# FINAL
# FEASIBILITY STUDY
# FOR
# INSTALLATION RESTORATION PROGRAM SITE 27, NAVAL WEAPONS STATION SEAL BEACH DETACHMENT FALLBROOK, CALIFORNIA

**CONTRACT NUMBER: N62583-09-D-0143**
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# FINAL Feasibility Study
# Installation Restoration Program Site 27

**NAVAL WEAPONS STATION SEAL BEACH**
**DETACHMENT FALLBROOK**
**FALLBROOK, CALIFORNIA**

**SIGNATURES**

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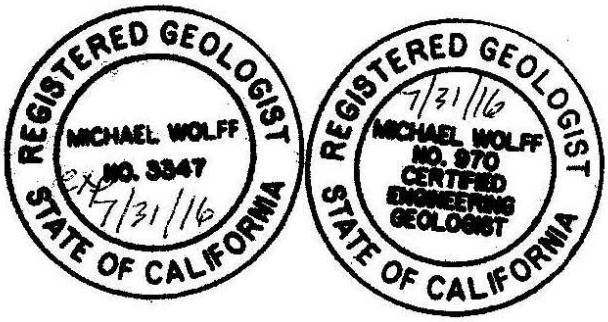


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## EXECUTIVE SUMMARY

This Feasibility Study (FS) was prepared for the Naval Facilities Engineering Command (NAVFAC) Southwest under Contract No. N62583-09-D-0143, Task Order No. 0003 to develop and evaluate remedial alternatives for Naval Weapons Station Seal Beach Detachment Fallbrook Installation Restoration Program (IRP) Site 27, Eucalyptus Grove Landfill in Fallbrook, California. This FS has been developed in accordance with Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), in coordination with the San Diego Regional Water Quality Control Board (RWQCB) and the California Environmental Protection Agency (Cal-EPA) Department of Toxic Substances Control (DTSC) as the regulatory support agencies. The objective of this FS is to identify suitable remedial alternatives to address potential exposures associated with waste material that was placed within the landfill at IRP Site 27 at Naval Weapons Station Seal Beach Detachment Fallbrook.

Detachment Fallbrook lies between the San Onofre and Santa Margarita Mountain ranges and has a moderate topography characterized by alluvial bottom lands of the Santa Margarita River to flat plateaus, steep ridges, and bluffs between the ranges (MARRS, 2009). IRP Site 27 was previously used as a landfill which was operated from the late 1960s until 1974 when the Navy began shipping waste off site and the landfill was closed (MARRS, 2009). Records indicate that the total estimated volume of refuse placed in the landfill is approximately 24,000 cubic yards ($yd^3$) based on an estimated 20 to 30 dumpsters of refuse disposed per week at the site (MARRS, 2009). The waste layer may contain potential sources of contamination, including small quantities of potentially hazardous waste (e.g., empty paint cans with dried paint residues, fluorescent lights, fluorescent light ballasts, spent silica sandblast grit containing paint chips, paint booth residue, rags with solvent residue, used paint brushes, and asbestos), metal scrap, and pallets that were potentially treated with pentachlorophenol and were also disposed at IRP Site 27. Naturally-occurring metals are an important part of site geology.

Based on the screening level human health risk assessment (HHRA) and the screening level ecological risk assessment (SLERA) presented in the remedial investigation (RI; SES-Tech, 2012b), no risks were identified for IRP Site 27 based on human health and ecological effects.

Elevated concentrations of arsenic, iron, and manganese have been detected in groundwater at IRP Site 27. Historically, these elevated detections have been observed in groundwater samples from MW-2, located within the landfill footprint. The phase (dissolved or solid) and mobility of the three metals of concern (i.e., arsenic, iron, and manganese) are dependent on the oxidation states of the metals. In each case, these elements occur in solid and aqueous phases, depending on whether the metal is oxidized or reduced. Based on the geochemical evaluation presented in Section 3.0, there is far more than sufficient naturally-occurring mass of arsenic, iron, and manganese in site soils for reducing subsurface conditions to cause naturally-occurring metals to dissolve in groundwater at MW-2. Additionally, results from upgradient and downgradient monitoring wells show these changes in geochemistry occur in a localized area and elevated concentrations of arsenic, iron, and manganese do not persist downgradient of the localized area in which groundwater and waste interact. Remedial action objectives (RAOs) have been developed to define the basis for remediation, and remedial technologies have been assessed and suitable alternatives developed. Based on the conclusions of the RI (SES-Tech, 2012b) and the updated conceptual site model (CSM) presented in Section 3.0, the following RAOs have been established to ensure IRP Site 27 is protective of potential future receptors:

- Prevent exposure of human and ecological receptors to historically landfilled waste.
- Prevent future exposure of human receptors to impacted groundwater.

- Prevent potential off-site impacts from the mobilization of naturally-occurring metals in groundwater resulting from interactions between the aquifer and landfill waste.

This FS evaluates three remedial alternatives in light of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP)/ CERCLA feasibility criteria. Three remedial alternatives were retained for evaluation, with one (No Action) retained because it is required by the NCP, and with the other two retained because they were determined to be the most suitable for addressing the RAOs for IRP Site 27, as follows:

- Alternative 1: No Action
- Alternative 2: Institutional Controls (ICs) and Long-Term Monitoring
- Alternative 3: Soil Cover Improvements with ICs and Long-Term Monitoring

The detailed analysis of remedial alternatives is based on the NCP/CERCLA feasibility criteria, including: overall protection of human health and the environment; compliance with ARARs; long-term effectiveness; reduction of toxicity, mobility, and volume through treatment; short-term effectiveness; implementability; and cost. Table ES-1 provides a summary of the results of the detailed evaluation of alternatives.

**Table ES-1. Results Summary of the Detailed Evaluation of Remedial Alternatives**

| Alternative | Overall Protection of Human Health and the Environment | Compliance with ARARs | Long-Term Effectiveness and Permanence | Reduction of Toxicity, Mobility, or Volume through Treatment | Short-Term Effectiveness | Implementability | Cost |
|---|---|---|---|---|---|---|---|
| 1. No Action | LOW | LOW | LOW | LOW | HIGH | HIGH | LOW[a] |
| 2. ICs and Long-Term Monitoring | HIGH | HIGH | HIGH | LOW | HIGH | HIGH | MODERATE |
| 3. Improved Soil Cover with ICs and Long-Term Monitoring | HIGH | HIGH | HIGH | LOW | MODERATE | HIGH | HIGH |

(a) No costs would be associated with Alternative 1.

Note: Community and state acceptance can only be considered after comments are received on the FS and during finalization of the Proposed Plan; these criteria will be weighed during remedy selection in the Record of Decision (ROD).

Based on the results of the detailed evaluation of alternatives, Alternative 2, ICs and long-term monitoring, had the most favorable evaluation based on the NCP/CERCLA feasibility criteria. Ultimately, the remedy for IRP Site 27 will be selected in the Proposed Plan and will consider input from state regulatory agencies and the public.

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| amsl | above mean sea level |
| ARAR | applicable or relevant and appropriate requirement |
| bgs | below ground surface |
| CAGN | coastal California gnatcatcher |
| Cal-EPA | California Environmental Protection Agency |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act of 1980 |
| CFR | Code of Federal Regulation |
| CHHSL | California human health screening level |
| COPC | contaminant of potential concern |
| CSM | Conceptual Site Model |
| DHS | Department of Health Services |
| DO | dissolved oxygen |
| DON | Department of the Navy |
| DTSC | Department of Toxic Substances Control |
| ESL | environmental screening level |
| FRTR | Federal Remediation Technology Roundtable |
| FS | Feasibility Study |
| gpm | gallons per minute |
| GRA | General Response Actions |
| HHRA | human health risk assessment |
| HQ | hazard quotient |
| IAS | initial assessment study |
| IC | Institutional control |
| IRP | Installation Restoration Program |
| LBV | Least Bell's vireo |
| LUC | land use control |
| MCB | Marine Corps Base |
| MCL | maximum contaminant level |
| NAVFAC | Naval Facilities Engineering Command |
| NCP | National Oil and Hazardous Substances Pollution Contingency Plan |
| NDMA | N-nitrosodimethylamine |
| NEESA | Naval Energy and Environmental Support Activity |
| ORP | oxidation-reduction potential |
| PCB | polychlorinated biphenyl |
| PP | Proposed Plan |

| | |
|---|---|
| RAO | remedial action objective |
| RCRA | Resource Conservation and Recovery Act |
| RI | Remedial Investigation |
| ROD | Record of Decision |
| RSL | Regional Screening Level |
| RWQCB | Regional Water Quality Control Board |
| SI | site inspection |
| SKR | Stephen's kangaroo rat |
| SLERA | screening level ecological risk assessment |
| SVOC | semivolatile organic compound |
| TPH | total petroleum hydrocarbon |
| UCL | upper confidence limit |
| U.S. EPA | United States Environmental Protection Agency |
| VOC | volatile organic compound |
| $yd^3$ | cubic yard |

# Section 1.0: INTRODUCTION

This Feasibility Study (FS) was prepared for the Naval Facilities Engineering Command (NAVFAC) Southwest under Contract No. N62583-09-D-0143, Task Order No. 0003 to develop and evaluate remedial alternatives for Naval Weapons Station Seal Beach Detachment Fallbrook Installation Restoration Program (IRP) Site 27, Eucalyptus Grove Landfill in Fallbrook California. This FS has been developed in accordance with Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), in coordination with the primary regulatory support agencies, the San Diego Regional Water Quality Control Board (RWQCB) and the California Environmental Protection Agency (Cal-EPA) Department of Toxic Substances Control (DTSC). Remedial alternatives evaluated in this report are assessed individually and in comparison with each other using the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) evaluation criteria, including: overall protection of human health and the environment; compliance with applicable or relevant and appropriate requirements (ARARs); short-term effectiveness; long-term effectiveness and permanence; reduction of toxicity, mobility and volume; implementability; and cost. State and community acceptance criteria will be evaluated further after developing and receiving comments on the Proposed Plan (PP).

## 1.1 Objectives

The primary objective of this FS is to identify suitable remedial alternatives to address potential exposures associated with waste material that was placed within the landfill at IRP Site 27 from the late 1960s to 1974. Remedial action objectives (RAOs) have been developed to define the basis for remediation. Remedial technologies have been assessed and suitable alternatives developed, and the effectiveness of the various remedial alternatives has been assessed against NCP criteria to determine their ability to meet the project RAOs.

## 1.2 Report Organization

This FS was prepared in accordance with the NCP and United States Environmental Protection Agency (U.S. EPA) guidance under CERCLA (U.S. EPA, 1988a). This FS is organized as follows:

**Section 1.0: Introduction.** This section provides a brief overview and the objectives of this FS.

**Section 2.0: Site Description and Background.** This section includes a description of the site and its physical setting, current and future land use, climate, biological survey results, and historical environmental investigations.

**Section 3.0: Summary of Remedial Investigation (RI) Findings and Conceptual Site Model (CSM).** This section provides an overview of the findings of the RI report (SES-Tech, 2012b), which have been used to develop an updated CSM for IRP Site 27. The updated CSM considers technical information, including contaminant source and release information, surface hydrology, geology, hydrogeology, risk assessment, contaminant fate and transport, and serves as the basis for RAO development in Section 4.0.

**Section 4.0: Development of RAOs.** This section presents RAOs based on the CSM for IRP Site 27 presented in Section 3.0.

**Section 5.0: Identification and Screening of Remedial Technologies.** This section provides a summary of possible remedial technologies and process options within each general response action (GRA) applicable to the site (e.g., to contain, remove, dispose of, or treat the contaminants in various environmental media). Technologies are screened to select those technologies that are most suitable and appropriate to be incorporated into remedial alternatives.

**Section 6.0: Evaluation of Remedial Alternatives.** This section presents a preliminary evaluation of remedial alternatives and a detailed evaluation of the most suitable remedial alternatives relative to the NCP criteria. This section also provides a comparison of the most suitable remedial alternatives relative to one another.

**Section 7.0: Conclusions.** This section summarizes the conclusions of the IRP Site 27 FS.

**Section 8.0: References.** This section provides the sources that were used to prepare this FS.

**Appendix A: Applicable or Relevant and Appropriate Requirements.** This appendix includes a detailed discussion of ARARs and tables summarizing the ARARs discussion in Section 3.0.

**Appendix B: Detailed SiteWise™ Evaluation Results.** This appendix includes detailed SiteWise™ evaluation results for the remedial alternatives identified and evaluated in Section 5.0.

**Appendix C: Remedial Alternative Cost Estimates.** This appendix includes detailed cost estimates for the alternatives identified and evaluated in Section 5.0 and lists assumptions that were made in developing the cost estimates.

**Appendix D: Responses to Comments on the Draft.** This appendix includes a table of responses to comments on the Draft FS provided by the DTSC and the RWQCB. The responses to agency comments on the Draft FS have been incorporated into the Final FS.

## Section 2.0: SITE DESCRIPTION AND BACKGROUND

### 2.1 Site Location and History

Detachment Fallbrook is located on the interior side of Marine Corps Base (MCB) Camp Pendleton in the northern area of San Diego County adjacent to the unincorporated area of Fallbrook (Figure 2-1). IRP Site 27 is located within the south magazine area of Detachment Fallbrook. IRP Site 27 is also referred to as the Eucalyptus Grove Landfill because eucalyptus trees were planted in the cover when the landfill was closed in 1974. The landfill is located within a dry ravine that trends south to north (Figure 2-1). The elevation at the south end of the landfill is approximately 640 feet above mean sea level (ft amsl) and the northern end of the landfill is at approximately 580 ft amsl.

Records indicate that the total estimated volume of refuse placed in the landfill is approximately 24,000 cubic yards ($yd^3$) based on an estimated 20 to 30 dumpsters of refuse disposed per week at the site (MARRS, 2009). The landfill was operated from the late 1960s until 1974 when the Navy began shipping waste off site and the landfill was closed (MARRS, 2009). The RI refined the estimated lateral and vertical extent of the landfill, which indicated the areal extent of the landfill waste, was 80,902 square feet ($ft^2$). Depth to waste encountered in the potholes, soil gas probes, and soil sampling ranged from approximately 1 to 2.5 ft, with an average cover thickness of approximately 2 ft. All coring and potholing data available for IRP Site 27 were used to develop a three-dimensional model of the site geology and waste layer. Based on modeling results, the actual in situ volume of waste and soil containing waste in the 4.5-acre landfill site is approximately 66,000 $yd^3$. Most of this amount, 42,000 $yd^3$, is soil (66,000 $yd^3$ total – 24,000 $yd^3$ waste).

The potential for groundwater, soil, and soil vapor impacts to IRP Site 27 were investigated based on the disposal of small quantities of hazardous waste, including empty paint cans with dried paint residues, fluorescent lights, fluorescent light ballasts, spent silica sandblast grit containing paint chips, paint booth residue, rags with solvent residue, used paint brushes, and asbestos. Metal and pallets that were potentially treated with pentachlorophenol were also disposed of at IRP Site 27 (MARRS, 2009).

### 2.2 Current and Future Land Use

In its 70 year history, NAVWPNSTA Detachment Fallbrook has functioned as a naval weapons facility. The installation has supported a variety of activities, including ordnance provision, inspection, maintenance, research, testing and storage for the Navy fleet. Much of the township adjacent to Detachment Fallbrook is sparsely populated and the dominant local activity is agricultural, including avocado farming, nurseries, and some ranching (MARRS, 2009). NAVWPNSTA Detachment Fallbrook has historically been used for cattle grazing. Grazing operations, although suspended from 2004 to 2010, currently function as part of fire suppression efforts and habitat protection for endangered species (Smith, 2010). Fire suppression is an essential part of base operations, especially in the magazine storage area of the facility.

IRP Site 27 is within a controlled munitions exclusion zone and is only accessible to authorized personnel. Access to the exclusion zone is controlled 24 hours a day, 7 days a week via video monitored gates, fencing, and armed guards.

Site 27 is a 4.5-acre site within one of the cattle grazing units at Detachment Fallbrook. Cattle grazing is the only current land use at Site 27. Because it is within the calculated explosive safety arcs of magazines; Site 27 and the surrounding area cannot be developed or contain inhabited buildings.

Land use at Site 27 will not change for the duration that NAVWPNSTA Detachment Fallbrook remains in operation unless it is repurposed.

## 2.3 Climate

The climate is classified as Mediterranean with mild winters and warm to hot summers. Temperatures range from winter lows in the 40 to 50 degrees Fahrenheit (°F) to summer highs in the 70 to 80°F. Annual precipitation averages 12 inches (in.), with approximately 90% occurring between the months of November and April. Prevailing winds average 3.8 miles per hour from the west. Occasional strong, dry winds from the northeast, known as the "Santa Anas," occur in the fall, winter, and early spring (MARRS, 2009).

## 2.4 Biological Survey

Three federally listed endangered animal species and one federally threatened animal species, which include Stephen's kangaroo rat (SKR, *Dipodomys stephensi*), coastal California gnatcatcher (CAGN, *Polioptila californica*), Arroyo toad (*Bufo californicus*), and Least Bell's vireo (LBV, *Vireo bellii pusillus*), inhabit Detachment Fallbrook. Three of the four species, SKR, CAGN, and LBV, dwell in the vicinity of IRP Site 27 (The Sandberg Group, Inc., 2010). The remaining species, the Arroyo toad, has not been reported as residing in the vicinity of IRP Site 27 and is unlikely to be found because there is a lack of suitable habitat.

Focused species surveys in the last 10 years have not documented LBV within the project footprint. However, it has been found that suitable habitat occurs adjacent to IRP Site 27 (The Sandberg Group, Inc., 2010). Although the CAGN was not observed within the boundary of IRP Site 27 in the most recent field survey performed in 2009, it has been found that suitable habitat occurs on and adjacent to IRP Site 27 and CAGN was observed between IRP Site 27 and the adjacent road (The Sandberg Group, Inc., 2010). A biologist completed a SKR survey at the site prior to RI field work and identified suitable habitat adjacent to IRP Site 27 but no active SKR burrows. Biological avoidance measures were implemented to reduce impacts to SKR, including avoidance of areas flagged as potential SKR habitat and limited access routes into and out of the site.

## 2.5 Historical Environmental Investigations

In 1985, Naval Energy and Environmental Support Activity (NEESA) conducted an initial assessment study (IAS) of Naval Weapons Station Seal Beach sites, including 12 located at Detachment Fallbrook. The IAS recommended additional evaluation at each of the Detachment Fallbrook sites. In response to the IAS, U.S. EPA and the California Department of Health Services (DHS) recommended additional soil and groundwater investigations to evaluate contaminants of concern, contaminant migration, and the potential exposure pathways (MARRS, 2009).

In response to these comments, Naval Weapons Station Seal Beach Detachment Fallbrook requested NEESA to prepare an addendum to the IAS. The addendum (completed in 1990) evaluated the recommendations of the U.S. EPA and DHS and recommended a site inspection (SI) be conducted at IRP Site 27 because hazardous wastes had been disposed of at the landfill.

In 2005, MARRS finalized a Work Plan to conduct an SI as described in the addendum. In 2007, the Navy implemented the work outlined in the Work Plan to determine the extent of the landfill and to assess the presence of contaminants of potential concern (COPCs) and their potential risk to human health and ecological receptors. During the SI, 38 soil samples and three groundwater samples were collected within the estimated extent of the landfill. Analytes detected in soil samples included

hexavalent chromium, polybrominated diphenyl ether, semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), and metals. Detected concentrations of these analytes in soil were below screening levels as reported in the SI Report (MARRS, 2009).

Analytes detected at concentrations above secondary maximum contaminant levels (MCLs) in groundwater samples collected from wells within the inferred landfill footprint included aluminum, iron, and manganese. In addition, N-nitrosodimethylamine (NDMA) and total petroleum hydrocarbons (TPH), which do not have established MCLs, were detected.

As part of the SI, a CSM that included the geology and hydrogeology of IRP Site 27 and the exposure pathways for humans and other ecological receptors was developed. In the basic hydrogeologic conceptual model presented in the SI, perched groundwater is migrating along the soil-bedrock interface and accumulating in the topographically low portion of the landfill at the northern extent. According to the SI, COPCs have been detected in soil at IRP Site 27, but it is unlikely that the COPCs present a risk to an on-site industrial worker, construction worker, resident, or off-site adult or child farmer (MARRS, 2009). In addition, the SI concluded that it is unlikely that the COPCs detected pose a significant risk to ecological receptors. Despite these conclusions, the Final SI Report recommended that an RI be conducted at IRP Site 27 to address specific data gaps and conduct a more thorough assessment of risks to human and ecological receptors. The findings of the RI and an updated CSM for IRP Site 27 are provided in Section 3.0.

## Section 3.0: SUMMARY OF RI FINDINGS AND CONCEPTUAL SITE MODEL

Detachment Fallbrook lies between the San Onofre and Santa Margarita Mountain ranges and has a moderate topography characterized by alluvial bottom lands of the Santa Margarita River to flat plateaus, steep ridges, and bluffs between the ranges (MARRS, 2009). IRP Site 27 is located within a north-south ravine with over 60 ft of elevation drop from south to north over the length of the landfill. The west side of the site is bounded by a ravine ranging from less than 1 to approximately 6 ft deep and joining a second smaller ravine in the north. The eastern side of the site is bounded by rocky outcrops covered by a thin layer of vegetation. As shown in Figure 3-1, IRP Site 27 is approximately 1 mile from the City of Fallbrook and approximately 3.6 miles from the nearest drinking water well located at MCB Camp Pendleton to the west.

### 3.1 Contaminant Source and Release Information

It is estimated that a total of 24,000 $yd^3$ of refuse was placed in the IRP Site 27 landfill; the estimated extent of waste and soil mixed with waste (see Figure 3-2) in the subsurface is approximately 66,000 $yd^3$. The waste layer may contain potential sources of contamination, including small quantities of potentially hazardous waste (e.g., empty paint cans with dried paint residues, fluorescent lights, fluorescent light ballasts, spent silica sandblast grit containing paint chips, paint booth residue, rags with solvent residue, used paint brushes, and asbestos), metal scrap, and pallets that were potentially treated with pentachlorophenol and were also disposed of at IRP Site 27. Naturally-occurring metals are an important part of site geology.

### 3.2 Surface Hydrology

The landfill is approximately 1,000 ft long and is located within the dry ravine extending south (640 ft amsl) to north (580 ft amsl), with an approximate surface grade of 6%. IRP Site 27 is located in the Upper Ysidora Area of the Santa Margarita River Basin, which, according to the Regional Water Quality Control Board (RWQCB) Plan for the San Diego Basin (RWQCB, 2011), includes municipal, domestic, and industrial beneficial uses of groundwater. Recharge of site groundwater is from rainwater infiltration during and after rain events. Based on the elevation contours for the area surrounding IRP Site 27, the catchment basin in which IRP Site 27 resides is approximately 43 acres. The direction of surface water runoff has been conceptualized in Figure 3-3 according to the ground surface elevation contours within the catchment basin and generally drains from south to north. The IRP Site 27 catchment basin (shown in Figure 3-3) is approximately 43 acres (compared to a landfill area of approximately 2.7 acres), is bounded to the south by a topographical high of approximately 700 ft amsl, and drains in a northerly direction to a ravine located at the northern end of the catchment basin at approximately 570 ft amsl. This ravine is heavily vegetated and would be expected to drain to the northwest, though the ravine has been dry during site visits conducted in 2009, 2010, and 2011. A small seasonal pond is located within this ravine at a distance of approximately 1,200 feet north northwest from IRP Site 27.

