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# Remedial Investigation for Munitions Response Program Site UXO5

## Naval Weapons Station Seal Beach
## Detachment Fallbrook
## Fallbrook, California

July 2016
Document Control No: KCH-2622-0063-0058

Contract No: N62473-09-D-2622

CTO No: 0063

Prepared for:

NAVFAC
Naval Facilities Engineering Command
NAVFAC SOUTHWEST

Prepared by:

KCH

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## Department of the Navy
## Naval Facilities Engineering Command Southwest

Prepared by:


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**CH2M HILL Kleinfelder, A Joint Venture**

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# Executive Summary

CH2M HILL Kleinfelder, A Joint Venture (KCH), prepared this remedial investigation (RI) report to address munitions and explosives of concern (MEC), material potentially presenting an explosive hazard (MPPEH), and munitions constituents (MC) for Munitions Response Program (MRP) Site Unexploded Ordnance (UXO) 5. The RI activities included biological monitoring, site land survey, vegetation removal, surface MEC clearance, soil sampling, digital geophysical mapping (DGM), reacquisition of DGM anomalies of interest, intrusive investigation of DGM anomalies, trenching investigation, MPPEH management, and preparation of an after action report.

MRP Site UXO5 is an open-space area adjacent to Buildings 307 and 308 at Naval Weapons Station (NAVWPNSTA) Seal Beach Detachment Fallbrook (Detachment Fallbrook), Fallbrook, California. This RI is being prepared for Naval Facilities Engineering Command (NAVFAC) Southwest under Contract Task Order 0063, Contract Number N62473-09-D-2622. At present, MRP Site UXO5 is not in use and is completely fenced.

MRP Site UXO5 (previously known as the Salvage Yard Burial Area) was originally identified under the Installation Restoration Program (IRP) and given the designation IRP Site 33. No IRP investigations were undertaken, and the site is now being addressed under the MRP. The site is now identified as MRP Site UXO5. MRP Site UXO5 was reported to be a burial area for munitions and munitions-related dunnage (Malcolm Pirnie, 2006). From 1952 through 1960, the area east of Building 307 was used to dispose of inert materials (Malcolm Pirnie, 2006). On historical maps, the area is labeled as a storage yard starting in the 1950s and ending in the late 1960s.

Records indicate that expended cartridges, primers, live projectiles, and inert anti-tank projectiles were buried in the area. In the mid-1960s, 2 pounds of smokeless powder in five partially filled cans were reportedly deposited at MRP Site UXO5. In the late 1980s, an onsite survey was conducted and revealed other materials, including electronic parts, inert missile parts, rubber missile shipping rings, missile test stands, practice shapes, electronic test equipment, empty powder cans, metal banding, and tires. In February 2002, a brush fire exposed munitions at MRP Site UXO5. During the same month, Explosive Ordnance Disposal (EOD) reported separate incidents in which EOD technicians from Marine Corps Base Camp Pendleton were called to MRP Site UXO5 to handle suspected MEC in the form of 20-millimeter (mm) and 40-mm projectiles and blasting caps, which confirmed that MRP Site UXO5 contained MEC and MPPEH (Malcolm Pirnie, 2006).

MRP Site UXO5 was included in a preliminary assessment (PA) that was conducted in 2004 and 2005 (Malcolm Pirnie, 2006). Two data collection teams conducted visual surveys of MRP Site UXO5 in September 2004 and March 2005. The visual data were collected by walking the perimeter of MRP Site UXO5 and walking several transects. Munitions observed during the survey activities included a 25-pound bomb; a 3-pound pyrotechnic bomb; a Mark (Mk) 76 practice bomb; a 2.36-inch anti-tank, high-explosive rocket; a 5-pound practice bomb; 20-mm casings; other projectiles; several smokeless powder cans and lids;

and other munitions debris. The PA recommended that a Site Inspection (SI) be conducted with respect to MPPEH identified at MRP Site UXO5.

An SI performed in 2007 (Tetra Tech, 2009) confirmed the presence of MPPEH, including fuzes, an Mk 106 practice bomb, 40-mm rounds, adapter-boosters, 3-inch/50 casings, and flash tubes. These items were observed on the ground surface of MRP Site UXO5 and in an exposed pit. An 8-foot-tall, chain-link fence was installed around MRP Site UXO5 as an interim action and the SI recommended that an RI and feasibility study be performed to further characterize the site and determine any required response actions as appropriate.

In 2011, a time-critical removal action (TCRA) was completed to remove MEC, MPPEH, and metallic debris from the site surface and the partially exposed pit containing 40-mm projectiles (SES-TECH, 2012a). The 40-mm projectiles removed as part of the TCRA were classified as inert. After completion of the TCRA, MRP Site UXO5 was surveyed in 2012 using a Geometrics G-858 magnetometer to identify geophysical anomalies and potential burial areas below grade as part of the planning stage for future investigations at the site (SES-TECH, 2012b). The geophysical survey covered approximately 80 percent of MRP Site UXO5 in areas where surface clearance had been previously performed. A total of 2,680 anomalies was identified in the geophysical survey.

In February 2014, a 40-mm cartridge casing was unearthed during excavation activities conducted during the installation of a mass notification system in the narrow strip of land between the MRP Site UXO5 western boundary and the Building 307 parking lot. It is not certain whether the origin of this item is the same as the munitions and munitions-related metallic debris found at MRP Site UXO5. This 0.24-acre area, just outside of the western fence line of MRP Site UXO5, was identified as an "Additional Work Area" and included in the RI field activities. This "Additional Work Area" is considered separate from MRP Site UXO5, unless it is later determined the area should be included as part of the MRP site.

The purposes of the RI field activities were as follows:

- Determine the nature and extent of MEC/MPPEH and MC at the site
- Provide data for the MEC hazard assessment and the MC baseline human health risk assessment (HHRA) and ecological risk assessment (ERA)
- Perform the MEC hazard assessment, HHRA, and ERA
- Collect sufficient data to develop and evaluate potential remedial alternatives as necessary
- Complete an RI to generate sufficient investigative information to develop, assess, and perform comparative analysis of remedial alternatives for those areas of concern within MRP Site UXO5 that have been determined to present an unacceptable explosives safety hazard or chemical risk to potential receptors

RI field activities included the following:

- Site preparation
- Anomaly avoidance measures
- Location surveying

- Utility locating
- Vegetation removal
- Biological avoidance
- Instrument verification
- MPPEH management
- Surface clearance
- Geophysical data collection
- Intrusive investigations of MEC (including 12 investigative trenches)
- Soil sampling for MC

Because the inferred depth to groundwater is greater than 100 feet below ground surface (bgs), groundwater is not considered a medium of concern at MRP Site UXO5 and is not addressed by this RI (KCH, 2015a).

Following the completion of DGM, the distribution of total anomalies detected as part of the EM61-MK2 survey during this RI, and the 2,680 anomalies from the G-858 magnetometer survey (SES-TECH, 2012b) were evaluated using Visual Sample Plan (VSP) (PNNL/Battelle, 2014). The number of anomalies required from each population to achieve a 95 percent confidence level and within a ±5 percent margin of error for defining nature and extent of potential MEC/MPPEH was then determined using the VSP Estimating a Proportion Method. Hence, only a percentage of anomalies were investigated as part of the RI fieldwork. The specific anomalies to be intrusively investigated were subsequently determined using a random number generator. The combined subset of DGM anomalies selected for intrusive investigation from the EM61-MK2 surveys and from the G-858 magnetometer survey were then re-acquired and marked in the field by the location surveyor. To assess the nature of the source of the selected DGM anomalies, UXO technicians used hand tools to investigate until the source of the anomaly was discovered. No MEC or material documented as an explosive hazard (MDEH) was recovered during the field operations at MRP Site UXO5 or the Additional Work Area during the RI field activities. MPPEH found at MRP Site UXO5 included the following items:

- Two M11A2 practice rifle grenades
- Two Mk 76 practice bombs (without spotting charges)
- Numerous 20-mm and 40-mm cartridge cases
- One 20-mm projectile, inert
- One 40-mm projectile, inert
- Two expended 40-mm cartridge primers
- One 57-mm projectile cartridge
- One M50B2 37-mm practice projectile
- One indiscernible fuze cap
- One 3-inch round cartridge case
- One 2.36-inch practice rocket
- One 90-mm projectile casing
- Numerous 0.50-caliber cartridge cases
- One igniter tube

The M50B2 37-mm practice projectile was identified as the source of anomaly T-22-002. Because this item could not be 100 percent visually inspected, it was demilitarized using

open detonation on March 18, 2015. Following open detonation, the item was confirmed to be material documented as safe (MDAS) and fragments were recovered. Remaining items listed above were determined to be MDAS.

No MEC was recovered during the field operations at MRP Site UXO5 or the Additional Work Area during the RI field activities. All MPPEH was determined to be MDAS. One drum of inspected, re-inspected, certified, and verified MDAS from MRP Site UXO5 was sent to Bonetti Explosives, Inc. in Columbus, Texas, for shredding and smelting on May 26, 2015. About 1,000 pounds of non-munitions-related metallic debris from MRP Site UXO5 was transported offsite to Fallbrook Waste and Recycling for recycling on April 15, 2015.

In conformance with Verification Sampling Program in VSP, Version 7.2 (PNNL/Battelle, 2014), the results of the total number of anomalies investigated at MRP Site UXO5 indicate that there is a 95 percent confidence (with ±5 percent sampling error) that the remaining uninvestigated DGM anomalies at MRP Site UXO5 and the Additional Work Area do not represent MEC. These statistical results cannot be applied to material remaining in the disposal areas.

During the 2007 SI, 29 soil samples were collected from 0 to 0.75 foot bgs. During the 2015 RI, 60 soil samples were collected from depths up to 4.5 feet bgs. For assessing the nature and extent of environmental impacts, samples were categorized as surface and/or subsurface samples based on the same criteria used for the HHRA. Samples collected from 0 to 0.5 foot bgs are considered surface soil samples and samples collected from 0 to 10 feet bgs are considered subsurface soil samples. Based on these categories, all surface samples are also considered to be subsurface samples. The 2007 SI soil samples (collected from 0 to 0.75 foot bgs) are categorized as both surface and subsurface samples. Perchlorate and explosives were not detected above United States Environmental Protection Agency (USEPA) regional screening levels (RSLs) in surface and subsurface soil samples. Metals were detected in soil at concentrations above background threshold values (BTVs) or the lower of USEPA RSLs and California Department of Toxic Substances Control (DTSC) screening levels (DTSC-SLs). Cobalt, copper, mercury, nickel, silver, and zinc were detected above their respective BTVs in one or more soil samples; however, none of these concentrations were above their respective residential and industrial RSLs or DTSC-SLs. Detected arsenic concentrations were above the residential and industrial DTSC-SLs but were above the BTV in only 4 of the 89 samples. Detected cadmium concentrations were above the BTV but were above the residential and industrial DTSC-SLs in only 3 of the 89 samples. Hexavalent chromium was detected at a concentration above the residential RSL in only 1 of the 89 soil samples. Detected lead concentrations were above the BTV, but only 1 of the 89 samples had a lead concentration above the residential DTSC-SL.

Based on the explosives hazards evaluation, the explosive hazard for MRP Site UXO5 is low to moderate. Although all items recovered as part of the RI field work were classified as MDAS, based on the items reported in the PA and SI, the potential for MEC/MPPEH in the subsurface at MRP Site UXO5 and the Additional Work Area is considered to remain, and thus the potential explosive hazard remains.

Based on the HHRA, arsenic, cadmium, and lead were identified as primary risk contributors. Arsenic is not recommended for further evaluation because arsenic concentrations were only slightly above the BTV for gabbro (Kgb) parent rock and well

within the range of naturally occurring concentrations. There were no collocated sample locations, and arsenic is not associated with munitions or munitions dunnage. Lead is not recommended for response action because only one sample contained a lead concentration above the residential screening criterion and there were no collocated high metals concentrations. Cadmium is recommended for further action because concentrations in 3 of 89 samples were above residential and industrial DTSC-SLs and these three samples were geographically collocated in the northwest portion of the site. Additionally, two of these three samples were located in an excavation trench from which non-munitions-related metallic debris was recovered.

The results of the ERA indicate that concentrations of constituents of potential ecological concern in soil samples collected during the SI and RI sampling are below levels that might be expected to pose ecological risk (as indicated by the High toxicity reference value-based ecological screening values [ESVs]) to receptor populations and communities for non-threatened and non-endangered species. However, concentrations of cadmium, lead, and zinc in site soil are above the Low ESV for the threatened California gnatcatcher, indicating a potential for risk.

Based on the results of the RI field investigation and risk assessments, the following are recommendations for future actions at MRP Site UXO5:

- Due to the presence of residual waste, it is recommended the site continue to be restricted for military use only, and remain fenced with warning signs. Land use controls should be continued to be implemented at MRP Site UXO5.
- MEC or MPPEH was not found in the Additional Work Area during RI activities; however, UXO construction support is recommended for construction at the Additional Work Area.
- An FS is recommended for MRP Site UXO5 to develop remedial action objectives and to develop and evaluate remedial alternatives to address potential human health risk from cadmium in soil; potential ecological risk from cadmium, lead, and zinc in soil; and potential MEC/MPPEH that could potentially remain at MRP Site UXO5.

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J Data Quality Assessment
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L MEC Hazard Assessment (CD Only)
M Human Health Risk Assessment
N Ecological Risk Assessment

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# Acronyms and Abbreviations

| | |
|---|---|
| °F | degrees Fahrenheit |
| < | less than |
| 95UCL | 95 percent upper confidence limit |
| | |
| Army | United States Department of the Army |
| | |
| BAMP | Biological Avoidance and Minimization Plan |
| bgs | below ground surface |
| Bonetti | Bonetti Explosives, Inc. |
| BTV | background threshold value |
| | |
| CAGN | California gnatcatcher |
| COPC | constituent of potential concern |
| COPEC | constituent of potential ecological concern |
| CSEM | conceptual site exposure model |
| CSM | conceptual site model |
| | |
| DD | United States Department of Defense |
| DDESB | United States Department of Defense Explosives Safety Board |
| Detachment Fallbrook | Naval Weapons Station Seal Beach Detachment Fallbrook |
| DGM | digital geophysical mapping |
| DMM | discarded military munitions |
| DoD | United States Department of Defense |
| DTSC | California Department of Toxic Substances Control |
| DTSC-SL | California Department of Toxic Substances Control screening level |
| | |
| EADA | elevated anomaly density area |
| EMP | Explosives Management Plan |
| EOD | explosive ordnance disposal |
| EPC | exposure point concentration |
| ERA | ecological risk assessment |
| ESS | Explosives Safety Submission |
| ESV | ecological screening value |
| | |
| FS | feasibility study |
| | |
| GPS | global positioning system |
| | |
| HA | hazard assessment |
| HE | high explosives |
| HHRA | human health risk assessment |
| HI | hazard index |
| IRP | Installation Restoration Program |

| | |
|---|---|
| IVS | instrument verification strip |
| KCH | CH2M HILL Kleinfelder, A Joint Venture |
| Kgb | gabbro (parent rock type) |
| $m^3/kg$ | cubic meter per kilogram |
| MC | munitions constituents |
| MCB | Marine Corps Base |
| MDAS | material documented as safe |
| MDEH | material documented as an explosive hazard |
| MEC | munitions and explosives of concern |
| mg/kg | milligram per kilogram |
| mm | millimeter |
| Mk | Mark |
| MPPEH | material potentially presenting an explosive hazard |
| MRP | Munitions Response Program |
| MRSIMS | Munitions Response Site Information Management System |
| MS | matrix spike |
| MSD | matrix spike duplicate |
| NAD | Naval Ammunition Depot |
| NAVFAC | Naval Facilities Engineering Command |
| NAVSEA | Naval Sea Systems Command |
| Navy | United States Department of the Navy |
| NIRIS | Naval Installation Restoration Information Solution |
| NOSSA | Naval Ordnance Safety and Security Activity |
| NAVWPNSTA | Naval Weapons Station |
| PA | preliminary assessment |
| PEF | particulate emission factor |
| PLS | Professional Land Surveyor |
| QC | quality control |
| RBC | risk-based concentration |
| RI | remedial investigation |
| RSL | regional screening level |
| RTK | real-time kinematic |
| SI | Site Inspection |
| SKR | Stephen's kangaroo rat |
| TCRA | time-critical removal action |
| TRV | toxicity reference value |
| USEPA | United States Environmental Protection Agency |
| USFWS | United States Fish and Wildlife Service |
| USMC | United States Marine Corps |
| UXO | unexploded ordnance |
| VSP | Visual Sample Plan |

# 1.0 Introduction

CH2M HILL Kleinfelder, A Joint Venture (KCH), prepared this remedial investigation (RI) report to address munitions and explosives of concern (MEC), material potentially presenting an explosive hazard (MPPEH), and munitions constituents (MC) for Munitions Response Program (MRP) Site Unexploded Ordnance (UXO) 5. Definitions for munitions-related terms are provided in Section 1.3.

MRP Site UXO5 is an open space adjacent to Buildings 307 and 308 at Naval Weapons Station (NAVWPNSTA) Seal Beach Detachment Fallbrook (Detachment Fallbrook), Fallbrook, California (Figures 1-1 and 1-2). An Additional Work Area, currently not part of MRP Site UXO5, was included in the investigation at the request of the United States Department of the Navy (Navy) as a result of finding of a 40-millimeter (mm) casing during site construction. This 0.24-acre area is located along a narrow strip of land between the MRP Site UXO5 western boundary and the Building 307 paved parking area (Figure 1-2). Available historical records indicate the operational history of this area is not consistent with MRP Site UXO5; therefore, the Additional Work Area was identified as a separate work area for this RI.

This RI report is being prepared for Naval Facilities Engineering Command (NAVFAC) Southwest under Contract Task Order 0063, Contract Number N62473-09-D-2622.

## 1.1 Project Objectives and Purpose

The objective for this Contract Task Order is to perform an RI under Comprehensive Environmental Response, Compensation, and Liability Act requirements to address the past presence of MEC and MC at MRP Site UXO5.

The purposes of this RI are as follows:

- Determine the nature and extent of MEC/MPPEH and MC at the site and the Additional Work Area
- Provide data for the MEC hazard assessment (HA) and the MC baseline human health risk assessment (HHRA) and ecological risk assessment (ERA)
- Perform the MEC HA, HHRA, and ERA
- Collect sufficient data to develop and evaluate potential remedial alternatives as necessary
- Complete an RI to generate sufficient investigative information to develop, assess, and perform comparative analysis on remedial alternatives for those areas of concern within MRP Site UXO5 (and the Additional Work Area) that have been determined to present an unacceptable explosives safety hazard or a chemical risk to potential human or ecological receptors

The RI field activities are briefly described as follows:

- Biological monitoring
- Site preparation (including vegetation clearance and utility locating)
- Surface MEC clearance
- Soil sampling
- Location surveys and mapping
- Digital geophysical mapping (DGM)
- Reacquisition and intrusive investigation of DGM anomalies
- Trenching investigations
- MPPEH management
- Preparation of an after action report
- Preparation of an RI report

The RI field activities were a follow-on to the 2012 time-critical removal action (TCRA) (SES-TECH, 2012a) and Geonics G-858 magnetometer survey of MRP Site UXO5 (SES-TECH, 2012b). Information from the G-858 magnetometer survey was used as part of the work approach planning conducted as part of this RI.

Project field and reporting activities were implemented by an integrated team specializing in environmental and MEC studies. The project team and associated lines of communication were detailed in the organization chart included as Worksheet #5 of the MEC Quality Assurance Project Plan and the Sampling and Analysis Plan (KCH, 2015a).

## 1.2 Report Organization

This RI report is organized into the following sections:

- Section 1 – Introduction
- Section 2 – Site Background
- Section 3 – Previous Investigations
- Section 4 – Remedial Investigation Field Activities
- Section 5 – Remedial Investigation Results
- Section 6 – Nature and Extent
- Section 7 – Explosives Hazards Evaluation
- Section 8 – Risk Assessments for Munitions Constituents
- Section 9 – Conceptual Site Model
- Section 10 – Conclusions and Recommendations
- Section 11 – References
- Appendix A – Figures and Tables from SI and TCRA Reports
- Appendix B – Photographic Log
- Appendix C – Biological Monitoring Report
- Appendix D – Utility Investigation Reports
- Appendix E – Instrument Verification Strip Report
- Appendix F – Digital Geophysical Mapping Survey Results Technical Memorandum
- Appendix G – Intrusive Anomaly Investigation Results Summary
- Appendix H – Disposal Documentation
- Appendix I – Laboratory Analytical Reports

- Appendix J – Data Quality Assessment
- Appendix K – Data Validation Reports
- Appendix L – MEC Hazard Assessment
- Appendix M – Human Health Risk Assessment
- Appendix N – Ecological Risk Assessment

## 1.3 Munition-related Terms Definitions

Throughout this report, specific munitions response terminology is used, including MEC, MPPEH, material documented as safe (MDAS), discarded military munitions (DMM), UXO, MC, and non-munitions-related metallic debris. Military munitions-related terms used throughout this document are consistent with the April 21, 2005, United States Department of the Army (Army) memorandum *Munitions Response Terminology* (Army, 2005) and are defined as follows:

- **MEC:** Specific categories of military munitions that may pose unique explosives safety risks, including (1) UXO as defined in 10 United States Code 2710(e)(9); (2) DMM, as defined in 10 United States Code 2710(e)(2); or (3) explosive munitions constituents present in high enough concentrations to pose an explosive hazard.
- **MPPEH:** Material owned or controlled by the United States Department of Defense (DoD) that, prior to determination of its explosives safety status, potentially contains explosives or munitions (for example, munitions containers and packaging material; munitions debris remaining after munitions use, demilitarization, or disposal) or potentially contains a high enough concentration of explosives that the material presents an explosive hazard (for example, equipment, drainage systems, holding tanks, piping, or ventilation ducts that were associated with munitions production, demilitarization, or disposal operations). Excluded from MPPEH are military munitions within the DoD's established munitions management system and other hazardous items that may present explosion hazards (such as gasoline cans or compressed gas cylinders) that are not munitions and are not intended for use as munitions.
- **UXO**: Military munitions that (1) have been primed, fuzed, armed, or otherwise prepared for action; (2) have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installation, personnel, or material; and (3) remain unexploded either by malfunction, design, or any other cause.
- **MDAS:** Munitions debris that has been assessed and documented as not presenting an explosive hazard and for which the chain of custody has been established and maintained. This material is no longer considered to be MPPEH.
- **Material documented as an explosive hazard (MDEH):** MPPEH that cannot be MDAS, that has been assessed and documented as to the maximum explosive hazards the material is known or suspected to present, and for which the chain of custody has been established and maintained. This material is no longer considered to be MPPEH.
- **DMM**: Military munitions that have been abandoned without proper disposal or removed from storage in a military magazine or other storage area for the purpose of disposal. The term does not include UXO, military munitions that are being held for

future use or planned disposal, or military munitions that have been properly disposed of, consistent with applicable environmental laws and regulations.

- **MC:** Any materials originating from UXO, DMM, or other military munitions, including explosive and non-explosive materials, and emission, degradation or breakdown elements of such ordnance or munitions.
- **Non-munitions related metallic debris:** Debris, other than munitions debris, collected from operational or former ranges or disposal areas (for example, target debris, military munitions packaging, or crating material).

# 2.0 Site Background

This section summarizes the location, description, and history for MRP Site UXO5. Additional background information is summarized in the final report for the 2007 Site Inspection (SI) (Tetra Tech, 2009).

## 2.1 Site Location and Description

Detachment Fallbrook is located approximately 53 miles north of San Diego in northern San Diego County, California, approximately 9 miles inland from the Pacific Coast (Figure 1-1). Detachment Fallbrook is bordered on the west by Marine Corps Base (MCB) Camp Pendleton and is south of the Santa Margarita River. The base currently occupies 8,852 acres, of which only 274 acres are developed. The remaining acreage is mostly open space because of the Explosive Safety Quantity Distance arcs required for the munitions operations.

MRP Site UXO5 covers approximately 13 acres and is located in the northeast corner of Detachment Fallbrook. MRP Site UXO5 is just east of Building 307 and is bounded on the southwest and southeast sides by Sparrow Road (an access road for Building 307) and the demolished Building 365, respectively (Figure 1-2). There are no buildings within MRP Site UXO5 boundaries.

### 2.1.1 Installation Mission and Operational History

In February 1942, what was then Naval Ammunition Depot (NAD) Fallbrook was commissioned. The depot's mission was to receive, store, and guard large quantities of explosives and ammunition, and then distribute and deliver them as needed to other installations. The original facilities included 133 magazines, barracks, and administration and service buildings; 16 miles of railroad; and 115 miles of roads and trails. In 1947, after World War II, NAD Fallbrook was put on caretaker status. This status ended with the onset of the Korean War in 1950. In 1953, the Marine Barracks at the depot became a separate command, which replaced the Marine Guard Detachment from MCB Camp Pendleton that had provided station security since the original commissioning in 1942 (Tetra Tech, 2009).

In 1958, NAD Fallbrook was designated an annex of NAD Seal Beach. In the 1960s, the depot's primary duty was to support the Pacific Marine Forces. It also stored, tested, and maintained several types of missiles. On October 1, 1997, following the reorganization of munitions handling installations, the depot's name changed to Detachment Fallbrook, and it reported to the present NAVWPNSTA Seal Beach. The Base currently has 190 magazines storing pyrotechnics, high explosives (HE), fuzes, detonators, and small arms, among other weapons. There are no active ranges within the Base (Tetra Tech, 2009).

Detachment Fallbrook contains the only West Coast air-launched missile production facility, where air-launched missiles such as the Phoenix, Sidewinder, Maverick, and high-speed, anti-radiation missiles are inspected, maintained, and recertified. The last remnants of the nation's napalm stockpile were stored at Detachment Fallbrook, and a state-of-the-art

facility was built there to help eliminate these weapons. The last full napalm canister was destroyed in March 2001 (Tetra Tech, 2009).

Detachment Fallbrook is unique among naval weapons storage areas because it is located inland. Ammunition is transferred to and from ships by a process known as vertical replenishment, where ammunition is taken by trucks from a magazine on Detachment Fallbrook to a helicopter pad located on the coast inside MCB Camp Pendleton. From there, a helicopter picks up the load and transfers it to the receiving ship waiting several miles offshore. In this manner, large vessels such as aircraft carriers and amphibious assault ships can be loaded without leaving their primary Southern California operating and training areas (Tetra Tech, 2009).

