permeability cap to meet Washington State Minimum Functional Standards for non-hazardous closure), air stripping ground water, ground water monitoring, and institutional controls.</p>
<p>12/20/93</p> <p>Naval Air Station, Whidbey Island, Ault Field (OU2), WA, Region 10</p>	<p>Area 2, 13 acres; Area 3, 1.5 acres. Both treated together due to close proximity.</p>	<p>Solid waste from the base, industrial wastes, and construction and demolition debris</p>	<p>Metals, PAHs</p>	<p>Remedy: Source: Institutional controls, ground water monitoring.</p>

DATA SUMMARY TABLE FOR MILITARY LANDFILLS APPENDIX (CONT.)

ROD / Site Name, State, Region, ROD Sign Date	Disposal Area, Size, Volume of Waste	Type of Waste Deposited	Contaminants of Concern	Remedy
Naval Reactor Facility, ID, Region 10 9/27/94	Landfill Unit 8-05-1, (350 ft. by 450 ft. by 4-25 ft.)	Construction debris, small quantities of paints, solvents, cafeteria wastes, and petroleum products	Metals, VOCs	Remedy: Capping (24-inch native soil cover), institutional controls.
Naval Reactor Facility, ID, Region 10 9/27/94	Landfill Unit 8-05-51, (450 ft. by 100 -175 ft. by 10-15 ft.)	Construction debris, small quantities of paints, solvents, cafeteria wastes, and petroleum products	Metals, VOCs	Remedy: Capping (24-inch native soil cover), institutional controls.
Naval Reactor Facility, ID, Region 10 9/27/94	Landfill Unit 8-06-53, (900 ft. by 1200 ft. by 7- 10 ft.)	Construction debris, small quantities of paints, solvents, cafeteria wastes, and petroleum products	Metals, VOCs	Remedy: Capping (24-inch native soil cover), institutional controls.



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Presumptive Remedy for CERCLA Municipal Landfill Sites

Office of Emergency and Remedial Response
Hazardous Site Control Division 5203G

Quick Reference Fact Sheet

Since Superfund's inception in 1980, the remedial and removal programs have found that certain categories of sites have similar characteristics, such as types of contaminants present, types of disposal practices, or how environmental media are affected. Based on information acquired from evaluating and cleaning up these sites, the Superfund program is undertaking an initiative to develop presumptive remedies to accelerate future cleanups at these types of sites. The presumptive remedy approach is one tool of acceleration within the **Superfund Accelerated Cleanup Model (SACM)**.

Presumptive remedies are preferred technologies for common categories of sites, based on historical patterns of remedy selection and EPA's scientific and engineering evaluation of performance data on technology implementation. The objective of the presumptive remedies initiative is to use the program's past experience to streamline site investigation and speed up selection of cleanup actions. Over time presumptive remedies are expected to ensure consistency in remedy selection and reduce the cost and time required to clean up similar types of sites. Presumptive remedies are expected to be used at all appropriate sites except under unusual site-specific circumstances.

This directive establishes **containment** as the presumptive remedy for CERCLA municipal landfills. The framework for the presumptive remedy for these sites is presented in a streamlining manual entitled *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites*, February 1991 (OSWER Directive 9355. 3-11). This directive highlights and emphasizes the importance of certain streamlining principles related to the scoping (planning) stages of the remedial investigation/feasibility study (RI/FS) that were identified in the manual. The directive also provides clarification of and additional guidance in the following areas: (1) the level of detail appropriate for risk assessment of source areas at municipal landfills and (2) the characterization of hot spots.

BACKGROUND

Superfund has conducted pilot projects at four municipal landfill sites¹ on the National Priorities List (NPL) to evaluate the effectiveness of the manual *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites* (hereafter referred to as "the manual") as a streamlining tool and as the framework for the municipal landfill presumptive remedy. Consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (or NCP), EPA's expectation was that containment technologies generally would be appropriate for municipal landfill waste because the volume and heterogeneity of the waste generally make treatment impracticable. The results of the pilots support this expectation and demonstrate that the manual is an effective tool for streamlining the RI/FS process for municipal landfills.

¹Municipal landfill sites typically contain a combination of principally municipal and to a lesser extent hazardous wastes.

Since the manual's development, the expectation to contain wastes at municipal landfills has evolved into a presumptive remedy for these sites.² Implementation of the streamlining principles outlined in the manual at the four pilot sites helped to highlight issues requiring further clarification, such as the degree to which risk assessments can be streamlined for source areas and the characterization and remediation of hot spots. The pilots also demonstrated the value of focusing streamlining efforts at the scoping stage, recognizing that the biggest savings in time and money can be realized if streamlining is incorporated at the beginning of the RI/FS process. Accordingly, this directive addresses those issues identified during the pilots and highlights streamlining opportunities to be considered during the scoping component of the RI/FS.

²See EPA Publication 9203.1-02I, SACM Bulletins, *Presumptive Remedies for Municipal Landfill Sites*, April 1992, Vol. 1, No. 1, and February 1993, Vol. 2, No. 1, and SACM Bulletin *Presumptive Remedies*, August 1992, Vol. 1, No. 3.

Finally, while the primary focus of the municipal landfill manual is on streamlining the RI/FS, Superfund's goal under SACM is to accelerate the entire clean-up process. Other guidance issued under the municipal landfill presumptive remedy initiative identifies design data that may be collected during the RI/FS to streamline the overall response process for these sites (see Publication No. 9355.3-18FS, *Presumptive Remedies: CERCLA Landfill Caps Data Collection Guide*, to be published in October 1993).

CONTAINMENT AS A PRESUMPTIVE REMEDY

Section 300.430(a)(iii)(B) of the NCP contains the expectation that engineering controls, such as containment, will be used for waste that poses a relatively low long-term threat where treatment is impracticable. The preamble to the NCP identifies municipal landfills as a type of site where treatment of the waste may be impracticable because of the size and heterogeneity of the contents (55 FR 8704). Waste in CERCLA landfills usually is present in large volumes and is a heterogeneous mixture of municipal waste frequently co-disposed with industrial and/or hazardous waste. Because treatment usually is impracticable, EPA generally considers containment to be the appropriate response action, or the "presumptive remedy," for the source areas of municipal landfill sites.

The presumptive remedy for CERCLA municipal landfill sites relates primarily to containment of the landfill mass and collection and/or treatment of landfill gas. In addition, measures to control landfill leachate, affected ground water at the perimeter of the landfill, and/or upgradient ground-water that is causing saturation of the landfill mass may be implemented as part of the presumptive remedy.

The presumptive remedy does not address exposure pathways outside the source area (landfill), nor does it include the long-term ground-water response action. Additional RI/FS activities, including a risk assessment, will need to be performed, as appropriate, to address those exposure pathways outside the source area. It is expected that RI/FS activities addressing exposure pathways outside the source generally will be reconducted concurrently with the streamlined RI/FS for the landfill source presumptive remedy. A response action for exposure pathways outside the source (if any) may be selected together with the presumptive remedy (thereby developing a comprehensive site response), or as an operable unit separate from the presumptive remedy.