### 3.3 Geology

As shown in the three-dimensional geologic cross section presented in Figure 3-4, site lithology consists of an upper layer of alluvium, comprised of clays, silts, sands, and landfill waste. As discussed in the RI Report (SES-Tech. 2012b), the landfill cover consists of well compacted weathered soil ranging in thickness from 1 to 3 ft, with hydraulic conductivities ranging from $1.47 \times 10^{-6}$ to $1.79 \times 10^{-7}$ cm/sec. Alluvium is underlain by an interval of moderately to highly weathered bedrock, which is

then underlain by competent bedrock consisting of quartz-granodiorite to tonalite. Bedrock is found approximately 5 to 41 ft below ground surface (bgs).

### 3.4 Hydrogeology

Detachment Fallbrook lies within the Santa Margarita River watershed (MARRS, 2009). The Santa Margarita River watershed contains alluvial river basins with a source of water-bearing sediments bounded by hills of non-water-bearing crystalline rocks (MARRS, 2009). As part of the Water Quality Control Board Plan developed for the San Diego Basin, the RWQCB (2011) defines the Santa Margarita watershed as the Santa Margarita Hydraulic Unit. IRP Site 27 is located in the Upper Ysidora Area, which has beneficial uses for municipal, domestic, and industrial water supplies (MARRS, 2009).

Groundwater within the Santa Margarita Hydrologic Unit is mainly unconfined; however, some areas have been identified as being under pressure (MARRS, 2009). The most developed regions are those within the alluvial basins, such as the Santa Margarita River Basin within MCB Camp Pendleton to the west and southwest (MARRS, 2009). The average yield of wells that are completed in the Santa Margarita River Basin, within the Chappo Subarea of the Upper Ysidora Area, ranges from 600 to 1,800 gallons per minute (gpm) with specific capacities ranging from 10 to 21 gpm per foot (gpm/ft) (MARRS, 2009).

IRP Site 27 drains into the Santa Margarita River watershed; however, the river is approximately 2.5 miles away and the site itself is a thin veneer of residuum over hard bedrock with groundwater locally perched on the bedrock surface. The IRP Site 27 catchment basin does not produce or store a significant quantity of groundwater, with an estimated 23 acre-feet of groundwater stored in the perched aquifer and only approximately 1.8 acre-feet of groundwater (or 8% of groundwater in the catchment basin) underlying the landfill. Because the water table is limited, discontinuous, perched and has a low recharge rate, the IRP Site 27 catchment basin is a relatively insignificant contributor of groundwater to the surrounding watershed. The size of the IRP Site 27 catchment basin (approximately 43 acres compared to the drainage to the east for the upstream watershed of approximately 500 acres) and low yield at monitoring wells (monitoring wells at the site produce an average of 0.46 gpm compared to 600 to 1,800 gpm pumped from production wells further west at MCB Camp Pendleton) further demonstrate its insignificance compared to the rest of the watershed. Based on the location and characteristics of the aquifer, it is not used for beneficial purposes and it is unlikely that it would be used in the future. Monitoring wells have consistently indicated a groundwater gradient ranging from 0.0038 to 0.0128 in a north-northeasterly direction. As shown in Figure 3-5, perched groundwater appears to migrate along the soil-bedrock interface, where it accumulates north of the landfill in a bedrock trough in the lowest topographical area of the catchment basin.

### 3.5 Nature and Extent of Contamination

As part of the RI for IRP Site 27, chemical sampling was conducted for soil, soil gas, groundwater, and storm water. A brief summary of the salient findings from the RI are provided below for each media:

- **Soil.** Soil samples were collected from 13 borings and analyzed for a total of 21 metals. All metals were detected in one or more soil samples with the exception of molybdenum, selenium, and thallium. Arsenic was identified as a primary chemical of concern in soil, but was only detected in a single soil sample (boring IR27B02) at a concentration (28.4 mg/kg) greater than its U.S. EPA residential and industrial regional screening levels (RSLs) and greater than the DTSC screening level of 12 mg/kg considered as background for southern California (SES-Tech. 2012b). The findings at IR27B02 were not

comparable to the concentrations observed in other samples collected at the site. In order to confirm the result, this location was re-sampled, which resulted in arsenic being detected at a much lower concentration (2.79 mg/kg). This result was consistent with the rest of the RI dataset and below the DTSC background screening level.

- **Soil Gas.** Soil gas samples were collected during the RI in October and November of 2010 and maximum soil gas concentrations were compared to the DTSC residential California human health screening levels (CHHSLs) (SES-Tech. 2012b). Naphthalene was the only constituent that exceeded the DTSC residential CHHSL, which had a maximum concentration of 33 $\mu g/m^3$ compared to a residential CHHSL of 32 $\mu g/m^3$, which equates to a cancer risk estimate of $1\times10^{-6}$. Based on these findings, soil gas was not identified as a media of concern. Methane, a common landfill gas, was only detected in one out of 11 soil gas samples; the detected concentration was over an order of magnitude below regulatory compliance criteria (detected concentration of 0.688% compared to 5% by volume).

- **Groundwater.** Recent IRP Site 27 groundwater monitoring activities included monitoring events in November 2012 and May 2013. NDMA slightly exceeded the screening level of 3 ng/L (3.85 ng/L) in November 2012, but this concentration dropped to 0.517 ng/L in May 2013. During these two events, hydrazine ranged from 1.1 to 5.3 mg/L, with the highest detection occurring at background well MW-12. There is neither an MCL nor a project action level established for hydrazine. The only other groundwater concentrations above screening levels detected during the November 2012 and May 2013 sampling events were three metals – arsenic, iron, and manganese. Arsenic, iron, and manganese concentrations above screening levels only occurred in the sample from well MW-2. No other COPCs were detected above the screening levels.

- **Storm Water.** Storm water samples were collected during the RI at IRP Site 27 to identify potential impacts from landfill waste to downgradient areas. Storm water runoff samples were collected from three areas where water temporarily pooled during a significant storm event. These three areas were located upgradient of the landfill, on the surface of the landfill, and downgradient of the landfill. The storm water samples were analyzed for volatile organic compounds (VOCs), metals, pesticides, PCBs, SVOCs, hydrazine, TPH, and general chemistry parameters. Several chemicals exceeded screening levels (e.g., hydrazine, manganese and sulfate). Potential human exposures to storm water via direct contact and/or ingestion were determined to be unlikely at IRP Site 27 due to low annual precipitation and the low residence time of storm water runoff (MARRS, 2009).

## 3.6 Risk Assessment

Based on the screening level human health risk assessment (HHRA) and the screening level ecological risk assessment (SLERA) presented in the RI (SES-Tech, 2012b), no risks were identified for IRP Site 27 based on human health and ecological effects.

**3.6.1 HHRA Results.** During the RI, a soil sample was collected at the location where the maximum arsenic concentration was observed during the SI. Arsenic was detected at this location during the RI at a concentration of 2.79 mg/kg. Arsenic concentrations are consistent with background metals concentrations determined in the Basewide Background Metals Soil Study conducted for Detachment Fallbrook (SES-Tech, 2012a), and are also considered within regional background for southern California (e.g., Chernoff et al., 2008; Hunter et al., 2005; UCR Kearney, 1996). Therefore, it is unlikely that this

COPC presents a human health risk above background. VOCs were detected at concentrations at or below residential soil gas CHHSLs, indicating the cancer risk estimates do not exceed the NCP acceptable risk range of $1 \times 10^{-6}$ to $1 \times 10^{-4}$ nor the DTSC target risk level for unrestricted land use. Based on a review of U.S. EPA RSLs, there are no federal criteria promulgated for soil gas; as a result, the CHHSLs are considered an appropriate source for soil gas screening levels that are protective of human health. Therefore, these VOCs do not present an unacceptable human health risk for the vapor intrusion pathway.

Historically, arsenic, iron, and manganese have been detected in groundwater from MW-2 at concentrations that exceed MCLs. In addition, hydrazine has been detected in both surface water and groundwater samples collected at IRP Site 27, both upgradient and downgradient of the former landfill. There is neither an MCL nor a project action level established for hydrazine. During the RI (SES-Tech, 2012b), hydrazine was detected in surface water at concentrations ranging from 38 to 44 μg/L, but was dismissed as a concern due to low precipitation and the low residence time of surface water runoff at IRP Site 27. Groundwater sampling conducted during the extended RI has identified hydrazine concentrations in groundwater ranging from 1.1 to 5.3 μg/L, with the highest detection occurring at background well MW-12. The reporting limit for hydrazine using ASTM Method D1385 is 2 μg/L, which is higher than the U.S. EPA Region 9 RSL for tap water (0.022 μg/L). While the hydrazine concentrations in groundwater at some IRP Site 27 wells exceed the RSL, there is no known source on site and the compound is present upgradient of the former landfill. Groundwater is not used as a water supply and is not expected to be in the future; therefore, ingestion of groundwater is not a complete exposure pathway and therefore does not pose a human health risk. Ingestion of storm water is not considered a complete exposure pathway since the average annual precipitation is minimal, residence time of storm water is limited, and workers are seldom at the site; therefore, the chemicals detected in groundwater at IRP Site 27, including hydrazine, are unlikely to pose a significant human health risk.

**3.6.2 SLERA Results.** The inhalation pathway from soil gas for ecological exposures is generally negligible relative to the ingestion pathway. Maximum detected concentrations of soil gas were one or more orders of magnitude below the calculated environmental screening levels (ESLs). Other than the small seasonal pond north of the site mentioned in Section 3.2, there are no surface water bodies, such as rivers, streams, or lakes, on or near IRP Site 27; therefore, the habitat is not suitable to support benthic or aquatic receptors. All hazard quotients (HQs) were estimated well below 1, indicating no unacceptable ecological risk from consumption of storm water. Further, the conservative assumptions of this evaluation are likely to overestimate risks. Since the landfill was closed 40 years ago no source COPCs have been available for transport elsewhere due to the lack of surface water and the presence of vegetation cover that reduces the mobility of detected constituents in soil.

## 3.7 Contaminant Fate and Transport

Elevated concentrations of arsenic, iron, and manganese have been detected in groundwater at IRP Site 27. These elevated detections have historically been observed in groundwater samples from MW-2. The phase (dissolved or solid) and mobility of the three metals of concern (i.e., arsenic, iron, and manganese) are dependent on the oxidation states of the metals. In each case, these elements can occur in solid and aqueous phases, depending on whether the metal is oxidized or reduced, as follows:

- $As^{+5}$ (Oxidized: Solid) ↔ $As^{+3}$ (Reduced: Aqueous)
- $Fe^{+3}$ (Oxidized: Solid) ↔ $Fe^{+2}$ (Reduced: Aqueous)
- $Mn^{+3}$ (Oxidized: Solid) ↔ $Mn^{+2}$ (Reduced: Aqueous)

Therefore, changes in the aquifer geochemistry (e.g., a transition from oxidizing to reducing conditions) cause metals that are naturally occurring in soil to mobilize, or dissolve, in groundwater until oxidizing conditions are encountered and mobilization and dissolution stops and solid phase precipitation occurs.

As shown in Figure 3-6, MW-2 is located and screened in an area of IRP Site 27 where there is an interaction between the aquifer and the waste layer. The presence of organic matter associated with the waste layer would be expected to cause reduced dissolved oxygen (DO) and a transition to overall reducing geochemical conditions in groundwater. Based on the redox chemistry of arsenic, iron, and manganese, this change in geochemistry results in the mobilization or dissolution of metals in the area of reducing conditions. Figure 3-7 provides a summary of DO, oxidation-reduction potential (ORP), and groundwater results for arsenic, iron, and manganese along a transect of monitoring wells down the centerline of the waste layer in the general direction of groundwater flow (i.e., north-northeast). As shown in Figure 3-7, geochemical conditions at MW-1 are aerobic and oxidizing upgradient of the intersection of the waste layer and aquifer. Dissolved concentrations of arsenic, iron, and manganese under oxidizing conditions at MW-1 favor solid phase, oxidized species of the three metals of concern. As shown in Figure 3-6, there is an interaction between the aquifer and the waste layer at MW-2 and, as expected, conditions in groundwater at MW-2 transition to anaerobic and reducing. The groundwater results for arsenic, iron, and manganese at MW-2 also exhibit a corresponding increase in concentrations, showing a shift in the speciation of naturally-occurring metals towards reduced species (i.e., $As^{+3}$, $Fe^{+2}$, and $Mn^{+2}$) which are soluble in groundwater. Groundwater conditions return to aerobic/oxidizing downgradient of MW-2 (i.e., at MW-3 and IRP27-MW-7), and concentrations of arsenic, iron, and manganese decrease to levels that are comparable to those observed in MW-1.

In order to show that that there is more than sufficient naturally-occurring metals in soil to contribute enough mass to produce the increased concentrations of arsenic, iron, and manganese observed in MW-2, a mass balance was conducted assuming that naturally-occurring metals in site soils are the only source of chemical mass to groundwater. The results of this evaluation are presented in Figure 3-8. A 95% upper confidence limit (UCL) for arsenic, iron, and manganese was calculated using all soil results for IRP Site 27. The 95% UCLs used for this evaluation were 1.5 mg/kg, 18,587 mg/kg, and 208.9 mg/kg for arsenic, iron, and manganese, respectively. The soil concentrations were evaluated against the MW-2 groundwater results from the November 2012 sampling event (i.e., 0.025 mg/L, 3.5 mg/L, and 4 mg/L for arsenic, iron, and manganese, respectively). The results of the evaluation are as follows:

- Assuming an arsenic concentration of 1.5 mg/kg in soil, only 0.28% of total arsenic would be required in a reduced state (i.e., soluble $As^{+3}$) to produce a groundwater concentration of 0.025 mg/L at MW-2.
- Assuming an iron concentration of 18,587 mg/kg in soil, only 0.0033% of total iron would be required in a reduced state (i.e., soluble $Fe^{+2}$) to produce a groundwater concentration of 3.5 mg/L at MW-2.
- Assuming a manganese concentration of 208.9 mg/kg in soil, only 0.33% of total manganese would be required in a reduced state (i.e., soluble $Mn^{+2}$) to produce a groundwater concentration of 4 mg/L at MW-2.

There is far more than sufficient naturally-occurring mass of arsenic, iron, and manganese at IRP Site 27 to produce the elevated metals concentrations observed in groundwater at MW-2. Only a small fraction of the total mass of arsenic, iron, and manganese is required in a reduced form to produce the corresponding metals concentrations observed in MW-2. The site soil data and redox changes observed in groundwater from MW-2 show that the elevated detections in MW-2 are attributable to the dissolution of naturally-occurring metals in site soil as a result of the geochemical effects of the landfill

waste on the aquifer. Additionally, results from upgradient and downgradient monitoring wells demonstrate that these changes in geochemistry occur in a localized area and that the increased concentrations of arsenic, iron, and manganese revert back to upgradient levels downgradient of the localized area in which groundwater and waste interact.

## Section 4.0: REMEDIAL ACTION OBJECTIVES

U.S. EPA guidance (U.S. EPA, 1988a) requires that RAOs be developed during the initial phase of the FS to be used as the framework for developing the remedial alternatives. Based on the conclusions of the RI and the associated risk assessments, chemical concentrations in soil, soil gas, groundwater, and surface water at IRP Site 27 do not pose unacceptable risks to human health or the environment. While groundwater consumption is not currently or a reasonable future complete exposure pathway, dissolved concentrations of arsenic, iron, and manganese detected in MW-2 did exceed drinking water criteria during the RI. The geochemical evaluation provided in Section 3.6 demonstrated that these elevated concentrations are attributable to localized reducing geochemical conditions within part of the landfill causing naturally-occurring metals to dissolve into groundwater. Downgradient of the landfill monitoring results indicate that elevated concentrations of arsenic, iron, and manganese revert back to levels consistent with levels upgradient of the landfill.

In addition, measurements of the landfill collected during the RI found variable cover thickness, ranging from 1 to 3 ft thick. Due to the smaller thickness of the soil cover in certain areas of the landfill and the downhill gradient of the surface topography, there is a concern that erosion resulting from runoff could expose the waste layer in the future; however, the cap is over 40 years old and has no sign of significant surface erosion because it is well stabilized with a covering of native species including coastal sage scrub.

IRP Site 27 does not currently pose a risk to human or ecological receptors. A potential for future exposure exists due to the limited thickness of the current cover. Future erosion of the landfill cover could result in the mobilization of naturally occurring metals in groundwater (i.e., resulting from reducing geochemical conditions associated with the landfill), potentially resulting in a complete pathway to both human and ecological receptors. However, the current landfill cover is stabilized with established native vegetation and does not currently show signs of erosion. Based on the conclusions of the RI (SES-Tech, 2012b) and the updated CSM presented in Section 3.0, the following RAOs have been established to ensure IRP Site 27 is protective of potential future receptors:

- Prevent exposure of human and ecological receptors to historically landfilled waste.
- Prevent future exposure of human receptors to impacted groundwater.
- Prevent potential off-site impacts from the mobilization of naturally-occurring metals in groundwater resulting from interactions between the aquifer and landfill waste.

## Section 5.0: IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

### 5.1 Technology Identification and Screening Approach

The primary objective of the technology identification and screening phase of the FS is to develop an appropriate range of possible technologies and process options suitable to achieve the RAOs established for IRP Site 27. In this section, various technologies and process options are identified, described, and subjected to an initial screening analysis.

GRAs are site-specific actions that would satisfy project RAOs (U.S. EPA, 1988a). The following potential GRAs were developed to satisfy the RAOs developed above for IRP Site 27:

- No action
- Institutional and engineering controls
- Soil cover improvements
- Engineered soil cap
- Monitoring

The technologies and process options presented in this section are grouped in accordance with these GRAs. Appropriate technologies and process options are identified and carried forward to Section 6.0, and used in the development of remedial alternatives (U.S. EPA, 1988a).

The initial screening analysis of technologies and process options is based on a subset of the CERCLA feasibility screening criteria. Specifically, the CERCLA criteria used for this initial screening analysis include effectiveness, implementability, and cost. These criteria are summarized below:

***Effectiveness***

The effectiveness of each technology or process option is evaluated based on the following criteria:

- The ability of the options to meet the RAOs.
- Potential effects to human health and the environment during the implementation phase.
- Reliability with respect to conditions at the site.

***Implementability***

Implementability encompasses both the technical and administrative feasibility of implementing a technology or process option. This includes the ability to obtain necessary permits, treatment, storage and disposal services and the availability of necessary equipment and labor to implement the process option.

***Cost***

Cost plays a limited role in the screening of technologies and process options. The relative cost for each option is estimated as to whether it is low, moderate, or high. Costs are based on engineering judgment and available historical information associated with the respective option.

## 5.2 No Action

Evaluation of the "No Action" option is required by the NCP as the baseline case to which all other response actions are compared. Under the no action response, no remedial activities would be conducted and there would not be any short- or long-term monitoring.

No action may be appropriate if a site does not currently pose a potential threat to human health or the environment or if previous remedial actions have eliminated the need for further action.

***Effectiveness***

The no action response represents the existing site conditions at IRP Site 27 as described in the final RI Report (SES-Tech, 2012b) and in Section 3.0 of this FS. This response would not reduce potential exposure to contaminated media. Therefore, this option would not be effective in reducing the potential risk to the receptors.

***Implementability***

Because no action would be taken, this response would be easily implementable.

***Cost***

Because no action would be taken, no costs would apply to this option.

***Screening Results***

Per the NCP, no action serves as a baseline for comparison with other response actions and is retained for further evaluation in Section 6.0.

## 5.3 Institutional and Engineering Controls

Institutional controls (ICs) are restrictive measures placed on the use of land or an area to prevent or limit exposure to hazardous substances left in place at a site, or to ensure effectiveness of a given remedy. ICs can generally be implemented by the property owner or a governmental body. Therefore, they fall into two general categories, namely proprietary controls and governmental controls.

Proprietary controls involve legal instruments placed in the chain of title of the site property to restrict future land uses. Proprietary controls include easements and covenants. Governmental controls are restrictions placed on the use of land that are within the auspices of the state or local authority to enforce. Such controls may include local zoning ordinances and administrative orders or consent decrees available to U.S. EPA under CERCLA and the Resource Conservation and Recovery Act (RCRA) that can be used to restrict the use of land.

Engineering controls include fencing or other physical means of preventing or minimizing exposure of receptors to contaminated media, or of ensuring the integrity of a physical remedy.

ICs and engineering controls for soil are retained for further evaluation.

***Effectiveness***

ICs would be effective measures in limiting human exposure to contaminated media. At IRP Site 27, these controls would be effective at protecting engineering components of a remedy such as a cover or cap on the landfill and ensuring that site groundwater, specifically around MW-2, remains in place. ICs would serve as an immediate measure to curtail human exposure at the site and could also be established to prohibit any intrusive activities which may occur at the site inside or outside areas of the

soil cover. Specifically, if any intrusive activities such as construction occurred after remedy completion, proper risk management plans could be required.

Engineering controls such as fencing is a method for limiting or restricting future land use of the area. Due to the mission of Detachment Fallbrook, the maintenance of explosives safety buffers related to the storage of ordnance already provide a significant degree of site control that prevents unauthorized individuals from accessing the area. Therefore, certain controls are already in place at IRP Site 27. Nonetheless, other measures, such as prohibiting the installation of groundwater production wells in the vicinity of the landfill might be required at IRP Site 27.

***Implementability***

ICs and engineering controls would be easily implemented at IRP Site 27. Establishment of appropriate controls on human behavior and/or proper warning signs could be an effective way of implementing this remedial component. Construction and maintenance involved for such remedial components would be easily implementable.

***Cost***

ICs and engineering controls would be comparatively lower in cost than most of the other remedial process options available.

***Screening Result***

ICs and engineering controls are effective, implementable, and low in cost. Therefore, they are carried forward to Section 6.0 for further analysis in the development of remedial alternatives.

## 5.4 Soil Cover Improvements

Landfill soil covers typically consist of a single layer of fill material placed and compacted to serve as a physical barrier between human and ecological receptors and waste. Soil covers are generally designed to be of a suitable thickness to act as an effective shield against underlying waste. Landfill soil covers do not necessarily minimize infiltration to the same degree as an engineered cap. In the case of IRP Site 27, additional improvements could include the placement and compaction of additional fill material to increase the thickness of the landfill cover in areas of the site where the depth to waste is shallow (e.g., 1 to 2 ft) as well as the installation of hardened surface drainage areas to mitigate the potential for future erosion of the soil cover.

***Effectiveness***

An improved soil cover could provide additional protection in shielding receptors from the underlying contamination at IRP Site 27. While there is some variability in the thickness of the existing landfill cover, the current cover has proven to be effective at preventing waste from being exposed at the ground surface for over 40 years and has no sign of significant surface erosion because it is well stabilized with a covering of native species including coastal sage scrub. Improving the soil cover by increasing the thickness in certain areas and providing hardened drainage to minimize erosion would ensure proper function and the integrity of the soil cover in the future. Appropriate ICs would need to be in place to prevent activities that could lead to a reduction in the effectiveness of the cover. Soil covers are only effective in generally limiting (i.e., not preventing) infiltration of precipitation to groundwater, but hardened drainage would serve as a preferential flow path for overland transport of stormwater and would mitigate, but not altogether eliminate, infiltration of stormwater within the areal extent of the landfill at IRP Site 27.