### 2.1.2 MRP Site UXO5 Background

MRP Site UXO5 (previously known as the Salvage Yard Burial Area) was originally identified under the Installation Restoration Program (IRP) and given the designation IRP Site 33. No IRP investigations were undertaken, and the site is now being addressed under the MRP as MRP Site UXO5.

MRP Site UXO5 was reported to be a burial area for munitions and munitions-related dunnage. From 1952 through 1960, the area east of Building 307 was used to dispose of inert materials. On historical maps from the 1950s through late 1960s, the area is labeled as a storage yard. Records indicate that expended cartridges, primers, live projectiles, and inert anti-tank projectiles were buried in the area (Malcolm Pirnie, 2006).

In the mid-1960s, five partially filled cans containing 2 pounds of smokeless powder were reportedly deposited at MRP Site UXO5. In the late 1980s, an onsite survey was conducted and revealed other materials in the disposal area, including electronic parts, inert missile parts, rubber missile shipping rings, missile test stands, practice shapes, electronic test equipment, empty powder cans, metal banding, and tires. In February 2002, a brush fire exposed munitions at MRP Site UXO5 (Tetra Tech, 2009). That same month, the Explosive Ordnance Disposal (EOD) unit from MCB Camp Pendleton responded to MRP Site UXO5 to handle suspected 20-mm and 40-mm projectiles and blasting caps found on the ground surface (Malcolm Pirnie, 2006).

In November 2004, the EOD unit from MCB Camp Pendleton, California conducted a site survey of the area, which had not yet been identified as an MRP site (United States Marine Corps, 2004). Although a map was not provided with the memorandum that summarized the results, it is believed that MRP Site UXO5 was either Site 3 ("an old landfill that contains numerous pieces of ordnance residue"), or Site 4 ("a dumpsite for UXO and also utilized ordnance residue for landfill and soil stabilization." It was recommended that Site 4 be placed off limits with appropriate warning signs (United States Marine Corps, 2004).

MRP Site UXO5 is not suspected to contain chemical warfare materiel-filled munitions or depleted uranium-associated munitions (Tetra Tech, 2009). At present, MRP Site UXO5 is not in use and is completely fenced.

There is no available information regarding the history of MEC use at the Additional Work Area. Based on site observations and its proximity to MRP Site UXO5, the Additional Work

Area is not suspected to contain chemical warfare materiel-filled munitions or depleted uranium-associated munitions.

## 2.2 Environmental Setting

### 2.2.1 Physiography and Topography

Detachment Fallbrook lies between the Santa Margarita and San Onofre mountain ranges. The topography is mostly moderate south- and west-facing slopes, with rough broken ridges. It varies from gently rolling hills in the southern area to steeply rising hills to the north. Elevations range from 200 to 840 feet above mean sea level. The local topography is characterized by low hills and natural ravines (Tetra Tech, 2009).

Historical topographic maps from 1948, 1949, 1968, 1982, 1988, and 1997 were reviewed in an attempt to discern changes to the local topography of MRP Site UXO5 that may be indicative of past disposal practices at MRP Site UXO5. Comparison of the 1948 and 1949 maps with the maps from 1968 and later indicates a slight change of topography in the central and southwest portion of MRP Site UXO5, which generally aligns with the central and southwest swaths of suspected disposal areas that were indicated by the high magnetic response within the existing geophysical data collected following the 2012 TCRA for MRP Site UXO5 (Figure 2-1) (SES-TECH, 2012b).

In addition, these areas feature linear and curved topographic features that appear to be anthropogenic and align with the terraces and sharp cliff (SES-TECH, 2012a; see Appendix A). These areas are also visible in the aerial imagery featured in Figure 1-2 and provide further indication of previous disposal areas.

### 2.2.2 Vegetation and Biological Setting

A significant portion of the vegetation within MRP Site UXO5 burned in February 2002 as a result of a fire that started near Gavilan Mountain southeast of De Luz Road (off Detachment Fallbrook). In the subsequent years, vegetation growth has advanced through patterns typical of post-burn seral plant ecology (SES-TECH, 2012a).

The vegetative communities associated with MRP Site UXO5 include California sagebrush (*Artemisa californica*), California buckwheat (*Eriogonum fasciculatum*), deer weed (*Lotus scoparius*), and a few individual occurrences of white sage (*Salvia apiana*) along the southern extremes (SES-TECH, 2012a). When MRP Site UXO5 was inspected in 2004, more than 98 percent of the vegetative material was less than 1 meter in height, and it was determined that it provided limited components of the Critical Habitat Code of Federal Regulations-identified constituent elements. Since that time, it has been noted that the vegetation has grown, and special-status species such as the California gnatcatcher (*Polioptila californica*) (CAGN) have been observed using the area. MRP Site UXO5 is within designated Critical Habitat for the CAGN, and constituent elements exist on MRP Site UXO5 (Tetra Tech, 2009).

Species federally listed as endangered or threatened that could potentially occur at MRP Site UXO5 (based on both their presence in similar areas in San Diego County and initial surveys conducted by the United States Fish and Wildlife Service [USFWS] on Detachment Fallbrook in March and April 1990) include the CAGN, Stephens' kangaroo rat (SKR) (*Dipodomys stephensi*), arroyo toad (*Bufo californicus*), least Bell's vireo (*Vireo bellii pusillus*),

quino checkerspot butterfly (*Euphydryas editha quino*), and thread-leaved brodiaea (*Brodiaea filifolia*). Several unlisted, yet sensitive, bird species are known to occur in this area of Detachment Fallbrook, including the rufus-crowned sparrow (*Aimophila ruficeps*), grasshopper sparrow (*Ammodramus savannarum*), and protected raptors such as the Cooper's hawk (*Accipter cooperii*) and Golden Eagle (*Aquila chrysaetos*) (NAVFAC Southwest, 2010).

In 2004, MRP Site UXO5 was characterized as not containing sufficient constituent elements to constitute a use-area visited with any frequency with reference to the CAGN. Navy natural resource biologists have conducted recent surveys for the presence of CAGN in the area; up until 2006, no sightings were documented on four separate occasions. A 2006 CAGN survey of the area showed multiple pairs in a 250-foot buffer area around, and in certain instances, inside the proposed project boundary area. During the SI work, multiple pairs were observed within MRP Site UXO5 by a qualified wildlife biologist; however, specific nesting sites were not found (NAVFAC Southwest, 2010).

During a 4-day trapping session in May 2004, two SKRs were captured within the MRP Site UXO5 boundary. Also during that trapping session, 18 non-listed Dulzura kangaroo rats were captured at MRP Site UXO5. Because SKRs were captured at proportionally and absolutely low numbers, and because the two SKRs were observed to return to burrows outside of the site boundary, it was determined that MRP Site UXO5 was occupied by SKRs, but at trace levels. (NAVFAC Southwest, 2010)

An SKR trapping survey was previously conducted over 5 nights between December 6 and 12, 2013, in support of planned RI field activities. No SKR were captured in the 5-night effort. Fifty-one non-endangered Dulzura kangaroo rat (*D. simulans*) captures were recorded, in the most open habitats as well as in more densely vegetated locations at MRP Site UXO5. Forty-one deer mice (*Peromyscus maniculatus*) and one California mouse (*Peromyscus californicus*) were also captured. Based on habitat conditions, the preponderance of historical surveys, and the most recent December 2013 trapping effort, SKR do not appear to be present on or in the vicinity of MRP Site UXO5 (KCH, 2015a).

In addition, nine focused CAGN surveys were conducted from June to December 2013 in support of the RI field work. Surveys were conducted at least 2 weeks apart, between the hours of 6:00 a.m. and 12:00 p.m. on June 27, July 16, July 30, August 13, September 13, October 11, October 25, November 8, and December 6, 2013. Surveys were performed during both the breeding and nonbreeding seasons. Based on the CAGN surveys, the habitat quality of MRP Site UXO5 was considered high and was occupied by at least one pair (one territory) of CAGN, which were heard calling on July 30, 2013. One female was heard or observed on August 13, September 13, October 11, October 25, and November 8, 2013 (KCH, 2015a).

The results of the SKR trapping event and CAGN surveys were detailed in the Biological Avoidance and Minimization Plan (BAMP), presented in the RI Work Plan (KCH, 2015a). Upon review of the BAMP, the USFWS required that an appropriately permitted biological monitor be present onsite and "responsible for overseeing project implementation to ensure compliance with the conservation measures and for preventing unanticipated impacts to federally listed species." As a result, a biological monitor provider (Bloom Biological Inc.) was subcontracted by KCH to provide appropriate CAGN monitoring during RI field activities at MRP Site UXO5. Additional CAGN monitoring details can be found in Section 4.4.

### 2.2.3 Geology

Detachment Fallbrook is in the Peninsular Ranges geomorphic province, which is characterized by a series of northwest-trending ranges and valleys. The geomorphic province is dominated by the igneous and metamorphic rocks of the Peninsular Range batholith (SES-TECH, 2012a).

Four bedrock types have been identified within the boundaries of Detachment Fallbrook: gabbro, granodiorite, tonalite, and metavolcanic/metasedimentary. The geology of MRP Site UXO5 has been mapped by the United States Geological Survey and described in the SI Report (Tetra Tech, 2009). The oldest bedrock types are late Jurassic to early Cretaceous-age volcanic and possibly metasedimentary rocks (greenschist facies) observed on the western portions of Detachment Fallbrook. The volcanics include aphanitic rhyolites, dacites, and andesites. Cretaceous-age plutonic rocks unconformably overlie and are coeval with the volcanics. Gabbros are observed in the northern portion of the installation and have been described as generally dark gray, massive, and medium to coarsely crystalline. Medium gray tonalites are observed in the central portion of the installation. Lighter gray granodiorites are observed in the northwestern and southern portions of the installation. The bedrock types each show differential degrees of weathering with the gabbros representing less weathering than the tonalites, which are quite weathered (SES-TECH, 2012a). A parent rock type of gabbro (Kgb) is used for risk assessment for MRP Site UXO5.

### 2.2.4 Hydrology

Detachment Fallbrook land is part of two coastal watersheds: the Santa Margarita River and the San Luis Rey River. The Santa Margarita River, Fallbrook Creek, and Pilgrim Creek make up the three major surface water drainages within the detachment. The Santa Margarita River provides an important water supply by restoring groundwater aquifers used by local residents and the United States Marine Corps (USMC). Fallbrook Creek would naturally be an intermittent or ephemeral stream within the Santa Margarita watershed, but because of runoff from agricultural and urban irrigation, it is now a perennial stream. Pilgrim Creek is located on the northeast end of Oceanside, and its flow is augmented in the summer months by runoff from an upstream nursery's water supply.

There are no permanent surface water drainages within MRP Site UXO5. An ephemeral stream located along the northern boundary of the site drains into the Santa Margarita River (located approximately 0.5 mile north of the site), and a culvert that runs under Sparrow Road on the western side of MRP Site UXO5 feeds a drainage way that flows southwest.

Based on information obtained from Detachment Fallbrook monitoring wells at Buildings 230 and 232, located approximately 1 mile south of MRP Site UXO5, the depth to water was measured to be between 50 and 60 feet below ground surface (bgs) and the groundwater elevation was approximately 595 feet above mean sea level in 2003. The groundwater gradient near Buildings 230 and 232 was estimated to be to the southwest (Malcolm Pirnie, 2006). Because the ground surface elevation at MRP Site UXO5 is approximately 50 to 100 feet higher than at Buildings 230 and 232, the depth-to-groundwater at MRP Site UXO5 is estimated to be at least 100 feet bgs.

### 2.2.5 Climate

The climate at Detachment Fallbrook is typical of the coastal Southern California climate and is characterized by mild winters, cool summers, and infrequent rainfall. The annual average temperature in the Detachment Fallbrook vicinity is 75.7 degrees Fahrenheit (°F). Summer temperatures range from 66°F at night to 90°F during the day. Precipitation ranges from 13.7 to 17.1 inches per year. January is the wettest month and July is the driest, with a mean of 0.02 inch of precipitation. Summers at the Installation are punctuated by the Santa Ana (offshore) winds (Tetra Tech, 2009).

# 3.0 Previous Investigations

Prior to the preliminary assessment (PA) of Detachment Fallbrook, USMC EOD technicians from the USMC EOD detachment on Camp Pendleton responded on more than one occasion to locate and remove MEC in the form of 20-mm and 40-mm projectiles and blasting caps, which confirmed that MRP Site UXO5 contains MEC and MPPEH (Malcolm Pirnie, 2006 and Tetra Tech, 2009).

## 3.1 Preliminary Assessment

One former range and five DMM sites at Detachment Fallbrook were identified through historical documents and interviews during the PA (Malcolm Pirnie, 2006). IRP Site 33 (now identified as MRP Site UXO5) was included in the PA that was conducted in 2004 and 2005. Two data collection teams were used to conduct visual surveys of MRP Site UXO5 in September 2004 and March 2005. The visual data were collected by walking the perimeter of MRP Site UXO5 and walking several transects (Malcolm Pirnie, 2006).

Munitions reported to have been observed during the survey activities included the following:

- Two 25-pound practice bombs (Mark [Mk] 76)
- A 3-pound practice bomb (Mk 23)
- A 2.36-inch anti-tank HE rocket (M6)
- A 5-pound practice bomb (Mk 106)
- 20-mm projectiles and other projectiles (not identified by size, condition, filler, or nomenclature)
- Several smokeless powder cans and lids
- Other munitions-related scrap

The PA recommended that an SI be conducted at IRP Site 33 with respect to MPPEH identified at the site.

Because of the PA's conclusion that IRP Site 33 was a burial area for munitions and munitions-related debris, the site was moved from the IRP to the MRP and was named MRP Site UXO5. This decision was based on the presence of the partially exposed burial pit containing 40-mm projectiles and previous reports of expended cartridges, primers, and live projectiles (Malcolm Pirnie, 2006).

## 3.2 Site Inspection

In 2007, an SI was performed at MRP Site UXO5 (Tetra Tech, 2009); pertinent figures and tables from the SI report are included in Appendix A. The SI activities included a geophysical survey to identify burial area boundaries, a surface search of the entire site, soil

sample collection, and installation of a fence around the site as an interim action. The geophysical and surface surveys confirmed the presence of MEC/MPPEH, including detonation fuses, an Mk 106 practice bomb, 40-mm rounds, adapter-boosters, 3-inch/50 casings, and flash tubes. These items were observed both on the ground surface of MRP Site UXO5 and in an exposed pit. Surface and near surface (maximum of 9 inches bgs) soil samples were collected to supplement the findings of the visual surface survey for MPPEH and the geophysical survey. The SI recommended that an RI and feasibility study (FS) be performed to further characterize the site and determine any required response actions as appropriate.

SI soil analytical results are summarized in Appendix A and on Figure 3-1. However, it should be noted that the soil analytical results presented in the final SI report and included in Appendix A were inadvertently submitted prior to validation. Following validation, the data were uploaded to the Naval Installation Restoration Information Solution (NIRIS). Several updates to analytical results and data qualifiers were identified during data validation and documented by Laboratory Data Consultants (LDC) (2007). According to the data validation report for the SI soil samples, the data required qualification for the following reasons:

- Some results for arsenic, barium, chromium, lead, and zinc were qualified as estimated because of laboratory duplicate relative percent difference outliers.
- Some results for chromium, molybdenum, and zinc were qualified as estimated because of matrix spike percent recovery outliers.
- Antimony results were qualified as estimated because of a laboratory control sample percent recovery outlier.
- Some antimony, arsenic, beryllium, and thallium detections were negated (i.e., qualified as non-detected) because of method blank contamination. The number of detected concentrations of beryllium were reduced from 21 to 0. The number of detected concentrations of molybdenum were reduced from 29 to 3. The number of detected concentrations of selenium were reduced from 7 to 0. The number of detected concentrations of thallium were reduced from 29 to 0.
- Seven explosive residue compounds were qualified as estimated, non-detect because of low matrix spike percent recoveries.

Validated data from NIRIS were used in discussions and risk assessments in this RI report.

## 3.3 Time-Critical Removal Action

In 2012, a TCRA was initiated to remove MEC, MPPEH, and metallic debris from the site surface and the partially exposed pit containing 40-mm projectiles (SES-TECH, 2012a). Pertinent figures and tables from the TCRA report are included in Appendix A. The TCRA resulted in the removal of metal objects from the ground surface and the removal of 40-mm projectiles from the partially exposed burial pit. During this action, recovered items were found to be inert and were removed and certified as material documented as safe (MDAS). Approximately 7,000 pounds of metal debris were removed from the site surface and recycled during the first stage of the TCRA. The second stage of the TCRA addressed the

burial pit, which was an eroded cavity that abutted a concrete retaining wall. Approximately 2 tons of inert munitions-related items, mostly 40-mm inert projectiles and 0.50-caliber expended casings, were excavated from the pit.

## 3.4 Post-TCRA Geophysical Survey

After completion of the TCRA, portions of MRP Site UXO5 were surveyed in 2012 using a Geometrics G-858 magnetometer to identify geophysical anomalies and potential burial areas as part of the planning stage for future investigations at the site (SES-TECH, 2012b). The survey findings are presented on Figure 2-1. The geophysical survey covered approximately 80 percent of MRP Site UXO5, in areas where surface clearance had been previously performed. A total of 2,680 anomalies was identified in the geophysical survey. The anomalies were not investigated as part of the TCRA, but select anomalies were investigated as part of the overall RI approach at MRP Site UXO5.

## 3.5 Additional Work Area

In January 2014, a 40-mm cartridge casing was unearthed during excavation activities conducted during the installation of a mass notification system in the narrow strip of land between the MRP Site UXO5 western boundary and the Building 307 parking lot (Colt, 2014). It is not certain whether the origin of this item is the same as the munitions and munitions-related metallic debris found at MRP Site UXO5. Historic maps and aerial photos do not indicate the operational history of this area was consistent with the salvage yard landfill operations of MRP Site UXO5. This 0.24-acre area just outside of the western fence line of MRP Site UXO5 has been identified as an Additional Work Area until it is determined the area should be included as part of the MRP site.

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# 4.0 Remedial Investigation Field Activities

Field work for the RI for MRP Site UXO5 was performed in accordance with the project Accident Prevention Plan and Site Safety and Health Plan (KCH, 2014). Based on monitoring wells located near Buildings 230 and 232, which are approximately 1 mile south of MRP Site UXO5, the depth to the top of groundwater was inferred to be greater than 100 feet at MRP Site UXO5 (elevation 650 to 750 feet above mean sea level); therefore, groundwater was not considered a medium of concern at MRP Site UXO5 and was not addressed during this RI. In addition, because of the absence of permanent surface water at MRP Site UXO5, surface water was not addressed during the RI.

The Explosives Safety Submission (ESS) for the RI at MRP Site UXO5 was submitted as a draft document to the Naval Ordnance Safety and Security Activity (NOSSA) for review and comment in March 2014. Comments were received and addressed between June 2014 and February 2015 and the draft final ESS was distributed to NOSSA for interim approval in January 2015. To allow the work to begin before the CAGN breeding season began, NOSSA provided authorization to proceed with RI field activities, pending review and response by the DoD Explosives Safety Board (DDESB). Following incorporation of minor edits, the ESS was endorsed by DDESB, and the Final ESS was completed on February 25, 2015 (KCH, 2015b). Work was performed in accordance with the NOSSA and DDESB-approved ESS.

In addition, an Explosives Management Plan (EMP) was prepared for the management of commercial explosives brought to Detachment Fallbrook for MEC/MPPEH disposal. The draft EMP was provided to the Detachment Fallbrook Explosives Safety Officer for review. Comments from the Explosives Safety Officer were incorporated and the final EMP was submitted with the Final RI Work Plan on February 27, 2015.

Photographs of field activities conducted during the RI are included in Appendix B.

## 4.1 Site Preparation

KCH and USA Environmental (UXO subcontractor) personnel mobilized to Detachment Fallbrook on February 9 and 10, 2015. Key site preparation activities included the following:

- Base access credentials were obtained by KCH and USA Environmental personnel.
- On February 10, 2015, a UXO hazard briefing was conducted by the KCH Munitions Response Project Quality Assurance Officer on behalf of the Fallbrook Explosives Safety Officer. In addition, an introductory overview of the site history and planned RI activities was given to USA Environmental personnel by the KCH task order manager.
- Delivery of a storage container, drums, an armored excavator, protective observation armor and shielding, a mini-excavator, and commercial explosives and detonators was completed.

## 4.2 Anomaly Avoidance Measures

Anomaly avoidance techniques were implemented by a USA Environmental UXO escort to avoid any potential surface or subsurface MEC during vegetation clearance, biological monitoring, and surveying. The UXO technician conducted a reconnaissance of the approach route to the site and located a clear path for the vegetation removal, surveying, and soil sampling teams. The UXO technician cleared a work site for soil samples with a magnetometer and clearly marked the boundaries. The area was large enough to provide a work area for the soil sampling team.

## 4.3 Location Surveys and Mapping

From February 9 to 13, 2015, survey boundaries, transects, and blind seed locations were established. A Professional Land Surveyor (PLS) subcontractor (Coast Surveying) established temporary benchmarks onsite for location control throughout the field activities. The PLS marked the boundary of the 0.87-acre area selected for 100 percent DGM coverage in the RI Work Plan (KCH, 2015a). In addition, the PLS staked out grid corners for the 100 percent DGM coverage area using a real-time kinematic (RTK) global positioning system (GPS) to survey-grade accuracy. Transect layout, location, and mapping were performed using GPS (Trimble GeoXH) and Munitions Response Site Information Management System (MRSIMS) handheld personal digital assistant devices.

Prior to the start of DGM, the PLS, escorted by UXO personnel, placed and documented buried quality control (QC) seed items. Following DGM, the PLS re-acquired and flagged geophysical anomalies selected for intrusive investigation from both the 2012 G-858 and EM61-MK2 surveys, including those selected within the Additional Work Area. Hand-held personal digital assistant devices were used for recording the locations of site features such as piles of debris, fences, and utilities.

GPS was used to support the data requirements of the RI. Project-related spatial data, including maps, models, and associated collected or created data, will be submitted back to NIRIS according to the NIRIS Non-NIRIS Electronic Data Deliverable Submittal Guidelines Standard Operating Procedure.

## 4.4 Biological Avoidance, Minimization, and Mitigation Measures

The results of previous SKR trapping events and CAGN surveys were detailed in the BAMP (KCH, 2015a). Upon review of the BAMP, USFWS required that an appropriately permitted biological monitor be present onsite and "responsible for overseeing project implementation to ensure compliance with the conservation measures and for preventing unanticipated impacts to federally listed species" (KCH, 2015a).

As a result, biological monitoring for CAGN was initiated on February 11, 2015, by Bloom Biological, Inc. and surveys continued throughout project field activities (Appendix C). Detections of CAGN within the fenced limits of MRP Site UXO5 were reported to be infrequent. Observations from February 20 through 23, 2015, narrowed a focal area for potential nesting, and a nest under construction was identified on March 6, 2015. Observations indicated the CAGN nest was near completion on March 10, 2015. However, the nest was located in an open area and immediately below power lines frequently used as

a perch by ravens, and any young likely would be depredated. A new nest by the same pair was discovered nearby on March 17, 2015. CAGN monitoring was continued through completion of the RI field activities at MRP Site UXO5 on March 31, 2015.

There were no indications that the work activities at MRP Site UXO5 adversely affected CAGNs. In addition to gnatcatchers, 48 other species of birds were detected during monitoring.

## 4.5 Utility Locating

On February 13 and March 6 and 26, 2015, a utility location subcontractor (Spectrum Geophysics) conducted checks for the locations of underground utilities prior to planned investigative trenching operations, using one or more of the following geophysical technologies:

- Radio Detection 4000 transmitter with matched receiver
- Schonstedt Mac 51b hand-held magnetometer
- Fisher TW-6 M-scope shallow-focus metal detector
- Dynatel 500A transmitter with matched receiver

Ground-penetrating radar was not used in the investigation because of the thick brush and rugged terrain that characterized a portion of MRP Site UXO5. During the investigation, Spectrum Geophysics detected several utility conduits that were marked on the ground with spray paint in a color code established by the American Public Works Association. Reports documenting utility locating activities are included in Appendix D.

## 4.6 Vegetation Removal

Before vegetation removal began, UXO technicians conducted a detector-aided visual sweep to ensure that the area was clear of MEC/MPPEH. Vegetation clearance was completed at 89 transects and portions of 11 grid cells in which DGM surveys were planned. Vegetation clearance was also conducted at 12 areas where investigative trenches were planned. Vegetation was cleared using loppers, man-portable weed-whackers, and chain saws. UXO technicians cleared vegetation to a height that provided suitable access for surface clearance, DGM, and intrusive investigations.

Vegetation clearance was limited to cutting of brush, vines, small trees, and tree limbs that directly impeded access for the DGM equipment personnel. Minor additional vegetation clearance was performed to provide equipment access in support of the investigative trenching. A skid steer loader was used to haul vegetation away from the work areas to an area near the MRP Site UXO5 gate so as to not impede data collection or create a safety hazard, and then fed through a chipper. In consultation with the Detachment Fallbrook biologist office, chipped vegetation was used to cover bare soil and erosion areas in the vicinity of the MRP Site UXO5 access gate.

Vegetation clearance of the DGM transects was completed on February 14, 2015, and vegetation clearance of the 100 percent DGM coverage areas (including the ravine area) and proposed investigative trench areas was completed on February 17, 2015. Final vegetation chipping, stockpiling and spreading was completed onsite on February 20, 2015.

## 4.7 Instrument Verification

Prior to conducting surface clearance and DGM at Site MRP UXO5 and the Additional Work Area, the analog magnetometers were tested and the DGM instrument and positional equipment were validated at an instrument verification strip (IVS). Information regarding installation and instrument testing at the IVS are provided in Appendix E.

## 4.8 MPPEH Management

A systematic approach was used to collect, inspect, and segregate items recovered during the investigation into three categories: MEC, MPPEH, and MDAS. The management approach was designed so that materials undergo a continual inspection and evaluation process from the time they are acquired until they are removed from the site.

Segregation procedures began when the item was discovered by the UXO technician. The UXO technician made a preliminary determination as to the item's classification into one of three categories: MEC/MDEH, MPPEH, or non-munitions-related metallic debris. The UXO Technician III confirmed the determination and recorded the location, depth, and category of each item in a log and handheld device.

For MPPEH inspection and management, KCH's MEC support contractor followed DoD Instruction 4140.62, *Material Potentially Presenting an Explosive Hazard* (DoD, 2008), and Naval Sea Systems Command (NAVSEA) Ordnance Pamphlet 5 Volume 1 (NAVSEA, 2015). These procedures ensured that MPPEH and other debris was inspected, re-inspected, certified, verified, and documented as free of explosive hazard and the chain-of-custody maintained. This material was then no longer considered MPPEH and was further managed as MDAS outside of MRP Site UXO5.