Highlight 1 identifies the components of the presumptive remedy. Response actions selected for individual sites will include only those components that are necessary, based on site-specific conditions.

Highlight 1: Components of the Presumptive Remedy: Source Containment

- Landfill cap;
- Source area ground-water control to contain plume;
- Leachate collection and treatment;
- Landfill gas collection and treatment; and/or
- Institutional controls to supplement engineering controls.

The EPA (or State) site manager will make the initial decision of whether a particular municipal landfill site is suitable for the presumptive remedy or whether a more comprehensive RI/FS is required. Generally, this determination will depend on whether the site is suitable for a streamlined risk evaluation, as described on page 4. The community, state, and potentially responsible parties (PRPs) should be notified that a presumptive remedy is being considered for the site before work on the RI/FS work plan is initiated. The notification may take the form of a fact sheet, a notice in a local newspaper, and/or a public meeting.

Use of the presumptive remedy eliminates the need for the initial identification and screening of alternatives during the feasibility study (FS). Section 300.430(e)(1) of the NCP states that, "... the lead agency shall include art alternatives screening step, when needed, (emphasis added) to select a reasonable number of alternatives for detailed analysis."

EPA conducted an analysis of potentially available technologies for municipal landfills and found that certain technologies are routinely and appropriately screened out on the basis of effectiveness, feasibility, or cost (NCP Section 300.430(e)(7)). (See Appendix A to this directive and "Feasibility Study Analysis for CERCLA Municipal Landfills," September 1993 available at EPA Headquarters and Regional Offices.) Based on this analysis, the universe of alternatives that will be analyzed in detail may be limited to the components of the containment remedy identified in Highlight 1, unless site-specific conditions dictate otherwise or alternatives are considered that were not addressed in the FS analysis. The FS analysis document, together with this directive, must be included in the administrative record for each municipal landfill presumptive remedy site to support elimination of the initial identification and screening of site-specific alternatives. Further detailed and comprehensive

supporting materials (e.g., FS reports included in analysis, technical reports) can be provided by Headquarters, as needed.

While the universe of alternatives to address the landfill source will be limited to those components identified in Highlight 1, potential alternatives that may exist for each component or combinations of components may be evaluated in the detailed analysis. For example, one component of the presumptive remedy is source area ground-water control. If appropriate, this component may be accomplished in a number of ways, including pump and treat, slurry walls, etc. These potential alternatives may then be combined with other components of the presumptive remedy to develop a range of containment alternatives suitable for site-specific conditions. Response alternatives must then be evaluated in detail against the nine criteria identified in Section 300.430(e)(g) of the NCP. The detailed analysis will identify site-specific ARARs and develop costs on the basis of the particular size and volume of the landfill.

EARLY ACTION AT MUNICIPAL LANDFILLS

EPA has identified the presumptive remedy site categories as good candidates for early action under SACM. At municipal landfills, the upfront knowledge that the source area will be contained may facilitate such early actions as installation of a landfill cap or a ground-water containment system. Depending on the circumstances, early actions may be accomplished using either removal authority (e.g., non-time-critical removal actions) or remedial authority. In some cases, it may be appropriate for an Engineering Evaluation/Cost Analysis to replace part or all of the RI/FS if the source control component will be a non-time-critical removal action. Some factors may affect whether a specific response action would be better accomplished as a removal or remedial action including the size of the action, the associated state cost share, and/or the scope of O&M. A discussion of these factors is contained in *Early Action and Long-term Action Under SACM - Interim Guidance*, Publication No. 9203.1-05I, December 1992.

SCOPING A STREAMLINED RI/FS UNDER THE PRESUMPTIVE REMEDY FRAMEWORK

The goal of an RI/FS is to provide the information necessary to: (1) adequately characterize the site; (2) define site dynamics; (3) define risks; and (4) develop the response action. As discussed in the following sections, the process for achieving each of these goals can be streamlined for CERCLA municipal landfill sites because of the upfront presumption that landfill contents will be contained. The strategy for streamlining each of these

areas should be developed early (i.e., during the scoping phase of the RI/FS).

1. Characterizing the Site

The use of existing data is especially important in conducting a streamlined RI/FS for municipal landfills. Characterization of a landfill's contents is not necessary or appropriate for selecting a response action for these sites except in limited cases; rather, existing data are used to determine whether the containment presumption is appropriate. Subsequent sampling efforts should focus on characterizing areas where contaminant migration is suspected, such as leachate discharge areas or areas where surface water runoff has caused erosion. It is important to note that the decision to characterize hot spots should also be based on existing information, such as reliable anecdotal information, documentation, and/or physical evidence (see page 6).

In those limited cases where no information is available for a site, it may not be advisable to initiate use of the presumptive remedy until some data are collected. For example, if there is extensive migration of contaminants from a site located in an area with several sources, it will be necessary to have some information about the landfill source in order to make an association between on-site and off-site contamination.

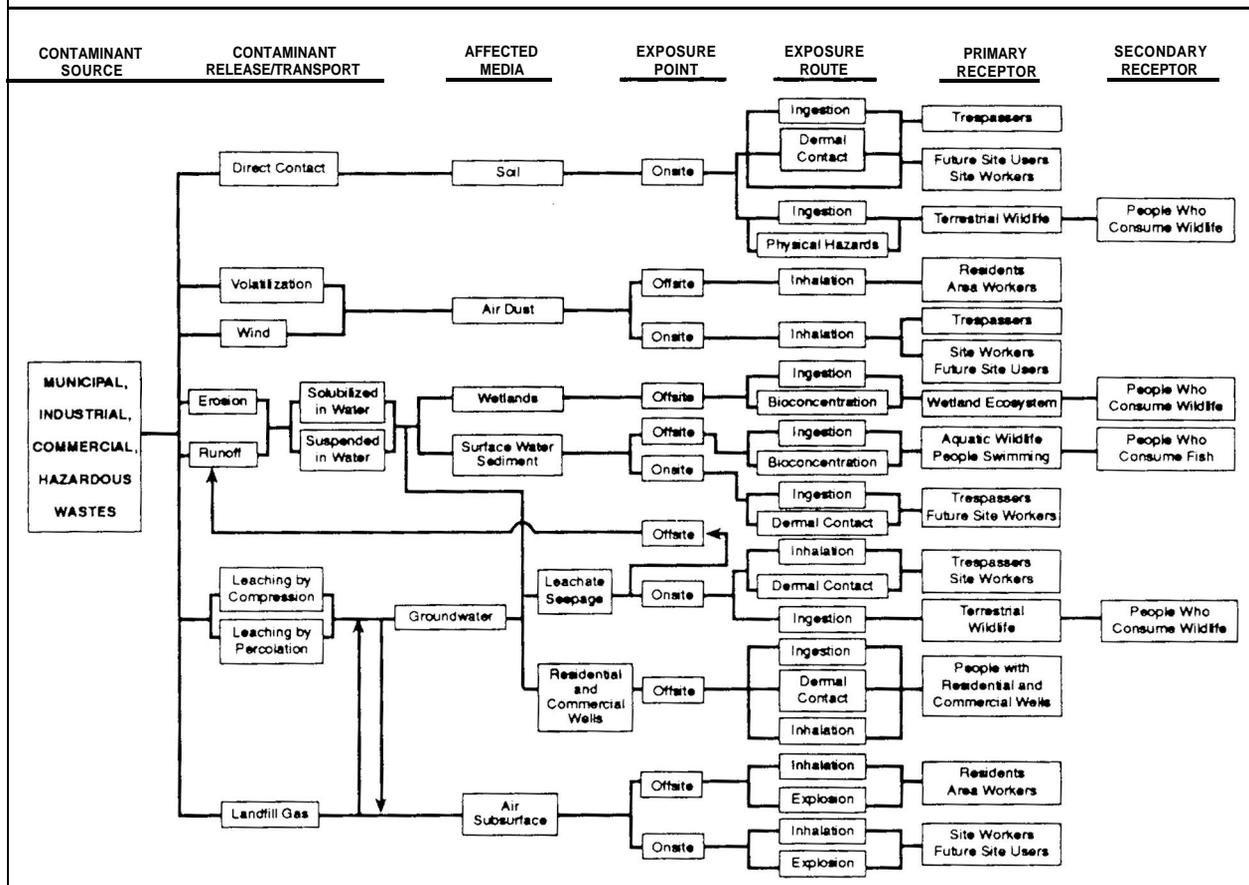
Sources of information of particular interest during scoping include records of previous ownership, state files, closure plans, etc., which may help to determine types and sources of hazardous materials present. In addition, a site visit is appropriate for several reasons, including the verification of existing data, the identification of existing site remediation systems, and to visually characterize wastes (e.g., leachate seeps). Specific information to be collected is provided in Sections 2.1 through 2.4 of the municipal landfill manual.