***Implementability***

The technology required to implement soil cover improvements is readily available and easily implementable. At IRP Site 27, cover improvements could easily be implemented given the availability of common earth materials and the equipment used to place this material. Soils used for cover layers are generally compacted common fill that has a permeability no greater than $1 \times 10^{-6}$ centimeters per second (cm/s). However, the IRP Site 27's well compacted cover already has a generally lower permeability ranging from $1.47 \times 10^{-6}$ to $1.79 \times 10^{-7}$ cm/sec. Compacted soil covers are generally installed in 6-in. minimum lifts to achieve a thickness of 2 ft or more (Federal Remediation Technology Roundtable [FRTR], 2006). The materials and expertise required to install hardened surface drainage across the site are also readily available, supporting a high degree of implementability for improvements to the landfill soil cover.

Thickening the landfill cover has the potential to kill the coastal sage scrub, which would be a loss of critical habitat for the California Gnatcatcher and would require documentation with the U.S. Fish and Wildlife Service. The loss of vegetation, on the other hand, would potentially create a viable habitat for the Stephan's kangaroo rat which prefers to burrow in relatively open ground. Because it would take time for vegetation to grow back to its current thickness, increased erosion is likely in the short term. Hydroseeding and the planting of vegetation will coincide with the thickening of the cap to curb the temporary increase in erosion. The loss of vegetation could also cause a temporary increase of water seepage into the waste because plant roots reduce the amount of water that can seep through the cap.

The IRP Site 27 landfill cover is currently stabilized by thick vegetation that includes native plant species such as coastal sage scrub. Based on observations of the current condition of the landfill cover, the existing vegetation is well established such that the combination of covered soil and established root systems has produced a highly stable ground surface that is resistant to erosion. Immediately after placing the improved soil cover, the ground surface would be compacted soil lacking vegetative cover. While replanting would be conducted to re-establish native vegetation, for the first year or two the improved areas of the cover would be more susceptible to erosion than the current ground surface. Another concern is that process would temporarily eliminate the existing vegetation which serves as habitat for native wildlife species.

***Cost***

Cost for improvements to the soil cover would generally be lower than other capping technologies (i.e., an engineered cap). ).

***Screening Result***

Improvements to the landfill soil cover would be a cost-effective, implementable, and effective way of providing additional protection in shielding receptors from the underlying contamination. Therefore, this technology is carried forward as a remedial option.

## 5.5 Engineered Soil Cap

In an engineered soil cap, a flexible, synthetic membrane or other form of liner is covered with a layer or layers of soil to form an impermeable cap. This cap design can be composed of a soil cover with a geomembrane liner made of an impermeable, synthetic material, as is commonly used for a landfill liner. An engineered cap differs from a soil cover because the cap would not allow infiltration of precipitation into the groundwater.

***Effectiveness***

An engineered cap would be effective in isolating waste from human and ecological receptors at IRP Site 27. This method of capping would be protective of groundwater because it would minimize infiltration. At IRP Site 27, the entire landfill area would be capped and, for this alternative to function effectively, proper drainage would need to be provided. In addition, while soil gas sampling has indicated that buildup of landfill gases is not currently a concern, gas vents may be required to mitigate buildup of landfill gases underneath the impermeable cap.

***Implementability***

Synthetic membranes are commercially available and are manufactured in a range of thicknesses and widths. They can be reinforced, have smooth or roughened surfaces, and can be designed to integrate ultraviolet protection. Specialized installation methods are required for cap construction. For instance, low impact earth moving equipment is generally required to prevent damage to the synthetic liner layer. In addition, given that the engineered cap is designed for impermeability, great care is required to establish proper site drainage and prevent ponding. With a surface grade of 6% from south to north, the site topography would support adequate drainage of runoff.

While sensitive species have not been observed at IRP Site 27, the site has been noted to contain habitat that could support local special status species, such as the SKR, CAGN and LBV. The installation of an impermeable, continuous engineered cap would require the clearance of all surface vegetation, including trees and shrubs at the south end of the landfill, and would severely disrupt habitat at the site. Due to the field work being conducted within potential sensitive habitat, field approaches would be modified to comply with state and federal ARARs and may include altering field schedules, providing an on-site biological monitor, and potential down time if sensitive species are observed onsite, An engineered cap would therefore be characterized by a moderate to low level of implementability.

***Cost***

Costs associated with the engineered capping technology would likely be higher compared to other capping technologies (i.e., soil cover).

***Screening Result***

While an engineered cap would be an effective means to ensure long-term isolation of the waste layer at IRP Site 27, its effectiveness is comparable to a soil cover. Furthermore, installation of an engineered cap over the entire landfill would be a high cost capping technology and is less implementable than an improved soil cover due to the widespread disruption of potential habitat. As a result, this technology is not carried forward as a viable remedial option.

## 5.6 Monitoring

If a cover or capping remedy was implemented, periodic inspections would be necessary to ensure the remedy is functioning as intended and achieve RAOs. In addition, if ICs were implemented, periodic site inspections would be required to document that site groundwater is not being used as a direct source of drinking water. Future monitoring of groundwater would also be necessary to support ICs. Specifically, limited long-term groundwater monitoring would be implemented to determine whether the landfill continues to support reducing geochemical conditions that cause metals to mobilize into the aquifer near the northern end of the landfill and to ensure there is no off-site migration of elevated metals concentrations. The monitoring process for groundwater involves regular inspections, groundwater monitoring and compliance reporting. A limited number of groundwater monitoring wells would be sampled periodically to monitor aquifer conditions in areas of interest.

***Effectiveness***

Periodic inspections would be an effective method of verifying the proper function of a capping or cover remedy and would also serve as a means by which site managers could verify that groundwater at IRP Site 27 is not being pumped for potable use. Signs prohibiting the removal or use of groundwater and restricting the excavation or disturbance of soil without prior authorization will be added to the area around IRP Site 27. Contact information will be listed on this sign. The Navy's Land Use Control (LUC) would ensure land use remains unchanged and would prohibit the installation of drinking water wells. The Navy would use its specifically developed LUC Tracker database to monitor the status of the site and verify that conditions align with the established LUCs. Groundwater monitoring would similarly be an effective approach for assessing aquifer conditions, particularly in the northern part of the landfill, while also documenting that elevated metals concentrations remain localized and are not migrating off site. Future monitoring results would also provide information that could be used to determine whether there is a change to the CSM. For example, if reducing geochemical conditions were shown to dissipate, such that metals were no longer mobilizing into the aquifer in the northern area of the landfill, ICs implemented to prevent future exposure of human receptors to impacted groundwater and to prevent off-site impacts from the potential mobilization of naturally-occurring metals in groundwater could potentially be removed from the site. Inspections would also be conducted to monitor the site for signs of landfill cap erosion.

***Implementability***

Various types of sampling and analysis and remedy effectiveness monitoring would be easily implementable across the site. Inspections and groundwater sampling and analysis would be highly implementable at IRP Site 27 as demonstrated by previous investigations.

***Cost***

The costs associated with various types of sampling and analysis and remedy effectiveness monitoring would likely be low to moderate, since inspection frequencies and the number of wells and analytes included in a long-term monitoring program could be minimized based on the CSM. Groundwater sampling and analysis would be a cost-effective process option if planned and executed effectively. Additionally, optimization reviews of the long-term monitoring plan could reduce future costs associated with this process option.

***Screening Result***

Sampling and analysis or monitoring as a stand-alone remedy is not considered a viable remedial approach for IRP Site 27. However, monitoring is retained as a process option that could support other options, such as a soil cover or cap and ICs. Long-term groundwater monitoring is a practical method of assessing changes in site conditions and to ensure that off-site migration of chemicals in groundwater is not an issue in the future. This process option is, therefore, retained as an effective technology to support other remedial alternatives.

## Section 6.0: DEVELOPMENT AND DETAILED EVALUATION OF REMEDIAL ALTERNATIVES

Based on the conclusions of the RI Report and the updated CSM presented in Section 3.0, project-specific RAOs were developed for IRP Site 27 based on the mobilization of naturally-occurring metals in groundwater (i.e., resulting from reducing geochemical conditions associated with the landfill) and the thickness of certain portions of the landfill cover. In this section, remedial alternatives are presented that would address the project-specific RAOs and satisfy the requirements of 40 Code of Federal Regulation (CFR) 300.430(e). As required by the NCP and recommended by U.S. EPA (1988b) guidance, acceptable engineering practices that relate to site-specific conditions were considered in developing the remedial action alternatives for IRP Site 27.

Based on the screening of remedial process options and technologies presented in Section 5.0, three remedial alternatives for IRP Site 27 were developed for detailed analysis. Only a limited number of alternatives are suitable for IRP Site 27, therefore a preliminary evaluation of remedial alternatives was not considered necessary and was not completed. CERCLA and the NCP permit the flexibility to conduct only a detailed analysis of alternatives when a preliminary evaluation is not practical or appropriate. The three remedial alternatives determined to be the most suitable for addressing the RAOs for IRP Site 27 are as follows (note that in accordance with the requirements of the NCP and CERCLA, the No Action alternative is presented and carried through the entire FS to serve as the baseline condition with which to compare other remedial alternatives):

- Alternative 1: No Action
- Alternative 2: ICs and Long-Term Monitoring
- Alternative 3: Soil Cover Improvements with ICs and Long-Term Monitoring

The detailed analysis of the three remedial alternatives is based on the NCP/CERCLA feasibility criteria: overall protection of human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost.

Overall protection of human health and the environment and compliance with ARARs are threshold criteria. CERCLA and the NCP require that a remedial action protect human health and the environment and comply with ARARs, unless justification to waive a particular ARAR is documented.

Long-term effectiveness and permanence, reduction of toxicity, mobility, or volume through treatment, short-term effectiveness, implementability, and cost are balancing criteria. Balancing criteria are the primary means by which alternatives are differentiated and compared. An environmental sustainability analysis was also performed for each alternative using the SiteWise™ tool, focusing on the on-site, construction-related elements of each alternative. Based on various inputs, the SiteWise™ tool quantifies environmental sustainability impacts specifically in terms of greenhouse gas emissions, energy consumption, consumption of other finite resources, priority air pollutant emissions, and collateral risks (i.e., hazards to humans from physical implementation of a remedy). The results of the sustainability analysis are considered within the short-term effectiveness balancing criterion for each alternative.

Community and state acceptance are considered modifying criteria, to be taken into account in ultimate remedy selection. The evaluation of community and state acceptance cannot be completed until comments on the RI/FS and PP are received and resolved. These criteria will therefore be more thoroughly addressed in the Proposed Plan and/or Record of Decision (ROD) for IRP Site 27.

Table 6-1 provides a summary of the detailed evaluation of the three alternatives presented in this section. Table 6-2 provides a summary of the environmental sustainability assessment for the alternatives based on the SiteWise™ tool, and Figure 6-1 provides the SiteWise™ environmental sustainability output in graphical form (detailed summaries of the SiteWise™ evaluation are provided in Appendix B). Table 6-3 summarizes the cost for each of the alternatives (detailed cost estimates for each alternative are provided in Appendix C).

## 6.1 Alternative 1: No Action

**6.1.1 Detailed Description of Alternative 1.** In accordance with the NCP, the No Action alternative is generally carried through the entire FS to serve as the baseline condition against which other alternatives are evaluated. Alternative 1 would entail no action of any kind, including inspections or monitoring of site conditions. Natural recovery processes, ICs, and long-term monitoring are also not components of this alternative.

### 6.1.2 Detailed Screening of Alternative 1

***6.1.2.1 Overall Protection of Human Health and the Environment.*** Alternative 1 would not include additional measures to increase the thickness of the landfill cap. Additionally, while consumption of site groundwater is currently an incomplete exposure pathway, Alternative 1 would not include controls to prevent site groundwater from being pumped for potable use. There are currently no unacceptable risks to human health or the environment; however, future erosion or installation of production wells on site could result in future risk to human and ecological receptors, and Alternative 1 would do nothing to prevent or protect against such risks.

***6.1.2.2 Compliance with ARARs.*** Alternative 1 would not generate action-specific ARARs, since under Alternative 1 no action would be taken at IRP Site 27. However, chemical- and location-specific ARARs would still apply or be relevant and appropriate for IRP Site 27 under Alternative 1, regardless of whether any response action is to be taken to address conditions at the site. Therefore, Alternative 1 would not comply with ARARs and thus would not meet the ARARs-based threshold criterion.

***6.1.2.3 Long-Term Effectiveness.*** The RAOs for IRP Site 27 have been developed to address long-term considerations that may result in exposed waste at the ground surface from potential future erosion or a change in future site use that results in potable use of site groundwater. Since Alternative 1 does not include action or controls of any kind, the long-term effectiveness of this alternative in meeting project RAOs would be low.

***6.1.2.4 Reduction of Toxicity, Mobility, and Volume through Treatment.*** The toxicity, mobility, and volume of contamination would not be reduced through treatment under the No Action alternative.

***6.1.2.5 Short-Term Effectiveness.*** Given that no remedial action would be undertaken in executing the No Action alternative, implementation of this alternative would impose no short-term risks to the community, the environment and/or site workers. Additionally, Alternative 1 is considered effective in the short term because there are currently no unacceptable risks to human health or the environment based on sampling of site soil, soil gas, groundwater, and surface water.

***6.1.2.6 Implementability.*** No equipment, manpower, or resources would be required to implement Alternative 1. No operations would be conducted, and no administrative efforts would be required. As such, the No Action alternative would be readily implementable.

***6.1.2.7 Cost.*** There would be no capital, permitting, monitoring, or operation and maintenance costs associated with Alternative 1.

***6.1.2.8 Community Acceptance.*** Community acceptance will be evaluated during the review and comment period on the FS and during preparation of the PP, and will be thoroughly addressed in the ROD.

***6.1.2.9 State Acceptance.*** As with community acceptance, state acceptance will be evaluated during the review and comment period on the FS and during preparation of the PP. State acceptance will be addressed, if and to the extent possible, in the PP, but will be thoroughly addressed in the ROD.

## 6.2 Alternative 2: Institutional Controls and Long-Term Monitoring

Alternative 2 would include ICs and long-term monitoring to ensure long-term achievement of the RAOs. The components of this alternative are described below.

### 6.2.1 Detailed Description of Alternative 2

***Institutional Controls***

ICs are legal and administrative mechanisms used to implement land use and access restrictions that are used to limit the exposure of future landowner(s) and/or user(s) of the property to hazardous substances and to maintain the integrity of the selected remedy. Legal mechanisms include proprietary controls such as restrictive covenants, negative easements, equitable servitudes, lease restrictions, and deed notices. Administrative mechanisms include notices, posting signs, adopted local land use plans and ordinances, construction permitting, or other existing land use management systems that may be used to ensure compliance with use restrictions. Monitoring and inspections are conducted to ensure that the ICs are being followed.

*Institutional Controls.* The following IC objectives to be achieved through land use restrictions will be incorporated into real property conveyance documents if the property containing IRP Site 27 is conveyed to a federal or non-federal entity:

*Restricted Land Uses.* The following land uses will be restricted for property in the IRP Site 27 areas requiring ICs. The Navy shall not modify or terminate ICs, or proceed with any anticipated action that may disrupt the effectiveness of the ICs or any action that may alter or negate the need for ICs, without first coordinating with and seeking the concurrence of the regulatory support agencies:

i. A residence, including any mobile home or factory built housing, constructed or installed for use as residential human habitation;

ii. A hospital for humans;

iii. A school for persons under 21 years of age;

iv. A daycare facility for children; or

v. Any permanently occupied human habitation other than those used for commercial or industrial purposes.

*Restricted Activities.* The following activities will be restricted for property in the IRP Site 27 areas requiring ICs. The Navy shall not undertake any such activity without first coordinating with and seeking the concurrence of the regulatory support agencies:

i. "Land disturbing activity" which includes, but is not limited to:
   (1) Excavation of soil;
   (2) Construction of roads, utilities, facilities, structures, and appurtenances of any kind;
   (3) Demolition or removal of "hardscape" (for example, concrete roadways, parking lots, foundations, and sidewalks);
   (4) Any activity that involves movement of soil to the surface from below the surface of the land; and
   (5) Any other activity that causes or facilitates the movement of known contaminated groundwater.

ii. Alteration, disturbance, or removal of any component of a response or cleanup action (including, but not limited to, pump-and-treat facilities, revetment walls and shoreline protection, and soil cap/containment systems); groundwater extraction, injection, and monitoring wells and associated piping and equipment; or associated utilities;

iii. Extraction of groundwater and installation of new groundwater wells; and

iv. Removal of or damage to security features (for example, locks on monitoring wells, survey monuments, fencing, signs, or monitoring equipment and associated pipelines and appurtenances).

*Implementation and Oversight.* The Department of the Navy (DON) will document the need for IC implementation and monitoring actions including periodic inspections in the remedial design. The remedial design report will include a land use control remedial design section to describe required IC implementation actions, including:

- Requirements for CERCLA 5-year remedy review;
- Frequency and requirements for periodic monitoring or visual inspections;
- Reporting results from monitoring and inspections;
- Notification procedures to the regulatory support agencies for any planned property conveyance, corrective action required, and/or response to actions inconsistent with ICs for the remedy;
- A list of ICs with their expected duration; and
- Maps identifying where ICs are to be implemented.

The DON will be responsible for implementing, monitoring, maintaining, inspecting, reporting, and enforcing the necessary ICs in accordance with the approved remedial design reports. Although the DON may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or other means, the DON will retain ultimate responsibility for remedy integrity. Should any of the ICs fail, the DON would ensure that appropriate actions are taken to re-establish protectiveness of the remedy and may initiate legal action to either compel action by a third party(ies) and/or recover the DON's costs for mitigating any discovered IC violation(s). The ICs would be maintained until such time as the DON state determines — in coordination with the state regulatory support agencies — that they are no longer necessary to allow for the planned future use of the property and to reduce potential exposure to acceptable levels.

The DON and the state regulatory support agencies and their authorized agents, employees, contractors, and subcontractors would have the right, with prior approval, to enter IRP Site 27 to conduct

investigations, tests, or surveys; inspect field activities; or construct, operate, and maintain any response or remedial action as required or necessary. IRP Site 27 is located within an active weapons storage facility and all parties requiring access would be subject to the security procedures and approvals required for Detachment Fallbrook. Specifically, barring exigent circumstances, all visits to Detachment Fallbrook for such purposes require two weeks advance notice, and individuals coming onto the installation for such visits would be required to take explosive safety training (or demonstrate having received equivalent training) before entering the magazine area, and to be escorted at all times while within the area.

***Long-Term Monitoring***

Long-term monitoring would consist of annual inspections of the existing soil cover and the IC mechanisms to ensure future cover integrity and effectiveness. Annual inspection of the soil cover would include a site visit to make direct observations of any issues pertaining to cover integrity (e.g., erosion channels). In addition to the annual inspection, quantitative surveys of the cap will also be conducted upon the signing of the ROD to provide baseline data and then every five years thereafter. The proposed surveying approach would involve establishing 10 survey transects that would be equally spaced (approximately every 100 ft) along the length of the landfill (i.e., a similar orientation to the cross-sections shown in Figure 6-2). A total of 20 permanent markers would be installed at the beginning and end of each transect. A baseline survey would be conducted to document conditions at the time of the ROD and monitoring surveys would be conducted every five years (in addition to visual surveys conducted annually) to provide a quantitative measure of cover stability at IRP Site 27. The surveys would be completed by a California-licensed professional land surveyor using a static surveying approach and equipment capable of achieving a vertical accuracy of 5 mm or less. The surveying results for each transect will be compared to the baseline survey to assess whether erosion is occurring. The results of these surveys would be presented in the five-year review, which would provide a mechanism to revisit the remedy if future erosion is observed.

As shown in the three-dimensional model developed for IRP Site 27 the filter pack for MW-2 intersects the waste layer, which results in a direct hydraulic connection between the well screen and the waste prism. Therefore, it is recommended that MW-2 be abandoned and replaced with an adjacent well that could serve to monitor site conditions in the downgradient area of the landfill. The replacement well should be designed so that the well seal isolates the waste layer from the filter pack and screened interval of the replacement monitoring well. MW-2 is the only well that consistently exhibits exceedances of drinking water criteria (i.e., metals that are considered to be attributable to a combination of background conditions and the geochemistry of the landfill). A properly installed monitoring well screened below the waste layer would provide information useful to further refine the CSM. Data from a replacement well could provide an indication as to whether the geochemical effects of the landfill are isolated to the waste layer or if those geochemical effects extend to groundwater 5 or 10 ft below the bottom of the waste prism.

The replacement of MW-2 would result in a monitoring well network that is suitable and appropriate to monitor site conditions and ensure off-site migration of elevated metals concentrations is not occurring. However, during the remedial design, a subset of the monitoring well network would be evaluated for inclusion in the long-term monitoring program. For the purpose of estimating costs and providing a reasonable approach to monitoring under this remedial alternative, long-term monitoring would consist of annual monitoring for 5 years followed by monitoring every 5 years for 25 years. Up to four monitoring wells, most likely MW-1, MW-2 (replacement), MW-3, and MW-7, would be sampled during each monitoring event. At a minimum, samples would be analyzed for metals and geochemical field parameters. Appropriate quality assurance/quality control samples would also be generated (e.g., field duplicates).

Monitoring would generate limited volumes of purge water and the sample results would be used to develop appropriate waste manifest documentation and support a limited off-site waste disposal effort for each sampling event. For purposes of developing costs, it is assumed that purge water would be classified as non-hazardous and disposed offsite at a waste disposal facility permitted for disposal of liquid non-hazardous waste. It is anticipated that monitoring would generate one 55-gallon drum of purge water per sampling event.

Long-term monitoring would also include an annual assessment of IC mechanisms to ensure their continued effectiveness. Annual reporting would be required to document the ongoing effectiveness of the ICs and the groundwater monitoring results. During the first 5 years, annual reporting of the monitoring results would be conducted, after which, monitoring results would be incorporated into the 5-year review document developed for the broader IRP at Detachment Fallbrook.

### 6.2.2 Detailed Screening of Alternative 2

***6.2.2.1 Overall Protection of Human Health and the Environment.*** Under Alternative 2, groundwater conditions would be monitored through a long-term monitoring program. Given that the metals of interest are naturally occurring and related to localized geochemical effects of the landfill, risks associated with groundwater at the site are low and would be adequately managed through a detailed monitoring program along with the ICs that would prevent groundwater from being pumped for potable use. Alternative 2 includes appropriate control measures (i.e., land use restrictions) to protect against use of site groundwater and potential exposure to groundwater containing metal concentrations that exceed drinking water standards. It is anticipated that Alternative 2 would be highly effective in ensuring that groundwater is not pumped for potable use and would also provide frequent monitoring results to confirm the CSM and document that localized impacts are not migrating off site. There are currently no unacceptable risks to human health or the environment, however future erosion or installation of production wells on site could result in future risk to human and ecological receptors. Through ICs and long-term monitoring, Alternative 2 would provide a high level of protection for humans and the environment in the context of site-specific conditions and the project RAOs.