## 4.9 Surface Clearance

From February 19 to 21, 2015, a detector-aided visual surface clearance was performed by UXO personnel along DGM transects and within DGM survey areas at MRP Site UXO5 and the Additional Work Area. Surface clearance was conducted at 89 transects and the portions of 100- by 100-foot grid cells designated for 100 percent DGM coverage (Appendix F, Figure F1-1). For the DGM transects, surface clearance was performed along a 5-foot width to clear the lane for access with the Geonics EM61-MK2. The grid cells were further subdivided into 5- by 100-foot search lanes marked with polypropylene rope to ensure the entire area was searched. The surface clearance was conducted by completing analog-instrument-aided visual inspections of each area. The analog instruments included Schonstedt Model GA-52CX and White's Model XLT. Instruments were checked in the IVS prior to and following each day that surface clearance operations took place, and determined to be functioning as intended.

No MEC/MPPEH was discovered during the surface clearance of transects and the 100 percent DGM coverage grid cell areas. Non-munitions-related debris 2 inches by 2 inches in size or greater that protruded or was visible from the top of ground (soil) surface was inspected and removed as part of the surface metal removal clearance and placed in a separate storage bin dedicated to non-munitions-related metallic debris. A description of

MPPEH inspection, management, and disposition procedures is provided in Appendix F, Section 5.

## 4.10 Geophysical Data Collection

DGM at MRP Site UXO5 was performed between February 19 and 26, 2015. The DGM survey was divided into the following three sub-areas within MRP Site UXO5, as described in the RI Work Plan (KCH, 2015a):

- Additional Work Area: 100 percent effective DGM survey coverage of an approximate 0.24-acre (0.1-hectare) portion of the site, south of Building 308 and east of Building 307 (Appendix F, Figure F1-1). The Additional Work Area encompasses a strip of land east of the Building 307 parking lot. Although it is located outside the MRP Site UXO5 boundary fence, it was added by the Navy during work planning to determine whether it should be added to the MRP site.
- Northern Grids: 100 percent effective DGM survey coverage within an approximate 0.87-acre (0.35-hectare) portion of the site, located northeast of Building 308 (Appendix F, Figure F1-1) and not surveyed during the 2012 G-858 magnetometer survey. This area was omitted from the G-858 magnetometer survey because of the presence of dense vegetation at the time (SES TECH, 2012a). However, for safety reasons, some of these areas were also not included in the DGM surveys because of the presence of a deep drainage ravine, with steeply incised sidewalls and visible metal in the ravine.
- Remainder of accessible portions of MRP Site UXO5 not characterized as elevated anomaly density areas (EADAs) from the SES-TECH (2012b) DGM survey: 10 percent effective coverage using widely-spaced transects (approximately 33 feet [10 meters] on center). These transects were intended to cover the portion of MRP Site UXO5 likely characterized by a more dispersed distribution of anomaly locations. The DGM instrument path for each transect is depicted on Figure F1-1 in Appendix F.

For the two areas mapped with 100 percent DGM coverage, a nominal lane spacing of 2.5 feet (0.75 meter) was used. Localized deviations from this lane spacing within the grids were associated with stumps, large rocks, manmade obstructions, or other features that could not be easily rolled over with the EM61-MK2 or which posed a health and safety risk. The EM61-MK2 operator followed the paths cleared by the UXO subcontractor during site preparations.

Field notes (including site conditions, weather conditions, instrument file names, and QC test file names) were recorded using KCH's MRSIMS. Daily QC tests were performed on the RTK GPS and EM61-MK2 as a means of maintaining confidence in the sensor performance and quality of the DGM data. Appendix F provides details regarding QC tests and results, as well as information regarding pre-processing and final processing of DGM data.

Nine target type categories (Type 1 through Type 9) were used by KCH for the DGM at MRP Site UXO5; an explanation of each is provided in Appendix F, Table 3. Based on the target types, target lists were then generated for each grid and transect and were provided to the QC geophysicist along with the processed data for review as part of the DGM data delivery package.

The results from the 100 percent DGM coverage at the Additional Work Area are shown on Appendix F, Figure F1-2. The results from the 100 percent DGM coverage of the grid cell area in the low-lying northern portion of the site are shown on Appendix F, Figure F1-3. The results of the EM61-MK2 transects for the northern area and southern area are shown on Appendix F, Figures F1-4 and F1-5, respectively.

Target locations derived from the EM61-MK2 data collected at MRP Site UXO5 are presented on Appendix F, Figure F1-6. For this RI, only the Type 1 targets (defined as a target of interest, of unknown nature) were considered for follow-up investigation; for clarity, Appendix F, Figure F1-6 presents the EM61-MK2 Type 1 targets using a different symbol color than the other EM61-MK2 target types.

Because the saturated response areas were defined by four vertices (defined as Type 8 or Type 9 targets), they are presented on the figure as polygons. It should be noted that, as part of the data tracking and flow in MRSIMS, a polygon cannot extend across grid boundaries. Therefore, the four saturated response areas shown in Appendix F on Figure F1-6 were part of the same elevated response feature depicted in the data on Figure F1-3. The location of this feature coincided with large quantities of metal observed protruding from the ground surface. It was interpreted to represent the edge of a disposal feature at MRP Site UXO5.

Appendix F, Figure F1-6 also presents the locations of the SES-TECH (2012b) G-858 magnetometer survey targets from within the portion of MRP Site UXO5 that overlaps with the EM61-MK2 transect survey. A total of 964 magnetometer targets (out of the initial 2,680) was identified within this dispersed anomaly area. Eleven of the 964 targets were seed items installed during the Post-TCRA geophysical survey (SES-TECH, 2012b). Of the 11 SES-TECH seeds in this overlapping section, 3 were targeted by the EM61-MK2 and included in the EM61-MK2 Type 1 target count.

## 4.11 Geophysical Anomaly Selection and Re-Acquisition

The distribution of total anomalies detected during the EM61-MK2 survey and the 2,680 anomalies from the G-858 magnetometer survey were evaluated using the Visual Sample Plan (VSP) (PNNL/Battelle, 2014) for the presence of potential clustering. The number of anomalies required from each population to achieve a 95 percent confidence level and within a ±5 percent margin of error for defining nature and extent of potential MEC/MPPEH was then determined using the VSP Estimating a Proportion Method.

The EM61-MK2 Type 1 target locations, the G-858 magnetometer survey target locations, and sensor instrument paths were imported into VSP. The results are presented on Appendix F, Figure F1-7. For this effort, the G-858 magnetometer survey targets that were coincident with EM61-MK2 target locations (within a 3.3-foot [1-meter] radius) were removed from the VSP analysis to avoid redundancy. Anomalies detected at the Additional Work Area were also excluded from the VSP analysis because of the dominating effect from cultural features and because the Additional Work Area did not appear to be a burial or disposal area for munitions and munitions-related dunnage consistent with previous operations at MRP Site UXO5.

The VSP results shown on Appendix F, Figure F1-7 demonstrated a target distribution consistent with the site history as a disposal area. Localized areas of higher target density in the northern portion of the site coincide with the location of known disposal features and the steeply sloped ravine with visible metal debris. Therefore, the target population assessment was based primarily on variation in site features on a microscale. It was determined that MRP Site UXO5 was best represented by four target populations:

- Population 1: The G-858 magnetometer survey targets provided by SES-TECH (2012b)
- Population 2: EM61-MK2 targets from the Additional Work Area mapped at 100 percent coverage
- Population 3: EM61-MK2 targets from the northern grids (low lying areas) mapped at 100 percent coverage
- Population 4: Targets from the EM61-MK2 transect survey (dispersed anomaly area)

Because of the inherent differences between the G-858 magnetometer and EM61-MK2 (all-metals detector) sensors, and because of the operational differences in how the two datasets were collected, it was determined that the G-858 magnetometer survey targets represent one target population. It was impractical to attempt to draw detailed conclusions on a target-by-target basis between the two datasets. The Additional Work Area was determined to be its own target population for the same reasons it was not incorporated into the VSP analysis. The relatively small area had a high number of detected targets, but it was suspected during DGM data analysis that many of these may be the result of effects from utilities, government trailers, and vehicles parked along the edge of the asphalt lot, and small pieces of metal debris visible on the surface consistent with parking lot debris.

Targets derived from the EM61-MK2 data collected in the northern grids were grouped into a separate anomaly population because the survey area appeared to encroach on disposal features. In addition, metal was observed in the ravine that bisects this survey area, so it was decided that there could be increased potential of encountering munitions-related items in this area because of the localized presence of abundant metal. The fourth and final population includes targets derived from the transect survey because the portions of the site covered by transects were suspected as being characterized as a “dispersed” anomaly area.

For each EM61-MK2 target population, the Type 1 targets were used as the basis for deriving the dig lists. QC seeds were removed from the statistical evaluation, but were subsequently added to the final dig list to be reacquired, investigated, and removed as ongoing validation of the data-gathering processes onsite.

The specific anomalies to be intrusively investigated were subsequently determined using a random number generator. A list of targets to be intrusively investigated was developed, including the anomaly unique identification, coordinates (eastings and northings), and geophysical response amplitude, and was imported into MRSIMS. Of the 624 Type 1 target anomalies, 282 were selected from the G-858 magnetometer surveys completed following the TCRA, 89 were selected from the EM61-MK2 survey at the Additional Work Area, 60 were selected for investigation from the EM61-MK2 grid cell surveys, and 193 were selected for investigation from the EM61-MK2 transect surveys. Each anomaly population possessed a unique identification, as follows:

- Anomalies from the G-858 magnetometer investigation were identified using the grid pattern identification established during the TCRA. For example, anomaly ST014-0013 was from the SES-TECH (2012b) grid cell ST-14, anomaly number 0013.
- Anomalies from the 100 percent EM61-MK2 survey of portions of the Northern Grid cells and grid cells in the Additional Work Area were identified using the grid cell identification number and anomaly number. For example, anomaly L-7-002 represented grid cell L-7, anomaly number 002.
- Anomalies from the EM61-MK2 transect surveys were identified using the transect identification and anomaly number. For example, anomaly T-016-00012 represented transect T-016, anomaly number 12.

The combined subset of DGM anomalies selected for intrusive investigation from the EM61-MK2 surveys and from the G-858 magnetometer survey were re-acquired in the field by the PLS subcontractor using RTK GPS. A flag with the unique anomaly identification was then placed within 12 inches of each contact in preparation for the MEC intrusive investigations.

## 4.12 MEC Intrusive Investigations

Two types of targeted intrusive investigations were completed at MRP Site UXO5. The first type was target anomaly investigation of selected subsurface anomalies identified during the G-858 magnetometer survey (SES-TECH, 2012b), the DGM of established transects, and from the 100 percent DGM coverage areas. The second type was excavation of 12 investigative trenches in EADAs identified during the 2012 G-858 investigation (SES-TECH, 2012b) to characterize potential MEC/MPPEH and MC contamination.

### 4.12.1 Target Anomaly Investigations

To assess the nature of the source of the selected DGM anomalies, UXO technicians used hand tools such as shovels, spades, trowels, and pry bars until the source of the anomaly was discovered. For deep or saturated anomaly areas, a low-input mechanized safety protocol using earth-moving machinery (a John Deere mini-excavator) was implemented to remove overburden to within 12 inches of the anomaly, but did not directly remove, expose, or disturb the anomaly. UXO technicians used hand tools, taking the necessary safety measures, to perform the intrusive investigation until the source of the anomaly was identified. Once the item was exposed for inspection, the UXO technicians determined if the item was MEC, MPPEH, or non-munitions-related metallic debris. Following investigation and removal of the anomaly, the UXO technician checked the excavation location with the EM61-MK2 to confirm that the source of the anomaly was removed.

Information regarding identification number, date, location, depth, type and nomenclature, fuze status, and disposal status was recorded for the anomalies using MRSIMS.

No MEC or MDEH was identified from intrusive investigations associated with anomalies selected from the EM61-MK2 survey grid cell area or from anomalies selected from the G-858 magnetometer survey completed following the TCRA (SES-TECH, 2012b). MPPEH was inspected and segregated into MDAS or non-munitions-related metallic debris. Approximately 39 pounds (field estimated weight) of MPPEH recovered from these

anomalies was segregated, inspected, certified, verified, documented to be MDAS on United States Department of Defense (DD) Form 1348-1A, and secured in 55-gallon drums. The items consisted of 20-mm and 40-mm cartridge cases, one 20-mm projectile, 0.50-caliber cartridges, and one 90-mm projectile casing. In addition, non-munitions-related metallic debris from the EM61-MK2 survey northern grids and from the G-858 magnetometer survey anomalies was segregated, inspected, certified, verified, documented on DD Form 1348-1A, and placed in a separate storage bin dedicated to non-munitions-related metallic debris.

No MEC or MDEH were recovered from intrusive investigations of anomalies selected from the EM61-MK2 transect surveys. MPPEH was inspected and segregated into MDAS requiring further processing or non-munitions-related metallic debris. A field estimated weight of 273 pounds of MDAS was then re-inspected, certified, verified, documented on Form 1348-1A, and secured in 55-gallon drums. The MDAS consisted of 20-mm and 40-mm cartridge cases; one inert 40-mm projectile; a 3-inch, round cartridge case; an indiscernible fuze cap; one 2.36-inch practice rocket; 0.50-caliber cartridge cases; M11A2 practice rifle grenades; an igniter tube; and one M50B2 37-mm practice projectile that required controlled detonation demilitarization to allow UXO technicians to fully inspect the item Non-munitions-related metallic debris was segregated, inspected, certified, verified, documented on DoD Form 1348-1A, and placed in a separate storage bin dedicated to non-munitions-related metallic debris. Five blind QC items placed in transects were detected during the DGM survey and recovered during intrusive investigations by the UXO subcontractor. Three additional QC seed items placed during the previous G-858 magnetometer survey were also recovered.

The findings of the investigation and daily field notes were recorded using KCH's MRSIMS. MPPEH found was photographed and location and item information was recorded.

Appendix G provides a summary of target anomaly intrusive investigations, including anomaly identification, amplitude, date of investigation, location coordinates, items recovered, photos, and QC seed items recovered.

### 4.12.2 Investigative Trenches at Elevated Anomaly Density Areas

The intrusive investigation included 12 investigative trenches in areas that contained a high concentration of magnetic anomalies (i.e., disposal areas). Each investigative trench was approximately 12 feet long, 3 feet wide, and up to 4.5 feet deep. Excavated soils were laid out for visual and metal detection inspection by a UXO technician. The excavation was considered complete when no additional anomalies were detected.

No MEC or MDEH was recovered from the investigative trench excavations. MPPEH was inspected and segregated into MDAS or non-munitions-related metallic debris. Field estimated weights of MDAS and non-munitions-related metallic debris were documented on field forms. Approximately 82 pounds (field estimated weight) of MPPEH was determined to be MDAS. The MDAS consisted of a spent 57-mm projectile cartridge at Trench 4, 40-mm cartridge cases at Trenches 5 and 6, one 0.50-caliber casing in the upper foot of Trench 6, two Mk 76 practice bombs (without spotting charges) at Trench 10, and two spent 40-mm cartridge primers at Trench 12. Non-munitions-related metallic debris recovered from Trenches 2, 3, 4, 5, 6, 7, 10, 11, and 12 was segregated and placed in a separate storage bin dedicated to non-munitions-related metallic debris. The findings for the investigative trenches are summarized in Table 4-1.

Investigative trenches were backfilled after soil and debris investigation activities were completed, following collection of soil samples and final inspection by the UXO QC Specialist. The backfilled areas were then tamped and graded to prevent erosion, to be generally consistent with surrounding grade.

### 4.12.3 Disposal of MDAS and Non-Munitions-Related Metallic Debris

One drum (410 pounds) of MDAS from MRP Site UXO5 was picked up at Detachment Fallbrook on April 16, 2015, and transported to Bonetti Explosives, Inc. (Bonetti [also known as Daley Iron & Metal]) located in Columbus, Texas.

The drum arrived at Bonetti on April 21, 2015, for final demilitarization. The drum was inspected and inventoried and the seal was found to be intact. A DoD Form 1348-1A accompanied each drum during transport, storage, treatment, and recycling. Upon arrival at Bonetti, the onsite KCH UXOQCS checked and verified every drum seal number and checked every DoD Form 1348-1A to confirm that required information was accurate.

A total of 410 pounds of MDAS from Detachment Fallbrook MRP Site UXO5 was shredded and smelted on May 26, 2015.

Non-munitions-related metallic debris was recovered during intrusive investigations of DGM anomalies and from the investigative trenches at MRP Site UXO5. The non-munitions-related metallic debris was segregated, inspected, certified, verified, documented on a DD Form 1348-1A and placed in a separate storage bin dedicated to non-munitions-related metallic debris. About 1,000 pounds of non-munitions-related metallic debris from MRP Site UXO5 was transported offsite to Fallbrook Waste and Recycling for recycling on April 15, 2015.

Disposal documentation is included in Appendix H. During RI field activities, inspected and verified MDAS from MRP Site UXO5 was combined with inspected and verified MDAS from MRP Site UXO4. The MDAS from MRP Site UXO5 filled one-half of one drum and the remaining contents of this drum included MDAS from MRP Site UXO4. The contents were documented on DD Form 1348-1A number 1, security seal identification number 629984.

The drum receipt and destruction confirmation letters from Bonetti do not distinguish drums of MDAS from MRP Sites UXO5 or UXO4. However, the security seal 629984 containing MDAS from MRP Site UXO5 is shown as being one of the drums received by Bonetti. This drum is included in the total count of drums of MDAS that was shredded and smelted on May 26, 2015. The fully executed DD Form 1348-1A number 1 is provided with the confirmation letters.

## 4.13 MC Investigation

Following MEC anomaly detection, flagging, and intrusive investigation (no soil sampling was performed during MEC investigations), the investigation for MC, consisting of the collection of soil samples, commenced at MRP Site UXO5 to determine the nature and extent of MC in surface and subsurface soil to a maximum depth of 4.5 foot bgs.

A total of 60 soil samples was collected from MRP Site UXO5 between February 21 and April 7, 2015. Three types of soil samples were collected, including bias-located samples beneath MPPEH, investigative trench samples, and non-biased located (random) samples.

A total of 14 biased soil samples was collected at one depth interval (approximately 0 to 0.5 foot bgs) in the vicinity of investigated anomalies (Table 4-2). A total of 26 soil samples was collected from the 12 investigative trenches at two or three depth intervals ranging from 0.5 to 4.5 feet bgs (Table 4-3). A total of 20 non-biased soil samples was collected from 10 locations at two depth intervals (0 to 0.5 foot bgs and 0.5 to 1 foot bgs) (Table 4-4). The non-biased soil sample locations were determined using the random point generator geoprocessing tool in ESRI ArcMap geographic information system software. Soil samples were not collected from the Additional Work Area because no MEC was found, MPPEH was similar to that found within the MRP Site UXO5 site boundary, and there were no soil impacts based on visual observations. Details regarding laboratory analysis of soil samples are included in Section 5.2. Additional details regarding the MC sampling procedures were provided in Appendix B of the RI Work Plan (KCH, 2015a).

Soil waste was not generated during sampling activities. Disposable sampling equipment was used to collect soil samples beneath MPPEH and from trenches, thereby minimizing the amount of decontamination water generated during sampling. A hand auger was used to collect soil samples from non-biased locations, which resulted in the generation of a minimal amount of decontamination water (less than 2 gallons) that was evaporated onsite. Therefore, no investigation derived wastes were generated, and sampling was not required.

### 4.13.1 Quality Control Program

Field QC samples consisted of a source water blank, an equipment rinsate blank, and matrix spike (MS) and matrix spike duplicates (MSDs). In conformance with the Sampling and Analysis Plan provided as Appendix B to the RI Work Plan (KCH, 2015a), field duplicates were not collected to assess sampling precision because of the heterogeneity of soil. The single equipment rinsate was collected after the hand auger was cleaned by collecting the rinse water from the cleaning process. The source water blank was collected from the source water used for the final rinse of the decontaminated hand auger. The MS/MSDs were collected and analyzed at the required minimum frequency of one MS/MSD per twenty samples.

Details regarding the QC program were provided in Worksheets #15 and #17 of the Sampling and Analysis Plan (Appendix B of the RI Work Plan [KCH, 2015a]).

### 4.13.2 Sample Analyses

Soil sampling was conducted during the RI at MRP Site UXO5 to assess the nature and extent of MC in the soil. Surface and subsurface soil samples were collected in the vicinity of removed MPPEH items that indicated a possible release of MC to the soil and in the investigative trenches where MPPEH items were discovered. Soil samples collected during the MC investigation were submitted for offsite analysis to EMAX Laboratories in Torrance, California, a DoD Environmental Laboratory Accreditation Program laboratory. Soil samples were submitted for the following analyses:

- Metals (United States Environmental Protection Agency [USEPA] Method 6020A)
- Mercury (USEPA Method 7470A/7471A)
- Hexavalent chromium (USEPA Method 7199)
- Explosives residue (USEPA Method 8330A)
- Perchlorate (USEPA Method 6850)

## 4.14 Site Restoration and Demobilization

Following completion of intrusive investigations of DGM anomalies, trench investigation and backfill activities, and MPPEH inspection and management operations, work areas at MRP Site UXO5 were restored to as close to pre-work conditions as possible. This included removal of the IVS constructed in the west-central portion of MRP Site UXO5.

One 55-gallon drum of inspected, re-inspected, and certified MDAS was transported offsite on April 16, 2015 for demilitarization and smelting. Containerized non-munitions-related metallic debris from MRP Site UXO5 was transported to Fallbrook Waste and Recycling on April 15, 2015.

Open detonation disposal of remaining unused commercial donor explosives was not permitted at Detachment Fallbrook and return of the items to the commercial explosives vendor was not allowed. With the permission of the Detachment Fallbrook ESO and Remedial Project Manager, remaining unused commercial donor explosives were transferred to EOD personnel from MCB Camp Pendleton on April 17, 2015. Field investigation personnel and equipment demobilized on April 17, 2015.

# 5.0 Remedial Investigation Results

## 5.1 MEC Investigation Findings

Although MPPEH items were found during the RI field activities at MRP Site UXO5 and the Additional Work Area, no MEC or MDEH was identified. MPPEH found at MRP Site UXO5 included the following items:

- Two M11A2 practice rifle grenades
- Two Mk 76 practice bombs (without spotting charges)
- Numerous 20-mm and 40-mm cartridge cases
- One 20-mm projectile, inert
- One 40-mm projectile, inert
- Two expended 40-mm cartridge primers
- One 57-mm projectile cartridge
- One M50B2 37-mm practice projectile
- One indiscernible fuze cap
- One 3-inch round cartridge case
- One 2.36-inch practice rocket
- One 90-mm projectile casing
- Numerous 0.50-caliber cartridge cases
- One igniter tube

Of these, the following were found at the Additional Work Area:

- Eleven 20-mm cartridge cases
- Three 40-mm cartridge cases with flash tube
- One 20-mm projectile, inert
- One igniter tube
- Four 0.50-caliber cartridge cases

The M50B2 37-mm practice projectile was identified as the source of anomaly T-22-002. Because this item could not be 100 percent visually inspected, it was demilitarized using open detonation on March 18, 2015. Following open detonation, the item was confirmed to be MDAS and fragments were recovered. Remaining items listed above were inspected, re-inspected, certified, and verified to be MDAS.

## 5.2 MC Investigation Findings

Between February 21 and April 7, 2015, 60 soil samples were collected from beneath MPPEH, investigative trenches, and non-biased locations. Samples were submitted to EMAX Laboratories and analyzed for the following:

- Metals (USEPA Method 6020A)
- Mercury (USEPA Method 7470A/7471A)
- Hexavalent chromium (USEPA Method 7199)

- Explosives residue (USEPA Method 8330A)
- Perchlorate (USEPA Method 6850)

Analytical results are summarized in Tables 5-1 and 5-2 and compared to background threshold values (BTVs) (SES-TECH, 2012c) and risk-based screening levels for human health. Risk-based screening levels are the more conservative levels of USEPA regional screening levels (RSLs) (USEPA, 2015) and California Department of Toxic Substances Control (DTSC) screening levels (DTSC-SLs) (DTSC, 2016). Soil sample locations and select analytical results are shown on Figure 5-1, while investigative trench locations are shown on Figure 5-2. Laboratory analytical reports are included in Appendix I. The analytical results were validated, as described in Section 5.2.5.

### 5.2.1 Analytical Results for Samples Collected beneath MPPEH

Fourteen biased soil samples were collected immediately beneath anomalies identified in the field. No explosive residues, perchlorate, or hexavalent chromium were reported in these soil samples.

Metals were not reported at concentrations above both BTVs and risk-based screening levels. A number of metals were reported at concentrations above one of their respective BTVs, RSLs, or DTSC-SLs, as follows:

- Arsenic was detected at concentrations above the residential DTSC-SL of 0.067 milligram per kilogram (mg/kg) and the industrial DTSC-SL of 0.25 mg/kg in all of the 14 samples, with the highest reported result at 1.54 mg/kg. Arsenic concentrations were below the BTV (3.07 mg/kg).
- Cadmium was detected above the BTV of 0.197 mg/kg in 10 of the 14 samples, with the highest reported result at 0.56 mg/kg. Cadmium concentrations were below the residential (5.2 mg/kg) and industrial (7.3 mg/kg) DTSC-SLs.
- Cobalt was detected above the BTV of 15.99 mg/kg in 2 samples, with the highest reported result at 19.6 mg/kg. Cobalt concentrations were below the residential (23 mg/kg) and industrial (350 mg/kg) RSLs.
- Copper was detected above the BTV of 102.5 mg/kg in 1 sample, at a concentration of 108 mg/kg. The copper concentration was below the residential (3,100 mg/kg) and industrial (47,000 mg/kg) RSLs.
- Lead was detected above the BTV of 7.408 mg/kg in 6 samples, with the highest reported result at 17.7 mg/kg. Lead concentrations were below the residential (80 mg/kg) and industrial (320 mg/kg) DTSC-SLs.
- Nickel was detected above the BTV of 11.88 mg/kg in 1 sample, at a concentration of 12.8 mg/kg. The nickel concentration was below the residential (490 mg/kg) and industrial (3,100 mg/kg) DTSC-SLs.
- Zinc was detected above the BTV of 44.85 mg/kg in 9 samples, with the highest reported result at 1,200 mg/kg. Zinc concentrations were below the residential (23,000 mg/kg) and industrial (350,000 mg/kg) RSLs.