2. Defining Site Dynamics

The collected data are used to develop a conceptual site model, which is the key component of a streamlined RI/FS. The conceptual site model is an effective tool for defining the site dynamics, streamlining the risk evaluation, and developing the response action. Highlight 2 presents a generic conceptual site model for municipal landfill. The model is developed before any RI field activities are conducted, and its purpose is to aid in understanding and describing the site and to present hypotheses regarding:

- The suspected sources and types of contaminants present;
- Contaminant release and transport mechanisms;

Highlight 2: Generic Conceptual Site Model



- Rate of contaminant release and transport (where possible);
- Affected media;
- Known and potential routes of migration; and
- Known and potential human and environmental receptors.

After the data are evaluated and a site visit is completed, the contaminant release and transport mechanisms relevant to the site should be determined. The key element in developing the conceptual site model is to identify those aspects of the model that require more information to make a decision about response measures. Because containment of the landfill's contents is the presumed response action, the conceptual site model will be of most use in identifying areas beyond the landfill source itself that will require further study, thereby focusing site characterization away from the source area and on areas of potential contaminant migration (e.g., ground water or contaminated sediments).

3. Defining Risks

The municipal landfill manual states that a streamlined or limited baseline risk assessment will be sufficient to initiate response action on the most obvious problems at a municipal landfill (e.g., ground water, leachate, landfill contents, and landfill gas). One method for establishing risk using a streamlined approach is to compare contaminant concentration levels (if available) to standards that are potential chemical-specific applicable or relevant and appropriate requirements (ARARs) for the action. The manual states that where established standards for one or more contaminants in a given medium are clearly exceeded, remedial action generally is warranted.³

It is important to note, however, that based on site-specific conditions, an active response is not required if ground-water contaminant concentrations exceed chemical-specific standards but the site risk is within the Agency's acceptable risk range (10^{-4} to 10^{-6}). For example, if it is determined that the release of

³See also OSWER Directive 9355.0-30, *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions*, April 22, 1991, which states that if MCLs or non-zero MCLGs are exceeded, [a response] action generally is warranted.

contaminants from a particular landfill is declining, and concentrations of one or more ground-water contaminants are at or barely exceed chemical-specific standards, the Agency may decide not to implement an active response. Such a decision might be based on the understanding that the landfill is no longer acting as a source of ground-water contamination, and that the landfill does not present an unacceptable risk from any other exposure pathway.

A site generally will not be eligible for a streamlined risk evaluation if ground-water contaminant concentrations do not clearly exceed chemical-specific standards or the Agency's accepted level of risk, or other conditions do not exist that provide a clear justification for action (e.g., direct contact with landfill contents resulting from unstable slopes). Under these circumstances, a quantitative risk assessment that addresses all exposure pathways will be necessary to determine whether action is needed.

Ultimately, it is necessary to demonstrate that the final remedy addresses all pathways and contaminants of concern, not just those that triggered the remedial action. As described in the following sections, the conceptual site model is an effective tool for identifying those pathways and illustrating that they have been addressed by the containment remedy.

Streamlined Risk Evaluation Of The Landfill Source

Experience from the presumptive remedy pilots supports the usefulness of a streamlined risk evaluation to initiate an early response action under certain circumstances. As a matter of policy, for the source area of municipal landfills, a quantitative risk assessment that considers all chemicals, their potential additive effects, etc., is not necessary to establish a basis for action if ground-water data are available to demonstrate that contaminants clearly exceed established standards or if other conditions exist that provide a clear justification for action.

A quantitative risk assessment also is not necessary to evaluate whether the containment remedy addresses all pathways and contaminants of concern associated with the source. Rather, all potential exposure pathways can be identified using the conceptual site model and compared to the pathways addressed by the containment presumptive remedy. Highlight 3 illustrates that the containment remedy addresses all exposure pathways associated with the source at municipal landfill sites.

Finally, a quantitative risk assessment is not required to determine clean-up levels because the type of cap will be determined by closure ARARs, and ground water that is extracted as a component of the presumptive remedy will be required to meet discharge limits, or other standards for its disposal. Calculation of clean-up levels for ground-water contamination that has migrated away from the source will not be accomplished under the presumptive

Highlight 3: Source Contaminant Exposure Pathways Addressed by Presumptive Remedy

1. Direct contact with soil and/or debris prevented by landfill cap;
2. Exposure to contaminated ground water within the landfill area prevented by ground-water control;
3. Exposure to contaminated leachate prevented by leachate collection and treatment; and
4. Exposure to landfill gas addressed by gas collection and treatment, as appropriate.

remedy, since such contamination will require a conventional investigation and a risk assessment.

Streamlining the risk assessment of the source area eliminates the need for sampling and analysis to support the calculation of current or potential future risk associated with direct contact. It is important to note that because the continued effectiveness of the containment remedy depends on the integrity of the containment system, it is likely that institutional controls will be necessary to restrict future activities at a CERCLA municipal landfill after construction of the cap and associated systems. EPA has thus determined that it is not appropriate or necessary to estimate the risk associated with future residential use of the landfill source, as such use would be incompatible with the need to maintain the integrity of the containment system. (Long-term waste management areas, such as municipal landfills, may be appropriate, however, for recreational or other limited uses on a site-specific basis.) The availability and efficacy of institutional controls should be evaluated in the FS. Decision documents should include measures such as institutional controls to ensure the continued integrity of such containment systems whenever possible.