***6.2.2.2 Compliance with ARARs.*** Alternative 2 would comply with all chemical-, location-, and action-specific ARARs identified in Appendix A.

***6.2.2.3 Long-Term Effectiveness.*** The RAOs for IRP Site 27 have primarily been developed to address long-term considerations that may result in exposed waste at the ground surface from long-term erosion or a change in future site use that could result in potable use of site groundwater. Since Alternative 2 includes controls and monitoring to ensure the site remains protective, this alternative would likely achieve the project RAOs. Long-term effectiveness would be influenced by the ability to effectively ensure the application of IC measures. Overall, Alternative 2 would be highly effective in the long term at mitigating risk, and mechanisms would be in place to ensure its continued effectiveness. Additionally, if long-term monitoring indicated that future erosion of the existing cover resulted in the exposure of waste at the ground surface, the 5-year review may result in recommendations for additional remedial action to address erosion of the landfill cover. Conversely, if long-term monitoring showed no signs of erosion, the 5-year review may result in recommendations to discontinue monitoring of the landfill cover.

***6.2.2.4 Reduction of Toxicity, Mobility, and Volume through Treatment.*** The toxicity, mobility, and volume of contamination would not be reduced through treatment under Alternative 2.

***6.2.2.5 Short-Term Effectiveness.*** There would be no significant construction activities at IRP Site 27 in conjunction with Alternative 2 and, as a result, there would be no appreciable short-term risk to

the community, environment and/or site workers. Measures in the form of ICs would be put in place to control short-term risks present at the site by prohibiting potential exposures to site waste and preventing potable use of site groundwater. Overall, the short-term effectiveness of Alternative 2 would be high.

***6.2.2.6 Implementability.*** Long-term monitoring is an easily implementable process and ICs are similarly a standard process that could be easily implemented at IRP Site 27. The overall technical and administrative implementability of this alternative would be high.

***6.2.2.7 Cost.*** Based on the assumptions in this FS, the total present worth cost for Alternative 2 would be moderate with a non-discounted total cost of $717,600. Costs would include ICs, monitoring, and routine maintenance costs associated with maintaining control of the site. Cost details are provided in Appendix C.

***6.2.2.8 Community Acceptance.*** Community acceptance will be evaluated during the review and comment period of the FS and during the public comment period on the PP, and will be thoroughly addressed in the ROD. Community acceptance of Alternative 2 likely would be based on the community's understanding that site risks would be adequately mitigated through a properly designed and implemented monitoring program and strict maintenance of controls.

***6.2.2.9 State Acceptance.*** As with community acceptance, state acceptance will be evaluated during the review and comment period of the FS and PP, and will be thoroughly addressed in the ROD. State acceptance of Alternative 2 likely would be based on regulators' understanding of the same issues described above for community acceptance. In addition, close coordination with regulatory agencies would be necessary to satisfactorily implement this remedy.

## 6.3 Alternative 3: Soil Cover Improvements with Institutional Controls and Long-Term Monitoring

Soil Alternative 3 would include improvements to the soil cover, which would include increasing the minimum cover thickness to 1.5 ft in all areas of the former landfill. During the development of Alternative 3, consideration was given to include hardened drainage at the ground surface in areas of the landfill cover that would be expected to convey significant runoff during high volume rain events. However, as described below in Section 6.3.1, hardened drainage has not been included as a cover improvement option for Alternative 3. The cover improvement options included in Alternative 3 would serve to isolate and prevent contact with buried waste. The soil cover improvements would be implemented in conjunction with the ICs and long-term monitoring discussed for Alternative 2. The IC and long-term monitoring components of Alternative 3 are described and evaluated in detail in Section 6.2. The following sections provide a description and evaluation of the soil cover improvement components of Alternative 3.

**6.3.1 Detailed Description of Alternative 3.** Under Alternative 3, landfill waste material and contaminated soil would remain in place but would continue to be contained under a soil cover. Figure 6-2 provides a site map with a series of cross-sections depicting the waste layer in relation to clean soil. As shown in Figure 6-2, the existing soil cover ranges from 1 to 2.5 ft thick across the former landfill extent, with the thinnest portion of the landfill cover being located near cross-section B. The existing soil cover would be improved by adding a 6-in. layer of topsoil in areas of the current landfill cover that were determined to be less than 1.5 ft thick. All material preferably would be derived from a local source. All necessary steps would be taken to ensure the material is from a clean source and uncontaminated. For purchased fill material, this would consist of ensuring the materials distributor maintains a guaranteed clean certification, with specific testing to confirm that only clean material is used.

The proposed increased cover thickness would result in a soil cover ranging from 1.5 to 2.5 ft thick over the landfill area. Some amount of preliminary site work may be required to provide a suitable surface over which to place the additional cover material in areas where the cover thickness is less than 1.5 ft. The cover material would be transported to the site via truck and the cover placement method would likely be direct release from trucks. The additional cover material would be installed by controlled placement and reworking of the cover materials using common earth moving equipment (i.e., trucks and graders). The cover would be constructed by placing fill material in a single 6-in. lift, followed by necessary compaction and grading to achieve a uniform cover thickness. The compaction goal would likely be on the order of a 90% Proctor value. Accurate surveying tools would be employed as necessary during cover placement to ensure the appropriate placement and thickness of the soil cover and the ultimate achievement of design elevations. Cover material would be placed and moved in a controlled manner by truck and/or earth moving equipment so as not to disturb underlying waste. A certified biologist would be present on site and biological mitigation and avoidance measures would be incorporated into the project plans and followed during field work to minimize direct impacts to any wildlife present at the site. As shown in Figure 6-3, the extent of the soil cover requiring additional material is approximately 0.5 acres. Several established trees are located within the area in which additional cover material would be placed. Surface preparation would include removing surface vegetation, but the established trees would not be removed. Rather, the additional cover material would be graded so that the ground surface elevation at the base of each tree would be maintained, with the cover material placed at least 3 ft away from the base of each tree. Despite these measures there is still a chance that the trees will be affected because increasing cap thickness will likely affect their root systems, especially if the soil cover fills in around the tree trunk, and could potentially lead to premature mortality of the trees.

Controlling infiltration is not an RAO for IRP Site 27, but the permeability of the additional cover material would be expected to be comparable to the existing soil cover, which exhibits hydraulic conductivities ranging from $1.47 \times 10^{-6}$ cm/sec to $1.79 \times 10^{-7}$ cm/sec. The multilayer soil cover would be a uniform thickness and would therefore follow the current grade of the site, which is approximately 6% in a north-south orientation. The natural grade would be expected to convey surface runoff in a manner that would prevent water from ponding at the ground surface. The upper surface of the multilayer soil cover would be seeded with a mixture of native vegetation to increase strength and erosion resistance and provide optimal conditions for ecological stability. The seed mixture would be selected in close consultation with the regulatory community, and would likely be administered via hydroseeding to cover the new soil surface. The seed would be thoroughly watered in, and repeated watering would be conducted for the first year to ensure adequate germination and vegetation growth.

The improved soil cover would continue to isolate the waste layer from the surrounding environment and would continue to prevent potential human or ecological receptors from being exposed to waste, while also stabilizing the underlying soil and waste material. Based on inspections of site conditions at IRP Site 27, the existing soil cover, which has been in place for over 40 years, did not exhibit signs of erosion. Erosion was documented in an alluvial depression, which appeared to be incised to bedrock that formed a continuous channel to the west of the waste extent. While runoff was not observed in the channel, there was evidence of erosion as well as indications that the channel serves as the preferential flow pathway for surface water collected from the western portion of the IRP Site 27 subcatchment. Erosion was not observed directly over the inferred extent of the landfill. Based on the lack of evidence of erosion within the extent of the existing soil cover, the presence of a preferential flow pathway ranging from roughly 50 to 100 ft west of the waste extent, the low hydraulic conductivity of the existing soil cover, and the relatively modest grade of the site (i.e., an average surface grade of 6%), armoring or hardened drainage to protect the cover from erosion is not needed and therefore not included as a component of Alternative 3. If Alternative 3 was selected as the most suitable remedy for IRP Site 27, design specifications and requirements would be established for the additional cover material during a

detailed design phase, to be completed following selection of the remedial alternative and issuance of the ROD, and prior to construction.

Placement of additional cover material in areas where the existing cover is less than 1.5 ft thick is an approach that is compatible with the current and future use of IRP Site 27, and would only require several weeks of field work to complete. As previously stated, Alternative 3 also includes ICs and long-term monitoring as described in Section 6.2.1.

### 6.3.2 Detailed Screening of Alternative 3

***6.3.2.1 Overall Protection of Human Health and the Environment.*** Under Alternative 3, the existing soil cover would be improved by adding 6 in. of additional cover material in areas of the site where the soil cover is less than 1.5 ft, which would be an adequate approach to isolate and prevent contact with buried waste. In addition, groundwater conditions would be monitored through a long-term monitoring program and ICs would prevent groundwater from being pumped for potable use (as discussed above with respect to Alternative 2). IRP Site 27 does not currently pose a risk to human or ecological receptors; however, mobilization of naturally-occurring metals in groundwater (i.e., resulting from reducing geochemical conditions associated with the landfill) and the potential for future erosion of the landfill cover suggest a potential for future risk to both human and ecological receptors, which would be adequately managed through ICs and long-term monitoring.

Increasing the soil cover in low thickness areas would augment the ability of the landfill cap to isolate wastes from human and ecological receptor potential. Alternative 3 would be highly effective in ensuring that groundwater is not pumped for potable use and would also provide frequent monitoring results to ensure localized impacts are not migrating off site. There are currently no unacceptable risks to human health or the environment, however future erosion or installation of production wells on site could result in future risk to human and ecological receptors. Through ICs and long-term monitoring, Alternative 3 would provide a high level of protection for humans and the environment in the context of site-specific conditions and the project RAOs. Soil cover improvements would theoretically provide additional protection from exposure to waste at the ground surface, however observations of site conditions did not indicate the presence of erosion within the soil cover overlying the waste prism.

***6.3.2.2 Compliance with ARARs.*** Alternative 3 would be compliant with all identified ARARs. Remediation activities under Alternative 3 would be expected to ensure the site is protective based on the planned future use. Best management practices would be used during site work to minimize the potential for disturbance to landfill waste and biological avoidance and mitigation measures would be implemented to minimize impacts to special status species. Alternative 3 would comply with all chemical-, location-, and action-specific ARARs identified in Appendix A.

***6.3.2.3 Long-Term Effectiveness.*** The RAOs for IRP Site 27 have primarily been developed to address long-term considerations that may result in exposed waste at the ground surface from long-term erosion or a change in future site use that could result in potable use of site groundwater. Since Alternative 3 includes improvements that would further stabilize the soil cover controls and monitoring to ensure the site remains protective, this alternative would achieve the project RAOs. Long-term effectiveness would be influenced by the ability to effectively ensure the application of IC measures and the performance of the improved soil cover, which would be inspected through the long-term monitoring program. Overall, Alternative 3 would be highly effective in the long term at mitigating risk, and mechanisms would be in place to ensure its continued effectiveness.

***6.3.2.4 Reduction of Toxicity, Mobility, and Volume through Treatment.*** The toxicity and volume of soil contaminants would not be altered at IRP Site 27 through treatment by implementing Alternative 3.

***6.3.2.5 Short-Term Effectiveness.*** Given the remoteness of the site and controls that would be in place during construction, the local community would not face short-term risks during remediation (e.g., construction noise and physical hazards such as traffic and heavy equipment associated with the soil cover construction). However, to the extent necessary, measures would be taken during construction to reduce and control short-term risks to the community by properly restricting access to work areas, and by limiting truck traffic to specific routes. If necessary, dust suppression measures would be taken to minimize exposures through air transport of dust. Suppression primarily would involve maintaining sufficient moisture in the soils during earthworking. If required, air monitoring would be implemented to establish specific boundaries of work areas, public access, and traffic routes.

Worker safety considerations would include heavy equipment hazards, occupational noise exposure, and potential slip, trip, or fall hazards. General site hazards would be reduced by providing a site-specific health and safety plan, appropriate safety equipment, and awareness training to orient personnel with the physical hazards at the site. Dust exposure would be minimized. Specific protection to be worn by on-site workers to prevent chemical exposures would be determined by the requirements established in the site-specific health and safety plan. Environmental impacts during a soil cover remedy would include potential impacts to native wildlife and vegetation. However, these exposures would be expected to be temporary. Control measures would include using careful and appropriate site work methods to minimize impacts within the soil cover area.

The IRP Site 27 landfill cover is currently stabilized by thick vegetation that includes native plant species such as coastal sage scrub. Based on observations of the current condition of the landfill cover, the existing vegetation is well established such that the combination of covered soil and established root systems has produced a highly stable ground surface that is resistant to erosion. Immediately after placing the improved soil cover, the ground surface would be compacted soil lacking vegetative cover. While replanting would be conducted to re-establish native vegetation, for the first year or two the improved areas of the cover would be more susceptible to erosion than the current ground surface. Another concern is that process would temporarily eliminate the existing vegetation which serves as habitat for native wildlife species.

Measures in the form of ICs would be put in place to control short-term risks present at the site by prohibiting potential exposures to site waste and preventing potable use of site groundwater. Overall, the short-term effectiveness of Alternative 3 would be moderate.

***6.3.2.6 Implementability.*** The technical implementability of this alternative would be high. The alternative would be implemented using standard earth moving equipment, and would rely on the availability of common earth materials. Long-term monitoring is an easily implementable process and ICs are similarly a standard process that could be easily implemented at IRP Site 27. The overall technical and administrative implementability of this alternative would be high.

***6.3.2.7 Cost.*** Based on the assumptions in this FS, the total present worth cost for Alternative 3 would be high at $1,125,020. Costs would include using clean earth materials from a fill source on the base, placement and working of the soil cover, grading and seeding, implementation of construction quality control testing and ICs, monitoring, and routine engineering costs. Cost assumptions and details are provided in Appendix C.

***6.3.2.8 Community Acceptance.*** Community acceptance will be evaluated during the review and comment period on the FS and during public comment period on the PP, and will be thoroughly addressed in the ROD. Community acceptance of Alternative 3 likely would be based on the community's understanding that site risks would be adequately mitigated through improvements to the soil cover and a properly designed and implemented monitoring program and strict maintenance of controls.

***6.3.2.9 State Acceptance.*** As with community acceptance, state acceptance will be evaluated during the review and comment period on the FS and PP, and will be thoroughly addressed in the ROD. State acceptance of Alternative 3 likely would be based on regulators' understanding of the same issues described above for community acceptance. In addition, close coordination with regulatory agencies would be necessary to satisfactorily implement this soil remedy.

## Section 7.0: CONCLUSIONS

This FS has been prepared to identify suitable remedial alternatives to address potential exposures associated with waste material that was placed within the landfill at IRP Site 27 at Naval Weapons Station Seal Beach Detachment Fallbrook. The CSM has been updated and refined using current information.

Arsenic, iron, and manganese have historically been detected in groundwater from MW-2 at concentrations exceeding MCLs. In addition, hydrazine has been detected in both surface water and groundwater samples collected at IRP Site 27, both upgradient and downgradient of the former landfill. There is neither an MCL nor a project action level established for hydrazine. Groundwater is not used as a water supply and is not expected to be in the future and ingestion of storm water is not considered a complete exposure pathway since the average annual precipitation is minimal, residence time of storm water is limited, and workers are seldom at the site. Additionally, site access is limited to authorized personnel because IRP Site 27 is located within explosive safety exclusion zones established for Detachment Fallbrook. Therefore, the chemicals detected in groundwater at IRP Site 27, including hydrazine, are unlikely to pose a significant human health risk. Furthermore, ICs included within Alternatives 2 and 3 were established to ensure these exposure pathways remain incomplete.

As shown in the three-dimensional model developed for IRP Site 27 the filter pack for MW-2 intersects the waste layer, which results in a direct hydraulic connection between the well screen and the waste prism. Therefore, it is recommended that MW-2 be abandoned and replaced with an adjacent well that could serve to monitor site conditions in the downgradient area of the landfill. The replacement well should be designed so that the well seal isolates the waste layer from the filter pack and screened interval of the replacement monitoring well. MW-2 is currently the only well that consistently exhibits exceedances of drinking water criteria (i.e., metals that are considered to be attributable to a combination of background conditions and the geochemistry of the landfill). A properly installed monitoring well that is screened below the waste layer would provide information that would be useful to further refine the CSM. Data from a replacement well could provide an indication as to whether the geochemical effects of the landfill are isolated to the waste layer or if those geochemical effects extend to groundwater 5 or 10 ft below the bottom of the waste prism.

RAOs have been developed to define the basis for remediation, and remedial technologies have been assessed and suitable alternatives developed. Based on the conclusions of the RI (SES-Tech, 2012b) and the updated CSM presented in Section 3.0, the following RAOs have been established to ensure IRP Site 27 is protective of potential future receptors:

- Prevent exposure of human and ecological receptors to historically landfilled waste.
- Prevent future exposure of human receptors to impacted groundwater.
- Prevent potential off-site impacts from the mobilization of naturally-occurring metals in groundwater resulting from interactions between the aquifer and landfill waste.

The three remedial alternatives determined to be the most suitable for addressing the RAOs for IRP Site 27 are as follows (note that, in accordance with the requirements of the NCP and CERCLA, the No Action alternative is presented and carried through the entire FS to serve as the baseline condition to which to compare other remedial alternatives):

- Alternative 1: No Action

- Alternative 2: ICs and Long-Term Monitoring
- Alternative 3: Soil Cover Improvements with ICs and Long-Term Monitoring

The detailed analysis of the three remedial alternatives is based on the NCP/CERCLA feasibility criteria: overall protection of human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. Based on the results of the detailed evaluation of alternatives, Alternative 2, ICs and long-term monitoring, had the most favorable evaluation results based on the NCP/CERCLA feasibility criteria. The Navy will propose a remedy for IRP Site 27 in a PP, and then will ultimately select either that proposed remedy or a different remedy (based on input from state regulatory agencies and the public subsequent to presentation of the PP) in a ROD.

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# APPENDIX A:

# APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

**CONTENTS**



*No state location-specific table is provided because no state location-specific ARARs were identified in the state response.

**Table A-1**
**Potential Federal Chemical-Specific[a] ARARs by Medium**

| Requirement | Prerequisite | Citation[b] | ARAR Determination | Comments |
|---|---|---|---|---|
| **GROUNDWATER** | | | | |
| **Safe Drinking Water Act (42 U.S.C., ch. 6A, § 300[f]–300[j]-26)[c]** | | | | |
| National primary drinking water standards are health-based standards for public water systems (MCLs). | Public water system. | 40 C.F.R. § 141.11–141.13, excluding § 141.11(d)(3), 141.15, 141.16, 141.61(a) and (c), and 141.62(b) | Relevant and Appropriate | MCLs as relevant and appropriate for groundwater determined to be a current or potential source of drinking water. Groundwater at IRP Site 27 is not used as a source of drinking water and the nearest production well is located approximately 3.6 miles away at MCB Camp Pendleton. |
| MCLGs pertain to known or anticipated adverse health effects (also known as recommended MCLs). | Public water system. | 40 C.F.R. § 141.50–141.51 | Not an ARAR | Chemicals with established nonzero MCLGs were not detected in groundwater during the RI for IRP Site 27. |
| National secondary drinking water regulations are standards for the aesthetic qualities of public water systems (SMCLs). | Public water system. | 40 C.F.R. § 143.3 | Not an ARAR | SMCLs are federal contaminant levels intended as guidelines for the states. Because they are not enforceable, federal SMCLs are not ARARs. |
| **Resource Conservation and Recovery Act (42 U.S.C., ch. 82, §§ 6901–6991[i])[c]** | | | | |
| Groundwater protection standards: Owners/operators of RCRA treatment, storage, or disposal facilities must comply with conditions in this section that are designed to ensure that hazardous constituents entering the groundwater from a regulated unit do not exceed the concentration limits for contaminants of concern set forth under Cal. Code Regs. tit. 22, § 66264.94 in the uppermost aquifer underlying the waste management area of concern at the POC. | A regulated unit that receives or has received hazardous waste before 26 July 1982 or regulated units that ceased receiving hazardous waste prior to 26 July 1982 where constituents in or derived from the waste may pose a threat to human health or the environment. | Cal. Code Regs. tit. 22, § 66264.94, except 66264.94(a)(2) and 66264.94(b) | Relevant and Appropriate | The IRP Site 27 landfill accepted municipal solid waste, which may have contained small quantities of hazardous wastes incidentally received at the landfill. Hazardous waste streams were not routinely disposed of at IRP Site 27. |

**Table A-1**
**Potential Federal Chemical-Specific[a] ARARs by Medium (Continued)**

| Requirement | Prerequisite | Citation[b] | ARAR Determination | Comments |
|---|---|---|---|---|
| **SOIL** | | | | |
| **Resource Conservation and Recovery Act (42 U.S.C., ch. 82, §§ 6901–6991[i])[c]** | | | | |
| Defines RCRA hazardous waste. A solid waste is characterized as toxic, based on the TCLP, if the waste exceeds the TCLP maximum concentrations. | Waste. | Cal. Code Regs. tit. 22, § 66261.21, 66261.22(a)(1), 66261.23, 66261.24(a)(1), and 66261.100 | Relevant and Appropriate | The IRP Site 27 landfill accepted municipal solid waste, which may have contained small quantities of hazardous wastes incidentally received at the landfill. Hazardous waste streams were not routinely disposed of at IRP Site 27. |
| Groundwater Protection Standards: requirements to ensure that hazardous constituents entering the groundwater from a regulated unit do not exceed the concentration limits for contaminants of concern in the uppermost aquifer underlying the waste management area of concern at the POC. | A regulated unit that receives or has received hazardous waste before 26 July 1982 or regulated units that ceased receiving hazardous waste prior to 26 July 1982 where constituents in or derived from the waste may pose a threat to human health or the environment. | Cal. Code Regs. tit. 22, § 66264.94(a)(1) and (3), (c), (d), and (e) | Relevant and Appropriate | The IRP Site 27 landfill accepted municipal solid waste, which may have contained small quantities of hazardous wastes incidentally received at the landfill. Hazardous waste streams were not routinely disposed of at IRP Site 27. |
| LDRs prohibit disposal of hazardous waste unless treatment standards are met. | Hazardous waste land disposal. | Cal. Code Regs. tit. 22, § 66268.1(f) | Not an ARAR | The IRP Site 27 landfill accepted municipal solid waste, which may have contained small quantities of hazardous wastes incidentally received at the landfill. Hazardous waste streams were not routinely disposed of at IRP Site 27. |
| Treatment standards including technology requirements before hazardous waste can be disposed to land. | Hazardous waste land disposal. | Cal. Code Regs. tit. 22, § 66268.40 | Not an ARAR | The IRP Site 27 landfill accepted municipal solid waste, which may have contained small quantities of hazardous wastes incidentally received at the landfill. Hazardous waste streams were not routinely disposed of at IRP Site 27. |

**Table A-1**
**Potential Federal Chemical-Specific[a] ARARs by Medium (Continued)**

| Requirement | Prerequisite | Citation[b] | ARAR Determination | Comments |
|---|---|---|---|---|
| Universal treatment standards used to comply with treatment standards. | Hazardous waste land disposal. | Cal. Code Regs. tit. 22, § 66268.48 | Not an ARAR | The IRP Site 27 landfill accepted municipal solid waste, which may have contained small quantities of hazardous wastes incidentally received at the landfill. Hazardous waste streams were not routinely disposed of at IRP Site 27. |
| **Toxic Substances Control Act (15 U.S.C., ch. 53, §§ 2601–2692)[c]** | | | | |
| Regulates storage and disposal of PCB remediation waste. There are three options: a) self-implementing on-site cleanup and disposal; b) performance-based disposal using existing approved disposal technologies; and c) risk-based disposal. | Soils, debris, sludge, or dredged materials contaminated with PCBs at concentrations greater than 50 ppm. | 40 C.F.R. § 761.61(a)(4), (b), and (c) | Not an ARAR | PCBs were detected within the waste layer at concentrations below 50 ppm. |

Notes:

[a] Many potential action-specific ARARs contain chemical-specific limitations and are addressed in the action-specific ARAR tables.