### 5.2.2 Analytical Results for Samples from Investigative Trenches

Up to three soil samples were collected from each investigative trench based on visual inspection at depths ranging from 0.5 to 4.5 feet. No explosive residues or perchlorate were reported in the investigative trench soil samples. Hexavalent chromium was reported in seven samples. Sample KCH-UXO5-TR10-S01-1.5 reported hexavalent chromium at 0.721 mg/kg, which is above the residential RSL of 0.30 mg/kg.

Cadmium was detected above both the BTV and risk-based screening levels. A number of metals were reported at concentrations above one of their respective BTVs, RSLs, or DTSC-SLs. Metals analytical results are summarized as follows:

- Arsenic was detected above the residential DTSC-SL of 0.067 mg/kg and industrial DTSC-SL of 0.25 mg/kg in the 26 samples, with the highest reported result at 2.94 mg/kg. Arsenic concentrations were below the BTV (3.07 mg/kg).
- Cadmium was detected above the BTV of 0.197 mg/kg in 8 samples and above the residential DTSC-SL of 5.2 mg/kg and industrial DTSC-SL of 7.3 mg/kg in 2 of the 8 samples, with the highest reported result at 27.8 mg/kg.
- Lead was detected above the BTV of 7.408 mg/kg in 4 samples, with the highest reported result at 22.5 mg/kg. Lead concentrations were below the residential (80 mg/kg) and industrial (320 mg/kg) DTSC-SLs.
- Nickel was detected above the BTV of 11.88 mg/kg in 1 soil sample, at a concentration of 12.6 mg/kg. The nickel concentration was below the residential (490 mg/kg) and industrial (3,100 mg/kg) DTSC-SLs.
- Zinc was detected above the BTV of 44.85 mg/kg in 4 samples, with the highest reported result at 191 mg/kg. Zinc concentrations were below the residential (23,000 mg/kg) and industrial (350,000 mg/kg) RSLs.

### 5.2.3 Analytical Results for Samples from Non-Biased Locations

Ten non-biased soil sampling locations were identified at MRP Site UXO5. Soil samples were collected at surface (0 to 0.5 foot bgs) and subsurface (0.5 to 1.0 foot bgs) depths at each location. No explosive residues or perchlorate were reported in these soil samples. Hexavalent chromium was not detected above residential or industrial RSLs.

Metals were not reported at concentrations above both BTVs and risk-based screening levels. A number of metals were reported at concentrations above one of their respective BTVs, RSLs, or DTSC-SLs, as follows:

- Arsenic was detected above the residential DTSC-SL of 0.067 mg/kg and industrial DTSC-SL of 0.25 mg/kg in the 20 samples, with the highest reported result at 1.94 mg/kg. Arsenic concentrations were below the BTV (3.07 mg/kg).
- Cadmium was detected above the BTV of 0.197 mg/kg in 12 samples, with the highest result at 2.24 mg/kg. Cadmium concentrations were below the residential (5.2 mg/kg) and industrial (7.3 mg/kg) DTSC-SLs.

- Lead was detected above the BTV of 7.408 mg/kg in 8 samples, with the highest reported result at 24.7 mg/kg. Lead concentrations were below the residential (80 mg/kg) and industrial (320 mg/kg) DTSC-SLs.
- Zinc was detected above the BTV of 44.85 mg/kg in 10 samples, with the highest result at 75.1 mg/kg. Zinc concentrations were below the residential (23,000 mg/kg) and industrial (350,000 mg/kg) RSLs.

### 5.2.4 Quality Control Samples

Data quality indicators for the analytical data generated during this investigation, as evaluated through QC samples, met the requirements of the Sampling and Analysis Plan (Appendix B of the RI Work Plan [KCH, 2015a]). An evaluation of QC sample results is included in the data quality assessment in Appendix J.

### 5.2.5 Data Validation and Evaluation

Data validation was conducted by MECX, Aurora, Colorado, in accordance with Environmental Work Instruction No. 1 Data Validation Guidelines for Chemical Analysis of Environmental Samples (NAVFAC Southwest, 2001) and updates from the USEPA Contract Laboratory Program *National Functional Guidelines for Inorganic Superfund Data Review* (USEPA, 2010) and USEPA Contract Laboratory Program *National Functional Guidelines for Superfund Organic Methods Data Review* (USEPA, 2008a). Since 100 percent of the data were usable, the data met the completeness project goal of 90 percent for usable data (KCH, 2015a). Data validation reports are provided in Appendix K.

# 6.0 Nature and Extent

## 6.1 Nature and Extent of MEC and MPPEH

This section summarizes the nature and extent of MEC and MPPEH at MRP Site UXO5. based on the results of the investigations conducted to date (Sections 3 and 5).

No MEC/MPPEH was discovered during the surface clearance of transects and grid cell areas. Non-munitions-related debris 2 inches by 2 inches in size or greater that protruded or was visible from the top of ground (soil) surface was inspected and removed as part of the surface metal removal clearance. Non-munitions-related metallic debris recovered during surface clearance of transects and grid cell clearance areas was segregated, inspected, certified, verified, documented on DD Form 1348-1A, and placed in a separate storage bin dedicated to non-munitions-related metallic debris.

Although MPPEH was recovered from intrusive investigations associated with anomalies selected from the EM61-MK2 survey grid cell area or from anomalies selected from the G-858 magnetometer survey completed following the TCRA (SES-TECH, 2012b), no MEC or MDEH was identified. MPPEH was inspected and segregated into MDAS or non-munitions-related metallic debris. Approximately 39 pounds (field estimated weight) of MPPEH recovered from these anomalies were segregated, inspected, certified, verified, documented to be MDAS on DD Form 1348-1A, and secured in 55-gallon drums. The items consisted of 20-mm and 40-mm cartridge cases, one 20-mm projectile (inert), 0.50-caliber cartridges, and one 90-mm projectile casing. Non-munitions-related metallic debris from the EM61-MK2 survey northern grids and from the G-858 magnetometer survey anomalies were segregated, inspected, certified, verified, documented on DD Form 1348-1A, and placed in a separate storage bin dedicated to non-munitions-related metallic debris.

Although MPPEH was recovered from intrusive investigations of anomalies selected from the EM61-MK2 transect surveys, no MEC or MDEH was identified. Approximately 273 pounds (field estimated weight) of MPPEH were inspected and segregated into MDAS requiring further processing or non-munitions-related metallic debris. MDAS was then re-inspected, certified, verified, documented on DD Form 1348-1A and secured in 55-gallon drums. The MDAS consisted of 20-mm and 40-mm cartridge cases, one inert 40-mm projectile, a 3-inch round cartridge case, an indiscernible fuze cap, one 2.36-inch practice rocket, 0.50-caliber cartridge cases, M11A2 practice rifle grenades, an igniter tube, and one M50B2 37-mm practice projectile that required controlled detonation demilitarization to allow UXO technicians to fully inspect the item. Non-munitions-related metallic debris was also segregated, inspected, certified, verified, documented on DD Form 1348-1A, and placed in a separate storage bin dedicated to non-munitions-related metallic debris.

Although MPPEH was recovered from the investigative trenches, no MEC or MDEH was identified. MPPEH was inspected and segregated into MDAS or non-munitions-related metallic debris. Approximately 82 pounds (field estimated weight) of MPPEH were determined to be MDAS. The MDAS consisted of a spent 57-mm projectile cartridge at Trench 4, 40-mm cartridge cases at Trenches 5 and 6, two Mk 76 practice bombs (without

spotting charges) at Trench 10, and two spent 40-mm cartridge primers at Trench 12. Non-munitions-related metallic debris recovered from Trenches 2, 3, 4, 5, 6, 7, 10, 11, and 12 was segregated and placed in a separate storage bin dedicated to non-munitions-related metallic debris.

For MRP Site UXO5, the distribution of anomalies detected during DGM and the nature of MPPEH recovered during intrusive investigations are consistent with the site history as a disposal area. Although MEC or MDEH was not found during the RI field investigation, the site history indicates the potential for these items to be present. MPPEH items were also reported during the PA and SI (Tetra Tech, 2009). Information is not available as to whether these items were confirmed to be MEC or MDEH. In conformance with Verification Sampling Program in VSP, Version 7.2 (PNNL/Battelle, 2014), the results of the total number of anomalies investigated for each population indicate that there is a 95 percent confidence (with ±5 percent sampling error) that the remaining uninvestigated DGM anomalies at MRP Site UXO5 and the Additional Work Area do not represent MEC. However, these statistical results cannot be applied to material remaining in the disposal areas.

MEC and MPPEH are suspected to remain in the subsurface at MRP Site UXO5. There is a potential for migration of MEC or MPPEH through erosion and surface water transport, particularly in the areas of steep sloping terrain. Precipitation runoff drains toward a ravine just north of Building 307 (at approximately 625 feet in elevation). If MEC/MPPEH migration occurs, it will likely be in the direction of the ravine (Figure 6-1). The lowest temperatures occur from December through February, with a mean annual low of 47.5°F. Thus, there is no frost line in Fallbrook, California, and no potential for frost heave to occur at MRP Site UXO5 that could potentially bring buried MEC or MPPEH to the surface. Based on the historical disposal activities, MEC/MPPEH is unlikely to be deeper than 5 feet; however, site activities (site work, construction) may disturb MEC/MPPEH below the surface and cause MEC/MPPEH to be exposed at the surface.

## 6.2 Nature and Extent of Environmental Impacts

During the 2007 SI, 29 soil samples were collected from 0 to 0.75 foot bgs. During the 2015 RI, 60 soil samples were collected from depths up to 4.5 feet bgs. For assessing the nature and extent of environmental impacts, samples were categorized as surface and/or subsurface samples based on the same criteria used for the HHRA. Samples collected from 0 to 0.5 foot bgs are considered surface soil samples and samples collected from 0 to 10 feet bgs are considered subsurface soil samples. Based on these categories, all surface samples are also considered to be subsurface samples. Hence, for the purpose of the HHRA, the 2007 SI soil samples (collected from 0 to 0.75 foot bgs) are categorized as both surface and subsurface samples.

The locations of surface soil samples collected during the SI and RI investigations are shown on Figures 3-1 and 5-1, respectively, with analytical results for the RI samples further summarized in Tables 5-1 and 5-2. Soil samples during both investigations were analyzed for explosives residues, perchlorate, and metals, with soil samples collected during the RI also analyzed for hexavalent chromium. Hexavalent chromium analyses were performed to provide information about chromium speciation for the risk assessments. Without these

data, chromium detected in soil would be considered the more toxic hexavalent form. The analytical data were compared to BTVs, RSLs, and DTSC-SLs. Analytes that exceeded RSLs, BTVs, or DTSC-SLs are presented in the following subsections.

### 6.2.1 Surface Soil

Samples collected from 0 to 0.5 foot bgs are considered surface soil samples. The 2007 SI soil samples (collected from 0 to 0.75 foot bgs) are included as surface soil samples. Perchlorate, explosives, and hexavalent chromium were not detected above RSLs in surface soil samples. Nine metals (arsenic, cadmium, cobalt, copper, lead, mercury, nickel, silver, and zinc) were detected in surface soil samples at concentrations above BTVs, RSLs, or DTSC-SLs and are summarized in Table 6-1.

- Arsenic concentrations in 29 SI surface soil samples and 25 RI surface soil samples were above the residential DTSC-SL of 0.067 mg/kg and the industrial DTSC-SL of 0.25 mg/kg. Arsenic concentrations in four SI surface soil samples were above the BTV (3.07 mg/kg).
- Cadmium concentrations in 21 SI surface soil samples and 16 RI surface soil samples were above the BTV of 0.197 mg/kg. The cadmium concentration in one SI surface soil sample was above the residential (5.2 mg/kg) and industrial (7.3 mg/kg) DTSC-SLs.
- Cobalt concentrations in one SI surface soil sample and two RI surface soil samples were above the BTV of 15.99 mg/kg.
- The copper concentration in one RI surface soil sample was above the BTV of 102.5 mg/kg.
- Lead concentrations in 18 SI surface soil samples and 12 RI surface soil samples were above the BTV of 7.408 mg/kg. The lead concentration in one SI surface soil sample was above the residential DTSC-SL (80 mg/kg).
- The mercury concentration in one SI surface soil sample was above the BTV of 0.0202 mg/kg.
- Nickel concentrations in two RI surface soil samples were above the BTV of 11.88 mg/kg.
- The silver concentration in one RI surface soil sample was above the BTV of 0.0941 mg/kg.
- Zinc concentrations in 18 SI surface soil samples and 14 RI surface soil samples were above the BTV of 44.85 mg/kg.

### 6.2.2 Subsurface Soil

Samples collected from 0 to 4.5 feet bgs are considered subsurface soil samples. All surface samples are also considered to be subsurface samples. Perchlorate and explosives were not detected above RSLs in subsurface soil samples. The hexavalent chromium concentration in one RI subsurface soil sample was above the residential RSL of 0.30 mg/kg. Nine metals (arsenic, cadmium, cobalt, copper, lead, mercury, nickel, silver, and zinc) were detected in

subsurface soil samples at concentrations above BTVs, RSLs, or DTSC-SLs and are summarized in Table 6-2.

- Arsenic concentrations in 29 SI subsurface soil samples and 60 RI subsurface soil samples were above the residential DTSC-SL of 0.067 mg/kg and the industrial DTSC-SL of 0.25 mg/kg. Arsenic concentrations in four SI subsurface soil samples were above the BTV (3.07 mg/kg).
- Cadmium concentrations in 21 SI subsurface soil samples and 29 RI subsurface soil samples were above the BTV of 0.197 mg/kg. Cadmium concentrations in one SI subsurface soil sample and two RI subsurface soil samples were above the residential DTSC-SL (5.2 mg/kg) and industrial DTSC-SL (7.3 mg/kg).
- Lead concentrations in 18 SI subsurface soil samples and 18 RI subsurface soil samples were above the BTV of 7.408 mg/kg. The lead concentration in one SI subsurface sample was above the residential DTSC-SL (80 mg/kg).
- The mercury concentration in one SI subsurface soil sample was above the BTV of 0.0202 mg/kg.
- Nickel concentrations in three RI subsurface soil samples were above the BTV of 11.88 mg/kg.
- The silver concentration in one RI subsurface soil sample was above the BTV of 0.0941 mg/kg.
- Zinc concentrations in 18 SI subsurface soil samples and 23 RI subsurface soil samples were above the BTV of 44.85 mg/kg.

### 6.2.3 Summary of Surface and Subsurface Soil

No explosives residues or perchlorate were detected at concentrations above RSLs in soil samples collected during the SI and RI. Hexavalent chromium was detected at a concentration above the residential RSL (0.30 mg/kg) in only 1 of the 89 soil samples. The following metals were detected in soil at concentrations above BTVs or RSLs and DTSC-SLs:

- Arsenic was detected at concentrations above the residential DTSC-SL (0.067 mg/kg) and industrial DTSC-SL (0.25 mg/kg); however, arsenic concentrations were above the BTV (3.07 mg/kg) in only 4 of the 89 samples. These samples were collected from 0 to 0.75 foot bgs during the SI. Arsenic concentrations were only slightly above the BTV for the Kgb parent rock and well within the range of naturally occurring concentrations. Arsenic is not associated with munitions or munitions dunnage.
- Cadmium was detected at concentrations above the BTV (0.197 mg/kg) in 50 of the 89 soil samples; however, cadmium concentrations were above the residential (5.2 mg/kg) and industrial (7.3 mg/kg) DTSC-SLs in only 3 of the 89 samples. The maximum detected concentration of cadmium (27.8 mg/kg) was detected in the sample collected from 4.5 feet bgs in Trench 10 and was collocated with the maximum detected concentrations of hexavalent chromium, cobalt, and manganese, and the third highest concentration of cadmium.

- Cobalt was detected at concentrations above the BTV (15.99 mg/kg) in 3 of the 89 soil samples; however, cobalt concentrations were below the residential (23 mg/kg) and industrial (350 mg/kg) RSLs. Cobalt concentrations were only slightly above the BTV for the Kgb parent rock and within the range of naturally occurring concentrations.
- Copper was detected at concentrations above the BTV (102.5 mg/kg) in 1 of the 89 soil samples; however, copper concentrations were below the residential (3,100 mg/kg) and industrial (47,000 mg/kg) RSLs. Copper concentrations were only slightly above the BTV for the Kgb parent rock and within the range of naturally occurring concentrations.
- Lead was detected at concentrations above the BTV (7.408 mg/kg) in 36 of the 89 soil samples; however, lead concentrations were above the residential DTSC-SL (80 mg/kg) in only 1 of the 89 samples. The maximum detection of lead was an estimated concentration at SIS-007 and appears to be an isolated occurrence. The lead concentrations in the RI surface and subsurface soil samples collected at KCH-UXO5-SB20, located about 25 feet north and downslope of sample location SIS-007, were above the BTV, but below the residential DTSC-SL.
- Mercury was detected above the BTV (0.0202 mg/kg) in 1 of the 89 soil samples; however, mercury concentrations were below the residential RSL (23 mg/kg) and industrial DTSC-SL (69 mg/kg). Mercury concentrations were only slightly above the BTV for the Kgb parent rock and within the range of naturally occurring concentrations.
- Nickel was detected above the BTV (11.88 mg/kg) in 3 of the 89 soil samples; however, nickel concentrations were below the residential (490 mg/kg) and industrial (3,100 mg/kg) DTSC-SLs. Nickel concentrations were only slightly above the BTV for Kgb parent rock and within the range of naturally occurring concentrations.
- Silver was detected above the BTV (0.0941 mg/kg) in 1 of the 89 soil samples; however, silver concentrations were below the residential (390 mg/kg) and industrial (1,500 mg/kg) RSLs.
- Zinc was detected above the BTV (44.85) in 41 of the 89 soil samples; however, zinc concentrations were below the residential (23,000 mg/kg) and industrial (350,000 mg/kg) RSLs.

Collocation of and risk associated with metals at MRP Site UXO5 are summarized in Section 8.

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# 7.0 Explosive Hazards Evaluation

The Interim MEC HA methodology (USEPA, 2008b) was used to evaluate the potential explosive hazards to receptors based on current conditions at the site (both geophysical and related to discovered ordnance), anticipated land use, and established screening levels for humans. The model uses inputs related to the site, human, and ordnance factors to produce a hazard level that provides a qualitative assessment of potential explosive hazards to humans based on current or anticipated future use. The output will serve as a baseline condition when comparing alternatives in the FS.

The MEC HA evaluates the potential explosive hazard associated with an MRP site, given current or reasonably anticipated future conditions, and under various cleanup, land use activities, and continued land use restrictions. As specified in the *Munitions and Explosives of Concern Hazard Assessment Methodology* (USEPA, 2008b), the MEC HA process fulfills the National Contingency Plan requirement for site-specific risk assessments.

The purpose of the MEC HA is to (1) support the hazard management decision-making process by analyzing site-specific information to assess land use activity decisions and to evaluate removal or remedial alternatives and (2) support the communication of MEC hazards by organizing site information in a consistent manner. The MEC HA also evaluates potential explosive safety risk. If future land uses other than what is specified in the MEC HA occur, explosive safety risks should be re-evaluated to incorporate additional information specific to these future land uses.

The MEC HA is primarily designed to be used at two points in the CERCLA process: once at the end of an RI to assess baseline explosive hazards and relative hazard reductions associated with remedial alternatives in an FS, and the other at the completion of a removal action to assess baseline explosive hazards and relative hazard reductions associated with a particular removal alternative.

One MEC HA was developed for MRP Site UXO5 and the Additional Work Area because the Additional Work Area is a small parcel of land (0.24 acre) located adjacent to MRP Site UXO5 (about 13 acres). This MEC HA presents current site configurations and conditions; incorporates the results of surface MEC clearance, previous investigations, and RI field investigation activities; and identifies land use activities associated with both areas. It was assumed that the current land use restrictions at MRP Site UXO5 and the Additional Work Area will continue. To determine risk reductions taken as a result of these restrictions and controls, the MEC HA first calculated exposure risk without site-specific land use restrictions (“moderate accessibility”), and then again with land use restrictions currently in place including the fence, gate, and signs (“limited accessibility”). Any changes in future land use for MRP Site UXO5 and the Additional Work Area must be approved by the Navy.

The planned future land use activities by potential receptors and corresponding contact hours at MRP Site UXO5 and the Additional Work Area were estimated conservatively and are listed in the following chart.

| Activity | Number of People per Year Who Participate in Activity | Number of Hours a Person Would Spend on Activity | Potential Contact Hours per Year |
|---|---|---|---|
| Natural resource investigations | 4 | 40 | 160 |
| Routine fence maintenance | 5 | 50 | 250 |
| Routine radio tower maintenance | 4 | 8 | 32 |
| **Total Potential Contact Hours** | | | 442 |

Note:
Land use activities do not include intrusive land uses.

The MEC HA is structured around the following three components of potential explosive hazard incidents:

- **Severity –** the potential consequences of the effect (for example, death or injury) on a human receptor if an MEC item detonates
- **Accessibility –** the likelihood that a human receptor will be able to come in contact with an MEC item
- **Sensitivity –** the likelihood that a human receptor will be able to interact with an MEC item so that it will detonate

These components were assessed by input factors that have two or more categories. Each category is associated with a numeric score that reflects the relative contribution of the different input factors to the MEC HA. The sum of the scores, although not a quantitative measurement of an explosive hazard, generates the output (or hazard level) that reflects the attributes of the site and its explosive hazard.

The following assumptions, input factors, and output factors were used:

- **Assumptions:** The MEC HA assumed that the 2009 surface MEC clearance action completed during the TCRA (SES-TECH, 2012a) and the 2015 surface MEC clearance action at DGM survey areas completed during RI field investigation activities satisfy the requirements for surface clearance at MRP Site UXO5 and the Additional Work Area.
- Input Factors:
  - Energetic material type for several munitions items was conservatively assumed to be HE. However, many of the items were determined to be practice rounds, which only contain spotting charges.
  - Future use activities were conservatively estimated as follows:
    - MRP Site UXO5 – 410 contact hours per year (no intrusive activities) for natural resource investigations and routine maintenance activities
    - Additional Work Area - 32 contact hours per year (no intrusive activities) for work at the communications tower

  - As previously mentioned, accessibility for future use was initially entered as "Moderate," defined as some barriers to entry, such as installation security procedures. With the implementation of land use restrictions, accessibility input was changed to "Limited," defined as significant barriers to entry, which would include existing fence, gate and warning signs.

- Output Factors:
  - Less than 10,000 receptor contact hours ("very few") annually were assumed for current and future use conditions, respectively, within MRP Site UXO5 and the Additional Work Area.

The combined MRP Site UXO5 and Additional Work Area MEC HA was developed to present the explosive risk under future moderate access and future limited-access site conditions. MEC HA scores are summarized in the following chart.

| Input Factor | Input Factor Category | Hazard Assessment Score | |
|---|---|---|---|
| | | **Future Moderate Access Conditions** | **Future Limited Access Conditions (with Land Use Restrictions)** |
| Energetic Material Type | HE and low explosive filler in fragmenting rounds | 100 | 100 |
| Distance of Additional Potential Receptors to Explosive Hazard Category | Inside of the explosive safety quantity distance | 30 | 30 |
| Site Accessibility | | Moderate - 55 | Limited - 15 |
| Potential Contact Hours | <10,000 receptor-hours/year | 15 | 15 |
| Amount of MEC | Burial pit | 140 | 140 |
| Migration Potential | Possible | 30 | 30 |
| MEC Classification | Fuzed DMM special case | 105 | 105 |
| MEC Size | Small | 40 | 40 |
| **Total Score** | | **565** | **525** |
| **Hazard Level** | | **Level 3** | **Level 4** |

Note:
< = less than

A hazard level of 3 has a score between 530 and 720 and identifies a site with moderate potential explosive hazard conditions. Sites with a hazard level of 3 may have been a former target area, open burn or open detonation area, function test range, or maneuver area; have moderate or limited accessibility; have less-sensitive MEC or MEC with less-dangerous filler potentially present at depths greater than intrusive activities (practice munitions or pyrotechnics, for example); or have undergone at least surface clearance. MRP Site UXO5 was a former disposal area.

A hazard level of 4 has a score between 125 and 525 and identifies a site with low potential explosive hazard conditions. Sites with a hazard level of 4 may have undergone a MEC cleanup, only have MEC present at depths below current intrusive activities, have Limited or Very Limited accessibility, or have few or very few contact hours. This may be the result of land use restrictions. For MRP Site UXO5, a surface clearance has been completed, and accessibility is limited by the boundary fence, Detachment Fallbrook controls preventing access to unauthorized personnel, and prohibitions against intrusive land uses.

Although all items recovered as part of the RI field work were classified as MDAS, based on the items reported in the PA and SI, the potential for MEC/MPPEH in the subsurface at MRP Site UXO5 and the Additional Work Area is considered to remain, indicating that the potential for explosive hazard remains. Therefore, restricted-access conditions are recommended through the use of land use restrictions, and any intrusive land use activities should only be authorized with the appropriate level of UXO support. The MEC HA workbook for MRP Site UXO5 and the Additional Work Area is provided in Appendix L.

# 8.0 Risk Assessments for Munitions Constituents

This section presents the results of the baseline HHRA and the ERA for MRP Site UXO5. The primary objective of the risk assessments is to evaluate site-related chemical risks that may pose a threat to human health, the environment, or both.

## 8.1 Baseline Human Health Risk Assessment

This section provides an overview of the HHRA methods and summarizes the results of the HHRA for MRP Site UXO5. A detailed discussion of the HHRA methods and results is provided in Appendix M.

The specific objectives of the HHRA were to (1) estimate the magnitude of potential risk to human health associated with current and potential future land use scenarios, (2) identify the environmental media and chemicals that pose the primary human health concerns, (3) identify the environmental media and chemicals that pose little or no threat to human health, and (4) provide a foundation for assessing the need for further consideration or response under the MRP.

The HHRA for MRP Site UXO5 consisted of four major steps: development of a conceptual site exposure model (CSEM), data evaluation and identification of constituents of potential concern (COPCs), estimation of exposure point concentrations (EPCs), and risk characterization. These steps of the HHRA are described below in Sections 8.1.1 through 8.1.4. Results of the HHRA are summarized in Section 8.1.5. These and other components of the risk assessment process, such as toxicity assessment and uncertainty analysis, are described in greater detail in Appendix M.