Areas of Contaminant Migration

Almost every municipal landfill site has some characteristic that may require additional study, such as leachate discharge to a wetland or significant surface water run-off caused by drainage problems. These migration pathways, as well as ground-water contamination that has migrated away from the source, generally will require characterization and a more comprehensive risk assessment to determine whether action is warranted beyond the source area and, if so, the type of action that is appropriate.

While future residential use of the landfill source area itself is not considered appropriate, the land adjacent to

landfills is frequently used for residential purposes. Therefore, based on site-specific circumstances, it may be appropriate to consider future residential use for ground water and other exposure pathways when assessing risk from areas of **contaminant migration**.

4. Developing the Response Action

As a first step in developing containment alternatives, response action objectives should be developed on the basis of the pathways identified for action in the conceptual site model. Typically, the primary response action objectives for municipal landfill sites include:

Presumptive Remedy

- Preventing direct contact with landfill contents;
- Minimizing infiltration and resulting contaminant leaching to ground water;
- Controlling surface water runoff and erosion;
- Collecting and treating contaminated ground water and leachate to contain the contaminant plume and prevent further migration from source area; and
- Controlling and treating landfill gas.

Non-Presumptive Remedy

- Remediating ground water;
- Remediating contaminated surface water and sediments; and
- Remediating contaminated wetland areas.

As discussed in Section 3, “Defining Risks,” the containment presumptive remedy accomplishes all but the last three of these objectives by addressing all pathways associated with the source. Therefore, the focus of the RI/FS can be shifted to characterizing the media addressed in the last three objectives (contaminated ground water, surface water and sediments, and wetland areas) and on collecting data to support design of the containment remedy.

Treatment of Hot Spots

The decision to characterize and/or treat hot spots is a site-specific judgement that should be based on the consideration of a standard set of factors. Highlight 4 lists questions that should be answered before making

the decision to characterize and/or treat hot spots. The overriding question is whether the combination of the waste’s physical and chemical characteristics and volume is such that the integrity of the new containment system will be threatened if the waste is left in place. This question should be answered on the basis of what is known about a site (e.g., from operating records or other reliable information). An answer in the affirmative to all of the questions listed in Highlight 4 would indicate that it is likely that the integrity of the containment system would be threatened, or that excavation and treatment of hot spots would be practicable, and that a significant reduction in risk at the site would occur as a result of treating hot spots. EPA expects that few CERCLA municipal landfills will fall into this category; rather, based on the Agency’s experience, the majority of sites are expected to be suitable for containment only, based on the heterogeneity of the waste, the lack of reliable information concerning disposal history, and the problems associated with excavating through refuse.

The volume of industrial and/or hazardous waste co-disposed with municipal waste at CERCLA municipal landfills varies from site to site, as does the amount of information available concerning disposal history. It is impossible to fully characterize, excavate, and/or treat the source area of municipal landfills, so uncertainty about the landfill contents is expected. Uncertainty by itself does not call into question the containment approach. However, containment remedies must be designed to take into account the possibility that hot spots are present in addition to those that have been identified and characterized. The presumptive remedy must be relied upon to contain landfill contents and prevent migration of contaminants. This is accomplished by a combination of measures, such as a landfill cap combined with a leachate collection system. Monitoring will further ensure the continued effectiveness of the remedy.

The following examples illustrate site-specific decision making and show how these factors affect the decision whether to characterize and/or treat hot spots.

Examples of Site-Specific Decision Making Concerning Hot Spot Characterization/Treatment

Site A

There is anecdotal information that approximately 200 drums of hazardous waste were disposed of at this 70-acre former municipal landfill, but their location and contents are unknown. The remedy includes a landfill cap and ground-water and landfill gas treatment.

A search for and characterization of hot spots is not supported at Site A based on the questions listed in

Highlight 4: Characterization of Hot Spots

If all of the following questions can be answered in the affirmative, it is likely that characterization and/or treatment of hot spots is warranted:

1. Does evidence exist to indicate the presence and approximate location of waste?
2. Is the hot spot known to be principal threat waste?*
3. Is the waste in a discrete, accessible part of the landfill?
4. Is the hot spot known to be large enough that its remediation will reduce the threat posed by the overall site but small enough that it is reasonable to consider removal (e.g., 100,000 cubic yards or less)?

*See *A Guide to Principal Threat and Low Level Threat Wastes*, November 1991, Superfund Publication No. 9380.3-06FS.

Highlight 4: (1) no reliable information exists to indicate the location of the waste; (2) the determination of whether the waste is principal threat waste cannot be made since the physical/chemical characteristics of the wastes are unknown; (3) since the location of the waste is unknown, the determination of whether the waste is in a discrete accessible location cannot be made; (4) in this case, the presence of 200 drums in a 70-acre landfill is not considered to significantly affect the threat posed by the overall site. Rather, the containment system will include measures to ensure its continued effectiveness (e.g., monitoring and/or leachate collection) given the uncertainty associated with the landfill contents and suspected drums.

Site B

Approximately 35,000 drums, many containing hazardous wastes, were disposed of in two drum disposal units at this privately owned 80-acre inactive landfill, which was licensed to receive general refuse. The site is divided into two operable units. The remedy for Operable Unit 1 (OU 1) is incineration of drummed wastes in the two drum disposal units. The remedy for OU 2 consists of treatment of contaminated ground water and leachate and containment of treatment residuals (from OU 1) and

remaining landfill contents, including passive gas collection and flaring.

Treatment of landfill contents is supported at Site B because all of the questions in Highlight 4 can be answered in the affirmative: (1) existing evidence from previous investigations and sampling conducted by the state (prior to the RI) indicated the presence and approximate location of wastes; (2) the wastes were considered principal threat wastes because they were liquids and (based on sampling) were believed to contain contaminants of concern; (3) the waste is located in discrete accessible parts of the landfill; and (4) the waste volume is large enough that its remediation will significantly reduce the threat posed by the overall site.

CLOSURE REQUIREMENTS

Subtitle D

In the absence of Federal Subtitle D closure regulations, State Subtitle D closure requirements generally have governed CERCLA response actions at municipal landfills as applicable or relevant and appropriate requirements (ARARs). New Federal Subtitle D closure and post-closure care regulations will be in effect on October 9, 1993 (56 FR 50978 and 40 CFR 258).⁴ State closure requirements that are ARARs and that are more stringent than the Federal requirements must be attained or waived.

The new Federal regulations contain requirements related to construction and maintenance of the final cover, and leachate collection, ground-water monitoring, and gas monitoring systems. The final cover regulations will be applicable requirements for landfills that received household waste after October 9, 1991. EPA expects that the final cover requirements will be applicable to few, if any, CERCLA municipal landfills, since the receipt of household wastes ceased at most CERCLA landfills before October 1991. Rather, the substantive requirements of the new Subtitle D regulations generally will be considered relevant and appropriate requirements for CERCLA response actions that occur after the effective date.

Subtitle C

RCRA Subtitle C closure requirements may be applicable or relevant and appropriate in certain circumstances. RCRA Subtitle C is applicable if the landfill received waste that is a listed or characteristic waste under RCRA, and:

1. The waste was disposed of after November 19, 1980 (effective date of RCRA), or

⁴An extension of the effective date has been proposed but not finalized at this time.