[b] Only the substantive provisions of the requirements cited in this table are potential ARARs.

[c] Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader; listing the statutes and policies does not indicate that the Department of the Navy accepts the entire statutes or policies as potential ARARs; specific potential ARARs are addressed in the table below each general heading; only pertinent substantive requirements of the specific citations are considered potential ARARs

Acronyms/Abbreviations:

ARAR – applicable or relevant and appropriate requirement
Cal. Code Regs. – *California Code of Regulations*
C.F.R. – *Code of Federal Regulations*
ch. – chapter
IRP – Installation Restoration Program
LDR – land disposal restriction
MCB – Marine Corps Base
MCL – maximum contaminant level
MCLG – maximum contaminant level goal
PCB – polychlorinated biphenyl
POC – point of compliance
ppm – parts per million
RCRA – Resource Conservation and Recovery Act
RI – remedial investigation
§ – section

**Table A-1**
**Potential Federal Chemical-Specific[a] ARARs by Medium (Continued)**

§§ – sections
SMCL – secondary maximum contaminant level
TCLP – toxicity characteristic leaching procedure
tit. – title
U.S.C. – *United States Code*

**Table A-2**
**Potential State Chemical-Specific[a] ARARs by Medium**

| Requirement | Prerequisite | Citation[b] | ARAR Determination | Comments |
|---|---|---|---|---|
| **GROUNDWATER** | | | | |
| **Cal/EPA Department of Toxic Substances Control[c]** | | | | |
| State MCL list. | Source of drinking water. | Cal. Code Regs. tit. 22, §§ 64431 and 64444 | Relevant and Appropriate | MCLs as relevant and appropriate for groundwater determined to be a current or potential source of drinking water. Groundwater at IRP Site 27 is not used as a source of drinking water and the nearest production well is located approximately 3.6 miles away at MCB Camp Pendleton. |
| **GROUNDWATER, SURFACE WATER, SOIL, AND SEDIMENTS** | | | | |
| **State and Regional Water Quality Control Boards[c]** | | | | |
| Authorizes the SWRCB and RWQCB to establish in water quality control plans beneficial uses and numerical and narrative standards to protect both surface water and groundwater quality. Authorizes regional water boards to issue permits for discharges to land or surface or groundwater that could affect water quality, including NPDES permits, and to take enforcement action to protect water quality. | | Cal. Water Code, div. 7, §§ 13241, 13243, 13263(a), 13269, and 13360 (Porter-Cologne Act) | Applicable | The DON accepts the substantive provisions of §§ 13241, 13243, 13263(a), 13269, and 13360 of the Porter-Cologne Act enabling legislation, as implemented through the beneficial uses, WQOs, waste discharge requirements, promulgated policies of the Basin Plan for the San Diego Region, as potential ARARs. |

**Table A-2**
**Potential State Chemical-Specific[a] ARARs by Medium (Continued)**

| Requirement | Prerequisite | Citation[b] | ARAR Determination | Comments |
|---|---|---|---|---|
| | | Cal. Water Code, div. 7, § 13304 | Not an ARAR | Section 13304 does not constitute an ARAR because it does not itself establish or contain substantive environmental "standards, requirements, criteria or limitations" (CERCLA Section 121) and is not in itself a directive in intent. In addition, Section 13304 is not more stringent than the substantive requirements of the potential state and federal ARARs. |
| Describes the water basins in the San Diego Region, establishes beneficial uses of groundwater and surface water, establishes WQOs, including narrative and numerical standards, establishes implementation plans to meet WQOs and protect beneficial uses, and incorporates statewide water quality control plans and policies; will not result in water quality less than that prescribed in the policies. It also states that any activity that produces or may produce a waste or increased volume or concentration of waste and that discharges or proposes to discharge to existing high-quality waters will be required to meet waste-discharge requirements that will result in the best practicable treatment or control of the discharge. | | Comprehensive Water Quality Control Plan for the San Diego Region (Basin Plan) (Cal. Water Code § 13240) | Applicable | Substantive requirements pertaining to beneficial uses, WQOs, and certain statewide water quality control plans are potential state ARARs for the surface water and groundwater components of this response action. |

**Table A-2**
**Potential State Chemical-Specific[a] ARARs by Medium (Continued)**

| Requirement | Prerequisite | Citation[b] | ARAR Determination | Comments |
|---|---|---|---|---|
| Describes requirements for RWQCB oversight of investigation and cleanup and abatement activities resulting from discharges of hazardous substances. RWQCB may decide on cleanup and abatement goals and objectives for the protection of water quality and beneficial uses of water within each region. Establishes criteria for "containment zones" where cleanup to established water-quality goals is not economically or technically practicable. | | Policies and procedures for investigation and cleanup and abatement of discharges under Cal. Water Code § 13304, SWRCB Res. 92-49 | Relevant and Appropriate | Not an ARAR for groundwater because SWRCB Res. 92-49 is not more stringent than Cal. Code Regs. tit. 22, § 66264.94(c), which was determined to be a federal ARAR, but is potentially relevant and appropriate for a containment zone or POC related to IRP Site 27. Not an ARAR for soil. |
| Establishes concentration limits for cleanup actions, including groundwater, surface water, and the unsaturated zones for other than hazardous waste at background. Allows a higher cleanup limit (but not to exceed MCLs) if background is not technically or economically achievable. | | Cal. Code Regs. tit. 27, §§ 20380(a); 20400(a), (c), (d), (e), and (g); and 20405 | Not an ARAR | Not more stringent than federal regulations at Cal. Code Regs. tit. 22, § 66264.94 and 66264.95. |

Notes:
[a] Many potential action-specific ARARs contain chemical-specific limitations and are addressed in the action-specific ARAR tables.
[b] Only the substantive provisions of the requirements cited in this table are potential ARARs.
[c] Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader; listing the statutes and policies does not indicate that the DON accepts the entire statutes or policies as potential ARARs; specific potential ARARs are addressed in the table below each general heading; only pertinent substantive requirements of specific citations are considered potential ARARs.

Acronyms/Abbreviations:
ARAR – applicable or relevant and appropriate requirement
Basin Plan – Water Quality Control Plan (RWQCB Region) Basin
Cal. Code Regs. – *California Code of Regulations*
Cal/EPA – California Environmental Protection Agency
Cal. Water Code – *California Water Code*
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
div. – division
DON – Department of the Navy

**Table A-2**
**Potential State Chemical-Specific[a] ARARs by Medium (Continued)**

IRP – Installation Restoration Program
MCB – Marine Corps Base
MCL – maximum contaminant level
NPDES – National Pollutant Discharge Elimination System
POC – point of compliance
Res. – Resolution
RWQCB – (California) Regional Water Quality Control Board
§ – section
§§ – sections
SWRCB – (California) State Water Resources Control Board
tit. – title
WQO – water quality objective

**Table A-3**
**Potential Federal Location-Specific ARARs**

| Location | Requirement | Prerequisite | Citation[a] | ARAR Determination | Comments |
|---|---|---|---|---|---|
| **Endangered Species Act of 1973 (16 U.S.C. §§ 1531–1543)[b]** | | | | | |
| Location where endangered or threatened species are present or location designated as critical habitat. | Federal agencies may not jeopardize the continued existence of any listed species or cause the destruction or adverse modification of critical habitat. | Presence of endangered species, listed species, or critical habitat. | 16 U.S.C. §§ 1531–1543 | Applicable | The substantive provisions of these requirements are potential ARARs due to the potential for federally threatened animal specifies, including Stephen's kangaroo rat, the coastal California gnatcatcher, and the Arroyo toad, which are present at or in the vicinity of the IRP Site 27. |
| **Migratory Bird Treaty Act of 1972 (16 U.S.C. §§ 703–712)[b]** | | | | | |
| Migratory bird area | Protects almost all species of native migratory birds in the U.S. from unregulated "take," which can include poisoning at hazardous waste sites. | Presence of migratory birds. | 16 U.S.C. § 703 | Relevant and Appropriate | The substantive provisions of 16 U.S.C. §§ 703–712 are relevant and appropriate due to the potential for migratory birds to be present at or near the site. |

Notes:

[a] Only the substantive provisions of the requirements cited in this table are potential ARARs.

[b] Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader; listing the statutes and policies does not indicate that the Department of the Navy accepts the entire statutes or policies as potential ARARs; specific potential ARARs are addressed in the table below each general heading; only substantive requirements of the specific citations are considered potential ARARs.

Acronyms/Abbreviations:

ARAR – applicable or relevant and appropriate requirement
IRP – Installation Restoration Program
§ – section
§§ – sections

**Table A-3**
**Potential Federal Location-Specific ARARs (Continued)**

U.S. – United States
U.S.C. – *United States Code*

**Table A-4**
**Potential Federal Action-Specific ARARs**

| **Remedial Alternatives for IRP Site 27: 1 - No Action; 2 - ICs and Long-Term Monitoring; 3 - Improved Soil Cover with ICs and Long-Term Monitoring** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | **ARAR Determination** | | | |
| **Action** | **Requirement** | **Prerequisite** | **Citation** | **A** | **RA** | **TBC** | **Comments** |
| Monitoring | The RCRA monitoring regulations apply during the active life of the regulated unit (including the closure period). After closure of the regulated unit, the regulations in this article apply during the postclosure care period under Cal. Code Regs. tit. 22, § 66264.117 of article 7 of this chapter and during any compliance period under Cal. Code Regs. tit. 22, § 66264.96 unless: (1) the regulated unit has been in compliance with the water quality protection standard for a period of 3 consecutive years; and (2) all waste, waste residues, contaminated containment system components, contaminated subsoils, and all other contaminated geologic materials are removed or decontaminated at closure. | Surface impoundment, waste pile, land treatment unit, or landfill for which constituents in or derived from waste in the unit may pose a threat to human health or the environment. | Cal. Code Regs. tit. 22, § 66264.90(c) | | 2,3 | | Substantive provisions are potential ARARs for determining when and how long monitoring is required. |
| | Owners/operators of a RCRA surface impoundment, waste pile, land treatment unit, or landfill shall conduct a monitoring and response program for each regulated unit. | Surface impoundment, waste pile, land treatment unit, or landfill for which constituents in or derived from waste in the unit may pose a threat to human health or the environment. | Cal. Code Regs. tit. 22, § 66264.91(a)(1)–(4) and (c), except as it cross-references permit requirements | | 2,3 | | Monitoring is proposed to assess geochemical conditions attributable to the landfill that are causing naturally occurring metals to dissolve into groundwater within MW-2 at concentrations that exceed MCLs and secondary MCLs. |

**Table A-4**
**Potential Federal Action-Specific ARARs (Continued)**

| Remedial Alternatives for IRP Site 27: 1 - No Action; 2 - ICs and Long-Term Monitoring; 3 - Improved Soil Cover with ICs and Long-Term Monitoring | | | | | |
|---|---|---|---|---|---|
| **Action** | **Requirement** | **Prerequisite** | **Citation** | **ARAR Determination A RA TBC** | **Comments** |
| Monitoring constituents of concern | Constituents of concern are the waste constituents, reaction products, and hazardous constituents that are reasonably expected to be in or derived from waste contained in the regulated unit. | Hazardous waste treatment, storage, or disposal facility. | Cal. Code Regs. tit. 22, § 66264.93 | Not an ARAR | Not applicable because the site did not contain a RCRA regulated unit. Not relevant and appropriate because there was no release from the site. |
| Monitoring | The point of compliance is a vertical surface, located at the hydraulically downgradient limit of the waste management area that extends through the uppermost aquifer underlying the regulated unit. | Hazardous waste treatment, storage, or disposal facility. | Cal. Code Regs. tit. 22, § 66264.95(a) and (b) | Not an ARAR | Not applicable because the site did not contain a RCRA regulated unit. Not relevant and appropriate because there was no release from the site. |
| Compliance period | (a) The compliance period is the number of years equal to the active life of the regulated unit (including any waste management activity prior to permitting, and the closure period) and constitutes the minimum period of time during which the owner or operator shall conduct a water quality monitoring program subsequent to a release from the regulated unit. (b) The compliance period begins each time the owner or operator initiates an evaluation monitoring program meeting the requirements of Cal. Code Regs. tit. 22, § 66264.99. (c) If the owner or operator is engaged in a corrective action program at the scheduled end of the compliance period specified under subsection (a) the compliance period is extended until the owner or operator can demonstrate that the regulated unit has been in compliance for a period of 3 consecutive years. | Hazardous waste treatment, storage, or disposal facility. | Cal. Code Regs. tit. 22, § 66264.96 | Not an ARAR | Not applicable because the site did not contain a RCRA regulated unit. Not relevant and appropriate because there was no release from the site. |

**Table A-4**
**Potential Federal Action-Specific ARARs (Continued)**

| Remedial Alternatives for IRP Site 27: 1 - No Action; 2 - ICs and Long-Term Monitoring; 3 - Improved Soil Cover with ICs and Long-Term Monitoring | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | ARAR Determination | | | |
| **Action** | **Requirement** | **Prerequisite** | **Citation** | **A** | **RA** | **TBC** | **Comments** |
| Monitoring | Requirements for monitoring groundwater, surface water, and the vadose zone. | Hazardous waste treatment, storage, or disposal facility. | Cal. Code Regs. tit. 22, § 66264.97 | Not an ARAR | | | Not applicable because the site did not contain a RCRA regulated unit. Not relevant and appropriate because there was no release from the site. |
| | Requirements for a detection monitoring program. | Hazardous waste treatment, storage, or disposal facility. | Cal. Code Regs. tit. 22, § 66264.98(e)(1-5), (i), (j), (k)(1-3), (4)(A) and (D),(5), (7)(C) and (D),(n)(1),(2)(B), and (C) | Not an ARAR | | | Not applicable because the site did not contain a RCRA regulated unit. Not relevant and appropriate because there was no release from the site. |
| | Requirements for an evaluation monitoring program. | Hazardous waste treatment, storage, or disposal facility. | Cal. Code Regs. tit. 2, § 6264.99(b), (e)(1)–(6), (f)(3), and (g) | Not an ARAR | | | Not applicable because the site did not contain a RCRA regulated unit. Not relevant and appropriate because there was no release from the site. |
| **Clean Water Act, as Amended (33 U.S.C., ch. 26, §§ 1251–1387)*** | | | | | | | |
| Discharge to surface waters, including storm water | Owners and operators of construction activities must be in compliance with discharge standards, including substantive provisions of the general requirements for storm water plans and best management practices (BMPs). | | CWA Section 402 (33 U.S.C. ch. 26, § 1342) and 40 C.F.R. § 122.44(k)(2) and (4) | Relevant and Appropriate | | | Soil cover improvements planned under Alternative 3 may have the potential to release contaminants to surface water. General stormwater BMPs may be implemented to control runoff from the site and prevent migration of contaminants. |

* Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader. Listing the statutes and policies does not indicate that the Department of the Navy accepts the entire statutes or policies as potential ARARs; specific potential ARARs are addressed in the table below each general heading; only substantive requirements of specific citations are considered potential ARARs.

**Table A-4**
**Potential Federal Action-Specific ARARs (Continued)**

Acronyms/Abbreviations:

A – applicable
ARAR – applicable or relevant and appropriate requirement
BMP – best management practice
Cal. Code Regs. – *California Code of Regulations*
C.F.R. – *Code of Federal Regulations*
ch. – chapter
CWA – Clean Water Act
IC – institutional control
IRP – Installation Restoration Program
MCL – maximum contaminant level
RA – relevant and appropriate
RCRA – Resource Conservation and Recovery Act
§ – section
SMCL – secondary
maximum contaminant level
TBC – to be considered
tit. – title
U.S.C. – *United States Code*

**Table A-5**
**Potential State Action-Specific ARARs**

| Remedial Alternatives for IRP Site 27: 1 - No Action; 2 - ICs and Long-Term Monitoring; 3 - Improved Soil Cover with ICs and Long-Term Monitoring | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | ARAR Determination | | | |
| **Action** | **Requirement** | **Prerequisite** | **Citation** | **A** | **RA** | **TBC** | **Comments** |
| **State Water Resources Control Board and Regional Water Quality Control Board*** | | | | | | | |
| Actions affecting water quality | Provides water quality criteria for classifying the beneficial use of groundwater as municipal/domestic. Criteria outlined as follows: total dissolved solids ≤ 3,000 mg/L or yielding 200 gallons per day or serving as a public water system. | Applies in determining beneficial uses for waters that may be affected by discharges of waste. | SWRCB Res. 88-63 ("Sources of Drinking Water Policy") (as contained in the Basin Plans) | | 2,3 | | The IRP Site 27 catchment basin does not produce or store a significant quantity of groundwater, with an estimated 23 acre-feet of groundwater stored in the aquifer. |
| | Establishes policies and procedures for the oversight of investigations and cleanup and abatement activities resulting from discharges of waste that affect or threaten water quality. | Cleanup and discharge of groundwater to groundwater or surface water and establishment of containment zones. | SWRCB Res. 92-49 (Policies and Procedures for Investigation and Cleanup and Abatement of Discharges) | | Not an ARAR | | Not an ARAR. No more stringent than Cal. Code Regs. tit. 22, § 66264.94. |

**Table A-5**
**Potential State Action-Specific ARARs (Continued)**

| Remedial Alternatives for IRP Site 27: 1 - No Action; 2 - ICs and Long-Term Monitoring; 3 - Improved Soil Cover with ICs and Long-Term Monitoring | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | ARAR Determination | | | |
| **Action** | **Requirement** | **Prerequisite** | **Citation** | **A** | **RA** | **TBC** | **Comments** |
| Maintenance and Monitoring of Closed, Abandoned, or Inactive Waste Units | Establishes general waste discharge requirements for postclosure maintenance of inactive nonhazardous waste landfills within the San Diego Region. | Nonhazardous waste landfills within the San Diego Region. | San Diego RWQCB General Order No. R9-2012-001 | Not an ARAR | | | General Order R9-2012-0001 (Order) is not a potential ARAR in and of itself for various reasons, including the fact that the Order contains a number of provisions that in themselves are not substantive in nature. However, the Navy would concede that, to whatever extent the substantive provisions contained within the Order derive from the California State Code and/or California Code of Regulations, are of general applicability, and address circumstances found at CERCLA sites, such substantive provisions would clearly require consideration as potential state ARARs. |
| **California Environmental Quality Act*** | | | | | | | |
| Actions by state | Requires analysis of environmental impacts of response actions, comparison of alternative actions, and implementation of appropriate mitigation measures. No hazardous substances may remain on site unless further mitigation is not feasible. | State actions. | CEQA, Cal. Pub. Res. Code §§ 21100–21178, 15000, and 15002 | Not an ARAR | | | Not an ARAR. Requirements of CEQA are applicable to state actions and not those of the federal government. The CERCLA process fulfills these requirements. |

**Table A-5**
**Potential State Action-Specific ARARs (Continued)**

| Remedial Alternatives for IRP Site 27: 1 - No Action; 2 - ICs and Long-Term Monitoring; 3 - Improved Soil Cover with ICs and Long-Term Monitoring | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | ARAR Determination | | | |
| **Action** | **Requirement** | **Prerequisite** | **Citation** | **A** | **RA** | **TBC** | **Comments** |
| **State Water Resources Control Board*** | | | | | | | |
| Landfill capping | Alternatives to construction or prescriptive standards. | Cal. Code Regs. tit. 27 requirements are only applicable for waste discharged after 18 July 1997 unless otherwise noted. | Cal. Code Regs. tit. 27, §§ 20080 (b) and (c) and 21090 | | 3 | | The IRP Site 27 landfill was closed in 1974; not applicable to waste discharged prior to 18 July 1997. Maintained as relevant and appropriate due to increasing the thickness of the existing soil cover under Alternative 3. |
| Monitoring | Persons responsible for discharges at units that were closed, abandoned, or inactive on or before 27 November 1984 may be required to develop and implement a monitoring program. | Closed, inactive, or abandoned waste management unit before 27 November 1984. | Cal. Code Regs. tit 27, § 20380 | 2,3 | | | Applicable to establishment of a detection groundwater monitoring program. |
| Landfill closure | Classified waste management units shall be closed in accordance with an approved closure and postclosure maintenance plan, which provides for continued compliance with the applicable standards for waste containment and precipitation and drainage controls and monitoring requirements. | Waste discharged after 18 July 1997. | Cal. Code Regs. tit. 27, § 21769 | | 2,3 | | Preparation of a postclosure maintenance plan is a procedural requirement. Maintained as relevant and appropriate because the substantive requirements of Cal. Code Regs. tit. 27, § 21769 will be considered in the remedial design. |
| Monitoring | Requires detection monitoring. Once a significant release has occurred, evaluation or corrective action monitoring is required. | Discharge of waste to land after 18 July 1997. | Cal. Code Regs. tit. 27, § 20385(a)(1) and (a)(2) | | Not an ARAR | | Not an ARAR because the citation is not more stringent than equivalent federal requirements (i.e., Cal. Code Regs. tit. 22, § 66264.91), which have been identified as ARARs. |

**Table A-5**
**Potential State Action-Specific ARARs (Continued)**

| Remedial Alternatives for IRP Site 27: 1 - No Action; 2 - ICs and Long-Term Monitoring; 3 - Improved Soil Cover with ICs and Long-Term Monitoring | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | ARAR Determination | | | |
| **Action** | **Requirement** | **Prerequisite** | **Citation** | **A** | **RA** | **TBC** | **Comments** |
| | Requires general soil, surface water, and groundwater monitoring. | Discharge of waste to land after 18 July 1997. | Cal. Code Regs. tit. 27, § 20415 and 20925 | | 2,3 | | Not applicable because IRP Site 27 was not a hazardous waste landfill and waste not was accepted after 18 July 1997. Relevant and appropriate for long-term monitoring activities described in Alternatives 2 and 3. |
| Groundwater monitoring | Provides minimum requirements for a groundwater detection monitoring program. | Discharge of waste to land after 18 July 1997. | Cal. Code Regs. tit. 27, § 20420 | | 2,3 | | Not applicable because IRP Site 27 was not a hazardous waste landfill and waste not was accepted after 18 July 1997. Relevant and appropriate for long-term monitoring activities described in Alternatives 2 and 3. |
| | Requires evaluation monitoring once a significant release is detected. | Discharge of waste to land after 18 July 1997. | Cal. Code Regs. tit. 27, § 20425 | | 2,3 | | Not applicable because IRP Site 27 was not a hazardous waste landfill and waste not was accepted after 18 July 1997. Relevant and appropriate for long-term monitoring activities described in Alternatives 2 and 3 |