### 8.1.1 Human Health Conceptual Site Exposure Model

The first step involved identifying sources of chemicals at the site; affected environmental media, chemical release and transport mechanisms that may occur at the site; human receptor populations that may be exposed to the affected media under current or future site conditions; and potential exposure pathways for each receptor population. This information was summarized in a CSEM. Figure 8-1 presents the CSEM for potential human receptors. As shown in the CSEM, the following receptors were identified for evaluation in the HHRA:

- Future industrial worker
- Future construction worker
- Hypothetical future resident (adult and child)

Health risks from exposure to COPCs were evaluated for each of these receptors. An unrestricted (residential) land use scenario generally represents the greatest potential for exposure to site chemicals. Although the future residential scenario is unlikely for MRP Site UXO5, it was evaluated to provide additional information to support risk management decisions for the site. With the exception of EOD and UXO-escort site investigations, MRP Site

UXO5 is not used for any purpose, and fencing prevent unauthorized access. Therefore, no current potential receptors were evaluated in the HHRA.

Potential exposure pathways for each of these receptors are shown in the CSEM; cancer risks and noncancer hazards were quantified in the HHRA for each exposure pathway identified as potentially complete. The soil exposure pathways identified as potentially complete are as follows:

- Incidental ingestion
- Dermal contact
- Inhalation of chemicals adsorbed to windblown soils released to outdoor air

Exposure to surface soil (0 to 0.5 foot bgs) from direct contact was evaluated for the future industrial worker and future resident; surface soil exposures represent a minimal development scenario during future land use (i.e., minimal excavation of site soils). Exposure to subsurface soil (0 to 10 feet bgs) was evaluated for the future industrial worker, future construction worker, and future resident; subsurface soil exposures represent an intrusive development scenario during future land use (i.e., intrusive excavation and mixing of deeper site soils with shallower soils).

In the absence of current receptors at MRP Site UXO5, soil exposure pathways and hence risks from exposure to soil are incomplete for current receptors.

Because of the inferred depth to groundwater (greater than 100 feet), groundwater is not considered a medium of concern at MRP Site UXO5 and is not addressed by this RI (KCH, 2015a). Potential exposure to surface water is expected to negligible and is not evaluated in the HHRA. An intermittent stream located along the northern boundary of the site drains into the Santa Margarita River (located approximately 0.5 mile north of the site). However, no permanent surface water drainages are present within MRP Site UXO5.

### 8.1.2 Data Evaluation and Identification of Constituents of Potential Concern

This step of the HHRA consisted of evaluating the analytical data for usability in the HHRA, grouping the analytical data by depth interval (surface and subsurface), and identifying COPCs for data grouping. Detected chemicals except inorganic chemicals considered to be essential human nutrients and metals detected at concentrations below Detachment Fallbrook-specific BTVs were identified as COPCs for the HHRA. COPCs were identified separately for surface soil (0 to 0.5 foot bgs) and subsurface soil (0 to 10 feet bgs).

### 8.1.3 Estimating Exposure Point Concentrations

EPCs for each COPC were estimated from measured concentrations for evaluation in the subsequent risk calculations. A 95 percent upper confidence limit (95UCL) was used as the EPC for each COPC for surface soil and subsurface soil, except when the 95UCL exceeded the maximum concentration or when the dataset was not sufficiently large to calculate a 95UCL. In these cases, the maximum concentration was used as the EPC.

### 8.1.4 Risk Characterization

This HHRA estimates health risks using a streamlined risk-based concentration (RBC) approach. The RBC approach uses the ratio of EPCs to receptor- and pathway-specific RBCs to estimate health risks. The resulting health risks estimates are numerically equivalent to

the estimates obtained using the forward risk calculation methodology outlined in the USEPA *Risk Assessment Guidance for Superfund Part A* framework (USEPA, 1989).

USEPA (2015) industrial and residential RSLs for soil were used as RBCs to evaluate future industrial worker and hypothetical future residential exposure to surface and subsurface soil. When available, DTSC-SLs (DTSC, 2016) were used as RBCs in lieu of USEPA RSLs. Soil RBCs for construction worker exposure were derived specifically for this HHRA because neither USEPA nor DTSC has established soil RBCs for construction worker exposure. The soil RBCs used for this HHRA are summarized in Table M-4 of Appendix M.

#### 8.1.4.1 Characterization of Cancer Risks

Risks associated with exposure to COPCs classified as carcinogens are estimated as the incremental probability that an individual will develop cancer over a lifetime as a direct result of an exposure. The estimated risk is expressed as a unitless probability.

USEPA guidance on exposure levels considered protective of human health was used to aid in interpreting the results of the risk assessment. In the National Contingency Plan (40 *Code of Federal Regulations* 300.430), USEPA defined general remedial action goals for sites on the National Priorities List. The goals include a range for residual cancer risk, which is "an excess upper-bound lifetime cancer risk to an individual of between 1E-04 [$10^{-4}$] and 1E-06 [$10^{-6}$]," or 1 in 10,000 to 1 in 1,000,000. This HHRA compares cumulative cancer risks with the USEPA range of $10^{-4}$ to $10^{-6}$ for management of cancer risk, referred to as the risk management range. This HHRA also compares cumulative cancer risks with the lower end of the range, $1 \times 10^{-6}$, which is the DTSC point of departure for management of cancer risks. Risks that do not exceed the point of departure ($1 \times 10^{-6}$) are considered negligible and do not require action. Comparison of cumulative cancer risks to both the DTSC point of departure and the USEPA risk management range is included to provide information for risk management decisions.

#### 8.1.4.2 Characterization of Noncancer Hazards

A noncancer hazard index (HI) is used to evaluate the potential for exposure that would result in adverse health effects other than cancer for COPCs not classified as carcinogens and for those carcinogens known to cause adverse health effects other than cancer. HIs for chemicals are summed to create an overall HI to evaluate the potential for adverse health effects other than cancer to result from simultaneous exposure to multiple chemicals. If the total HI exceeds 1, further evaluation in the form of a segregation of HI based on a target organ analysis may be performed to identify whether the noncancer HIs are a concern.

#### 8.1.4.3 Characterization of Risks from Exposure to Lead

Lead was identified as a COPC in surface soil and subsurface soil. The HHRA evaluated the potential for health effects from exposure to lead in surface and subsurface soil by comparing EPCs with the DTSC-SLs of 80 mg/kg for residential exposure and 320 mg/kg for industrial exposure (DTSC, 2016). These screening concentrations are based on a biomarker (blood lead levels); for this reason, the risks from exposure to lead were characterized separately and were not included in risk or hazard calculations.

### 8.1.5 Results of the Human Health Risk Assessment

In addition to summarizing the results of the HHRA, this section identifies the primary risk contributors for MRP Site UXO5. The HHRA evaluated three scenarios: future industrial worker, future construction worker, and future resident. Risk calculations are provided Appendix M.

This HHRA identifies a COPC as a primary risk contributor when (1) the COPC-specific cancer risk exceeds $1 \times 10^{-6}$ (the lower end of the risk management range for cancer risks) or (2) the COPC-specific noncancer HI exceeds 1 (the threshold level for noncancer effects). Each of the COPCs identified as primary risk contributors was evaluated further to assess whether detections could be attributed to non-Navy-related conditions. Primary risk contributors that could be attributed to Navy site-use-related conditions are recommended for further consideration or response under the MRP. Primary risk contributors that are not attributed to Navy site-use-related conditions are not recommended for additional evaluation. The evaluation of primary risk contributors is presented in Section 8.1.5.4.

#### 8.1.5.1 Surface Soil

##### Future Industrial Worker

The cumulative cancer risk for future industrial worker exposure to surface soil is $7 \times 10^{-6}$. The cancer risk exceeds the DTSC point of departure of $1 \times 10^{-6}$, but is within the USEPA risk management range of $10^{-4}$ to $10^{-6}$. Arsenic is the primary risk contributor, and accounts for nearly 100 percent of the cancer risk.

The cumulative noncancer HI for future industrial worker exposure to surface soil is 0.9, which is less than the noncancer threshold of 1.

##### Future Resident

The cumulative cancer risk for future residential exposure to surface soil is $3 \times 10^{-5}$. The cancer risk exceeds the DTSC point of departure of $1 \times 10^{-6}$, but is within the USEPA risk management range of $10^{-4}$ to $10^{-6}$. Arsenic is the primary risk contributor, and accounts for nearly 100 percent of the cancer risk.

The cumulative noncancer HI for future residential exposure to surface soil is 8, which exceeds the noncancer threshold of 1. Arsenic is also a primary risk contributor for noncancer effects, and accounts for 88 percent of the cumulative noncancer hazard. Segregation of the HI by target organ was not done for the residential scenario because the other than arsenic, the sum of the HIs for other COPCs in surface soil does not exceed 1.

#### 8.1.5.2 Subsurface Soil

##### Future Industrial Worker

The cumulative cancer risk for future industrial worker exposure to subsurface soil is $6 \times 10^{-6}$. The cancer risk exceeds the DTSC point of departure of $1 \times 10^{-6}$, but is within the USEPA risk management range of $10^{-4}$ to $10^{-6}$. Arsenic is the primary risk contributor, and accounts for nearly 100 percent of the cancer risk.

The cumulative noncancer HI for future industrial worker exposure to subsurface soil is 0.9, which is less than the noncancer threshold of 1.

#### Future Resident

The cumulative cancer risk for future residential exposure to subsurface soil is $2 \times 10^{-5}$. The cancer risk exceeds the DTSC point of departure of $1 \times 10^{-6}$, but is within the USEPA risk management range of $10^{-4}$ to $10^{-6}$. Arsenic is the primary risk contributor, and accounts for nearly 100 percent of the cancer risk.

The cumulative noncancer HI for future residential exposure to subsurface soil is 7, which exceeds the noncancer threshold of 1. Arsenic is also a primary risk contributor for noncancer effects, and accounts for 86 percent of the cumulative noncancer hazard. Segregation of the HI by target organ was not done for the residential scenario because the other than arsenic, the sum of the HIs for other COPCs in surface soil does not exceed 1.

#### Future Construction Worker

The cumulative cancer risk for future construction worker exposure to subsurface soil is $4 \times 10^{-6}$. The cancer risk exceeds the DTSC point of departure of $1 \times 10^{-6}$, but is within the USEPA risk management range of $10^{-4}$ to $10^{-6}$. Cadmium is the primary risk contributor for the construction worker scenario, and accounts for 72 percent of the cancer risk.

The cumulative noncancer HI for future construction worker exposure to subsurface soil is 4, which exceeds the noncancer threshold of 1. Segregation of the HI by target organ shows that the highest segregated HI is 2. Two target organs are associated with a segregated HI of 2: the respiratory system and the urinary system. Exposure to arsenic, cobalt, and nickel contribute to an HI of 2 for the respiratory system, and exposure to cadmium contributes to an HI of 2 for the urinary system. Based on these results, arsenic, cadmium, cobalt, and nickel are identified as primary risk contributors based on noncancer effects.

#### 8.1.5.3 Lead

EPCs for lead in surface and subsurface soil are based on 95UCLs and are less than the residential DTSC-SL of 80 mg/kg and the industrial DTSC-SL of 320 mg/kg.

Use of 95UCL concentrations for evaluation lead is appropriate provided geographically collocated areas of elevated concentrations or individual samples with elevated concentrations are not present (DTSC, 2015). Although EPCs for lead are below residential and industrial screening criteria, the maximum detected concentration of lead (227 J mg/kg at SIS-007, 0 to 0.75 foot bgs) is approximately 2.8 times higher than the residential screening criterion of 80 mg/kg, while remaining sample results for lead are two or more times lower than the screening criterion. For this reason, lead is identified as a primary risk contributor for surface and subsurface soil.

### 8.1.6 Evaluation of Primary Risk Contributors

Arsenic, cadmium, cobalt, lead, and nickel were identified in the HHRA as primary risk contributors. These chemicals were evaluated further to assess whether detections could be attributed to Navy-related conditions. Primary risk contributors that are not be attributed to Navy site-use-related conditions are not recommended for additional evaluation. Primary risk contributors that could be attributed to Navy site-use-related conditions are recommended for further consideration or response under the MRP.

#### 8.1.6.1 Arsenic

Arsenic was identified as a primary risk contributor for surface and subsurface soil based on cancer risks that exceed $1 \times 10^{-6}$ for the future industrial and residential scenarios and based on its contribution to a segregated noncancer HI of 2 for the future construction worker scenario. The segregated HI exceeds the threshold HI of 1 is based on effects to the respiratory system. Arsenic was detected in the 54 surface soil (0- to 0.5-foot-bgs) samples and in the 89 subsurface soil (0- to 10-feet-bgs) samples at concentrations ranging from 0.69 J to 5.2 J mg/kg. Both the minimum and maximum detected concentrations were estimated concentrations ("J-qualified") below the laboratory reporting limit.

Arsenic was selected as a COPC for surface and subsurface soil because the maximum detected concentration (5.2 J mg/kg) exceeds the BTV for soils with gabbro parent rock type (Kgb soils) of 3.07 mg/kg. However, evaluation of results for arsenic shows that only four of the 89 samples for arsenic exceed the BTV for Kgb soils and that each of the four samples was collected in 2009 for the SI and analyzed using USEPA Method SW6020. Concentrations of these four samples range from 4.2 to 5.2 J mg/kg, and are only slightly above the BTV (less than a factor of two); none of the samples are collocated. Concentrations for the remaining 85 of 89 samples for arsenic are less than the BTV.

Furthermore, detected concentrations for arsenic at MRP Site UXO5 are within the range of background concentrations of arsenic for Detachment Fallbrook. Background concentrations for arsenic, regardless of parent rock type, range from 0.32 to 8.2 mg/kg. Although the maximum detected background concentration is not associated with the Kgb parent rock type, this comparison shows that the range of naturally occurring background arsenic concentrations do not vary widely across Detachment Fallbrook, regardless of parent rock type, and measured arsenic concentrations at MRP Site UXO5 are well within the range of naturally occurring concentrations.

Lastly, arsenic is not associated with munitions or munitions dunnage, and historical use of the MRP Site UXO5 does not indicate any use or disposal of arsenic. Based on comparability to background arsenic concentrations for Detachment Fallbrook, arsenic concentrations measured at MRP Site UXO5 are likely to be naturally occurring. For these reasons, arsenic is not recommended for further evaluation.

#### 8.1.6.2 Cadmium

Cadmium was identified as a primary risk contributor for subsurface soil (future construction worker scenario). Cadmium was detected in the 89 subsurface soil (0 to 10 feet bgs) samples at concentrations ranging from 0.0703 J to 27.8 mg/kg. The cancer risk for cadmium for the construction worker scenario is $3 \times 10^{-6}$ and the noncancer HI is 2. Segregation of the HI by target organ shows that cadmium contributes to a segregated HI of 2 for the urinary system; no other COPCs are associated with the segregated HI for this target organ. The cadmium cancer risk for the construction worker scenario ($3 \times 10^{-6}$) exceeds the cadmium risk for the hypothetical future residential (unrestricted use) scenario ($1 \times 10^{-9}$) because of (1) differences between cancer toxicity values incorporated in the USEPA RSLs (used as RBCs to estimate risks for the future industrial and residential scenarios) and the more stringent DTSC cancer toxicity values used to calculate construction worker RBCs and (2) the higher DTSC-recommended (2014) particulate emission factor for the construction scenario. The noncancer HI for the construction worker scenario exceeds the HI for the hypothetical future residential

scenario because of the higher DTSC-recommended (2014) particulate emission factor for the construction scenario and shorter duration for averaging noncancer exposures for the construction scenario.

Although cadmium was not identified as a primary risk contributor for the future industrial and residential scenarios, cadmium concentrations in three samples were above the residential and industrial RBCs of 5.2 and 7.3 mg/kg, respectively. The maximum detected concentration (27.8 mg/kg at KCH-UXO5-TR10, at 4.5 feet bgs) is 5.3 times higher than the residential RBC, is collocated with maximum detected concentrations of chromium VI, cobalt, and manganese, and is associated with an excavation trench from which non-munitions-related metallic debris was recovered. The maximum concentration is also collocated with the third highest detection of cadmium (12.1 mg/kg at KCH-UXO5-TR10, at 1.5 feet bgs). KCH-UXO5-TR10 was sampled during the RI, and is located approximately 250 feet northeast of Building 308 in the northwest portion of the site (Figure 5-1). The second highest detection of cadmium (13 mg/kg, SIS-001, at 0 to 0.75 foot bgs) was sampled during the SI, and is also located in the northwest portion of the site, approximately 225 feet north of Building 308 (Figure 3-1).

Based on geographical collocation of the sample results that exceed residential and industrial RBCs and the level of exceedance, cadmium is recommended for further consideration under the MRP.

#### 8.1.6.3 Cobalt

Cobalt was identified as a primary risk contributor for subsurface soil (future construction worker scenario). Cobalt was detected in all 89 subsurface soil (0 to 10 feet bgs) samples at concentrations ranging from 5.8 to 19.6 mg/kg. However, concentrations do not exceed the DTSC (2016) residential RBC for cobalt of 23 mg/kg or the construction worker RBC for cobalt calculated for this HHRA of 20 mg/kg. The lower RBC for the construction worker compared with the RBC for the residential receptor is based on use of the more stringent DTSC (2014)-recommended particulate emission factor (PEF) to estimate soil-to-outdoor air concentrations from construction-related soil activities ($1 \times 10^6$ cubic meters per kilogram [$m^3$/kg]) rather than the DTSC (2014)-recommended PEF to estimate outdoor air concentrations from non-construction activities ($1.36 \times 10^9$ $m^3$/kg).

Cobalt was identified as a primary risk contributor because it contributes to a segregated HI of 2 for the future construction worker scenario, based on a target organ analysis. The segregated HI of 2 exceeds the threshold HI of 1 and is based on effects to the respiratory system. The chemical-specific noncancer HI for cobalt for the future construction worker scenario is 0.5; noncancer HIs for arsenic and nickel compose the remainder of the segregated HI calculated for the respiratory system.

Cobalt was selected as a COPC for subsurface soil because the maximum detected concentration (19.6 mg/kg) exceeds the BTV for Kgb soils of 15.99 mg/kg. However, evaluation of results for cobalt shows that only 3 of the 89 samples for cobalt exceed the BTV for Kgb soils. Concentrations of these three samples range from 16.8 to 19.6 mg/kg; none of the three samples is collocated, and none of the samples was located in an investigation trench with elevated magnetic anomalies. Concentrations for the remaining 86 samples for cobalt are less than the BTV.

Furthermore, detected concentrations for cobalt at MRP Site UXO5 (5.8 to 19.6 mg/kg) are within the range of background concentrations of cobalt for Detachment Fallbrook. Background concentrations for cobalt, regardless of parent rock type, range from 1.2 to 20.4 mg/kg. Concentrations of naturally occurring background cobalt concentrations do not vary widely across Detachment Fallbrook (no greater than a factor of 3.5 between the minimum and maximum background concentration), regardless of parent rock type, and measured cobalt concentrations at MRP Site UXO5 are well within the range of naturally occurring concentrations.

Based on this information – comparability to background cobalt concentrations for Detachment Fallbrook, lack of collocation of the highest measured cobalt concentrations, relatively low chemical-specific for HI cobalt (0.5) relative to the segregated HI (2), and no exceedances of the residential cobalt RBC – cobalt is not recommended for further evaluation.

#### 8.1.6.4 Lead

Lead was identified as a primary risk contributor for surface and subsurface soil (future residential scenarios). Lead was detected in the 54 surface soil (0 to 0.5 foot bgs) samples and in the 89 subsurface soil (0 to 10 feet bgs) samples.

The sample with the maximum detected concentration of lead (227 J mg/kg at SIS-007, at 0 to 0.75 foot bgs) is the only sample out of 89 samples with a lead concentration above the residential screening criterion of 80 mg/kg; no individual sample results exceed the industrial screening criterion. The maximum concentration is approximately 2.8 times higher than the residential screening criterion, and the next highest concentration of lead (40.1 J mg/kg) is two times lower than the screening criterion. No other maximum concentrations, however, are collocated at SIS-007. Moreover, concentrations of other metals detected at SIS-007 are either below BTVs or are below respective residential and industrial screening criteria. These comparisons indicate that the maximum detection of lead at SIS-007 is an isolated occurrence, and SIS-007 is not affected by MEC-related activities. Lastly, the maximum concentration of lead is an estimated (J-qualified) concentration. Therefore, lead is not recommended for further evaluation at MRP Site UXO5.

#### 8.1.6.5 Nickel

Nickel was identified as a primary risk contributor for subsurface soil (future construction worker scenario). Nickel was detected in all 89 subsurface soil (0 to 10 feet bgs) samples at concentrations ranging from 12.3 J to 12.8 mg/kg. However, concentrations do not exceed the DTSC (2016) residential RBC for nickel of 490 mg/kg or the construction worker RBC for nickel calculated for this HHRA of 57 mg/kg. The lower RBC for the construction worker compared with the RBC for the residential receptor is based on use of the more stringent DTSC (2014)-recommended PEF to estimate soil-to-outdoor air concentrations from construction-related soil activities ($1 \times 10^6$ $m^3$/kg) rather than the DTSC (2014)-recommended PEF to estimate outdoor air concentrations from non-construction activities ($1.36 \times 10^9$ $m^3$/kg).

Nickel was identified as a primary risk contributor because the HHRA results show that it contributes to a segregated HI of 2 for the future construction worker scenario, based on a target organ analysis. The segregated HI of 2 exceeds the threshold HI of 1 and is based on

effects to the respiratory system. The chemical-specific noncancer HI for nickel for the future construction worker scenario is 0.1; noncancer HIs for arsenic and cobalt compose the remainder of the segregated HI calculated for the respiratory system.

Nickel was selected as a COPC for subsurface soil because the maximum detected concentration (12.8 mg/kg) exceeds the BTV for Kgb soils of 11.88 mg/kg. However, evaluation of results for nickel shows that only 3 of the 89 samples for nickel exceed the BTV for Kgb soils. Concentrations of these three samples range from 12.2 to 12.8 mg/kg; none of the three samples is collocated. Concentrations for the remaining 86 samples for nickel are less than the BTV.

Furthermore, detected concentrations for nickel at MRP Site UXO5 (12.3 J to 12.8 mg/kg) are within the range of background concentrations of nickel for Detachment Fallbrook. Background concentrations for nickel, regardless of parent rock type, range from 0.58 to 15 mg/kg. Measured nickel concentrations at MRP Site UXO5 are well within the range of naturally occurring concentrations.

Based on this information – comparability to background nickel concentrations for Detachment Fallbrook, lack of collocation of the highest measured nickel concentrations, relatively low chemical-specific for HI nickel (0.1) relative to the segregated HI (2), and no exceedances of the residential nickel RBC – nickel is not recommended for further evaluation.

## 8.2 Ecological Risk Assessment

An ERA was conducted, as part of the RI for MRP Site UXO5, in accordance with the guidelines published by USEPA and DTSC. The overall objective of the ERA was to quantitatively and qualitatively evaluate baseline or existing exposure and risks to ecological receptors, and to provide risk managers with information needed to achieve their ecological management goals and help determine remedial decisions, if necessary.

The ERA was conducted in phases as recommended by the Navy policy for conducting ERAs (Navy, 1999 and 2003) and is consistent with USEPA (USEPA, 1997 and 1998) and DTSC (1996) guidance for conducting ERAs. Each of the following phases is more detailed and focused than the preceding phase, and data from one phase are used to determine whether further studies are needed to meet the objectives of the assessment:

- Tier 1 Screening-level ERA
- Tier 2 Baseline ERA
- Tier 3 Evaluation of Remedial Alternatives

The tiered approach is designed to focus the evaluation on those receptor types and constituents of potential ecological concern (COPECs) considered of greatest concern. The Tier 1 screening-level ERA uses conservative assumptions to determine the chemicals, receptors, and exposure pathways to carry forward to the site-specific Tier 2 assessment and included the maximum detected concentration and Low ESVs. Tier 2 included use of refined exposure assumptions (e.g., use of areal average concentrations as represented by the 95UCL and consideration of High toxicity reference value [TRV]-based ESLs) to provide more realistic estimates of exposure and risk. Tier 3 is initiated when the results of the Tier 2

Baseline ERA indicate that site-related chemicals of ecological concern pose unacceptable risks to one or more assessment endpoints.

Risks were estimated for terrestrial birds and mammals. These estimates were conducted under the hypothetical assumption that soil at MRP Site UXO5 is readily accessible for exposure by these receptors. Figure 8-2 presents the CSEM for potential ecological receptors. Potential risks to terrestrial birds and mammals were estimated using the dosage-based food-chain uptake model and Low and High TRVs to derive ESVs.

Low TRV-based ESVs are used to estimate potential risks to special-status species. Before RI sampling, MRP Site UXO5 was monitored for CAGN and SKR; of these, the CAGN was found to be present at the site (Section 4.4). Given this finding, the results using the Low TRV-based ESVs are considered most appropriate for assessing the potential for adverse effects on the CAGN and the High TRV-based ESVs are considered most appropriate for assessing the receptor populations and communities for non-threatened and non-endangered species.

The results of the ERA for MRP Site UXO5 indicate that concentrations of COPECs found in MRP Site UXO5 soil during the SI and RI sampling are below levels that might be expected to pose ecological risk (as indicated by the High TRV-based ESVs) to receptor populations and communities for non-threatened and non-endangered species. However, concentrations of cadmium, lead, and zinc in site soil are above the Low ESV for the CAGN, indicating a potential for risk. Although site concentrations of copper (95UCL of 28.1 mg/kg) also exceed the Low ESV for the CAGN of 13.5 mg/kg, background concentrations of copper (95UCL of 22.4 mg/kg) also exceed the Low ESV. The incremental copper concentration (site minus background) is 5.7 mg/kg, which is below the Low ESV. Therefore, copper is not identified as a risk driver at MRP Site UXO5.

The ERA also included an assessment of uncertainties inherent in the assumptions used to estimate risks. Uncertainties in risk assessment methods may result in understating or overstating the ecological risks. The ERA process, results, and uncertainties are discussed in more detail in Appendix N.

# 9.0 Conceptual Site Model

This updated conceptual site model (CSM) for MRP Site UXO5 integrates RI results with background information, environmental setting and demographic information to identify sources, release mechanisms, transport pathways, potentially affected media, and receptors for potential contamination at the site. The CSM is summarized in the following chart. Exposure pathway evaluations for MC for potential human receptors and MC for potential ecological receptors are included as Figures 8-1 and 8-2, respectively. An exposure pathway evaluation for MEC for potential human receptors is included as Figure 9-1.