2. The new response action constitutes disposal under RCRA (i.e., disposal back into the original landfill).⁵

The decision about whether a Subtitle C closure requirement is relevant and appropriate is based on a variety of factors, including the nature of the waste and its hazardous properties, the date on which it was disposed, and the nature of the requirement itself. For more information on RCRA Subtitle C closure requirements, see *RCRA ARARs: Focus on Closure Requirements*, Directive No. 9234.2-04FS, October 1989.

⁵Note that disposal of only small quantity hazardous waste and household hazardous waste does not make Subtitle C applicable.

Notice:

The policies set out in this document are intended solely as guidance to the U.S. Environmental Protection Agency (EPA) personnel; they are not final EPA actions and do not constitute rulemaking. These policies are not intended, nor can they be relied upon, to create any rights enforceable by any party in litigation with the United States. EPA officials may decide to follow the guidance provided in this document, or to act at variance with the guidance, based on an analysis of specific site circumstances. EPA also reserves the right to change the guidance at any time without public notice.

APPENDIX A TECHNICAL BASIS FOR PRESUMPTIVE REMEDIES

This Appendix summarizes the analysis that EPA conducted of feasibility study (FS) and Record of Decision (ROD) data from CERCLA municipal landfill sites which led to the establishment of containment as the presumptive remedy for these sites. The objective of the study was to identify those technologies that are consistently included in the remedies selected, those that are consistently screened out, and to identify the basis for their elimination. Results of this analysis support the decision to eliminate the initial technology identification and screening steps on a site-specific basis for this site type. The technical review found that certain technologies are appropriately screened out based on effectiveness, implementability, or excessive costs.

The methodology for this analysis entailed reviewing the technology identification and screening components of the remedy selection process for a representative sample of municipal landfill sites. The number of times each technology was either screened out or selected in each remedy was compiled. A detailed discussion of the methodology used is provided below.

METHODOLOGY

Identification of Sites for Feasibility Study Analysis

Of the 230 municipal landfill sites on the NPL, 149 sites have had a remedy selected for at least one operable unit. Of the 149 sites, 30 were selected for this study on a random basis, or slightly greater than 20 percent. The sites range in size from 8.5 acres to over 200 acres and are located primarily in Regions 1,2,3, and 5. This geographical distribution approximates the distribution of municipal landfills on the NPL.

Technology Screening and Remedial Alternative Analysis

The FS analysis involved a review of the technology identification and screening phase, including any pre-screening steps, followed by a review of the detailed analysis and comparative analysis phases. Information derived from each review was documented on site-specific data collection forms, which are available for evaluation as part of the Administrative Record for this presumptive remedy directive. The review focused on the landfill source contamination only; ground-water technologies and alternatives were not included in the analysis.

For the screening phase, the full range of technologies considered was listed on the data collection forms, along with the key reasons given for eliminating technologies from further consideration. These reasons were categorized according to the screening criteria: cost, effectiveness, or implementability. The frequency with which specific reasons were given for eliminating a technology from further consideration was then tallied and compiled into a screening phase summary table.

For the detailed analysis and comparative analysis, information on the relative performance of each technology/alternative with respect to the seven NCP criteria was documented on the site-specific data collection forms. The advantages and disadvantages associated with each clean-up option were highlighted. In some cases, a technology was combined with one or more technologies into one or more alternatives. The disadvantages of a technology/alternative were then compiled into a detailed analysis/comparative analysis summary table, under the assumption that these disadvantages contributed to non-selection. All summary tables are available for review as part of the Administrative Record.

**APPENDIX A
TECHNICAL BASIS FOR PRESUMPTIVE REMEDIES (continued)**

RESULTS

The information from the technology screening and remedial alternative analyses is provided in Table 1. It demonstrates that containment (the presumptive remedy), was chosen as a component of the selected remedy at all thirty of the sites analyzed. No other technologies or treatments were consistently selected as a remedy or retained for consideration in a remedial alternative. However, at eight of the thirty sites, there were circumstances where technologies were included in the selected remedy to address a site-specific concern, such as principal threat wastes. These technologies are included in the column entitled "Tech. Not Primary Component of Alternative"¹ in Table 1 and include incineration at two sites, waste removal and off-site disposal at two sites, soil vapor extraction at two sites, and bioreclamation at one site.

Leachate collection and gas collection systems were also tracked as part of the detailed analysis and comparison of remedial alternatives. These types of systems generally were not considered as remediation technologies during the screening phases. At fifteen sites, leachate collection was selected as part of the overall containment remedy. At seventeen sites, gas collection systems were selected as part of the overall containment remedy.

This analysis supports the decision to eliminate the initial technology identification and screening step for municipal landfill sites. On a site-specific basis, consideration of remediation technologies may be retained as needed.

¹ This column title is used for record-keeping purposes only and is not meant to imply that these treatment technologies are not considered important components of the selected remedies.

TABLE 1• SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR LANDFILLS¹

TECHNOLOGY ²	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	Cost	Effectiveness	Implement	# FSs Where Criterion Contributed To Screening Out ³	# RODs Tech. Selected	# RODs Tech. Not Selected	#RODS WHERE CRITERION CONTRIBUTED TO NON-SELECTION							
											ARARs	TMV Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem.	State Concerns ⁴	Community Concerns ⁴
Multi-layer Cap	28	25	3	0	2	2	0	18	7	1	0	0	1	3	5	3	---	---
Clay Cap	16	8	8	0	1	8	0	4	4	2	2	1	2	1	0	1	---	---
Asphalt Cap	17	0	17	0	2	14	5	0	0	0	0	0	0	0	0	0	---	---
Concrete Cap	17	0	17	0	3	14	5	0	0	0	0	0	0	0	0	0	---	---
Soil Cover	16	7	5	4	0	5	1	5	2	1	0	0	0	0	0	0	---	---
Synthetic Cap	13	3	10	0	0	10	1	2	1	1	1	1	1	1	1	1	---	---
Chemical Seal	5	0	5	0	0	4	0	0	0	0	0	0	0	0	0	0	---	---
Slurry Wall	22	5	14	3	2	8	6	2	3	3	2	2	1	2	0	2	---	---
Grout Curtain	18	0	18	0	3	15	9	0	0	0	0	0	0	0	0	0	---	---
Sheet Piling	17	1	16	0	0	13	5	0	1	0	0	0	0	0	0	0	---	---
Grout Injection	8	0	8	0	0	8	2	0	0	0	0	0	0	0	0	0	---	---
Block Displacement	5	0	5	0	0	3	3	0	0	0	0	0	0	0	0	0	---	---
Bottom Sealing	5	0	5	0	0	3	4	0	0	0	0	0	0	0	0	0	---	---