**Table A-5**
**Potential State Action-Specific ARARs (Continued)**

| Remedial Alternatives for IRP Site 27: 1 - No Action; 2 - ICs and Long-Term Monitoring; 3 - Improved Soil Cover with ICs and Long-Term Monitoring | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | ARAR Determination | | | |
| **Action** | **Requirement** | **Prerequisite** | **Citation** | **A** | **RA** | **TBC** | **Comments** |
| Gas Monitoring | § 20921(a)(1), (2), and (3): The operator shall ensure that landfill gases generated at a disposal site are controlled. Methane must not exceed 1.25 percent by volume in air within on-site structures, concentrations of methane gas migrating from the landfill must not exceed 5 percent by volume in air at the property boundary, and trace gases shall be controlled to prevent adverse acute and chronic exposure to toxic and/or carcinogenic compounds. | Discharge of waste to land after 18 July 1997. Available data suggest landfill conditions have the potential to generate regulated landfill gases. | Cal. Code Regs. tit. 27, § 20921(a)(1), (2), and (3) | Not at ARAR | | | There are no buildings and no plans to construct buildings at IRP Site 27. Furthermore, soil gas results from the RI indicated that methane was only detected in one of 12 samples at 0.688% by volume in soil gas (i.e., from soil gas centrally located in the waste later), and was not detected in any sampling location along the landfill perimeter. The RI data support that that the IRP Site 27 landfill does not have the potential to generate regulated landfill gases at levels that exceed 5% by volume in soil gas at the site boundary. |
| | The operator shall ensure that the conditions of § 20921 are met by designing a gas monitoring and control program that satisfies specific requirements. | Discharge of waste to land after 18 July 1997. | Cal. Code Regs. tit. 27, § 20923 | Not an ARAR | | | See the rationale provided above for Cal. Code Regs. tit. 27, § 20921(a)(1), (2), and (3). |
| Corrective action | Requires implementation of corrective action measures that ensure that cleanup levels are achieved throughout the zone affected by the release by removing the waste constituents or treating them in place. Source control may be required. Also requires monitoring to determine the effectiveness of the corrective actions. | Discharge of waste to land after 18 July 1997. | Cal. Code Regs. tit. 27, § 20430 | | 2,3 | | Relevant and appropriate in the event that detection and evaluation monitoring shows evidence that a new release has occurred. |

**Table A-5**
**Potential State Action-Specific ARARs (Continued)**

| Remedial Alternatives for IRP Site 27: 1 - No Action; 2 - ICs and Long-Term Monitoring; 3 - Improved Soil Cover with ICs and Long-Term Monitoring | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | ARAR Determination | | | |
| **Action** | **Requirement** | **Prerequisite** | **Citation** | **A** | **RA** | **TBC** | **Comments** |
| **Air Quality Management District/Air Pollution Control District*** | | | | | | | |
| Air emission | Restricts (1) discharges of visible dust emissions into the atmosphere beyond the property line for a period or periods aggregating more than 3 minutes in any 60 minute period; (2) visible roadway dust as a result of active operations; and (3) spillage from transport trucks, erosion, or track-out/carry-out activities. | Construction or demolition activity capable of generating fugitive dust emissions. | SDAPCD Regulation IV – Rule 55 | 3 | | | Fill placement and grading activities have the potential to produce visible emissions due to fugitive dust. Substantive requirements pertaining to visible emissions, such as wetting the soil or waste, may be required to minimize fugitive dust. |

Note:

* Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs for the convenience of the reader; listing the statutes and policies does not indicate that the Department of the Navy accepts the entire statutes or policies as potential ARARs; specific potential ARARs are addressed in the table below each general heading; only substantive requirements of the specific actions are considered potential ARARs.

Acronyms/Abbreviations:
A – applicable

ARAR – applicable or relevant and appropriate requirement
Cal. Code Regs. – *California Code of Regulations*
Cal. Pub. Res. Code – *California Public Resources Code*
CEQA – California Environmental Quality Act
CERCLA – Comprehensive Environmental Response, Compensation, and Liability Act
IC – institutional control
IRP – Installation Restoration Program
$PM_{10}$ – particulate matter, less than 10 micrometers in diameter
RA – relevant and appropriate
Res. – resolution
RI – remedial investigation
RWQCB – Regional Water Quality Control Board
§ – section
§§ – sections
SDAPCD – San Diego Air Pollution Control District

**Table A-5**
**Potential State Action-Specific ARARs (Continued)**

SWRCB – (California) State Water Resources Control Board
TBC – to be considered
tit. – title

# APPENDIX B:

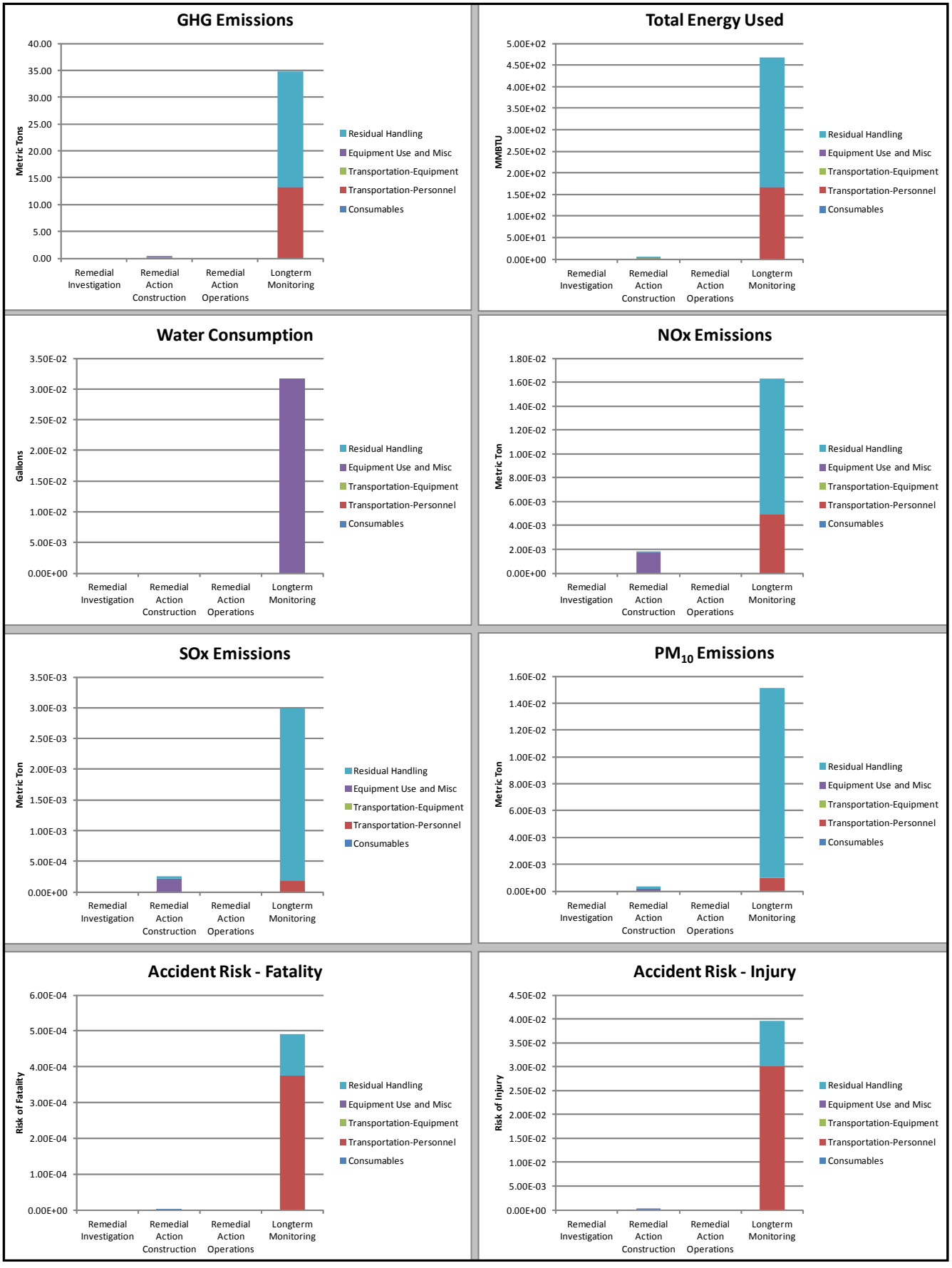
# DETAILED SITEWISE™ EVALUATION RESULTS

## Sustainable Remediation - Environmental Footprint Summary
## ICs with LTM

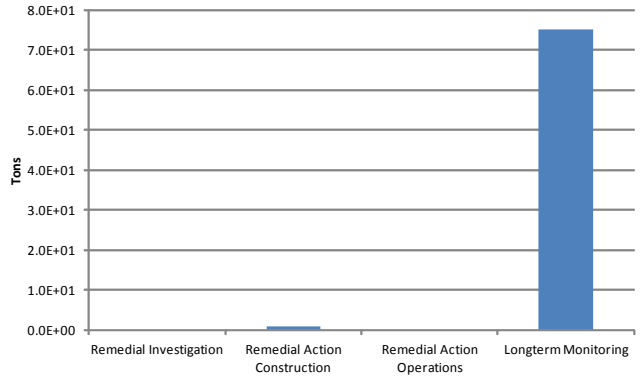
| Phase | Activities | GHG Emissions | Total energy Used | Water Consumption | NOx emissions | SOx Emissions | PM10 Emissions | Accident Risk Fatality | Accident Risk Injury |
|---|---|---|---|---|---|---|---|---|---|
| | | metric ton | MMBTU | gallons | metric ton | metric ton | metric ton | | |
| Remedial Investigation | Consumables | 0.00 | 0.0E+00 | NA | NA | NA | NA | NA | NA |
| | Transportation-Personnel | 0.00 | 0.0E+00 | NA | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Transportation-Equipment | 0.00 | 0.0E+00 | NA | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Equipment Use and Misc | 0.00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Residual Handling | 0.00 | 0.0E+00 | NA | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Sub-Total | 0.00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Remedial Action Construction | Consumables | 0.03 | 1.8E-01 | NA | NA | NA | NA | NA | NA |
| | Transportation-Personnel | 0.02 | 2.8E-01 | NA | 8.2E-06 | 2.9E-07 | 1.7E-06 | 6.2E-07 | 5.0E-05 |
| | Transportation-Equipment | 0.07 | 9.6E-01 | NA | 2.3E-05 | 4.1E-07 | 2.1E-06 | 3.9E-07 | 3.1E-05 |
| | Equipment Use and Misc | 0.17 | 2.1E+00 | 0.0E+00 | 1.7E-03 | 2.1E-04 | 1.6E-04 | 1.8E-07 | 4.6E-05 |
| | Residual Handling | 0.08 | 1.2E+00 | NA | 8.6E-05 | 3.5E-05 | 1.8E-04 | 3.9E-07 | 3.1E-05 |
| | Sub-Total | 0.37 | 4.66E+00 | 0.00E+00 | 1.83E-03 | 2.50E-04 | 3.47E-04 | 1.59E-06 | 1.59E-04 |
| Remedial Action Operations | Consumables | 0.00 | 0.0E+00 | NA | NA | NA | NA | NA | NA |
| | Transportation-Personnel | 0.00 | 0.0E+00 | NA | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Transportation-Equipment | 0.00 | 0.0E+00 | NA | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Equipment Use and Misc | 0.00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Residual Handling | 0.00 | 0.0E+00 | NA | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Sub-Total | 0.00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Longterm Monitoring | Consumables | 0.00 | 0.0E+00 | NA | NA | NA | NA | NA | NA |
| | Transportation-Personnel | 13.26 | 1.7E+02 | NA | 4.9E-03 | 1.7E-04 | 1.0E-03 | 3.7E-04 | 3.0E-02 |
| | Transportation-Equipment | 0.00 | 0.0E+00 | NA | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Equipment Use and Misc | 0.00 | 6.4E-04 | 3.2E-02 | 1.7E-08 | 1.5E-08 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Residual Handling | 21.49 | 3.0E+02 | NA | 1.1E-02 | 2.8E-03 | 1.4E-02 | 1.2E-04 | 9.4E-03 |
| | Sub-Total | 34.75 | 4.68E+02 | 3.16E-02 | 1.63E-02 | 3.00E-03 | 1.51E-02 | 4.91E-04 | 3.96E-02 |
| **Total** | | **3.5E+01** | **4.7E+02** | **3.2E-02** | **1.8E-02** | **3.2E-03** | **1.5E-02** | **4.9E-04** | **4.0E-02** |

| Remedial Alternative Phase | Non-Hazardous Waste Landfill Space | Hazardous Waste Landfill Space | Topsoil Consumption | Costing | Lost Hours - Injury |
|---|---|---|---|---|---|
| | tons | tons | cubic yards | $ | |
| Remedial Investigation | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0 | 0.0E+00 |
| Remedial Action Construction | 1.0E+00 | 0.0E+00 | 0.0E+00 | 0 | 1.3E-03 |
| Remedial Action Operations | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0 | 0.0E+00 |
| Longterm Monitoring | 7.5E+01 | 0.0E+00 | 0.0E+00 | 642,000 | 3.2E-01 |
| **Total** | **7.6E+01** | **0.0E+00** | **0.0E+00** | **$642,000** | **3.2E-01** |

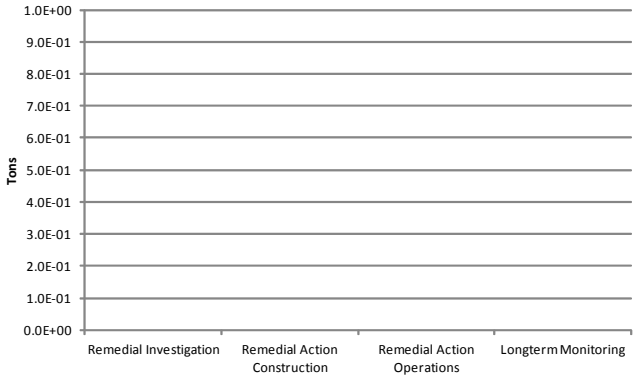
| Total Cost with Footprint Reduction |
|---|
| **$642,000** |


GHG Emissions
Metric Tons
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables
Total Energy Used
MMBTU
5.00E+02
4.50E+02
4.00E+02
3.50E+02
3.00E+02
2.50E+02
2.00E+02
1.50E+02
1.00E+02
5.00E+01
0.00E+00
Water Consumption
Gallons
3.50E-02
3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00
NOx Emissions
Metric Ton
1.80E-02
1.60E-02
1.40E-02
1.20E-02
1.00E-02
8.00E-03
6.00E-03
4.00E-03
2.00E-03
0.00E+00
SOx Emissions
Metric Ton
3.50E-03
3.00E-03
2.50E-03
2.00E-03
1.50E-03
1.00E-03
5.00E-04
0.00E+00
PM10 Emissions
Metric Ton
1.60E-02
1.40E-02
1.20E-02
1.00E-02
8.00E-03
6.00E-03
4.00E-03
2.00E-03
0.00E+00
Accident Risk - Fatality
Risk of Fatality
6.00E-04
5.00E-04
4.00E-04
3.00E-04
2.00E-04
1.00E-04
0.00E+00
Accident Risk - Injury
Risk of Injury
4.50E-02
4.00E-02
3.50E-02
3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00