Conceptual Site Model

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| **Size** | 13 acres (plus approximately 0.24 acre for the Additional Work Area) |
| **Access** | Fenced, accessed from Sparrow Road (Building 307 access road). |
| **Terrain** | Low hills and natural ravines. |
| **Vegetation/Biological Setting** | A significant portion of the vegetation at MRP Site UXO5 burned in February 2002 as a result of the Gavilan fire. Vegetation growth has since advanced through patterns typical of post-burn seral plant ecology. Vegetative communities include California sagebrush (*Artemisa californica*), California buckwheat (*Eriogonum fasciculatum*), deer weed (*Lotus scoparius*), and a few individuals of white sage (*Salvia apiana*). |
| **Hydrology/Surface Water** | Detachment Fallbrook is part of two coastal watersheds: the Santa Margarita River and the San Luis Rey River. The Santa Margarita River, Fallbrook Creek, and Pilgrim Creek make up the three major surface water drainages within the detachment.<br>There are no permanent surface water drainages within MRP Site UXO5. An ephemeral stream located along the northern boundary of the site drains into the Santa Margarita River (located approximately 0.5 mile north of the site), and a culvert that runs under Sparrow Road on the western side of MRP Site UXO5 feeds a drainage way that flows southwest. |
| **Geology/Hydrogeology** | Detachment Fallbrook is in the Peninsular Ranges geomorphic province, which is characterized by a series of northwest-trending ranges and valleys. The geomorphic province is dominated by the igneous and metamorphic rocks of the Peninsular Range batholith. Four bedrock types have been identified within the boundaries of Detachment Fallbrook: gabbro, granodiorite, tonalite, and metavolcanic/metasedimentary.<br>Based on information obtained from Detachment Fallbrook monitoring wells at Buildings 230 and 232, the depth to water was estimated to be approximately 100 feet bgs. The groundwater gradient was estimated to be to the southwest. |
| **Current Use** | MRP Site UXO5 is not in use and is completely fenced. There are no buildings within MRP Site UXO5 boundaries.<br>The Additional Work Area is outside of the MRP Site UXO5 perimeter fence (adjacent to the Building 307 parking area) and is currently unused. |
| **Historical Use** | Burial area for munitions and munitions-related dunnage. From 1952 through 1960, the area east of Building 307 was used to dispose of inert materials. On historical maps, starting in the 1950s and ending in the late 1960s, the area is labeled as a storage yard. Records indicate that expended cartridges, primers, live projectiles, and inert anti-tank projectiles were buried in the area.<br>In the mid-1960s, five partially filled cans containing 2 pounds of smokeless powder were reportedly deposited at MRP Site UXO5. In the late 1980s, an onsite survey was conducted and revealed other materials in the disposal area, |

Conceptual Site Model

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| | including electronic parts, inert missile parts, rubber missile shipping rings, missile test stands, practice shapes, electronic test equipment, empty powder cans, metal banding, and tires. |
| **Primary Source/Release Mechanisms** | Burial area for munitions and munitions-related dunnage. Releases of MC and other COPCs may have occurred to the surface. |
| **Secondary Release or Transport Mechanisms** | Intentional or inadvertent burial of discarded munitions or related materials resulting in the potential release of MC as materials deteriorate. |
| **Suspected Contaminants** | Releases from debris, MEC, and MPPEH. |
| **Target Munitions** | Munitions reported to have been observed during the PA survey activities included two 25-pound practice bombs (Mk 76), a 3-pound practice bomb (Mk 23), a 2.36-inch anti-tank HE rocket (M6), a 5-pound practice bomb (Mk 106), 20-mm projectiles and other projectiles (not identified by size, condition, filler, or nomenclature), several smokeless powder cans and lids, and other munitions-related scrap.<br>The geophysical and surface surveys during the SI confirmed the presence of MEC/MPPEH including detonation fuses, an Mk 106 practice bomb, 40-mm rounds, adapter-boosters, 3-inch/50 casings, and flash tubes.<br>No MEC/MDEH was identified during RI investigations. MPPEH was inspected and segregated into MDAS or non-munitions-related metallic debris. MDAS items recovered consisted of 20-mm and 40-mm cartridge cases, one inert 20-mm projectile, one inert 40-mm projectile, a 3-inch round cartridge case, an indiscernible fuze cap, one 2.36-inch practice rocket, 0.50-caliber cartridges, M11A2 practice rifle grenades, an igniter tube, one 90-mm projectile casing, and one M50B2 37-mm practice projectile which required controlled detonation demilitarization to allow UXO technicians to fully inspect. MDAS items recovered from investigative trenches consisted of a spent 57-mm projectile cartridge at Trench 4, 40-mm cartridge cases at Trenches 5 and 6, two Mk 76 practice bombs (without spotting charges) at Trench 10 and two spent 40-mm cartridge primers at Trench 12. |
| **Potential Transport Mechanisms** | Intrusive human activities and burrowing animals. |
| **Sensitive Ecological Habitats** | When MRP Site UXO5 was inspected in 2004, more than 98 percent of the vegetative material was less than 1 meter in height, and it was determined that it provided limited components of the Critical Habitat Code of Federal Regulations identified constituent elements. Since that time, it has been noted that the vegetation has grown, and special-status species such as the CAGN have been observed using the area. MRP Site UXO5 is within designated Critical Habitat for the CAGN, and constituent elements exist on MRP Site UXO5. |
| **Current Human Receptors** | Detachment Fallbrook workers, contractors, and visitors.<br>For the purposes of the HHRA there are no current human receptors because the site is located on an active military installation and access to the site is currently restricted by fencing, locked gates, and signage. |
| **Future Human Receptors** | Detachment Fallbrook workers, contractors, and visitors, and future construction workers at the Additional Work Area.<br>For the purposes of the HHRA, the future human receptors were industrial workers, construction workers, and hypothetical residents. |
| **Previous MEC Investigations and Removal Actions** | **PA:** Two data collection teams were used to conduct visual surveys of MRP Site UXO5 in September 2004 and March 2005. The visual data were collected by walking the perimeter of MRP Site UXO5 and walking several transects. Munitions reported to have been observed during the PA survey activities included two 25-pound practice bombs (Mk 76), a 3-pound practice bomb (Mk 23), a 2.36-inch anti-tank HE rocket (M6), a 5-pound practice bomb (Mk 106), 20-mm projectiles and other projectiles (not identified by size, |

Conceptual Site Model

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| | condition, filler, or nomenclature), several smokeless powder cans and lids, and other munitions-related scrap. The PA recommended that an SI be conducted with respect to MPPEH identified at MRP Site UXO5.<br>**SI:** A geophysical survey to identify burial area boundaries, a surface search of the entire site, soil sample collection, and installation of a fence around the site as an interim action. The geophysical and surface surveys confirmed the presence of MEC/MPPEH including detonation fuses, an Mk 106 practice bomb, 40-mm rounds, adapter-boosters, 3-inch/50 casings, and flash tubes. These items were observed on the ground surface of MRP Site UXO5 and in an exposed pit.<br>**TCRA:** In 2011, a TCRA was initiated to remove MEC, MPPEH, and metallic debris from the site surface and a partially exposed pit containing 40-mm shells (SES-TECH, 2012). Recovered MPPEH items were removed from MRP Site UXO5 as MDAS. Approximately 7,000 pounds of metal debris were removed from the site surface during the first stage of the TCRA. None of the surface items removed qualified as MEC/MPPEH. The second stage of the TCRA addressed the burial pit, which was an eroded cavity that abutted a concrete retaining wall in the southwest portion of the site. Approximately 2 tons of inert munitions-related items, mostly 40-mm inert projectiles and 0.50-caliber expended casings, were excavated from the burial pit. All munitions-related items removed from the burial pit were inspected and certified as MDAS.<br>**Post-TCRA Geophysical Survey:** After completion of the TCRA, portions of MRP Site UXO5 were surveyed in 2012 using a Geometrics G-858 magnetometer to identify geophysical anomalies and potential burial areas as part of the planning stage for future investigations at the site (SES-TECH, 2012b). The geophysical survey covered approximately 80 percent of MRP Site UXO5, in areas where surface clearance had been previously performed. A total of 2,680 anomalies was identified in the geophysical survey. The anomalies were not investigated as part of the TCRA. |
| **Current MEC Investigation** | The RI consisted of digital geophysical mapping, intrusive investigation of selected anomalies and excavation and investigation of 12 investigative trenches to assess the nature and extent of MEC and munitions debris in the surface and subsurface at MRP Site UXO5 and the Additional Work Area. A surface clearance of DGM survey areas was conducted by completing analog-instrument-aided visual inspections of each area. |
| **Previous MC Investigations** | A total of 29 soil samples (0 to 0.75 foot bgs) was collected in 2007 for the SI. Soil samples were analyzed for explosives residues, perchlorate, and metals. |
| **Current MC Investigation** | A total of 60 soil samples (0 to 4.5 feet bgs) was collected in 2015 for the RI. Soil samples were analyzed for explosives residues, perchlorate, metals, and hexavalent chromium. |
| **MEC Pathways** | Potential human exposures to MEC physical hazards are possible at MRP Site UXO5, but not likely. The potential for exposure is attributed to exposure pathways, which are influenced by site accessibility, duration of potential for contact, quantity and type of MEC, depth of MEC versus work undertaken, and the potential for MEC migration.<br>Access to MRP Site UXO5 is currently restricted by both physical barriers and administrative access restrictions. MRP Site UXO5 is located entirely within the secured Detachment Fallbrook boundary. The site constraints of restricted access and controlled activity type support the position of an incomplete source/receptor pathway. However, because the possibility of direct MEC contact remains, the source potential receptor pathway is determined to be complete for authorized personnel, and the site users are considered potential receptors. |

Conceptual Site Model

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|---|---|
| **MC Pathways** | **HHRA:** The soil exposure pathways identified as potentially complete are as follows:<br>• Incidental ingestion<br>• Dermal contact<br>• Inhalation of chemicals adsorbed to windblown soils released to outdoor air<br>**ERA:** Direct exposure to soil and indirect exposure through food web exposure via consumption of contaminated prey/forage. |
| **Nature and Extent** | **MEC/MPPEH:** No MEC/MDEH was identified during RI investigations. MPPEH was inspected and segregated into MDAS or non-munitions-related metallic debris. MDAS items recovered during intrusive investigations consisted of 20-mm and 40-mm cartridge cases, one inert 20-mm projectile, 0.50-caliber cartridges, one 90-mm projectile casing, one inert 40-mm projectile, a 3-inch round cartridge case, an indiscernible fuze cap, one 2.36-inch practice rocket, 0.50-caliber cartridge cases, M11A2 practice rifle grenades, an igniter tube, and one M50B2 37-mm practice projectile which required controlled detonation demilitarization to allow UXO technicians to fully inspect. MDAS items recovered from investigative trenches consisted of a spent 57-mm projectile cartridge at Trench 4, 40-mm cartridge cases at Trenches 5 and 6, two Mk 76 practice bombs (without spotting charges) at Trench 10, and two spent 40-mm cartridge primers at Trench 12. About 1,000 pounds of non-munitions-related metallic debris from MRP Site UXO5 was transported offsite for recycling.<br>The distribution of anomalies detected during DGM and the nature of MPPEH recovered during intrusive investigations are consistent with the site history as a disposal area. Although MEC or MDEH was not found during the RI field investigation, the site history indicates the potential for these items to be present. Also, MEC/MPPEH items were reported during the PA and SI. Information is not available as to whether these items were confirmed to be MEC or MDEH.<br>In conformance with Verification Sampling Program in VSP, Version 7.2 (PNNL/Battelle, 2014), the results of the total number of anomalies investigated for each population indicate that there is a 95 percent confidence (with ±5 percent sampling error) that the remaining uninvestigated DGM anomalies at MRP Site UXO5 and the Additional Work Area do not represent MEC. However, these statistical results cannot be applied to material remaining in the disposal areas.<br>MEC and MPPEH are suspected in the subsurface at MRP Site UXO5. There is a potential for migration of MEC or MPPEH through erosion and surface water transport, particularly in the areas of steep sloping terrain. Precipitation runoff drains toward a ravine just north of Building 307. If MEC/MPPEH migration occurs, it will likely be in the direction of the ravine. The lowest temperatures occur from December through February, with a mean annual low of 47.5°F. Thus, there is no frost line in Fallbrook, California, and no potential for frost heave to occur at MRP Site UXO5 that could potentially bring buried MEC or MPPEH to the surface. Based on the historical disposal activities, MEC/MPPEH is unlikely to be deeper than 5 feet; however, site activities (site work, construction) may disturb MEC/MPPEH below the surface and cause MEC/MPPEH to be exposed at the surface.<br>**MC:** Soil has been characterized through investigations conducted during 2007 and 2015, resulting in the collection of 89 samples (0 to 4.5 feet bgs). No explosives residues or perchlorate were detected at concentrations above RSLs in soil samples collected during the SI and RI. Hexavalent chromium was detected at a concentration above the residential RSL in only 1 of the 89 soil samples. Metals were detected in soil at concentrations above BTVs, RSLs, or DTSC-SLs. Cobalt, copper, mercury, nickel, silver, and zinc were detected above their respective BTVs in one or more soil samples; however, none of these concentrations were above their respective residential and industrial |

Conceptual Site Model

| | |
|---|---|
| | RSLs or DTSC-SLs. Detected arsenic concentrations were above the residential and industrial DTSC-SLs but were above the BTV in only 4 of the 89 samples. Detected cadmium concentrations were above the BTV but were above the residential and industrial DTSC-SLs in only 3 of the 89 samples. Detected lead concentrations were above the BTV, but only 1 sample had a lead concentration above the residential DTSC-SL. |
| **Risk Assessment** | **MEC/MPPEH:** Based on the explosives hazards evaluation, the explosive hazard for MRP Site UXO5 is low to moderate. Although all items recovered as part of the RI field work were classified as MDAS, based on the items reported in the PA and SI, the potential for MEC/MPPEH in the subsurface at MRP Site UXO5 and the Additional Work Area is considered to remain, indicating that the potential for explosive hazard remains.<br>**MC:** Based on the evaluation of primary risk contributors in the HHRA, cadmium is recommended for further consideration or response under the MRP.<br>The results of the ERA indicate that concentrations of cadmium, lead, and zinc have been found in site soil at levels above the Low ESV for the threatened CAGN, and are considered to pose a potential for risk to this receptor. |

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# 10.0 Conclusions and Recommendations

## 10.1 Conclusions

The following conclusions are based on findings from the SI and RI investigations:

- No MEC was recovered during the field operations at MRP Site UXO5 or the Additional Work Area during the RI field activities. All MPPEH was determined to be MDAS. One drum of inspected, re-inspected, certified, and verified MDAS from MRP Site UXO5 was sent to Bonetti in Columbus, Texas, for shredding and smelting on May 26, 2015. About 1,000 pounds of non-munitions-related metallic debris from MRP Site UXO5 was transported offsite to Fallbrook Waste and Recycling for recycling on April 15, 2015.
- No explosives residues or perchlorate were detected at concentrations above RSLs in soil samples collected during the SI and RI. Metals were detected in soil at concentrations above BTVs, RSLs, or DTSC-SLs and were evaluated in the HHRA.
- Arsenic, cadmium, and lead were identified in the HHRA as primary risk contributors. Arsenic is not recommended for further evaluation because arsenic concentrations were only slightly above the BTV for Kgb parent rock and well within the range of naturally occurring concentrations, there were no collocated sample locations, and arsenic is not associated with munitions or munitions dunnage. Cadmium is recommended for further action because concentrations (12.1 to 27.8 mg/kg) in 3 of 89 samples were above residential and industrial DTSC-SLs (5.2 and 7.3 mg/kg, respectively) and these three samples were geographically collocated in the northwest portion of the site. Additionally, two of these three samples were located in an excavation trench from which non-munitions-related metallic debris was recovered. Lead is not recommended for response action because only one sample contained a lead concentration above the residential screening criterion and there were no collocated high metals concentrations.
- The results of the ERA for MRP Site UXO5 indicate that concentrations of COPECs found in MRP Site UXO5 soil during the SI and RI sampling are below levels that might be expected to pose ecological risk (as indicated by the High TRV-based ESVs) to receptor populations and communities for non-threatened and non-endangered species. However, concentrations of cadmium, lead, and zinc in site soil are above the Low ESV for the CAGN, a threatened species, indicating a potential for risk. Although site concentrations of copper (95UCL of 28.1 mg/kg) also exceed the Low ESV for the CAGN of 13.5 mg/kg, background concentrations of copper (95UCL of 22.4 mg/kg) also exceed the Low ESV. The incremental copper concentration (site minus background) is 5.7 mg/kg, which is below the Low ESV. Therefore, copper is not identified as a risk driver at MRP Site UXO5.
- The distribution of anomalies detected during DGM and the nature of MPPEH recovered during intrusive investigations are consistent with the site history as a disposal area. Although all items recovered as part of the RI fieldwork were classified as MDAS, based on the items reported in the PA and SI, the potential for MEC/MPPEH in

the subsurface at MRP Site UXO5 and the Additional Work Area is considered to remain, indicating that the potential for explosive hazard remains. There is a potential for migration of MEC or MPPEH through erosion and surface water transport, particularly in the areas of steep sloping terrain. If MEC/MPPEH migration occurs, it will likely be in the direction of the ravine located north of Building 307. Based on the historical disposal activities, MEC/MPPEH is unlikely to be deeper than 5 feet; however, site activities (site work, construction) may disturb MEC/MPPEH below the surface and cause MEC/MPPEH to be exposed at the surface. Therefore, restricted-access conditions and prohibitions against intrusive activities should continue, and any intrusive land use activities should only be authorized with the appropriate level of UXO support.

## 10.2 Recommendations

The following recommendations are made for future actions at MRP Site UXO5:

- Future land use at MRP Site UXO5 is expected to remain the same as current use, which is natural habitat area. As a result of the residual waste present, it is recommended the site continue to be restricted to military use for the foreseeable future and remain fenced with warning signs. These land use controls are recommended to be continued to be implemented at MRP Site UXO5. The anomaly investigations, investigative trenches, and soil sampling are believed to be sufficient for the purpose of determining the nature of the wastes and refining the vertical extent of the wastes.
- MEC or MPPEH was not found at the Additional Work Area during the surface clearance or intrusive investigations. However, UXO construction support is recommended for construction at the Additional Work Area.
- An FS is recommended for MRP Site UXO5 in order to develop remedial action objectives and to develop and evaluate remedial alternatives to address potential human health risk from cadmium in soil, potential ecological risk from cadmium, lead, and zinc in soil, and potential MEC/MPPEH that could potentially remain at MRP Site UXO5.

# 11.0 References

California Department of Toxic Substances Control (DTSC). 1996. *Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities*. July 4.

California Department of Toxic Substances Control (DTSC). 2014. *Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities*. Office of Human and Ecological Risk (HERO) HERO HHRA Note Number 1. September 30.

California Department of Toxic Substances Control (DTSC). 2016. *DTSC-Modified Screening Levels (DTSC SLs)*. Human and Ecological Risk Office (HERO). HERO HHRA Note Number 3. January.

CH2M HILL Kleinfelder, A Joint Venture (KCH). 2015a. *Work Plan Remedial Investigation for Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach, Detachment Fallbrook, Fallbrook, California*. February.

CH2M HILL Kleinfelder, A Joint Venture (KCH). 2015b. *Explosives Safety Submission for Munitions Response Program Site UXO5. Naval Weapons Station Seal Beach Detachment Fallbrook, Fallbrook, California*. February.

Colt/NAVFAC SW, Ann. 2014. FW: Uncovered Ordnance Item During MNS Install (Det Fallbrook). Message to Gus Thrasher/CH2M. E-mail. May 14.

Laboratory Data Consultants (LDC). 2007. Detachment Fallbrook, Data Validation, LDC Project #16842. June 8.

Malcolm Pirnie, Inc. (Malcolm Pirnie). 2006. *Final Preliminary Assessment for the Munitions Response Program, Naval Weapons Station Seal Beach Detachment Fallbrook, California*. June.

Naval Facilities Engineering Command (NAVFAC) Southwest. 2001. *Environmental Work Instruction (EWI) No. 1, Data Validation Guidelines for Chemical Analysis of Environmental Samples*. November.

Naval Facilities Engineering Command (NAVFAC) Southwest. 2010. *Action Memorandum, Time-Critical Removal Action for Munitions Response Program Site UXO5, Salvage Yard Burial Area, Naval Weapons Station Seal Beach, Detachment Fallbrook, Fallbrook, California*. August.

Naval Sea Systems Command (NAVSEA). 2015 Ordnance Pamphlet 5 Volume 1. *Ammunition and Explosives Safety Ashore*, 7th Rev with Change 13. April 2.

Pacific Northwest National Laboratory (PNNL)/Battelle. 2014. *Visual Sample Plan*. Version 7.2. http://vsp.pnnl.gov/.

SES-TECH. 2012a. *Final Project Completion Report, Time Critical Removal Action, Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach, Detachment Fallbrook, Fallbrook, California*. November.

SES-TECH, 2012b. *Final Geophysical Report, Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach, Detachment Fallbrook, Fallbrook, California*. November.

SES-TECH. 2012c. *Final Basewide Metals Background Soil Study Report, Naval Weapons Stations Seal Beach, Detachment Fallbrook, Fallbrook, California.* November.

Tetra Tech EC, Inc. (Tetra Tech). 2009. *Final Site Inspection Report, Naval Weapons Station Seal Beach, Detachment Fallbrook, Munitions Response Program Site UXO5, Salvage Yard Burial Area, Fallbrook, California*. Prepared for Naval Facilities Engineering Command Southwest. February 4.

United States Department of Defense (DoD). 2008. *Material Potentially Presenting an Explosive Hazard* and Ordnance Pamphlet 5 Volume 1. DoD Instruction 4140.62.

United States Department of the Army (Army). 2005. *Munitions Response Terminology*. Memorandum. April 21.

United States Department of the Navy (Navy). 1999. Chief of Naval Operations. *Memorandum: Navy Policy for Conducting Ecological Risk Assessments.* April 5.

United States Department of the Navy (Navy). 2003. *Navy Guidance for Conducting Ecological Risk Assessments.* Originally published April 5, 1999. Web site version last updated February 28, 2003: http://web.ead.anl.gov/ecorisk/process/pdf/index.cfm.

United States Environmental Protection Agency (USEPA). 1989. *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)*, *Interim Final.* EPA/540-1-89/002. Office of Solid Waste and Emergency Response. December.

United States Environmental Protection Agency (USEPA). 1997. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments.* Interim Final. EPA/540/R-97/006. OSWER 9285.7-25. June.

United States Environmental Protection Agency (USEPA). 1998. *Final Guidelines for Ecological Risk Assessment.* Risk Assessment Forum, EPA. Washington D.C. EPA/630/R-95/002F. April.

United States Environmental Protection Agency (USEPA). 2008a. *National Functional Guidelines for Superfund Organic Methods Data Review.* USEPA-540-R-08-01. June.

United States Environmental Protection Agency (USEPA). 2008b. *Munitions and Explosives of Concern Hazard Assessment Methodology*. Interim. October.

United States Environmental Protection Agency (USEPA). 2010. *National Functional Guidelines for Inorganic Superfund Data Review.* USEPA Contract Laboratory Program. USEPA 540-R-10-011. January.

United States Environmental Protection Agency (USEPA). 2015. *Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites.* November.

United States Marine Corps. 2004. Memorandum from Explosive Ordnance Disposal Chief, Camp Pendleton, California, to Explosive Safety Officer, Naval Weapons Station Seal Beach, Fallbrook Annex. Subject: Results of EOD Site Survey of NAVWPNSTASB, Fallbrook Annex on 041109.