TABLE 1• SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR LANDFILLS ¹																		
TECHNOLOGY ²	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	Cost	Effectiveness	Implement	# FSs Where Criterion Contributed To Screening Out 3	# RODS Tech. Selected	# RODS Tech. Not Selected	#RODS WHERE CRITERION CONTRIBUTED TO NON-SELECTION							
											ARARs	TMY Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem.	State Concerns ⁴	Community Concerns ⁴
Vibrating Beam	5	0	5	0	0	3	3	0	0	0	0	0	0	0	0	0	---	---
Liners	2	0	2	0	0	1	2	0	0	0	0	0	0	0	0	0	---	---
Offsite Nonhazardous Landfill	3	0	3	0	0	0	3	0	0	0	0	0	0	0	0	0	---	---
Offsite RCRA Landfill	17	0	13	4	8	3	12	0	0	0	0	0	0	0	0	0	---	---
Offsite Landfill (unspecified)	9	1	8	0	5	3	5	1	0	0	0	0	0	0	0	0	---	---
Onsite Nonhazardous Landfill	2	0	2	0	1	1	1	0	0	0	0	0	0	0	0	0	---	---
Onsite RCRA Landfill	14	1	11	2	3	2	10	0	1	0	0	0	0	0	0	1	---	---
Onsite Landfill (unspecified)	7	0	6	1	3	3	6	0	0	0	0	0	0	0	0	0	---	---
Bioremediation (unspecified)	13	0	13	0	0	13	1	0	0	0	0	0	0	0	0	0	---	---
Bioremediation Ex-situ	10	0	10	0	0	7	7	0	0	0	0	0	0	0	0	0	---	---
Bioremediation In-situ	15	1	14	0	1	13	7	1	0	0	0	0	0	0	0	0	---	---
Dechlorination/APEG	6	0	5	1	1	4	2	0	0	0	0	0	0	0	0	0	---	---
Oxidation/Reduction	12	0	12	0	1	8	5	0	0	0	0	0	0	0	0	0	---	---

TABLE 1• SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR LANDFILLS¹

TECHNOLOGY ²		# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	Cost	Effectiveness	Implement	# FSs Where Criterion Contributed To Screening Out 3	# RODs Tech. Selected	# RODs Tech. Not Selected	#RODS WHERE CRITERION CONTRIBUTED TO NON-SELECTION						
												ARARs	TMV Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem.	State Concerns ⁴
Neutralization	4	0	3	1	0	2	1	0	0	0	0	0	0	0	0	0	---	---
Thermal Destruction (unspecified)	6	0	6	0	0	3	4	0	0	0	0	0	0	0	0	0	---	---
Offsite Incineration (unspecified)	19	2	14	3	9	5	10	1	1	0	0	0	0	1	1	0	---	---
Onsite Incineration (unspecified)	12	0	8	3	5	5	6	0	1	0	0	0	0	1	1	1	---	---
Fluidized Bed	9	0	9	0	5	6	4	0	0	0	0	0	0	0	0	0	---	---
Infrared	8	0	7	1	6	3	3	0	0	0	0	0	0	0	0	0	---	---
Pyrolysis	5	2	3	1	2	2	1	0	1	0	1	0	0	1	1	1	---	---
Multiple Hearth	4	0	4	0	2	2	1	0	0	0	0	0	0	0	0	0	---	---
Rotary Kiln	10	0	9	1	6	5	4	0	0	0	0	0	0	0	0	0	---	---
Vitrification	21	0	21	0	8	15	11	0	0	0	0	0	0	0	0	0	---	---
Low Temperature Thermal Desorp/ Stripping	13	1	11	1	2	9	3	0	1	0	0	0	0	0	1	0	---	---
In-situ Steam Stripping	5	0	5	0	1	4	2	0	0	0	0	0	0	0	0	0	---	---
Soil Flushing	16	2	14	0	2	9	10	0	0	0	0	0	0	0	0	0	---	---

TABLE 1• SUMMARY OF SCREENING AND DETAILED ANALYSIS FOR LANDFILLS¹

TECHNOLOGY ²	# FSs Where Technology Considered	# FSs Tech. Passed Screening	# FSs Tech. Screened Out	Tech. Not Primary Component of Alternative	Cost	Effectiveness	Implement	# FSs Where Criterion Contributed To Screening Out ³	# RODs Tech. Selected	# RODs Tech. Not Selected	#RODS WHERE CRITERION CONTRIBUTED TO NON-SELECTION							
											ARARs	TMY Through Treatment	Long-term Effect.	Short-term Effect.	Cost	Implem.	State Concerns ⁴	Community Concerns ⁴
Soil Washing	12	2	9	1	1	8	6	0	0	0	0	0	0	0	0	0	---	---
Soil Vapor Extraction (SVE)	14	1	11	2	2	9	5	1	0	0	0	0	0	0	0	0	---	---
Fixation	7	1	5	1	0	4	2	2	0	0	0	0	0	0	0	0	---	---
Stabilization/Solidification	20	0	19	2	1	13	6	0	0	0	0	0	0	0	0	0	---	---
Aeration	7	0	7	0	0	5	3	0	0	0	0	0	0	0	0	0	---	---

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¹ The study was conducted on 30 RODs and their corresponding FSs.
² This does not include the no-action or institutional control only alternatives. No RODs selected either of these as remedies.
³ FSs and RODs may contain more than one criterion for screening or non-selection of technology. Also, some FSs did not fully explain the criteria for screening out a technology. Thus, the totals for screening and non-selection criteria are not equal to the number of FSs and RODs considered.
⁴ Information on State and community concerns was not included in this analysis because FSs do not contain this information and RODs generally only reference supporting documentation (i.e., State concurrence letter and responsiveness summary).

APPENDIX B
COST DEVELOPMENT ASSUMPTIONS

Removal and Disposal - Alternative LF 2
Capital Cost Sub-Element

Site Preparation

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
Site Preparation									
Mob/Demob	1	LS	\$4,606	\$21,135	-	-	\$25,741	\$25,741	Excavators, loaders
Strip and Stockpile Topsoil	1	LS	\$20,721	\$31,503	-	\$2,825	\$55,048	\$55,048	
Install Erosion Controls	1	LS	\$12,882	\$11,320	-	-	\$24,202	\$24,202	
SUBTOTAL								\$104,991	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$22,771	
TOTAL UNIT COST								\$127,762	

Removal and Disposal - Alternative LF 2
Capital Cost Sub-Element

Excavation

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
Excavation									
Stormwater Management - Riprap	1	LS	\$48,992	\$46,502	-	\$1,883	\$97,378	\$97,378	
Stormwater Management - Drainage Features	1	LS	\$11,032	\$8,506	-	-	\$19,538	\$19,538	
Excavate and Load Landfill Debris	1	LS	\$1,115,396	\$24,243	-	\$21,554	\$1,161,193	\$1,161,193	Removal of approx 542,080 cy of debris
Excavation Dewatering	1	LS	\$53,262	-	-	-	\$53,262	\$53,262	Disposal cost is included in T&D cost
Deliver and Emplace Clean Fill	1	LS	\$1,257,158	\$415,093	-	\$4,657,420	\$6,329,671	\$6,329,671	
Replace Topsoil and Reseed	1	LS	\$29,854	\$53,058	-	\$50,778	\$133,690	\$133,690	
SUBTOTAL								\$7,794,731	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$1,011,626	
TOTAL UNIT COST								\$8,806,358	