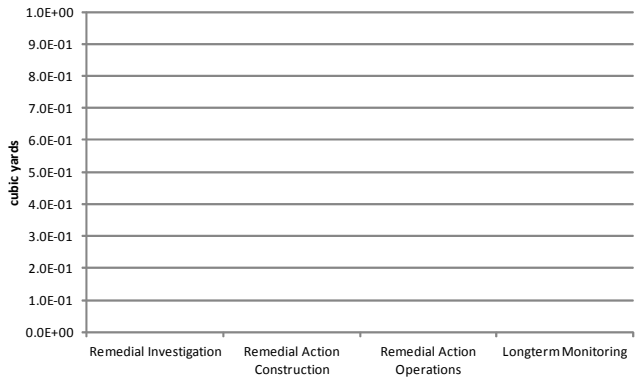
## Non-Hazardous Waste Landfill Space



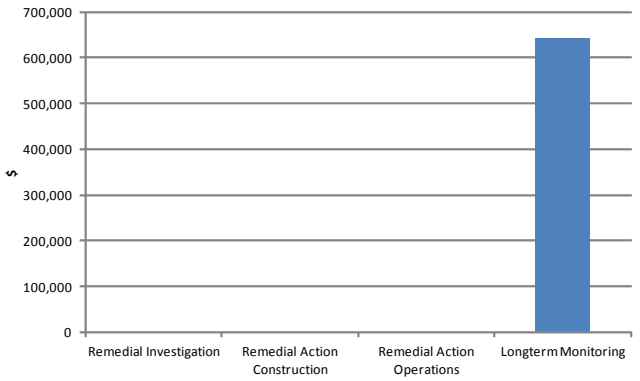

## Hazardous Waste Landfill Space



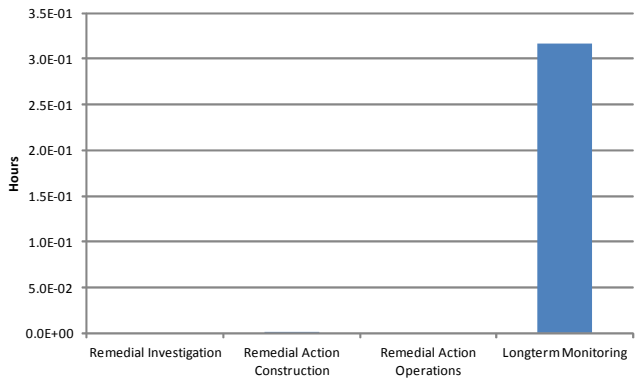

## Topsoil Consumption




## Costing



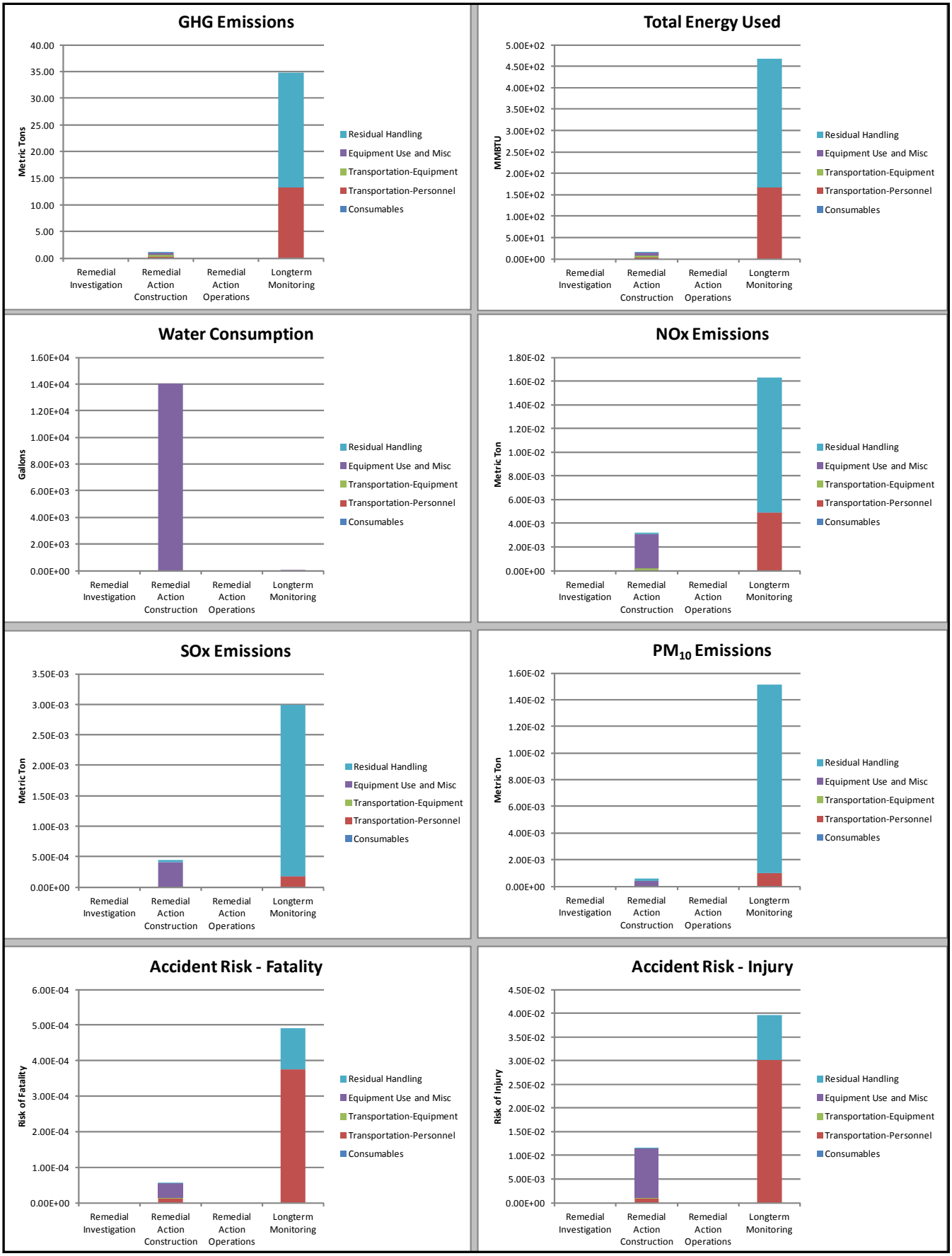

## Lost Hours - Injury

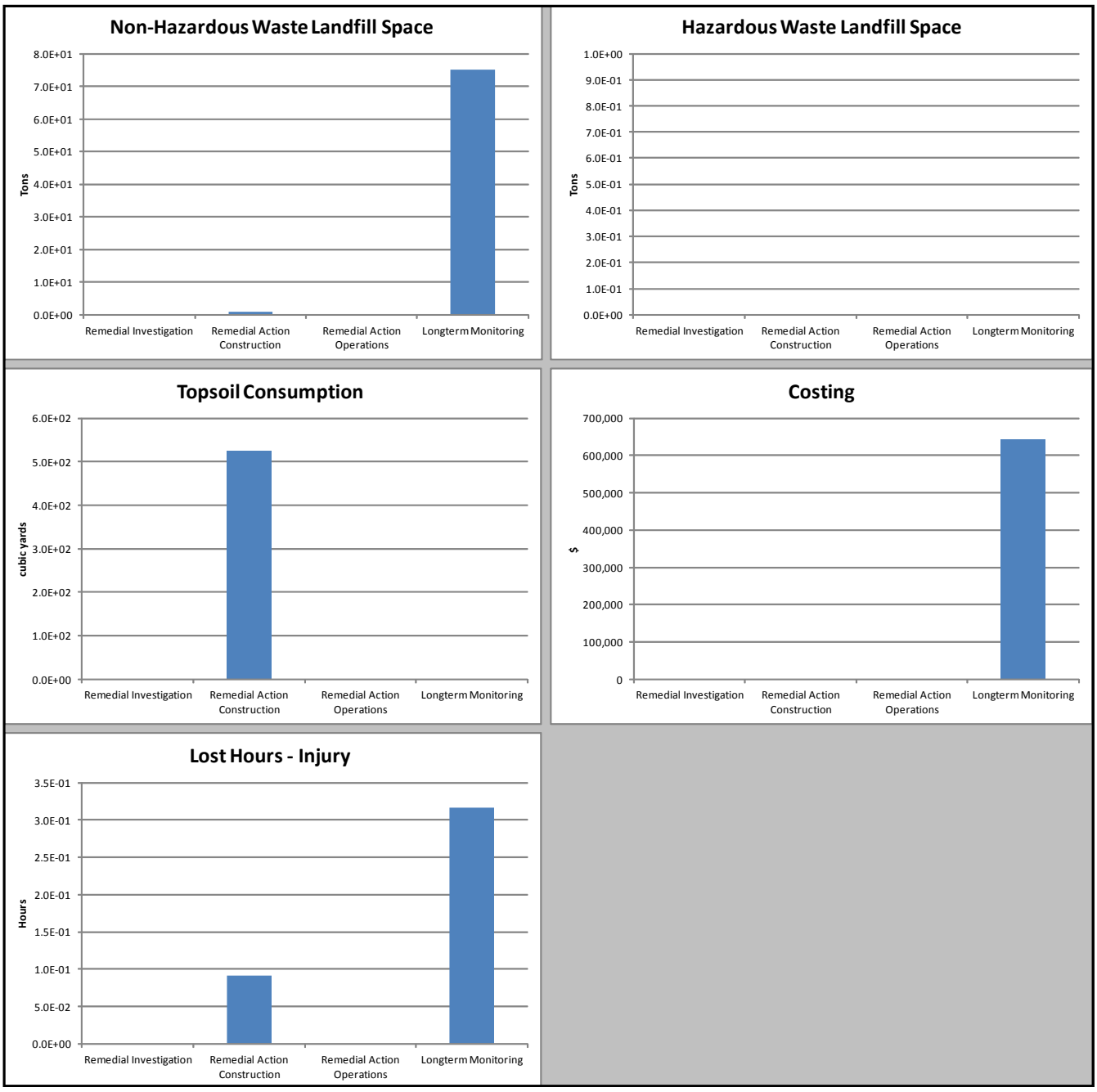


## Sustainable Remediation - Environmental Footprint Summary
## Cover Improvements and ICs with LTM

| Phase | Activities | GHG Emissions | Total energy Used | Water Consumption | NOx emissions | SOx Emissions | PM10 Emissions | Accident Risk Fatality | Accident Risk Injury |
|---|---|---|---|---|---|---|---|---|---|
| | | metric ton | MMBTU | gallons | metric ton | metric ton | metric ton | | |
| Remedial Investigation | Consumables | 0.00 | 0.0E+00 | NA | NA | NA | NA | NA | NA |
| | Transportation-Personnel | 0.00 | 0.0E+00 | NA | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Transportation-Equipment | 0.00 | 0.0E+00 | NA | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Equipment Use and Misc | 0.00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Residual Handling | 0.00 | 0.0E+00 | NA | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Sub-Total | 0.00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Remedial Action Construction | Consumables | 0.03 | 1.8E-01 | NA | NA | NA | NA | NA | NA |
| | Transportation-Personnel | 0.24 | 3.1E+00 | NA | 9.0E-05 | 3.2E-06 | 1.8E-05 | 1.3E-05 | 1.1E-03 |
| | Transportation-Equipment | 0.25 | 3.3E+00 | NA | 7.9E-05 | 2.0E-06 | 6.8E-06 | 1.2E-06 | 9.4E-05 |
| | Equipment Use and Misc | 0.53 | 7.5E+00 | 1.4E+04 | 2.9E-03 | 4.1E-04 | 4.0E-04 | 4.1E-05 | 1.0E-02 |
| | Residual Handling | 0.08 | 1.2E+00 | NA | 8.6E-05 | 3.5E-05 | 1.8E-04 | 3.9E-07 | 3.1E-05 |
| | Sub-Total | 1.13 | 1.52E+01 | 1.40E+04 | 3.18E-03 | 4.48E-04 | 6.13E-04 | 5.54E-05 | 1.14E-02 |
| Remedial Action Operations | Consumables | 0.00 | 0.0E+00 | NA | NA | NA | NA | NA | NA |
| | Transportation-Personnel | 0.00 | 0.0E+00 | NA | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Transportation-Equipment | 0.00 | 0.0E+00 | NA | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Equipment Use and Misc | 0.00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Residual Handling | 0.00 | 0.0E+00 | NA | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Sub-Total | 0.00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Longterm Monitoring | Consumables | 0.00 | 0.0E+00 | NA | NA | NA | NA | NA | NA |
| | Transportation-Personnel | 13.26 | 1.7E+02 | NA | 4.9E-03 | 1.7E-04 | 1.0E-03 | 3.7E-04 | 3.0E-02 |
| | Transportation-Equipment | 0.00 | 0.0E+00 | NA | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Equipment Use and Misc | 0.00 | 6.4E-04 | 3.2E-02 | 1.7E-08 | 1.5E-08 | 0.0E+00 | 0.0E+00 | 0.0E+00 |
| | Residual Handling | 21.49 | 3.0E+02 | NA | 1.1E-02 | 2.8E-03 | 1.4E-02 | 1.2E-04 | 9.4E-03 |
| | Sub-Total | 34.75 | 4.68E+02 | 3.16E-02 | 1.63E-02 | 3.00E-03 | 1.51E-02 | 4.91E-04 | 3.96E-02 |
| **Total** | | **3.6E+01** | **4.8E+02** | **1.4E+04** | **2.0E-02** | **3.4E-03** | **1.6E-02** | **5.5E-04** | **5.1E-02** |

| Remedial Alternative Phase | Non-Hazardous Waste Landfill Space | Hazardous Waste Landfill Space | Topsoil Consumption | Costing | Lost Hours - Injury | Total Cost with Footprint Reduction |
|---|---|---|---|---|---|---|
| | tons | tons | cubic yards | $ | | |
| Remedial Investigation | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0 | 0.0E+00 | |
| Remedial Action Construction | 1.0E+00 | 0.0E+00 | 5.3E+02 | 0 | 9.1E-02 | |
| Remedial Action Operations | 0.0E+00 | 0.0E+00 | 0.0E+00 | 0 | 0.0E+00 | |
| Longterm Monitoring | 7.5E+01 | 0.0E+00 | 0.0E+00 | 642,000 | 3.2E-01 | |
| **Total** | **7.6E+01** | **0.0E+00** | **5.3E+02** | **$642,000** | **4.1E-01** | **$642,000** |


GHG Emissions
Metric Tons
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Residual Handling
Equipment Use and Misc
Transportation-Equipment
Transportation-Personnel
Consumables
Total Energy Used
MMBTU
5.00E+02
4.50E+02
4.00E+02
3.50E+02
3.00E+02
2.50E+02
2.00E+02
1.50E+02
1.00E+02
5.00E+01
0.00E+00
Water Consumption
Gallons
1.60E+04
1.40E+04
1.20E+04
1.00E+04
8.00E+03
6.00E+03
4.00E+03
2.00E+03
0.00E+00
NOx Emissions
Metric Ton
1.80E-02
1.60E-02
1.40E-02
1.20E-02
1.00E-02
8.00E-03
6.00E-03
4.00E-03
2.00E-03
0.00E+00
SOx Emissions
Metric Ton
3.50E-03
3.00E-03
2.50E-03
2.00E-03
1.50E-03
1.00E-03
5.00E-04
0.00E+00
PM10 Emissions
Metric Ton
1.60E-02
1.40E-02
1.20E-02
1.00E-02
8.00E-03
6.00E-03
4.00E-03
2.00E-03
0.00E+00
Accident Risk - Fatality
Risk of Fatality
6.00E-04
5.00E-04
4.00E-04
3.00E-04
2.00E-04
1.00E-04
0.00E+00
Accident Risk - Injury
Risk of Injury
4.50E-02
4.00E-02
3.50E-02
3.00E-02
2.50E-02
2.00E-02
1.50E-02
1.00E-02
5.00E-03
0.00E+00


Non-Hazardous Waste Landfill Space
Tons
8.0E+01
7.0E+01
6.0E+01
5.0E+01
4.0E+01
3.0E+01
2.0E+01
1.0E+01
0.0E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Hazardous Waste Landfill Space
Tons
1.0E+00
9.0E-01
8.0E-01
7.0E-01
6.0E-01
5.0E-01
4.0E-01
3.0E-01
2.0E-01
1.0E-01
0.0E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Topsoil Consumption
cubic yards
6.0E+02
5.0E+02
4.0E+02
3.0E+02
2.0E+02
1.0E+02
0.0E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Costing
$
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring
Lost Hours - Injury
Hours
3.5E-01
3.0E-01
2.5E-01
2.0E-01
1.5E-01
1.0E-01
5.0E-02
0.0E+00
Remedial Investigation
Remedial Action Construction
Remedial Action Operations
Longterm Monitoring

# APPENDIX C:

# REMEDIAL ALTERNATIVE COST ESTIMATES

**SUMMARY OF COSTS FOR REMEDIAL ALTERNATIVES**
**Feasibility Study, Installation Restoration Program Site 27, Naval Weapons Station Seal Beach, Detachment Fallbrook, Fallbrook, California**

| Description | ALTERNATIVE 2 - Long Term Monitoring with Institutional Controls | ALTERNATIVE 3 - Soil Cover Improvements with Long Term Monitoring and Institutional Controls |
|---|---|---|
| Project Management | $25,000 | $40,000 |
| RD/RAWP | NA | $80,000 |
| LTM Implementation Plan | $50,000 | $15,000 |
| IC Implementation Plan | $50,000 | $50,000 |
| RA Implementation | NA | $279,517 |
| LTM Implementation | $263,000 | $263,000 |
| Maintain and Enforce ICs | $60,000 | $60,000 |
| 5 Year Reviews and Reporting | $150,000 | $150,000 |
| Contingency | $119,600 | $187,503 |
| **Total** | **$717,600** | **$1,125,020** |
| **Present Worth Total** | **$489,034** | **$765,888** |

**ALTERNATIVE 2 - Long Term Monitoring with Institutional Controls**
**Feasibility Study, Installation Restoration Program Site 27, Naval Weapons Station Seal Beach, Detachment Fallbrook, Fallbrook, California**

| Description | Quantity | Measure | Unit Cost | Extended Cost | Source |
|---|---|---|---|---|---|
| **PROJECT MANAGEMENT** | | | | | |
| Project Management | 1 | LS | $25,000 | $25,000 | Engineer's Estimate |
| | | | **PM Subtotal** | **$25,000** | |
| | | | | | |
| **INSTITUTIONAL CONTROL IMPLEMENTATION PLAN** | | | | | |
| Plan Preparation | 1 | LS | $50,000 | $50,000 | Engineer's Estimate |
| | | | **IC Implementation Plan Subtotal** | **$50,000** | |
| | | | | | |
| **LONG TERM MONITORING PLAN** | | | | | |
| Plan Preparation | 1 | LS | $50,000 | $50,000 | Engineer's Estimate |
| | | | **LTM Implementation Plan Subtotal** | **$50,000** | |
| | | | | | |
| **IMPLEMENTATION OF LONG TERM MONITORING** | | | | | |
| Long Term Monitoring (Year 1 through 5 - Annually) | 5 | EA | $20,000 | $100,000 | Engineer's Estimate |
| Long Term Monitoring (Year 6 through 30 - Every 5 Years) | 5 | EA | $20,000 | $100,000 | Engineer's Estimate |
| Landfill Surveys (Year 0 through 30 - Every 5 Years) | 7 | EA | $9,000 | $63,000 | Quote |
| | | | **LTM ImplementationSubtotal** | **$263,000** | |
| | | | | | |
| **ENFORCING INSTITUTIONAL CONTROLS** | | | | | |
| Institutional Control Review (annually, 30 years) | 30 | LS | $2,000 | $60,000 | Engineer's Estimate |
| | | | **Subtotal** | **$60,000** | |
| | | | | | |
| **5-YEAR REVIEWS AND REPORTING** | | | | | |
| 5-Year Reviews (per event) | 6 | EA | $25,000 | $150,000 | Engineer's Estimate |
| | | | **Subtotal** | **$150,000** | |
| | | | | | |
| | | | **SUBTOTAL** | **$598,000** | |
| | | | **Contingency (20%)** | **$119,600** | |
| | | | | | |
| | | | **TOTAL** | **$717,600** | |

**ALTERNATIVE 3 - Soil Cover Improvements with Long Term Monitoring and Institutional Controls**
**Feasibility Study, Installation Restoration Program Site 27, Naval Weapons Station Seal Beach, Detachment Fallbrook, Fallbrook, California**

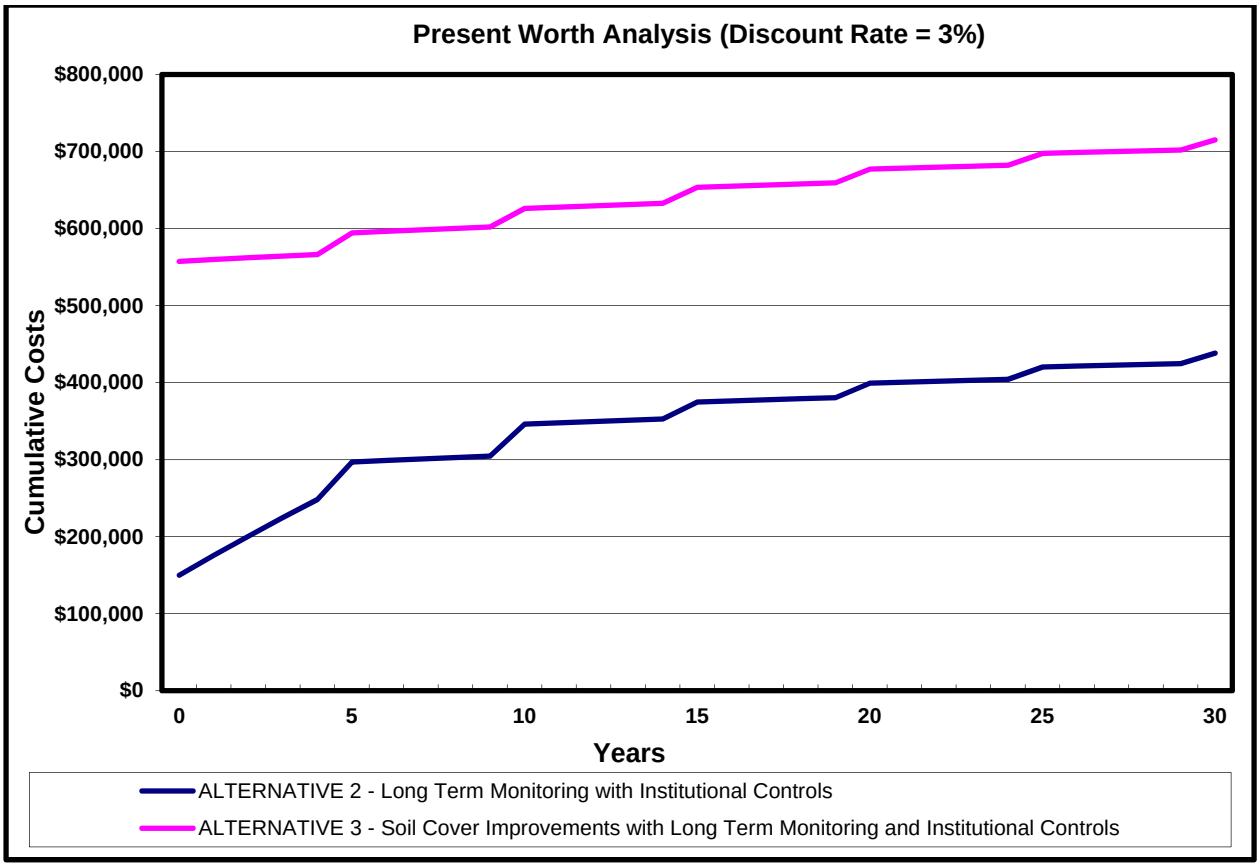
| | Description | Quantity | Measure | Unit Cost | Extended Cost | Source |
|---|---|---|---|---|---|---|
| | **PROJECT MANAGEMENT** | | | | | |
| | Project Management | 1 | LS | $40,000 | $40,000 | Engineer's Estimate |
| | | | | **PM Subtotal** | **$40,000** | |
| | | | | | | |
| | **REMEDIAL DESIGN AND REMEDIAL ACTION WORK PLAN** | | | | | |
| | Plan Preparation | 1 | LS | $80,000 | $80,000 | Engineer's Estimate |
| | | | | **RD/RAWP Subtotal** | **$80,000** | |
| | | | | | | |
| | **INSTITUTIONAL CONTROL IMPLEMENTATION PLAN** | | | | | |
| | Plan Preparation | 1 | LS | $50,000 | $50,000 | Engineer's Estimate |
| | | | | **IC Implementation Plan Subtotal** | **$50,000** | |
| | | | | | | |
| | **LONG TERM MONITORING PLAN** | | | | | |
| | Plan Preparation | 1 | LS | $15,000 | $15,000 | Engineer's Estimate |
| | | | | **MNR Implementation Plan Subtotal** | **$15,000** | |
| | | | | | | |
| | **SOIL COVER IMPROVEMENTS** | | | | | |
| | | | | | | |
| | **Place and Compact Additional Cover Material** | | | | | |
| | Mobilization | 1 | LS | $10,000.00 | $10,000 | Vendor Quote |
| | Biological Monitoring | 80 | hr | $95.00 | $7,600 | Vendor Quote |
| | Prepare Area for Cover Placement | 1 | LS | $12,800.00 | $12,800 | Vendor Quote |
| | Transport of Imported Fill Material | 700 | ton | $54.00 | $37,800 | Vendor Quote |
| | Place and Compact Additional Cover Material | 1 | LS | $90,684.00 | $90,684 | Vendor Quote |
| | Offsite Disposal of Cleared Vegetation | 100 | cubic yard | $5.00 | $500 | Engineer's Estimate |
| | Cover Testing | 1 | LS | $4,000.00 | $4,000 | Engineer's Estimate |
| | Revegetation - Hydroseed | 20692 | sq ft | $0.25 | $5,173 | Engineer's Estimate |
| | Demobilization | 1 | LS | $3,000.00 | $3,000 | Vendor Quote |
| | | | | **Subtotal** | **$171,557** | |
| | | | | | | |
| | **Surface Drainage** | | | | | |
| | Mobilization | 1 | LS | $10,000.00 | $10,000 | Vendor Quote |
| | Biological Monitoring | 50 | hr | $95.00 | $4,750 | Vendor Quote |
| | Prepare Surface for Cover Placement | 1 | LS | $29,060.00 | $29,060 | Vendor Quote |
| | Place Geotextile and Aggregate | 1 | LS | $61,000.00 | $61,000 | Vendor Quote |
| | Offsite Disposal of Cleared Vegetation | 30 | cubic yard | $5.00 | $150 | Engineer's Estimate |
| | Demobilization | 1 | LS | $3,000.00 | $3,000 | Vendor Quote |
| | | | | **Subtotal** | **$107,960** | |
| | | | | | | |
| | **ENFORCING INSTITUTIONAL CONTROLS** | | | | | |
| | Institutional Control Review (annually, 30 years) | 30 | LS | $2,000 | $60,000 | Engineer's Estimate |
| | | | | **Subtotal** | **$60,000** | |
| | | | | | | |

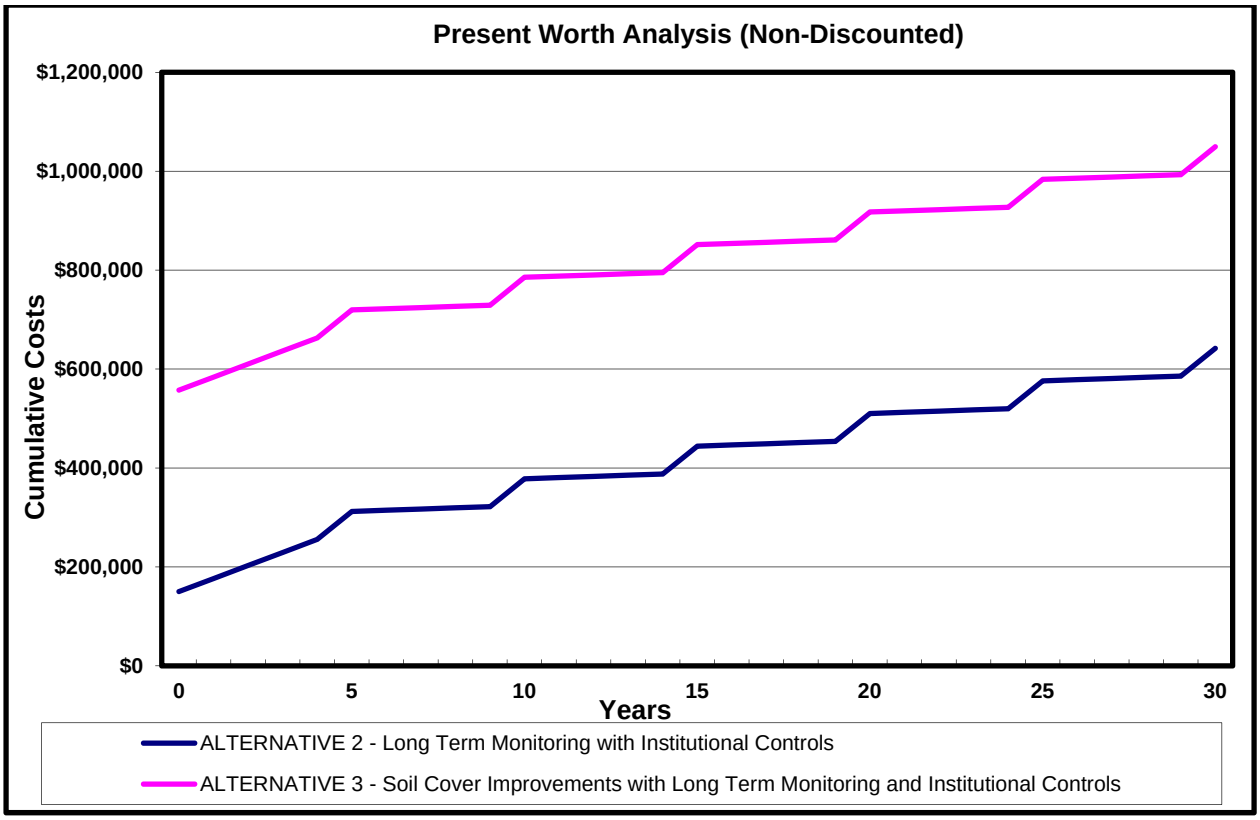
**ALTERNATIVE 3 - Soil Cover Improvements with Long Term Monitoring and Institutional Controls**
**Feasibility Study, Installation Restoration Program Site 27, Naval Weapons Station Seal Beach, Detachment Fallbrook, Fallbrook, California**

| | Description | Quantity | Measure | Unit Cost | Extended Cost | Source |
|---|---|---|---|---|---|---|
| | **IMPLEMENTATION OF LONG TERM MONITORING** | | | | | |
| | Long Term Monitoring (Year 1 through 5 - Annually) | 5 | EA | $20,000 | $100,000 | Engineer's Estimate |
| | Long Term Monitoring (Year 6 through 30 - Every 5 Years) | 5 | EA | $20,000 | $100,000 | Engineer's Estimate |
| | Landfill Surveys (Year 0 through 30 - Every 5 Years) | 7 | EA | $9,000 | $63,000 | Quote |
| | | | | **LTM ImplementationSubtotal** | **$263,000** | |
| | | | | | | |
| | **5-YEAR REVIEWS AND REPORTING** | | | | | |
| | 5-Year Reviews (per event) | 6 | EA | $25,000 | $150,000 | Engineer's Estimate |
| | | | | **Subtotal** | **$150,000** | |
| | | | | | | |
| | | | | **SUBTOTAL** | **$937,517** | |
| | | | | **Contingency (20%)** | **$187,503** | |
| | | | | | | |
| | | | | **TOTAL** | **$1,125,020** | |