# Tables

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TABLE 4-1

Summary of Investigative Trenches

*RI for MRP Site UXO5, Detachment Fallbrook, Fallbrook, California*

| Trench ID | Location Coordinate Easting (center of excavation) | Location Coordinate Northing (center of excavation) | Depth (feet bgs) | MEC/MDEH (number of items) | MDAS (pounds) | Non-Munitions Related Metallic Debris (pounds) | Comments |
|---|---|---|---|---|---|---|---|
| 1 | 6251227.928 | 2085174.569 | 3 | 0 | 0 | 0 | |
| 2 | 6251357.803 | 2085079.802 | 3 | 0 | 0 | 1 | |
| 3 | 6251636.733 | 2085626.552 | 3 | 0 | 0 | 0 | |
| 4 | 6251812.094 | 2085599.438 | 3.5 | 0 | 2.5 | 7 | Spent 57-mm projectile cartridge found at base of NW corner at 3.5 feet bgs |
| 5 | 6251760.969 | 2085371.864 | 3 | 0 | 8 | 0 | Spent 40-mm cartridges |
| 6 | 6251635.058 | 2085683.100 | 3 | 0 | 3 | 102 | High density (90 pounds) of non-munitions-related metallic debris on surface. 12 pounds of non-munitions related metallic debris, 1 spent 40-mm cartridge, and 1 0.50-caliber casing in upper foot of excavation. |
| 7 | 6251462.478 | 2085400.676 | 3 | 0 | 0 | 1 | |
| 8 | 6251500.100 | 2085239.947 | 3 | 0 | 0 | 0 | |
| 9 | 6251499.460 | 2085054.327 | 3 | 0 | 0 | 0 | |
| 10 | 6251562.575 | 2085705.307 | 4.5 | 0 | 50 | 87 | Two Mk 76 practice bombs (no spotting charge) in upper 0.5 foot of trench |
| 11 | 6251453.551 | 2085784.503 | 3 | 0 | 0 | 8 | |
| 12 | 6251755.227 | 2085448.464 | 3 | 0 | 1 | 1 | Two spent 40-mm cartridge primers, one at 0.5 foot and one at 1.5 feet bgs |
| | | | **Total:** | 0 | 64.5 | 207 | |

Notes:

bgs = below ground surface

ID = identification

MDAS = material documented as safe

MDEH = material documented as an explosive hazard

MEC = munitions and explosives of concern

Mk = mark

mm = millimeter

MRP = Munitions Response Program

NAVWPNSTA = Naval Weapons Station

NW = northwest

UXO = unexploded ordnance

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**TABLE 4-2**

Summary of Soil Samples Collected beneath MPPEH

*RI for MRP Site UXO5, Detachment Fallbrook, Fallbrook, California*

| Location ID | Sample Date | Depth (feet bgs) | Anomaly ID Location | MPPEH Description |
|---|---|---|---|---|
| KCH-UXO5-SB01 | 3/19/2015 | 0.33 | ST049-109 | 20-mm cartridge |
| KCH-UXO5-SB02 | 3/19/2015 | 0.33 | ST048-0050 | 20-mm cartridge |
| KCH-UXO5-SB03 | 3/19/2015 | 0.25 | ST059-0013 | 20-mm cartridge |
| KCH-UXO5-SB04 | 3/19/2015 | 0.5 | ST049-0069 | 3-inch round cartridge case |
| KCH-UXO5-SB05 | 3/19/2015 | 0.25 | ST049-0108 | 20-mm cartridge |
| KCH-UXO5-SB06 | 3/19/2015 | 0.33 | T006-0008 | 20-mm cartridge |
| KCH-UXO5-SB07 | 3/19/2015 | 0.25 | T011-0004 | 20-mm projectile |
| KCH-UXO5-SB08 | 3/19/2015 | 0.33 | T019-0007 | M11A2 practice rifle grenade |
| KCH-UXO5-SB09 | 3/19/2015 | 0.33 | T031-0006 | 0.50-caliber cartridge |
| KCH-UXO5-SB10 | 3/19/2015 | 0.33 | T022-0018 | 40-mm projectile |
| KCH-UXO5-SB11 | 3/19/2015 | 0.33 | T022-0002 | M50B2 37-mm projectile |
| KCH-UXO5-SB12 | 3/25/2015 | 0.25 | T044-0006 | Fuze cap |
| KCH-UXO5-SB13 | 3/28/2015 | 0.25 | T088-0001 | 2.36-inch practice rocket |
| KCH-UXO5-SB14 | 3/31/2015 | 0.5 | T052-0008 | Many 40-mm cartridges |

Notes:
bgs = below ground surface
ID = identification
mm = millimeter
MPPEH = material potentially presenting an explosive hazard
MRP = Munitions Response Program
NAVWPNSTA = Naval Weapons Station
UXO = unexploded ordnance

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TABLE 4-3
Summary of Soil Samples Collected from Investigative Trenches
*RI for MRP Site UXO5, Detachment Fallbrook, Fallbrook, California*

| Trench ID | Sample Location ID | Sample Date | Depth (feet bgs) |
|---|---|---|---|
| 1 | KCH-UXO5-TR01 | 2/21/2015 | 1.5 |
| | | 2/21/2015 | 3 |
| 2 | KCH-UXO5-TR02 | 3/2/2015 | 1.5 |
| | | 3/2/2015 | 3 |
| 3 | KCH-UXO5-TR03 | 3/3/2015 | 1.5 |
| | | 3/3/2015 | 3 |
| 4 | KCH-UXO5-TR04 | 3/3/2015 | 1 |
| | | 3/3/2015 | 1.5 |
| | | 3/3/2015 | 3.5 |
| 5 | KCH-UXO5-TR05 | 3/3/2015 | 1 |
| | | 3/3/2015 | 1.5 |
| | | 3/3/2015 | 3 |
| 6 | KCH-UXO5-TR06 | 3/4/2015 | 1.5 |
| | | 3/4/2015 | 3 |
| 7 | KCH-UXO5-TR07 | 3/4/2015 | 1.5 |
| | | 3/4/2015 | 3 |
| 8 | KCH-UXO5-TR08 | 3/4/2015 | 1.5 |
| | | 3/4/2015 | 3 |
| 9 | KCH-UXO5-TR09 | 3/4/2015 | 1.5 |
| | | 3/4/2015 | 3 |
| 10 | KCH-UXO5-TR10 | 3/9/2015 | 1.5 |
| | | 3/9/2015 | 4.5 |
| 11 | KCH-UXO5-TR11 | 3/10/2015 | 1.5 |
| | | 3/10/2015 | 3 |
| 12 | KCH-UXO5-TR12 | 3/9/2015 | 0.5 |
| | | 3/9/2015 | 3 |

Notes:
bgs = below ground surface
ID = identification
MRP = Munitions Response Program
NAVWPNSTA = Naval Weapons Station
UXO = unexploded ordnance

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TABLE 4-4

Summary of Non-biased Soil Samples

*RI for MRP Site UXO5, Detachment Fallbrook, Fallbrook, California*

| Location ID | Sample Date | Depth (feet bgs) |
|---|---|---|
| KCH-UXO5-SB15 | 4/7/2015 | 0.5 |
| | 4/7/2015 | 1 |
| KCH-UXO5-SB16 | 4/7/2015 | 0.5 |
| | 4/7/2015 | 1 |
| KCH-UXO5-SB17 | 4/7/2015 | 0.5 |
| | 4/7/2015 | 1 |
| KCH-UXO5-SB18 | 4/7/2015 | 0.5 |
| | 4/7/2015 | 1 |
| KCH-UXO5-SB19 | 4/7/2015 | 0.5 |
| | 4/7/2015 | 1 |
| KCH-UXO5-SB20 | 4/7/2015 | 0.5 |
| | 4/7/2015 | 1 |
| KCH-UXO5-SB21 | 4/7/2015 | 0.5 |
| | 4/7/2015 | 1 |
| KCH-UXO5-SB22 | 4/7/2015 | 0.5 |
| | 4/7/2015 | 1 |
| KCH-UXO5-SB23 | 4/7/2015 | 0.5 |
| | 4/7/2015 | 1 |
| KCH-UXO5-SB24 | 4/7/2015 | 0.5 |
| | 4/7/2015 | 1 |

Notes:

bgs = below ground surface

ID = identification

MRP = Munitions Response Program

NAVWPNSTA = Naval Weapons Station

UXO = unexploded ordnance

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TABLE 5-1
Soil Analytical Results - Perchlorate and Explosives
*RI for MRP Site UXO5, Detachment Fallbrook, Fallbrook, California*

| | | Chemical | Perchlorate | 1,3,5-Trinitrobenzene | 1,3-Dinitrobenzene | 2,4,6-Trinitrotoluene | 2,4-Dinitrotoluene | 2,6-Dinitrotoluene | 2-Amino-4,6-dinitrotoluene | 2-Nitrotoluene | 3-Nitrotoluene | 4-Amino-2,6-dinitrotoluene | 4-Nitrotoluene | HMX | Nitrobenzene | RDX | Tetryl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location ID** | **Sample Date** | **Depth (feet bgs)** | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q |
| **Samples Collected beneath MPPEH** | | | | | | | | | | | | | | | | | |
| KCH-UXO5-SB01 | 03/19/2015 | 0.33 | < 2.04 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB02 | 03/19/2015 | 0.33 | < 2.04 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 200 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB03 | 03/19/2015 | 0.25 | < 2.04 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 1000 U | < 100 U | < 200 U | < 100 U |
| KCH-UXO5-SB04 | 03/19/2015 | 0.5 | < 2.05 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 3000 U | < 100 U | < 1000 U | < 100 U |
| KCH-UXO5-SB05 | 03/19/2015 | 0.25 | < 2.04 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB06 | 03/19/2015 | 0.33 | < 2.05 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 500 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB07 | 03/19/2015 | 0.25 | < 2.04 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 200 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB08 | 03/19/2015 | 0.33 | < 2.61 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB09 | 03/19/2015 | 0.33 | < 2.56 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 200 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB10 | 03/19/2015 | 0.33 | < 2.07 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB11 | 03/19/2015 | 0.33 | < 2.04 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 200 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB12 | 03/25/2015 | 0.25 | < 2.07 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB13 | 03/28/2015 | 0.25 | < 2.03 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 500 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB14 | 03/31/2015 | 0.5 | < 2.03 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 200 U | < 200 U | < 99 U | < 200 U | < 198 U | < 99 U | < 99 U | < 99 U |
| **Samples Collected from Trenches** | | | | | | | | | | | | | | | | | |
| KCH-UXO5-TR01 | 02/21/2015 | 1.5 | < 2.1 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| | 02/21/2015 | 3 | < 2.04 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-TR02 | 03/02/2015 | 1.5 | < 2.31 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| | 03/02/2015 | 3 | < 2.17 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-TR03 | 03/03/2015 | 1.5 | < 2.07 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 200 U | < 200 U | < 99 U | < 200 U | < 99 U | < 99 U | < 99 U | < 99 U |
| | 03/03/2015 | 3 | < 2.11 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 200 U | < 200 U | < 99 U | < 200 U | < 99 U | < 99 U | < 99 U | < 99 U |
| KCH-UXO5-TR04 | 03/03/2015 | 1 | < 2.07 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| | 03/03/2015 | 1.5 | < 2.1 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| | 03/03/2015 | 3.5 | < 2.09 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 200 U | < 200 U | < 99 U | < 200 U | < 99 U | < 99 U | < 99 U | < 99 U |
| KCH-UXO5-TR05 | 03/03/2015 | 1 | < 2.15 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 200 U | < 200 U | < 99 U | < 200 U | < 99 U | < 99 U | < 99 U | < 99 U |
| | 03/03/2015 | 1.5 | < 2.19 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| | 03/03/2015 | 3 | < 2.1 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-TR06 | 03/04/2015 | 1.5 | < 2.17 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| | 03/04/2015 | 3 | < 2.1 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-TR07 | 03/04/2015 | 1.5 | < 2.12 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| | 03/04/2015 | 3 | < 2.13 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-TR08 | 03/04/2015 | 1.5 | < 2.08 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 200 U | < 200 U | < 99 U | < 200 U | < 99 U | < 99 U | < 99 U | < 99 U |
| | 03/04/2015 | 3 | < 2.09 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-TR09 | 03/04/2015 | 1.5 | < 2.17 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| | 03/04/2015 | 3 | < 2.17 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-TR10 | 03/09/2015 | 1.5 | < 2.24 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 200 U | < 200 U | < 99 U | < 200 U | < 99 U | < 99 U | < 99 U | < 99 U |
| | 03/09/2015 | 4.5 | < 2.17 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-TR11 | 03/10/2015 | 1.5 | < 2.34 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 200 U | < 200 U | < 99 U | < 200 U | < 99 U | < 99 U | < 99 U | < 99 U |
| | 03/10/2015 | 3 | < 2.15 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 200 U | < 200 U | < 99 U | < 200 U | < 99 U | < 99 U | < 99 U | < 99 U |
| KCH-UXO5-TR12 | 03/09/2015 | 0.5 | < 2.06 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 99 U | < 200 U | < 200 U | < 99 U | < 200 U | < 99 U | < 99 U | < 99 U | < 99 U |
| | 03/09/2015 | 3 | < 2.27 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |

TABLE 5-1
Soil Analytical Results - Perchlorate and Explosives
*RI for MRP Site UXO5, Detachment Fallbrook, Fallbrook, California*

| | | Chemical | Perchlorate | 1,3,5-Trinitrobenzene | 1,3-Dinitrobenzene | 2,4,6-Trinitrotoluene | 2,4-Dinitrotoluene | 2,6-Dinitrotoluene | 2-Amino-4,6-dinitrotoluene | 2-Nitrotoluene | 3-Nitrotoluene | 4-Amino-2,6-dinitrotoluene | 4-Nitrotoluene | HMX | Nitrobenzene | RDX | Tetryl |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location ID** | **Sample Date** | **Depth (feet bgs)** | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q |
| **Samples Collected from Non-Biased Locations** | | | | | | | | | | | | | | | | | |
| KCH-UXO5-SB15 | 04/07/2015 | 0.5 | < 2.03 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| | 04/07/2015 | 1 | < 2.05 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB16 | 04/07/2015 | 0.5 | < 2.08 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 200 U | < 100 U | < 100 U | < 100 U |
| | 04/07/2015 | 1 | < 2.11 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB17 | 04/07/2015 | 0.5 | < 2.04 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| | 04/07/2015 | 1 | < 2.06 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 200 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB18 | 04/07/2015 | 0.5 | < 2.06 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 200 U | < 100 U | < 100 U | < 100 U |
| | 04/07/2015 | 1 | < 2.08 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB19 | 04/07/2015 | 0.5 | < 2.07 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 200 U | < 100 U | < 100 U | < 100 U |
| | 04/07/2015 | 1 | < 2.13 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 200 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB20 | 04/07/2015 | 0.5 | < 2.09 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 200 U | < 100 U | < 100 U | < 100 U |
| | 04/07/2015 | 1 | < 2.09 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB21 | 04/07/2015 | 0.5 | < 2.06 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| | 04/07/2015 | 1 | < 2.08 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB22 | 04/07/2015 | 0.5 | < 2.07 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| | 04/07/2015 | 1 | < 2.12 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB23 | 04/07/2015 | 0.5 | < 2.03 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| | 04/07/2015 | 1 | < 2.04 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| KCH-UXO5-SB24 | 04/07/2015 | 0.5 | < 2.05 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 100 U | < 100 U | < 100 U | < 100 U |
| | 04/07/2015 | 1 | < 2.02 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 100 U | < 200 U | < 200 U | < 100 U | < 200 U | < 200 U | < 100 U | < 100 U | < 100 U |
| **Residential Screening Criteria[a]** | | | 55,000 | 2,200,000 | 6,300 | 21,000 | 1,700 | 360 | 150,000 | 3,200 | 6,300 | 150,000 | 34,000 | 3,900,000 | 5,100 | 6,100 | 160,000 |
| **Industrial Screening Criteria[a]** | | | 820,000 | 32,000,000 | 82,000 | 96,000 | 7,400 | 1,500 | 2,300,000 | 15,000 | 82,000 | 2,300,000 | 140,000 | 57,000,000 | 22,000 | 28,000 | 2,300,000 |

Notes:
Results reported in micrograms per kilogram (µg/kg)
[a] Residential and industrial screening criteria are RSLs (USEPA, 2015).
< = less than
bgs = below ground surface
HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
ID = identification
MPPEH = material potentially presenting an explosive hazard
MRP = Munitions Response Program
NAVWPNSTA = Naval Weapons Station
Q = result qualifier assigned by third-party validation
RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine
RSL = regional screening level
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
USEPA = United States Environmental Protection Agency
UXO = unexploded ordnance

Sources:
United States Environmental Protection Agency (USEPA). 2015. Regional Screening Levels for Chemical Contaminants at Superfund Sites. November.

TABLE 5-2
Soil Analytical Results - Total Metals
*RI for MRP Site UXO5, Detachment Fallbrook, Fallbrook, California*

| Location ID | Sample Date | Depth (feet bgs) | Chemical | Aluminum | Antimony | Arsenic | Barium | Beryllium | Cadmium | Calcium | Chromium | Chromium VI | Cobalt | Copper | Iron | Lead | Magnesium | Manganese | Mercury | Molybdenum | Nickel | Potassium | Selenium | Silver | Sodium | Strontium | Thallium | Tin | Vanadium | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q |
| **Samples Collected beneath MPPEH** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| KCH-UXO5-SB01 | 03/19/2015 | 0.33 | | 13200 | 0.534 J | **0.941** | 197 | 0.0775 J | **0.308** J | 1770 | 24 J | < 0.0409 U | 10.6 | 24.4 J | 26700 | 2.57 | 7560 | 257 J | < 0.0202 U | 0.475 J | 6.5 | 6640 | < 0.101 U | **< 0.101** U | 162 | 22.8 | 0.352 J | < 10.1 U | 93.1 | **67.5** J |
| KCH-UXO5-SB02 | 03/19/2015 | 0.33 | | 14500 | 0.665 | **1.1** | 209 | 0.107 J | **0.199** J | 1990 | 25.2 | < 0.0409 U | 10.7 | 27.2 | 29400 | 5.1 | 7690 | 251 | < 0.0201 U | 0.535 | 6.56 | 6590 | < 0.0987 U | **< 0.0987** U | 179 | 27.3 | 0.339 J | < 9.87 U | 106 | **58.6** |
| KCH-UXO5-SB03 | 03/19/2015 | 0.25 | | 11100 | 5.94 | **1.35** | 177 | 0.098 J | **0.56** | 2390 | 19.9 | < 0.163 U | 7.84 | 20.1 | 24100 | **17.7** | 5750 | 229 | < 0.0202 U | 0.571 | 6.54 | 5110 | 0.0568 J | **< 0.0999** U | 136 | 24.8 | 0.294 J | < 9.99 U | 72.6 | **112** |
| KCH-UXO5-SB04 | 03/19/2015 | 0.5 | | 11600 | 1.08 | **1.11** | 151 | 0.0883 J | **0.463** J | 2960 | 20.1 | < 0.0819 U | 8.2 | 18.4 | 23000 | **13.2** | 6460 | 224 | 0.0152 J | 0.436 J | 6.34 | 6150 | < 0.102 U | **< 0.102** U | 125 | 25.7 | 0.336 J | < 10.2 U | 71.1 | **96** |
| KCH-UXO5-SB05 | 03/19/2015 | 0.25 | | 14000 | 0.364 J | **0.994** | 213 | 0.0831 J | **0.295** J | 1980 | 23.6 | < 0.0407 U | 10.5 | 25.8 | 27900 | 2.12 | 7950 | 257 | **< 0.0203** U | 0.449 J | 6.76 | 6740 | < 0.0989 U | **< 0.0989** U | 175 | 26.5 | 0.368 J | < 9.89 U | 98.2 | **64.4** |
| KCH-UXO5-SB06 | 03/19/2015 | 0.33 | | 13800 | 4.81 | **1.24** | 195 | 0.0946 J | **0.409** J | 2010 | 23.5 | < 0.041 U | 9.79 | 23.2 | 26800 | **11.6** | 6980 | 243 | < 0.0202 U | 0.591 | 6.73 | 5710 | 0.0523 J | **< 0.102** U | 171 | 23.3 | 0.327 J | < 10.2 U | 90.2 | **88.9** |
| KCH-UXO5-SB07 | 03/19/2015 | 0.25 | | 14500 | 0.86 | **1.2** | 201 | 0.0968 J | **0.239** J | 1960 | 24.4 | < 0.0409 U | 10.7 | 28 | 29400 | 6.03 | 7560 | 259 | **< 0.0204** U | 0.578 | 6.78 | 6640 | < 0.100 U | 0.0514 J | 185 | 26.7 | 0.33 J | < 10.0 U | 107 | **64.1** |
| KCH-UXO5-SB08 | 03/19/2015 | 0.33 | | 18400 | < 0.256 U | **1.05** | 191 | 0.187 J | 0.0921 J | 2710 | 41.5 | < 0.0522 U | **17.9** | 24.7 | 25300 | 2.28 | 5390 | 208 | **< 0.0257** U | 0.422 J | **12.2** | 2940 | 0.0753 J | **< 0.128** U | 326 | 33.1 | 0.204 J | < 12.8 U | 88.1 | 36.1 |
| KCH-UXO5-SB09 | 03/19/2015 | 0.33 | | 16300 | < 0.250 U | **1.44** | 257 | 0.101 J | 0.0959 J | 2830 | 29 | < 0.0512 U | 11.3 | 29.1 | 27300 | 5.24 | 8220 | 201 | **< 0.0256** U | 0.393 J | 10 | 4820 | < 0.125 U | **< 0.125** U | 269 | 51.7 | 0.291 J | < 12.5 U | 92.2 | 40.4 |
| KCH-UXO5-SB10 | 03/19/2015 | 0.33 | | 20700 | < 0.203 U | **1.33** | 232 | 0.23 J | 0.131 J | 2420 | 44.6 | < 0.0415 U | **19.6** | 27.2 | 30000 | 3.16 | 6390 | 244 | 0.0189 J | 0.501 J | **12.8** | 3080 | 0.106 J | **< 0.102** U | 222 | 41.3 | 0.228 J | < 10.2 U | 105 | 43.4 |
| KCH-UXO5-SB11 | 03/19/2015 | 0.33 | | 16600 | < 0.198 U | **1.47** | 218 | 0.129 J | 0.113 J | 2790 | 35.4 | < 0.0408 U | 12.5 | 27.5 | 29600 | **9.75** | 7830 | 218 | 0.0117 J | 0.417 J | 10.6 | 4760 | 0.0681 J | **< 0.0991** U | 224 | 44.3 | 0.278 J | < 9.91 U | 106 | 41.9 |
| KCH-UXO5-SB12 | 03/25/2015 | 0.25 | | 11900 | 0.4 J | **0.993** | 106 | 0.157 J | **0.208** J | 1250 | 21.7 | < 0.0415 U | 8.32 | 33.8 J | 19200 | 6.09 | 3780 | 276 | 0.0131 J | 0.337 J | 5.73 J | 3610 | 0.088 J | **< 0.103** U | 126 | 18.1 | 0.196 J | < 10.3 U | 71.5 | 40.8 |
| KCH-UXO5-SB13 | 03/28/2015 | 0.25 | | 13500 | 1.27 | **1.54** | 194 | 0.109 J | **0.275** J | 2410 | 28.5 | < 0.0406 U | 10.2 | 24.7 | 29800 | **7.85** | 7230 | 265 | < 0.0201 U | 0.554 | 7.6 | 6310 | 0.0557 J | **0.305** J | 178 | 26.6 | 0.321 J | < 9.90 U | 94.5 | **56.5** |
| KCH-UXO5-SB14 | 03/31/2015 | 0.5 | | 13800 | 1.24 | **1.27** | 143 | 0.115 J | **0.403** J | 2140 | 25.4 | < 0.0407 U | 9.42 | **108** | 24700 | **15.8** | 7080 | 237 | **< 0.0203** U | 0.426 J | 7.52 | 6130 | < 0.101 U | **< 0.101** U | 175 | 27.5 | 0.398 J | < 10.1 U | 78.1 | **1200** |
| **Samples Collected from Trenches** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| KCH-UXO5-TR01 | 02/21/2015 | 1.5 | | 14900 | < 0.205 U | **1.17** | 136 | 0.19 J | 0.113 J | 1480 | 23.2 | 0.0939 J | 9.62 | 20.5 | 21600 | 2.87 | 5570 | 262 | **< 0.021** U | 0.348 J | 6.81 | 4850 | 0.121 J | **< 0.102** U | 124 | 19 | 0.293 J | < 10.2 U | 71.4 | 33.2 |
| | 02/21/2015 | 3 | | 15300 | 0.114 J | **1.12** | 151 | 0.166 J | 0.111 J | 1700 | 24.5 J | 0.0881 J | 9.84 J | 20.8 J | 22600 J | 2.88 | 6450 J | 228 | **< 0.0207** U | 0.329 J | 7.14 J | 4920 J | 0.098 J | **< 0.100** U | 124 | 21.9 | 0.315 J | < 10.0 U | 73.6 J | 33.8 |
| KCH-UXO5-TR02 | 03/02/2015 | 1.5 | | 19900 | < 0.228 U | **2.47** | 127 | 0.255 J | 0.157 J | 2420 | 25 | < 0.0461 U | 6.62 | 11.4 | 28200 | 2.8 | 6280 | 121 | 0.0118 J | 0.377 J | 6.06 | 1870 | 0.104 J | **< 0.114** U | 237 | 28.9 | 0.185 J | < 11.4 U | 121 | 25.4 |
| | 03/02/2015 | 3 | | 17100 | < 0.211 U | **1** | 168 | 0.121 J | 0.104 J | 1910 | 28.6 | < 0.0434 U | 13.3 | 14.5 | 25100 | 1.89 | 9520 | 286 | 0.0161 J | 0.875 | 9.79 | 5770 | < 0.105 U | **< 0.105** U | 190 | 23.9 | 0.431 J | < 10.5 U | 84.6 | 40.6 |
| KCH-UXO5-TR03 | 03/03/2015 | 1.5 | | 14200 | < 0.202 U | **1.2** | 127 | 0.202 J | 0.103 J | 1210 | 21.7 | < 0.0414 U | 9.17 | 15.5 | 20600 | 2.38 | 4780 | 233 | **< 0.0204** U | 0.342 J | 6.36 | 4120 | 0.0822 J | **< 0.101** U | 148 | 21.8 | 0.242 J | < 10.1 U | 76.9 | 30.3 |
| | 03/03/2015 | 3 | | 14700 | 0.116 J | **1.2** | 127 | 0.202 J | **0.258** J | 1220 | 20.8 | < 0.0422 U | 9.01 | 15.4 | 20200 | 3.26 | 4730 | 249 | **< 0.0211** U | 0.364 J | 6.35 | 4240 | 0.106 J | **< 0.103** U | 131 | 21.1 | 0.243 J | < 10.3 U | 74.9 | 32.3 |
| KCH-UXO5-TR04 | 03/03/2015 | 1 | | 13100 | 0.368 J | **1.6** | 125 | 0.188 J | **0.264** J | 1720 | 23.6 | < 0.0415 U | 14.2 | 16.1 | 22500 | 3.73 | 3580 | 337 | 0.011 J | 0.541 | 5.93 | 2980 | 0.15 J | **< 0.103** U | 223 | 21.3 | 0.17 J | < 10.3 U | 75.8 | 33 |
| | 03/03/2015 | 1.5 | | 16400 | 0.297 J | **1.36** | 109 | 0.212 J | **0.269** J | 2130 | 31.5 | < 0.042 U | 8.67 | 18.1 | 22600 | 4.99 | 3460 | 227 | **< 0.0207** U | 0.41 J | 6.46 | 2210 | 0.112 J | **< 0.104** U | 260 | 26.3 | 0.142 J | < 10.4 U | 96.6 | 34.4 |
| | 03/03/2015 | 3.5 | | 14600 | 0.319 J | **1.32** | 124 | 0.212 J | **0.286** J | 2030 | 28 | < 0.0418 U | 9.6 | 17.5 | 22000 | 4.34 | 3590 | 242 | **< 0.0206** U | 0.445 J | 6.19 | 2740 | 0.113 J | **< 0.103** U | 254 | 29.3 | 0.157 J | < 10.3 U | 89.4 | 37.4 |
| KCH-UXO5-TR05 | 03/03/2015 | 1 | | 21900 | < 0.212 U | **1.25** | 134 | 0.199 J | 0.0869 J | 1730 | 25.8 | < 0.0429 U | 11.6 | 16.8 | 24800 | 2.02 | 6950 | 229 | **< 0.0214** U | 0.297 J | 6.69 | 4130 | 0.0813 J | **< 0.106** U | 148 | 15.8 | 0.319 J | < 10.6 U | 94.2 | 34.9 |
| | 03/03/2015 | 1.5 | | 23400 | 0.116 J | **1.82** | 157 | 0.268 J | 0.119 J | 2010 | 28 | < 0.0438 U | 10.8 | 28.6 | 29300 | 3.41 | 6970 | 220 | **< 0.0216** U | 0.394 J | 7.37 | 4010 | 0.208 J | **< 0.107** U | 171 | 20.8 | 0.319 J | < 10.7 U | 116 | 41.9 |
| | 03/03/2015 | 3 | | 19000 | < 0.202 U | **1.09** | 129 | 0.141 J | 0.0703 J | 2090 | 23.7 | < 0.0419 U | 11 | 17.9 | 24800 | 1.74 | 7640 | 200 | **< 0.0206** U | 0.224 J | 6.48 | 4700 | 0.126 J | **< 0.101** U | 219 | 20.2 | 0.35 J | < 10.1 U | 92.7 | 33.7 |
| KCH-UXO5-TR06 | 03/04/2015 | 1.5 | | 12400 | < 0.213 U | **1.06** | 128 | 0.198 J | 0.178 J | 1100 | 18.6 | < 0.0434 U | 8.67 | 14 | 17500 | 2.34 | 3980 | 297 | **< 0.0215** U | 0.352 J | 6.07 | 3930 | 0.127 J | **< 0.106** U | 116 | 20.1 | 0.219 J | < 10.6 U | 64 | 28.7 |
| | 03/04/2015 | 3 | | 13400 | < 0.205 U | **1.12** | 124 | 0.184 J | 0.11 J | 1220 | 19.6 | < 0.0419 U | 8.43 | 14.8 | 18500 | 2.26 | 4350 | 251 | **< 0.0207** U | 0.375 J | 6.18 | 4220 | 0.0805 J | **< 0.103** U | 140 | 23.5 | 0.222 J | < 10.3 U | 66.9 | 26.6 |
| KCH-UXO5-TR07 | 03/04/2015 | 1.5 | | 19400 | < 0.204 U | **1.17** | 144 | 0.199 J | 0.0831 J | 1270 | 23.4 | < 0.0423 U | 9.62 | 15.6 | 24200 | 3.03 | 6580 | 226 | **< 0.021** U | 0.29 J | 6.72 | 5740 | 0.0659 J | **< 0.102** U | 151 | 12.7 | 0.335 J | < 10.2 U | 85.8 | 35.3 |
| | 03/04/2015 | 3 | | 19600 | < 0.208 U | **1.25** | 145 | 0.182 J | 0.0782 J | 2050 | 24.1 | < 0.0427 U | 9 | 20.6 | 24500 | 3.05 | 7030 | 184 | **< 0.0211** U | 0.248 J | 6.84 | 4720 | 0.0625 J | **< 0.104** U | 171 | 19.1 | 0.313 J | < 10.4 U | 87.7 | 33 |
| KCH-UXO5-TR08 | 03/04/2015 | 1.5 | | 12400 | < 0.207 U | **1.11** | 122 | 0.161 J | 0.0915 J | 1050 | 21.5 | < 0.0416 U | 7.72 | 15 | 22300 | 2.26 | 3910 | 213 | **< 0.0207** U | 0.455 J | 5.14 | 4280 | 0.101 J | **< 0.104** U | 116 | 19.4 | 0.189 J | < 10.4 U | 81.4 | 29.1 |
| | 03/04/2015 | 3 | | 16900 | < 0.204 U | **1.46** | 156 | 0.238 J | 0.112 J | 1680 | 23.4 | < 0.0418 U | 9.13 | 18.4 | 24500 | 2.45 | 5090 | 221 | **< 0.0208** U | 0.439 J | 6.25 | 3610 | 0.0839 J | **< 0.102** U | 175 | 22.7 | 0.231 J | < 10.2 U | 91 | 32 |
| KCH-UXO5-TR09 | 03/04/2015 | 1.5 | | 20500 | < 0.211 U | **1.53** | 200 | 0.219 J | 0.133 J | 1910 | 25.7 | < 0.0434 U | 9.07 | 18.3 | 25800 | 2.18 | 7440 | 188 | **< 0.0217** U | 0.377 J | 7.3 | 5510 | 0.0868 J | **< 0.105** U | 150 | 27.8 | 0.315 J | < 10.5 U | 89.8 | 41.7 |
| | 03/04/2015 | 3 | | 15900 | < 0.213 UJ | **1.29** | 188 | 0.154 J | 0.106 J | 1910 | 21.7 | < 0.0433 U | 8.05 | 21.1 J | 25200 | 1.44 | 7130 | 164 | **< 0.0213** U | 0.358 J | 6.27 | 5180 | 0.0647 J | **< 0.107** U | 192 | 26.7 J | 0.272 J | < 10.7 U | 91.8 | 37.3 |
| KCH-UXO5-TR10 | 03/09/2015 | 1.5 | | 18300 | 0.496 J | **2.94** | 117 | 0.233 J | **12.1** | 1660 | 33 | **0.721** | 10.9 | 22 | 36400 | **22.5** | 4980 | 365 | **< 0.0223** U | 0.572 | **12.6** | 3640 | 0.118 J | **< 0.111** U | 125 | 16.8 | 0.274 J | < 11.1 U | 75.8 | **160** |
| | 03/09/2015 | 4.5 | | 13000 | 0.54 | **1.58** | 93.3 | 0.192 J | **27.8** | 1150 | 18.6 | 0.129 | 6.93 | 16.8 | 19100 | **15.8** | 3760 | 217 | **< 0.0213** U | 0.402 J | 6.67 | 3430 | 0.0997 J | **< 0.106** U | 104 J | 13.3 | 0.23 J | < 10.6 U | 57.5 | **162** |
| KCH-UXO5-TR11 | 03/10/2015 | 1.5 | | 17200 | 0.132 J | **1.59** | 134 | 0.22 J | **0.447** J | 1830 | 20.8 | < 0.0468 U | 9.92 | 16.8 | 23300 | 4.2 | 5280 | 340 | **< 0.0234** U | 0.399 J | 6.43 | 3950 | 0.0991 J | **< 0.112** U | 188 | 20.3 | 0.286 J | < 11.2 U | 77.6 | 42.5 |
| | 03/10/2015 | 3 | | 21900 | < 0.213 UJ | **1.39** | 173 | 0.23 J | 0.0969 J | 2790 J | 34.8 | 0.0904 J | 11.1 | 26.8 J | 28900 J | 2.5 | 7020 J | 208 | **< 0.021** U | 0.236 J | 8.48 J | 2380 | 0.0981 J | **< 0.107** U | 290 | 41.4 | 0.259 J | < 10.7 U | 121 | 31.9 |
| KCH-UXO5-TR12 | 03/09/2015 | 0.5 | | 11200 | 0.265 J | **1.24** | 106 | 0.159 J | 0.195 J | 1200 | 21.2 | 0.0965 J | 8.52 | 39.2 | 19700 | **10.3** | 3840 | 301 | 0.0124 J | 0.408 J | 6.01 | 3760 | 0.0951 J | **< 0.102** U | 116 | 16.4 | 0.199 J | < 10.2 U | 64.8 | **191** |
| | 03/09/2015 | 3 | | 13700 | 0.466 J | **1.26** | 101 | 0.156 J | **3.63** | 1620 | 20.1 | 0.0992 J | 9.54 | 13.8 | 19700 | **9.52** | 3680 | 216 | **< 0.0227** U | 0.302 J | 5.46 | 2440 | 0.0644 J | **< 0.111** U | 170 | 19.8 | 0.159 J | < 11.1 U | 67.7 | **63.5** |