Removal and Disposal - Alternative LF 2
Capital Cost Sub-Element

Removal and Disposal

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
Removal & Disposal									
Transportation & Disposal of Landfill Debris	1	LS	\$5,036	-	-	\$7,403,856	\$7,408,892	\$7,408,892	Disposal of 542,080 cy
Transportation & Disposal of Dewatering Liquids	1	LS	\$5,036	-	-	\$146,055	\$151,091	\$151,091	Assumed 30,000 gallons
Transportation & Disposal of Well Development Water	1	LS	\$1,450	-	-	\$2,140	\$3,590	\$3,590	
Transportation & Disposal of Well Cuttings	1	LS	\$1,219	-	-	\$3,927	\$5,146	\$5,146	
SUBTOTAL								\$7,568,720	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$923,788	
TOTAL UNIT COST								\$8,492,508	

Removal and Disposal - Alternative LF 2
Capital Cost Sub-Element

Monitoring Well Installation

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
Monitoring Well Installation	1	LS	\$3,088	\$1,525	-	\$7,390	\$12,003	\$12,003	Replacement of 4 monitoring wells
SUBTOTAL								\$12,003	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$7,448	
TOTAL UNIT COST								\$19,451	

Removal and Disposal - Alternative LF 2
Capital Cost Sub-Element

Planning & Reporting

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
Planning & Reporting									
ROD/Proposed Plan	1	LS	\$101,101	\$2,418	-	-	\$103,518	\$103,518	
RD Field Activities	1	LS	\$28,689	\$14,067	-	\$32,027	\$74,783	\$74,783	
Remedial Design/Remedial Action WP	1	LS	\$122,022	\$2,612	-	\$2,779	\$127,413	\$127,413	
Completion Report	1	LS	\$89,157	\$2,418	-	-	\$91,575	\$91,575	Post construction submittal
SUBTOTAL								\$397,289	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$73,281	
TOTAL UNIT COST								\$470,570	

Removal and Disposal - Alternative LF 2
Periodic Cost Sub-Element

GW Monitoring

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
GW Monitoring									
GW Sampling - Year 1	1	LS	\$9,656	\$5,956	-	\$4,600	\$20,212	\$20,212	Sampling of 10 wells
GW Sampling Report - Year 1	1	LS	\$26,571	\$1,209	-	-	\$27,780	\$27,780	
GW Sampling - Years 2-5	4	EA	\$7,768	\$4,154	-	\$4,600	\$16,522	\$66,087	Annual sampling of 10 wells
GW Sampling Report- Years 2-5	4	EA	\$19,928	\$1,209	-	-	\$21,137	\$84,549	
SUBTOTAL								\$198,628	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$24,319	
TOTAL UNIT COST								\$222,948	

Removal and Disposal - Alternative LF 2
Periodic Cost Sub-Element

Five-Year Review

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
Five-Year Review	1	LS	\$4,254		-		\$4,254	\$4,254	
SUBTOTAL								\$4,254	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$6,462	
TOTAL UNIT COST								\$10,717	

Landfill Containment - Alternative LF 3
Single Layer Soil Cover and Institutional Controls including LTM and LUCs
Capital Cost Sub-Element

Site Preparation

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
Site Preparation									
Mob/Demob	1	LS	\$4,606	\$21,135	-	-	\$25,741	\$25,741	Excavators, loaders
Strip and Stockpile Topsoil	1	LS	\$20,721	\$31,503	-	\$2,825	\$55,048	\$55,048	
Install Erosion Controls	1	LS	\$12,882	\$11,320	-	-	\$24,202	\$24,202	
SUBTOTAL								\$104,991	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$22,771	
TOTAL UNIT COST								\$127,762	

Landfill Containment - Alternative LF 3
 Single Layer Soil Cover and Institutional Controls including LTM and LUCs
 Capital Cost Sub-Element

Landfill Containment

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT	TOTAL	NOTES
Landfill Containment									
Address Settlement/Erosion	1	LS	\$23,754	\$15,336	-	\$19,229	\$58,319	\$58,319	
Stormwater Management - Riprap	1	LS	\$37,676	\$39,612	-	\$1,883	\$79,172	\$79,172	
Stormwater Management - Drainage Features	1	LS	\$11,032	\$8,506	-	-	\$19,538	\$19,538	
Removal of Debris and Consolidation	1	LS	\$32,540	\$25,529	-	\$21,554	\$79,624	\$79,624	
Augment Soil Cover	1	LS	\$151,566	\$121,214	-	\$459,138	\$731,918	\$731,918	Cover 16 acres with 2 feet of soil
Replace Topsoil and Reseed	1	LS	\$34,300	\$52,419	-	\$41,656	\$128,376	\$128,376	Reseed 16 acres
SUBTOTAL								\$1,096,947	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$218,898	
TOTAL UNIT COST								\$1,315,845	

Landfill Containment - Alternative LF 3
Single Layer Soil Cover and Institutional Controls including LTM and LUCs
Capital Cost Sub-Element

Planning & Reporting

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
Planning & Reporting									
ROD/Proposed Plan	1	LS	\$92,219	\$2,418	-	-	\$94,637	\$94,637	
RD Field Activities	1	LS	\$27,160	\$13,884	-	\$29,405	\$70,449	\$70,449	
Remedial Design/Remedial Action WP	1	LS	\$109,393	\$2,612	-	\$2,779	\$114,785	\$114,785	
Completion Report	1	LS	\$80,963	\$2,418	-	-	\$83,381	\$83,381	Post construction submittal
SUBTOTAL								\$363,251	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$70,558	
TOTAL UNIT COST								\$433,808	

Landfill Containment - Alternative LF 3
Single Layer Soil Cover and Institutional Controls including LTM and LUCs
Periodic Cost Sub-Element

LTM Sampling and Reporting

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
LTM Sampling									
LTM Sampling - Year 1	1	LS	\$9,656	\$5,901	-	\$3,813	\$19,371	\$19,371	Sampling of 10 wells
LTM Sampling Report - Year 1	1	LS	\$26,571	\$1,209	-	-	\$27,780	\$27,780	
LTM Sampling - Years 2-10	9	EA	\$7,768	\$4,099	-	\$3,813	\$15,680	\$141,123	Annual sampling of 10 wells
LTM Sampling Report- Year 2-10	9	EA	\$19,928	\$1,209	-	-	\$21,137	\$190,235	
SUBTOTAL								\$378,508	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$78,228	
TOTAL UNIT COST								\$456,736	

Landfill Containment - Alternative LF 3
Single Layer Soil Cover and Institutional Controls including LTM and LUCs
Capital Cost Sub-Element

Land Use Controls

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
Land Use Controls									
Land Use Controls Plan	1	LS	\$12,014	\$1,209	-	-	\$13,223	\$13,223	Describe controls/implementation
Groundwater Use Restrictions	1	LS	\$6,606	-	-	-	\$6,606	\$6,606	Includes registry filings
Provide Update for Base General Plan	1	LS	\$5,285	\$1,209	-	-	\$6,493	\$6,493	
SUBTOTAL								\$26,322	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$24,047	
TOTAL UNIT COST								\$50,369	