**Table 1. Present Value Calculations**

| Year | ALTERNATIVE 2 - Long Term Monitoring with Institutional Controls | | | | ALTERNATIVE 3 - Soil Cover Improvements with Long Term Monitoring and Institutional Controls | | | |
|---|---|---|---|---|---|---|---|---|
| | Present Worth Cost (Discount Rate = 3%) | | Present Worth Cost (Non-Discounted) | | Present Worth Cost (Discount Rate = 3%) | | Present Worth Cost (Non-Discounted) | |
| | Annual | Cumulative | Annual | Cumulative | Annual | Cumulative | Annual | Cumulative |
| **RA Impl** | **$150,000** | | **$150,000** | | **$557,420** | | **$557,420** | |
| **5 Yr Reviews** | $30,000 | | $30,000 | | $30,000 | | **$30,000** | |
| **ICs** | $2,400 | | $2,400 | | $2,400 | | **$2,400** | |
| **Landfill Surveys** | $10,800 | | $10,800 | | $10,800 | | $10,800 | |
| **LTM** | $24,000 | | $24,000 | | $24,000 | | $24,000 | |
| 0 | $160,800 | $160,800 | $160,800 | $160,800 | $568,220 | $568,220 | $568,220 | $568,220 |
| 1 | $25,631 | $186,431 | $26,400 | $187,200 | $2,330 | $570,550 | $26,400 | $594,620 |
| 2 | $24,885 | $211,316 | $26,400 | $213,600 | $2,262 | $572,813 | $26,400 | $621,020 |
| 3 | $24,160 | $235,475 | $26,400 | $240,000 | $2,196 | $575,009 | $26,400 | $647,420 |
| 4 | $23,456 | $258,931 | $26,400 | $266,400 | $2,132 | $577,141 | $26,400 | $673,820 |
| 5 | $57,967 | $316,899 | $67,200 | $333,600 | $37,265 | $614,406 | $67,200 | $741,020 |
| 6 | $2,010 | $318,909 | $2,400 | $336,000 | $2,010 | $616,416 | $2,400 | $743,420 |
| 7 | $1,951 | $320,860 | $2,400 | $338,400 | $1,951 | $618,368 | $2,400 | $745,820 |
| 8 | $1,895 | $322,755 | $2,400 | $340,800 | $1,895 | $620,262 | $2,400 | $748,220 |
| 9 | $1,839 | $324,594 | $2,400 | $343,200 | $1,839 | $622,101 | $2,400 | $750,620 |
| 10 | $49,598 | $374,192 | $67,200 | $410,400 | $32,145 | $654,246 | $67,200 | $817,820 |
| 11 | $1,734 | $375,926 | $2,400 | $412,800 | $1,734 | $655,980 | $2,400 | $820,220 |
| 12 | $1,683 | $377,610 | $2,400 | $415,200 | $1,683 | $657,663 | $2,400 | $822,620 |
| 13 | $1,634 | $379,244 | $2,400 | $417,600 | $1,634 | $659,298 | $2,400 | $825,020 |
| 14 | $1,587 | $380,831 | $2,400 | $420,000 | $1,587 | $660,884 | $2,400 | $827,420 |
| 15 | $28,909 | $409,740 | $67,200 | $487,200 | $27,728 | $688,613 | $67,200 | $894,620 |
| 16 | $1,496 | $411,235 | $2,400 | $489,600 | $1,496 | $690,108 | $2,400 | $897,020 |
| 17 | $1,452 | $412,687 | $2,400 | $492,000 | $1,452 | $691,561 | $2,400 | $899,420 |
| 18 | $1,410 | $414,097 | $2,400 | $494,400 | $1,410 | $692,970 | $2,400 | $901,820 |
| 19 | $1,369 | $415,466 | $2,400 | $496,800 | $1,369 | $694,339 | $2,400 | $904,220 |
| 20 | $24,797 | $440,263 | $67,200 | $564,000 | $23,919 | $718,258 | $67,200 | $971,420 |
| 21 | $1,290 | $441,553 | $2,400 | $566,400 | $1,290 | $719,548 | $2,400 | $973,820 |
| 22 | $1,253 | $442,806 | $2,400 | $568,800 | $1,253 | $720,800 | $2,400 | $976,220 |
| 23 | $1,216 | $444,022 | $2,400 | $571,200 | $1,216 | $722,016 | $2,400 | $978,620 |
| 24 | $1,181 | $445,202 | $2,400 | $573,600 | $1,181 | $723,197 | $2,400 | $981,020 |
| 25 | $21,286 | $466,489 | $67,200 | $640,800 | $20,633 | $743,830 | $67,200 | $1,048,220 |
| 26 | $1,113 | $467,601 | $2,400 | $643,200 | $1,113 | $744,943 | $2,400 | $1,050,620 |
| 27 | $1,080 | $468,682 | $2,400 | $645,600 | $1,080 | $746,023 | $2,400 | $1,053,020 |
| 28 | $1,049 | $469,731 | $2,400 | $648,000 | $1,049 | $747,072 | $2,400 | $1,055,420 |
| 29 | $1,018 | $470,749 | $2,400 | $650,400 | $1,018 | $748,090 | $2,400 | $1,057,820 |
| 30 | $18,284 | $489,034 | $67,200 | $717,600 | $17,798 | $765,888 | $67,200 | $1,125,020 |


Present Worth Analysis (Discount Rate = 3%)
$800,000
$700,000
$600,000
$500,000
$400,000
$300,000
$200,000
$100,000
$0
Cumulative Costs
0
5
10
15
20
25
30
Years
ALTERNATIVE 2 - Long Term Monitoring with Institutional Controls
ALTERNATIVE 3 - Soil Cover Improvements with Long Term Monitoring and Institutional Controls


Present Worth Analysis (Non-Discounted)
$1,200,000
$1,000,000
$800,000
$600,000
$400,000
$200,000
$0
Cumulative Costs
0
5
10
15
20
25
30
Years
ALTERNATIVE 2 - Long Term Monitoring with Institutional Controls
ALTERNATIVE 3 - Soil Cover Improvements with Long Term Monitoring and Institutional Controls

# APPENDIX D:

# RESPONSES TO COMMENTS ON THE DRAFT

| Comment Number | Page/Section Numbers | Comment | Response |
|---|---|---|---|
| **General Comments – Dr. Stephen Niou, P.E., Brownfields and Environmental Restoration Program, Department of Toxic Substances Control, Comments Dated November 18, 2014** | | | |
| 1. | General | DTSC proposes to add a RAO: to prevent future disposal of wastes at the closed landfill. | The Navy agrees that the prevention of unauthorized disposal of waste is an appropriate consideration for IRP Site 27, as well as other areas of Detachment Fallbrook that may be subject to similar practices. However, the results of the RI do not provide a risk-basis under CERCLA to support an RAO addressing the issue of unauthorized waste disposal in the future. DTSC's concerns have been communicated to base personnel who will consider best management practices (BMPs) to prevent these activities in the future (though such efforts would not be considered part of a remedy under CERCLA). |
| 2. | General | Please provide a signed and stamped version by a registered civil engineer or certified engineering geologist of the cover sheet after revisions are final in accordance with California Code of Regulation (CCR) Title 27 Section 21800 (27CCR§21800). | The Final FS Report will be signed and stamped by a registered civil engineer or certified engineering geologist, as requested. |
| 3. | General | The information in the Feasibility Study needs to present cumulative data and function as a standalone document. Please summarize past investigative findings and conclusions into this report. Particularly, please discuss the nature and extent of contamination at IRP Site 27. | Section 3.0 has been updated to include a subsection providing a brief summary of the nature and extent of contamination at IRP Site 27, which is based on the findings of the RI. |
| 4. | General | The report does not discuss if gas generation/migration is a concern at the site in the text of the report. Although a limited discussion is presented in Table A-5, there is no mention of whether integrated surface sampling or modeling has been conducted for the landfill. Furthermore, there is no discussion of landfill gas probes for gas detection or historical results presented. | Section 3.0 has been updated to include a subsection providing a brief summary of previous sampling conducted to assess the presence of landfill gas in the vadose zone at IRP Site 27. Modeling has not been conducted, but historical direct measurements support that landfill gases are generally not detected, with the exception of a single location where methane was |

| Comment Number | Page/Section Numbers | Comment | Response |
|---|---|---|---|
| | | | detected an order of magnitude below concentrations that require regulation. |
| 5. | General | Please provide the final proposed cover design description of either prescriptive cover or that of an engineered alternative cover. | Based on the results of the RI and field observations during site walks, the range of alternatives presented in the Draft FS each provide adequate protection of human health and the environment and comply with ARARs. The Navy does not intend to include additional alternatives in the FS. |
| **Specific Comments – Dr. Stephen Niou, P.E., Brownfields and Environmental Restoration Program, Department of Toxic Substances Control, Comments Dated November 18, 2014** | | | |
| 1. | Section 3.3 | Please provide the data and sampling locations of the cover testing hydraulic conductivity cited. | A reference to the Final Remedial Investigation Report has been added to Section 3.3, which is the source of the hydraulic conductivity data available for IRP Site 27. The data are available in the RI and will not be added to the FS, but Figure 2-1 has been updated to provide the locations of soil samples from potholes, LCE-1 through LCE-10, which were used to conduct the hydraulic conductivity testing. |
| 2. | Section 3.4 | Please provide the data for the groundwater monitoring results cited. | A reference to the Final Remedial Investigation Report has been added to Section 3.3, which is the source of the groundwater monitoring results for IRP Site 27. The full data are available in the RI and are summarized in the FS at a level of detail that is appropriate for this report. |
| 3. | Section 3.5.1 | Please note that DTSC no longer uses the California Human Health Screening Levels (CHHSLs) for screening risk-based evaluations because they have not been updated regularly, and now recommends the use of USEPA Regional Screening Levels (RSLs) and DTSC-modified screening levels in the Human Health Risk Assessment (HHRA) Note Number 3 (http://www.dtsc.ca.gov/AssessingRisk/upload/HHR | The RI has been completed and the human health risk assessment will not be reevaluated. However, Section 3.5 has been updated to include the results of a comparison of the CHHSLs used in the RI to the current U.S. EPA RSLs to support conclusions related to potential uncertainty in the risk assessment. |

| Comment Number | Page/Section Numbers | Comment | Response |
|---|---|---|---|
| | | A-Note-3-2.pdf). Please reevaluate the human health risk assessment with latest updated screening levels. | |
| 4. | Section 6.2.1 | Because of newer waste disposal such as tires, car exhaust pipes, etc., found at the landfill, DTSC believes it may be necessary to prevent future dumping at the site. Please include the installation of a fence for site security in addition to the other institutional control proposed. Additional appropriate restrictions for land use will be determined after the completion of remedial activities in consultation with DTSC and RWQCB. | As stated in the response to general comment #1, DTSC's concerns have been communicated to base personnel who will consider BMPs to prevent these activities in the future (though such efforts would not be considered part of a remedy under CERCLA). |
| 5. | Sections 6.3.1 and 6.3.2.1 | Please ensure that the overall thickness of the landfill cover is two feet or greater. The final cover under 27CCR§21090 requires a minimum of a two foot thick foundation layer, one foot thick low-hydraulic conductivity layer, and one foot thick erosion-resistant layer. | The IRP Site 27 Landfill was closed in 1974 and is not leaching contaminants to the underlying aquifer. The landfill requirements under 27CCR§21090 are not applicable to landfills that were closed prior to November 27, 1984 and are not leaching contaminants to groundwater. Furthermore, while 27CCR§21090 is relevant, it is the Navy's position that it is not appropriate to consider the installation of an engineered soil cover over the entire landfill area in accordance with the substantive requirements of the stated regulation because:<br>(1) the existing soil cover has been in place for over 40 years and is stable;<br>(2) the remedial investigation concluded that there are no unacceptable risks based on the current and planned future use of the property; and<br>(3) the area serves as potential habitat for special status species.<br>In order to address agency concerns regarding the long term stability of the cap, the long term monitoring component of Alternatives 2 and 3 has been enhanced by adding requirements to conduct transect surveys on |

| Comment Number | Page/Section Numbers | Comment | Response |
|---|---|---|---|
| | | | an annual basis for the first five years and then every five years thereafter. These surveys will be conducted in addition to the visual inspections to provide a quantitative measure of long term cap performance. Long term monitoring will also include annual reporting to the regulatory agencies to summarize the results of these surveys for each year they are conducted. In addition to long term monitoring, IRP Site 27 will be subject to the Five Year Review process, which will provide a mechanism for evaluating remedy effectiveness and verifying that site conditions, as determined in the remedial investigation, are still valid. If monitoring indicates that erosion is an issue in the future, the Five Year Review will provide a mechanism for revisiting the remedy for IRP Site 27. However, the available data and site conditions summarized in the remedial investigation demonstrate that the cap is stable. Therefore, the technical approach for the soil cover improvements described for Alternative 3, Soil Cover Improvements with Institutional Controls and Long-Term Monitoring, will be maintained. |
| 6. | Section 6.3.1 | Please clarify the reference to the hydraulic conductivity provided in Section 5.4 of "$1.47x10^{-6}$" to that of "$1.47x10^{-7}$"centimeters per second (cm/s) provided in Section 6.3.1. | The hydraulic conductivity values in Section 5.4 are correct; the values in Section 6.3.1 have been corrected to "$1.47 \times 10^{-6}$ cm/sec to $1.79 \times 10^{-7}$ cm/sec". |
| 7. | Section 7.0 | Alternative 3 provides the most favorable evaluation because it restores the required two feet of cover (notwithstanding the foundation layer) to the landfill in conjunction to institutional controls and long-term monitoring in accordance with ARARs, whereas Alternative 2 provides a status quo for the deficient cover not in accordance with the ARARs. As a result please update Tables ES-1 and Table 6-1 accordingly. | Refer to the response to comment #5 regarding the Navy's position on landfill cover provisions of CCR Title 27 landfill regulations. The alternative analysis summarized in Table ES-1 and Table 6-1 has been maintained. |

| Comment Number | Page/Section Numbers | Comment | Response |
|---|---|---|---|
| 8. | Table A-5 | Please update the requirements with the appropriate rules in the table as the site is in the San Diego Air Pollution Control District jurisdiction. | Table A-5 has been updated to reference the San Diego Air Pollution Control Board Rule 55, which contains applicable requirements for fugitive dust control under Alternative 3. |
| **Technical Comments – Ms. Beatrice Griffey, P.G., Northern Cleanup Unit, San Diego Regional Water Quality Control Board, Comments Dated November 18, 2014** | | | |
| 1. | Executive Summary and Section 6.2 | Remedial Alternative 2 Balancing and Threshold Criteria Rating. Based on Site conditions, proposed Remedial Alternative (RA) 2 seems to warrant a low rating for the Long-Term Effectiveness and Permanence, and ARARs compliance criteria. According to Tables ES-1 and 6-1, Remedial Alternative 2 is assigned a high rating for Long-Term Effectiveness and Permanence, and ARARs Compliance. Such ratings do not seem to take into consideration the fact that the landfill cover is relatively thin (1-3 feet) and is subject to drainage and erosional processes associated with surface water runoff. It is not apparent that Site cover conditions currently comply with the California Code of Regulations (CCR) landfill cover performance and prescriptive requirements, which are Applicable or Relevant and Appropriate Requirements (ARARs). Additionally, whereas the presence of plant species growing on the cover may stabilize cover soil within the plants radius of influence, it has not been demonstrated that conditions throughout the landfill cover are and will be adequate to comply with all the CCR requirements for the required time frame, i.e. until such time that there are no potential adverse impacts associated with the presence of disposed of waste at the Site. Field photographs from the December 2010 stormwater sampling event indicate the presence of suspended and settleable solids in | The IRP Site 27 Landfill was closed in 1974 and is not leaching contaminants to the underlying aquifer. The landfill requirements under CCR Title 27 are not applicable to landfills that were closed prior to November 27, 1984 and are not leaching contaminants to groundwater. Therefore, the Navy considers Alternative 2 to be compliant with ARARs. Furthermore, the Navy does not consider the presence of suspended solids in surface runoff to be an indicator of landfill erosion. By area, the landfill cover represents approximately 6% of the stormwater catchment associated with IRP Site 27, which includes a dirt road and dirt paths. Furthermore, the degradation of surface organic material and transport of fine sediment via wind are also reasonable mechanisms that would result in the presence of suspended solids in surface runoff. The landfill cover has been in place for over 40 years and the RI has shown the cover to be intact. Alternative 2 includes provisions for long-term monitoring on an annual basis to inspect the cover and ensure it remains competent in the future. As discussed in the response to DTSC specific comment #5, the long term monitoring component of Alternatives 2 and 3 has been enhanced by adding requirements to conduct transect surveys to provide a quantitative measure of long term cap performance. Based on the LTM component of Alternative 2 (including the addition of survey transects), the Navy considers a high Long- |

| Comment Number | Page/Section Numbers | Comment | Response |
|---|---|---|---|
| | | surface water. The most likely source of these solids is the landfill cover, which is evidence that the cover is being eroded. Based on the level of uncertainty that currently exists regarding the long-term integrity of the current landfill cover, it seems that a low rating for the Long-Term Effectiveness and Permanence, and ARARs Compliance criteria are more appropriate for RA 2. In the RTC, please provide additional justification for the proposed rating of RA 2 that addresses the raised concern or a revised Draft FS Tables ES-1 and 6-1, whichever is appropriate. | Term Effectiveness and Permanence rating to be justified and appropriate. |
| 2. | Appendix A, Table A-4 | **Clean Water Act Section 402 and 40 CFR Sections 122, 123, and 124.** It is the San Diego Water Board's position that the Clean Water Act and 40 CFR Sections 122, 123, and 124 are Site ARARs. According to Draft FS, Table A-4, Page A4-3, the Clean Water Act and 40 CFR Sections 122, 123, and 124 are not ARARs because the Site does not have the potential to release "contaminants" to surface water. The comment seems to consider adverse water quality impacts related only to chemical contaminants and does not address other potential applicable threats to water quality that may violate applicable water quality objectives (San Diego Water Board, 1994). As an example, the findings of the December 2010 stormwater sampling event indicate that suspended and settleable solids are potential threats to surface water quality at and down gradient of the Site. Therefore, it is the San Diego Water Board's position that the Clean Water Act and 40 CFR Sections 122, 123, and 124 are Site ARARs. In the RTC, please provide either additional justification supporting the ARAR determination for the Clean Water Act and 40 CFR Sections 122, 123, and 124 that addresses the | Table A-4 has been updated to clarify that the Clean Water Act and 40 CFR Section 122.44(k)(2) and (4) are action-specific ARARs because they are relevant and appropriate during earthwork associated with cover improvements under Alternative 3. |

| Comment Number | Page/Section Numbers | Comment | Response |
|---|---|---|---|
| | | raised concern or a revised Draft FS, Table A-4, Page A4-3, whichever is appropriate. | |
| 3. | Appendix A, Table A-5 | **San Diego Water Board General Order R9-2012-0001.** It is the San Diego Water Board's position that General Order R9-2012-0001 (Order) is a Site ARAR. According to Draft FS, Table A-5, Page A5-1, Order R9-2012-001 is not an ARAR because it is considered to be a regional requirement and not part of a state plan. The Order was issued pursuant to the California Water Code, implements statewide applicable regulations and policies, meets the NCP "general applicability" requirement [National Oil and Hazardous Substances Pollution Contingency Plan Section 300.400 (g)(4)], and therefore is considered to be a Site ARAR. The Order is not regional in nature with regards to substantive requirements. In the RTC, please provide either additional justification supporting the subject Order ARAR determination or a revised Draft FS, Table A-5 that identifies the Order as a Site ARAR, whichever is appropriate. | The Navy respectfully contends that the General Order R9-2012-0001 (Order) is not a potential ARAR in and of itself for various reasons, including the fact that the Order contains a number of provisions that in themselves are not substantive in nature. However, the Navy would concede that, to whatever extent the substantive provisions contained within the Order derive from the California State Code and/or California Code of Regulations, are of general applicability, and address circumstances found at CERCLA sites, such substantive provisions would clearly require consideration as potential state ARARs. |
| **Editorial Comments – Ms. Beatrice Griffey, P.G., Northern Cleanup Unit, San Diego Regional Water Quality Control Board, Comments Dated November 18, 2014** | | | |
| 1. | Executive Summary, Section 2.1, and Section 3 | The Executive Summary, Page iii, Second Paragraph; Subsection 2.1, Second Paragraph; and Subsection 3.1 contain conflicting information regarding the duration that disposal activities were conducted at IR Site 27. According to the Executive Summary, Page iii, Second Sentence, IR Site 27 was in operation from 1960 through 1974. Yet the Executive Summary, Page iii, Fourth Sentence utilizes a five-year life to estimate the waste quantity disposed of at the Site on a daily basis. Please provide either clarification regarding this matter, or revised Executive Summary, Subsection 2.1, and Subsection | The Executive Summary, Section 2.1, and Section 3.0 have been updated to remove the following sentence from the text:<br><br>"Based on an approximate 5-year life for the landfill, this span would amount to approximately 10 to 15 $yd^3$ per day of disposal."<br><br>The deleted text was included in the RI Report to provide a basis for calculating a daily rate of disposal. However, the five-year duration is arbitrary and |

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| | | 3.1 that addresses this disparity, whichever is appropriate. | contradicts records that show the landfill operated from 1960 to 1974. |
| 2. | Section 1.2 | Subsection 1.2 requires a space between Sections 4 and 5 descriptions. | As requested, the formatting of Section 1.2 has been adjusted to include a line break between the descriptions of Sections 4 and 5. |
| 3. | Section 2.1 | Subsection 2.1, Second Paragraph, Last Sentence states "... is approximately 66,000 yd3 Most of this...." and seems to require review and revision. | The referenced text in Section 2.1 has been revised as follows:<br>"Based on modeling results, the actual in situ volume of waste and soil containing waste in the 4.5-acre landfill site is approximately 66,000 $yd^3$. Most of this amount, 42,000 $yd^3$, is soil (66,000 $yd^3$ total – 24,000 $yd^3$ waste)." |