Landfill Containment - Alternative LF 3
Single Layer Soil Cover and Institutional Controls including LTM and LUCs
Periodic Cost Sub-Element

Five-Year Review

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
Five-Year Review	6	LS	\$4,254		-		\$4,254	\$25,527	6, 5-yr reviews over 30-yr period
SUBTOTAL								\$25,527	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$35,820	
TOTAL UNIT COST								\$61,347	

Landfill Containment - Alternative LF 3
Single Layer Soil Cover and Institutional Controls including LTM and LUCs
Periodic Cost Sub-Element

Operations & Maintenance

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
Landfill Cover Inspection and Manintenance									
Landfill Cover Inspection	30	EA	\$2,383		-	-	\$2,383	\$71,501	Annual inspection for 30 years
Landfill Cover Maintenance	6	EA	\$6,968		-	-	\$6,968	\$41,807	Maintenance every 5 years
SUBTOTAL								<u>\$113,308</u>	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								<u>\$5,311</u>	
TOTAL UNIT COST								\$118,619	

Landfill Containment - Alternative LF 4
Composite Cover of Soil and Engineered Biota Barrier, Institutional Controls including LTM and LUCs
Capital Cost Sub-Element

Site Preparation

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
Site Preparation									
Mob/Demob	1	LS	\$4,606	\$21,135	-	-	\$25,741	\$25,741	Excavators, loaders
Strip and Stockpile Topsoil	1	LS	\$20,721	\$31,503	-	\$2,825	\$55,048	\$55,048	
Install Erosion Controls	1	LS	\$12,882	\$11,320	-	-	\$24,202	\$24,202	
SUBTOTAL								\$104,991	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$22,771	
TOTAL UNIT COST								\$127,762	

Landfill Containment - Alternative LF 4
Composite Cover of Soil and Engineered Biota Barrier, Institutional Controls including LTM and LUCs
Capital Cost Sub-Element

Landfill Containment

Site: Site 3

Date: 7/16/10

Location : Buckley AFB, Aurora, Colorado

Phase: Feasibility Study (-30% to +50%)

Base Year: 2010

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT	TOTAL	NOTES
Landfill Containment									
Address Settlement/Erosion	1	LS	\$23,754	\$15,336	-	\$19,229	\$58,319	\$58,319	
Stormwater Management - Riprap	1	LS	\$37,676	\$39,612	-	\$1,883	\$79,172	\$79,172	
Stormwater Management - Drainage Features	1	LS	\$11,032	\$8,506	-	-	\$19,538	\$19,538	
Removal of Debris and Consolidation	1	LS	\$32,540	\$25,529	-	\$21,554	\$79,624	\$79,624	
Augment Soil Cover	1	LS	\$265,241	\$144,415	-	\$790,581	\$1,200,236	\$1,200,236	Cover 28 acres with 2 feet of soil
Emplace Biota Barrier	1	LS	\$12,282	\$2,047	-	\$4,033,970	\$4,048,299	\$4,048,299	Emplace 16 inches of biota barrier
Replace Topsoil and Reseed	1	LS	\$34,300	\$54,507	-	\$71,486	\$160,294	\$160,294	Reseed 28 acres
SUBTOTAL								\$5,645,482	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$767,379	
TOTAL UNIT COST								\$6,412,861	

Landfill Containment - Alternative LF 4
Composite Cover of Soil and Engineered Biota Barrier, Institutional Controls including LTM and LUCs
Capital Cost Sub-Element

Planning & Reporting

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
Planning & Reporting									
ROD/Proposed Plan	1	LS	\$92,219	\$2,418	-	-	\$94,637	\$94,637	
RD Field Activities	1	LS	\$27,160	\$13,884	-	\$29,405	\$70,449	\$70,449	
Remedial Design/Remedial Action WP	1	LS	\$109,393	\$2,612	-	\$2,779	\$114,785	\$114,785	
Completion Report	1	LS	\$80,963	\$2,418	-	-	\$83,381	\$83,381	Post construction submittal
SUBTOTAL								\$363,251	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$70,558	
TOTAL UNIT COST								\$433,808	

Landfill Containment - Alternative LF 4
Composite Cover of Soil and Engineered Biota Barrier, Institutional Controls including LTM and LUCs
Periodic Cost Sub-Element

LTM Sampling and Reporting

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
LTM Sampling									
LTM Sampling - Year 1	1	LS	\$9,656	\$5,901	-	\$3,813	\$19,371	\$19,371	Sampling of 10 wells
LTM Sampling Report - Year 1	1	LS	\$26,571	\$1,209	-	-	\$27,780	\$27,780	
LTM Sampling - Years 2-10	9	EA	\$7,768	\$4,099	-	\$3,813	\$15,680	\$141,123	Annual sampling of 10 wells
LTM Sampling Report- Year 2-10	9	EA	\$19,928	\$1,209	-	-	\$21,137	\$190,235	
SUBTOTAL								\$378,508	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$78,228	
TOTAL UNIT COST								\$456,736	

Landfill Containment - Alternative LF 4
Composite Cover of Soil and Engineered Biota Barrier, Institutional Controls including LTM and LUCs
Capital Cost Sub-Element

Land Use Controls

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
Land Use Controls									
Land Use Controls Plan	1	LS	\$12,014	\$1,209	-	-	\$13,223	\$13,223	Describe controls/implementation
Groundwater Use Restrictions	1	LS	\$6,606	-	-	-	\$6,606	\$6,606	Includes registry filings
Provide Update for Base General Plan	1	LS	\$5,285	\$1,209	-	-	\$6,493	\$6,493	
SUBTOTAL								\$26,322	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$24,047	
TOTAL UNIT COST								\$50,369	

Landfill Containment - Alternative LF 4
Composite Cover of Soil and Engineered Biota Barrier, Institutional Controls including LTM and LUCs
Periodic Cost Sub-Element

Five-Year Review

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
Five-Year Review	6	LS	\$4,254		-		\$4,254	\$25,527	6, 5-yr reviews over 30-yr period
SUBTOTAL								\$25,527	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								\$35,820	
TOTAL UNIT COST								\$61,347	

Landfill Containment - Alternative LF 4
Composite Cover of Soil and Engineered Biota Barrier, Institutional Controls including LTM and LUCs
Periodic Cost Sub-Element

Operations & Maintenance

Site: Site 3
 Location : Buckley AFB, Aurora, Colorado
 Phase: Feasibility Study (-30% to +50%)
 Base Year: 2010

Date: 7/16/10

DESCRIPTION	QTY	UNIT	LABOR	EQUIP	MTRL	SUB	UNIT TOTAL	TOTAL	NOTES
Landfill Cover Inspection and Manintenance									
Landfill Cover Inspection	30	EA	\$2,383		-	-	\$2,383	\$71,501	Annual inspection for 30 years
Landfill Cover Maintenance	6	EA	\$8,361		-	-	\$8,361	\$50,168	Maintenance every 5 years
SUBTOTAL								<u>\$121,669</u>	
Other Costs (PM, Overhead, Fringe, G&A, Fee)								<u>\$5,423</u>	
TOTAL UNIT COST								\$127,092	