TABLE 5-2
Soil Analytical Results - Total Metals
*RI for MRP Site UXO5, Detachment Fallbrook, Fallbrook, California*

| | | Chemical | Aluminum | Antimony | Arsenic | Barium | Beryllium | Cadmium | Calcium | Chromium | Chromium VI | Cobalt | Copper | Iron | Lead | Magnesium | Manganese | Mercury | Molybdenum | Nickel | Potassium | Selenium | Silver | Sodium | Strontium | Thallium | Tin | Vanadium | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Location ID** | **Sample Date** | **Depth (feet bgs)** | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q | Result Q |
| **Samples Collected from Non-Biased Locations** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| KCH-UXO5-SB15 | 04/07/2015 | 0.5 | 12600 | 0.247 J | **0.982** | 128 | 0.171 J | 0.157 J | 1640 | 23.9 | < 0.0407 U | 9.01 | 18.8 | 21300 | 7.15 | 4460 | 281 | < 0.0201 U | 0.366 J | 6.51 | 4710 | 0.12 J | **< 0.100** U | < 109 U | 21.5 | 0.226 J | < 10.0 U | 75.4 | 39.9 |
| | 04/07/2015 | 1 | 13500 | 0.117 J | **1.07** | 141 | 0.191 J | 0.121 J | 1260 | 24.5 | < 0.041 U | 9.39 | 18.7 | 22400 | 3.04 | 4740 | 290 | **< 0.0203** U | 0.39 J | 6.91 | 5080 | 0.138 J | **< 0.102** U | < 96.2 U | 17.6 | 0.243 J | < 10.2 U | 77 | 31.8 |
| KCH-UXO5-SB16 | 04/07/2015 | 0.5 | 14100 | 1.61 | **1.44** | 136 | 0.178 J | **0.894** | 1360 | 22.8 | < 0.0415 U | 8.75 | 20.9 | 22100 | **8.22** | 5190 | 243 | **< 0.0207** U | 0.539 | 6.27 | 5230 | 0.106 J | **< 0.102** U | < 102 U | 17.8 | 0.282 J | < 10.2 U | 68.9 | **67.8** |
| | 04/07/2015 | 1 | 14900 | 0.6 | **1.52** | 148 | 0.18 J | **0.433** J | 1550 | 25.1 | < 0.0421 U | 9.35 | 21.6 | 22600 | 4.33 | 5530 | 240 | **< 0.0209** U | 0.376 J | 6.94 | 4670 | 0.117 J | **< 0.104** U | < 121 U | 24.7 | 0.269 J | < 10.4 U | 77.2 | **46** |
| KCH-UXO5-SB17 | 04/07/2015 | 0.5 | 15600 | 0.287 J | **1.25** | 182 | 0.135 J | **0.323** J | 2680 | 37.6 | < 0.0408 U | 10.2 | 38.2 | 25400 | 5.47 | 7360 | 244 | **< 0.0203** U | 0.408 J | 9.62 | 5110 | 0.0659 J | **< 0.0991** U | < 242 U | 29.5 | 0.302 J | < 9.91 U | 73.2 | **68.6** |
| | 04/07/2015 | 1 | 12200 | 0.782 | **1.14** | 141 | 0.0972 J | **0.596** | 2780 | 19.7 | < 0.0412 U | 8.18 | 20 | 22000 | **18.2** | 5210 | 224 | **< 0.0204** U | 0.427 J | 6.27 | 4420 | 0.0671 J | **< 0.102** U | < 230 U | 25.3 | 0.248 J | < 10.2 U | 73.5 | **64.6** |
| KCH-UXO5-SB18 | 04/07/2015 | 0.5 | 16600 | 0.154 J | **1.37** | 111 | 0.194 J | **0.246** J | 2630 | 34.8 | < 0.0413 U | 9.61 | 20.2 | 24100 | 5.5 | 3540 | 267 | **< 0.0204** U | 0.403 J | 6.78 | 2750 | 0.112 J | **< 0.0993** U | < 250 U | 31.6 | 0.142 J | < 9.93 U | 102 | 33.5 |
| | 04/07/2015 | 1 | 15400 | 0.136 J | **1.45** | 107 | 0.193 J | **0.243** J | 2660 | 39.7 | < 0.0417 U | 10 | 21.5 | 26600 | 4.62 | 3300 | 255 | **< 0.0207** U | 0.434 J | 6.45 | 1830 | 0.126 J | **< 0.102** U | < 268 U | 33.3 | 0.125 J | < 10.2 U | 120 | 27.9 |
| KCH-UXO5-SB19 | 04/07/2015 | 0.5 | 13900 | 0.185 J | **1.16** | 106 | 0.193 J | 0.163 J | 1230 | 22.1 | < 0.0413 U | 8.65 | 13.5 | 19800 | **11.3** | 4170 | 268 | **< 0.0205** U | 0.378 J | 6.01 | 3910 | 0.13 J | **< 0.101** U | < 99.6 U | 14 | 0.24 J | < 10.1 U | 70.9 | 28.1 |
| | 04/07/2015 | 1 | 20200 J | < 0.210 UJ | **1.5** | 147 | 0.249 J | 0.143 J | 1710 J | 26.2 J | < 0.0427 U | 11.3 J | 15.9 J | 25300 J | 4.4 | 5320 J | 305 | **< 0.0211** U | 0.405 J | 7.36 J | 3400 J | 0.194 J | **< 0.105** U | < 132 U | 17.3 | 0.31 J | < 10.5 U | 88.2 J | 30.2 |
| KCH-UXO5-SB20 | 04/07/2015 | 0.5 | 12700 | 0.324 J | **1.33** | 127 | 0.151 J | **2.24** | 2250 | 24.2 | < 0.0419 U | 7.97 | 19.7 | 21900 | **11.7** | 4750 | 283 | 0.0104 J | 0.462 J | 6.14 | 4670 | 0.116 J | **< 0.103** U | < 121 U | 20.9 | 0.241 J | < 10.3 U | 73.1 | **72.3** |
| | 04/07/2015 | 1 | 14400 | 0.155 J | **1.36** | 124 | 0.177 J | **0.827** | 1550 | 23.2 | < 0.0418 U | 8.52 | 19.1 | 22700 | 4.95 | 5050 | 249 | **< 0.0209** U | 0.458 J | 6.41 | 4830 | 0.129 J | **< 0.103** U | < 132 U | 17.9 | 0.272 J | < 10.3 U | 75.1 | **75.1** |
| KCH-UXO5-SB21 | 04/07/2015 | 0.5 | 22300 | < 0.205 U | **1.42** | 201 | 0.203 J | 0.131 J | 2110 | 31.1 | < 0.0412 U | 10.5 | 17.7 | 25200 | 3.32 | 6670 | 225 | **< 0.0206** U | 0.403 J | 8.31 | 3740 | 0.128 J | **< 0.102** U | < 123 U | 23.3 | 0.287 J | < 10.2 U | 84.1 | 34.4 |
| | 04/07/2015 | 1 | 22100 | < 0.207 U | **1.14** | 191 | 0.174 J | 0.107 J | 1730 | 30.4 | < 0.0415 U | 10.3 | 14.8 | 24000 | 2.38 | 6810 | 229 | **< 0.0205** U | 0.422 J | 8.43 | 4380 | 0.109 J | **< 0.103** U | < 124 U | 19.1 | 0.318 J | < 10.3 U | 76.1 | 32.8 |
| KCH-UXO5-SB22 | 04/07/2015 | 0.5 | 26500 J | 0.115 J | **1.66** | 241 | 0.258 J | 0.164 J | 1630 J | 30 J | < 0.0415 U | 10.2 J | 13.7 J | 28400 J | 4.58 | 6440 J | 319 J | < 0.0202 U | 0.451 J | 7.96 J | 4370 J | 0.153 J | **< 0.102** U | < 162 UJ | 20.3 | 0.327 J | < 10.2 U | 91.6 J | 43.3 |
| | 04/07/2015 | 1 | 26800 | < 0.210 U | **1.78** | 248 | 0.271 J | 0.191 J | 1770 | 29.9 | < 0.0423 U | 10.3 | 13 | 28400 | 4.64 | 6600 | 309 | **< 0.0211** U | 0.441 J | 8.69 | 4380 | 0.147 J | **< 0.105** U | < 175 U | 20.1 | 0.33 J | < 10.5 U | 87.9 | **45.7** |
| KCH-UXO5-SB23 | 04/07/2015 | 0.5 | 14500 | 1.18 | **1.55** | 147 | 0.142 J | **0.511** | 1220 | 19.4 | 0.165 | 8.58 | 18.7 | 20200 | **15.1** | 5500 | 210 | < 0.0202 U | 0.374 J | 5.88 | 4730 | 0.0845 J | **< 0.101** U | < 111 U | 15.8 | 0.291 J | < 10.1 U | 59.1 | **54.5** |
| | 04/07/2015 | 1 | 10000 | 0.726 | **1.73** | 99 | 0.136 J | **0.381** J | 848 | 17.7 | 0.159 | 5.83 | 12.6 | 15900 | **13.6** | 3500 | 165 | < 0.02 U | 0.504 J | 4.09 | 3060 | 0.0756 J | **< 0.101** U | < 81.5 U | 16.4 | 0.247 J | < 10.1 U | 40.2 | **47.1** |
| KCH-UXO5-SB24 | 04/07/2015 | 0.5 | 13500 | 0.14 J | **1.38** | 111 | 0.193 J | **0.312** J | 1180 | 26 | < 0.041 U | 7.82 | 16.3 | 20600 | **24.7** | 4580 | 253 | **< 0.0203** U | 0.469 J | 6.15 | 4500 | 0.138 J | **< 0.100** U | < 109 U | 14 | 0.301 J | < 10.0 U | 63.3 | 34 |
| | 04/07/2015 | 1 | 11700 | 0.657 | **1.94** | 93.9 | 0.194 J | **0.974** | 1140 | 16.3 | < 0.0404 U | 6.17 | 15.5 | 19400 | **14.8** | 3710 | 236 | < 0.0202 U | 0.668 | 4.86 | 4210 | 0.123 J | **< 0.0991** U | < 91.2 U | 12.2 | 0.336 J | < 9.91 U | 50.6 | **61** |
| **Background Threshold Value[a]** | | | 28,333 | -- | 3.07 | 502.8 | 0.716 | 0.197 | -- | 58.9 | -- | 15.99 | 102.5 | 43,815 | 7.408 | -- | 479.9 | 0.0202 | -- | 11.88 | -- | 0.477 | 0.0941 | -- | 144.8 | 0.595 | -- | 216.4 | 44.85 |
| **Residential Screening Criteria[b]** | | | 77,000 | 31 | 0.067 | 15,000 | 15.0 | 5.2 | -- | 36,000 | 0.30 | 23 | 3,100 | 55,000 | 80 | -- | 1,800 | 23 | 390 | 490 | -- | 390 | 390 | -- | 47,000 | 0.78 | 47,000 | 390 | 23,000 |
| **Industrial Screening Criteria[b]** | | | 1,100,000 | 470 | 0.25 | 220,000 | 210 | 7.3 | -- | 170,000 | 6.3 | 350 | 47,000 | 820,000 | 320 | -- | 6,900 | 69 | 5,800 | 3,100 | -- | 5,800 | 1,500 | -- | 700,000 | 12 | 700,000 | 1,000 | 350,000 |

Notes:
Results reported in milligrams per kilogram (mg/kg)
[a] BTVs are installation-specific upper tolerance limits developed in SES-TECH (2012). BTVs for the Kgb (Gabbro) parent rock type are used, based on the prevalence of this rock type where MRP Site UXO5 is located.
[b] Residential and industrial screening criteria are the lower criteria of RSLs (USEPA, 2015) and DTSC-SLs (DTSC, 2015). DTSC-SLs are indicated by shaded cells. Criteria for mercury based on mercuric chloride and other mercury salts. Criteria for chromium based on trivalent chromium.
**Bold** indicates the concentration exceeds the BTV and/or RSL
< = less than
-- = not applicable or not available
bgs = below ground surface
BTV = background threshold value
DTSC-SL = California Department of Toxic Substances Control screening level
ID = identification
J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
mg/kg = milligram per kilogram
MPPEH = material potentially presenting an explosive hazard
MRP = Munitions Response Program
NAVWPNSTA = Naval Weapons Station
Q = result qualifier assigned by third-party validation
RSL = regional screening level
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.
USEPA = United States Environmental Protection Agency
UXO = unexploded ordnance

Sources:
California Department of Toxic Substances Control (DTSC). 2016. "DTSC-Modified Screening Levels (DTSC SLs)." Human and Ecological Risk Office (HERO). HERO HHRA Note Number 3. January.
SES-TECH. 2012. Final Basewide Metals Background Soil Study Report, Naval Weapons Stations Seal Beach, Detachment Fallbrook, Fallbrook, California. November.
United States Environmental Protection Agency (USEPA). 2015. Regional Screening Levels for Chemical Contaminants at Superfund Sites. November.

TABLE 6-1

Summary of Exceedances in Surface Soil (0 to 0.5 foot bgs[a])

*RI for MRP Site UXO5, Detachment Fallbrook, Fallbrook, California*

| Constituent | Detection Frequency | Range of Detected Concentrations (mg/kg) | Screening Criteria[b,c] | Value (mg/kg) | Number of Exceedances |
|---|---|---|---|---|---|
| Arsenic | 54/54 | 0.69 J - 5.2 J | BTV | 3.07 | 4 |
| | | | Residential | 0.067 | 54 |
| | | | Industrial | 0.25 | 54 |
| Cadmium | 54/54 | 0.0921 J - 13 | BTV | 0.197 | 37 |
| | | | Residential | 5.2 | 1 |
| | | | Industrial | 7.3 | 1 |
| Cobalt | 54/54 | 5.8 - 19.6 | BTV | 15.99 | 3 |
| | | | Residential | 23 | 0 |
| | | | Industrial | 350 | 0 |
| Copper | 54/54 | 7.4 - 108 | BTV | 102.5 | 1 |
| | | | Residential | 3,100 | 0 |
| | | | Industrial | 47,000 | 0 |
| Lead | 54/54 | 2.12 - 227 J | BTV | 7.408 | 30 |
| | | | Residential | 80 | 1 |
| | | | Industrial | 320 | 0 |
| Mercury | 7/54 | 0.0104 J - 0.105 | BTV | 0.0202 | 1 |
| | | | Residential | 23 | 0 |
| | | | Industrial | 69 | 0 |
| Nickel | 54/54 | 2.3 J - 12.8 | BTV | 11.88 | 2 |
| | | | Residential | 490 | 0 |
| | | | Industrial | 3,100 | 0 |
| Silver | 2/54 | 0.0514 J - 0.305 J | BTV | 0.0941 | 1 |
| | | | Residential | 390 | 0 |
| | | | Industrial | 1,500 | 0 |
| Zinc | 54/54 | 23.6 - 1,200 | BTV | 44.85 | 32 |
| | | | Residential | 23,000 | 0 |
| | | | Industrial | 350,000 | 0 |

Notes:

Analytes shown are those that had one or more exceedances of BTVs, RSLs, or DTSC-SLs.

[a] The 2007 SI soil samples (collected from 0 to 0.75 foot bgs) are considered surface soil samples.

[b] BTVs are installation-specific upper tolerance limits developed in SES-TECH (2012). BTVs for the Kgb (Gabbro) parent rock type are used, based on the prevalence of this rock type where MRP Site UXO5 is located.

[c] Residential and industrial screening criteria are the lower criteria of RSLs (USEPA, 2015) and DTSC-SLs (DTSC, 2015). DTSC-SLs are indicated by shaded cells. Criteria for mercury based on mercuric chloride and other mercury salts.

DTSC-SL = California Department of Toxic Substances Control screening level
ID = identification
J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
mg/kg = milligram per kilogram
MRP = Munitions Response Program
NAVWPNSTA = Naval Weapons Station
RSL = regional screening level
USEPA = United States Environmental Protection Agency
UXO = unexploded ordnance

Sources:

California Department of Toxic Substances Control (DTSC). 2016. “DTSC-Modified Screening Levels (DTSC SLs).” Human and Ecological Risk Office (HERO). HERO HHRA Note Number 3. January.

SES-TECH. 2012. Final Basewide Metals Background Soil Study Report, Naval Weapons Stations Seal Beach, Detachment Fallbrook, Fallbrook, California. November.

United States Environmental Protection Agency (USEPA). 2015. Regional Screening Levels for Chemical Contaminants at Superfund Sites. November.

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TABLE 6-2

Summary of Exceedances in Subsurface Soil (0 to 10 feet bgs)

*RI for MRP Site UXO5, Detachment Fallbrook, Fallbrook, California*

| Constituent | Frequency | Concentrations (mg/kg) | Criteria[a,b] | (mg/kg) | Exceedances |
|---|---|---|---|---|---|
| Arsenic | 89/89 | 0.69 J - 5.2 J | BTV | 3.07 | 4 |
| | | | Residential | 0.067 | 89 |
| | | | Industrial | 0.25 | 89 |
| Cadmium | 89/89 | 0.0703 J - 27.8 | BTV | 0.197 | 50 |
| | | | Residential | 5.2 | 3 |
| | | | Industrial | 7.3 | 3 |
| Chromium VI | 9/60 | 0.0881 J - 0.721 | BTV | -- | -- |
| | | | Residential | 0.3 | 1 |
| | | | Industrial | 6.3 | 0 |
| Cobalt | 89/89 | 5.8 - 19.6 | BTV | 15.99 | 3 |
| | | | Residential | 23 | 0 |
| | | | Industrial | 350 | 0 |
| Copper | 89/89 | 7.4 - 108 | BTV | 102.5 | 1 |
| | | | Residential | 3,100 | 0 |
| | | | Industrial | 47,000 | 0 |
| Lead | 89/89 | 1.44 - 227 J | BTV | 7.408 | 36 |
| | | | Residential | 80 | 1 |
| | | | Industrial | 320 | 0 |
| Mercury | 10/89 | 0.0104 J - 0.105 | BTV | 0.0202 | 1 |
| | | | Residential | 23 | 0 |
| | | | Industrial | 69 | 0 |
| Nickel | 89/89 | 2.3 J - 12.8 | BTV | 11.88 | 3 |
| | | | Residential | 490 | 0 |
| | | | Industrial | 3,100 | 0 |
| Silver | 2/89 | 0.0514 J - 0.305 J | BTV | 0.0941 | 1 |
| | | | Residential | 390 | 0 |
| | | | Industrial | 1,500 | 0 |
| Zinc | 89/89 | 23.6 - 1,200 | BTV | 44.85 | 41 |
| | | | Residential | 23,000 | 0 |
| | | | Industrial | 350,000 | 0 |

Notes:

Analytes shown are those that had one or more exceedances of BTVs, RSLs, or DTSC-SLs.

a BTVs are installation-specific upper tolerance limits developed in SES-TECH (2012). BTVs for the Kgb (Gabbro) parent rock type are used, based on the prevalence of this rock type where MRP Site UXO5 is located.

b Residential and industrial screening criteria are the lower criteria of RSLs (USEPA, 2015) and DTSC-SLs (DTSC, 2015). DTSC-SLs are indicated by shaded cells. Criteria for mercury based on mercuric chloride and other mercury salts.

-- = not applicable or not available

DTSC-SL = California Department of Toxic Substances Control screening level

ID = identification

J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram per kilogram

MRP = Munitions Response Program

NAVWPNSTA = Naval Weapons Station

RSL = regional screening level

USEPA = United States Environmental Protection Agency

UXO = unexploded ordnance

Sources:

California Department of Toxic Substances Control (DTSC). 2016. “DTSC-Modified Screening Levels (DTSC SLs).” Human and Ecological Risk Office (HERO). HERO HHRA Note Number 3. January.

SES-TECH. 2012. Final Basewide Metals Background Soil Study Report, Naval Weapons Stations Seal Beach, Detachment Fallbrook, Fallbrook, California. November.

United States Environmental Protection Agency (USEPA). 2015. Regional Screening Levels for Chemical Contaminants at Superfund Sites. November.

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# Figures

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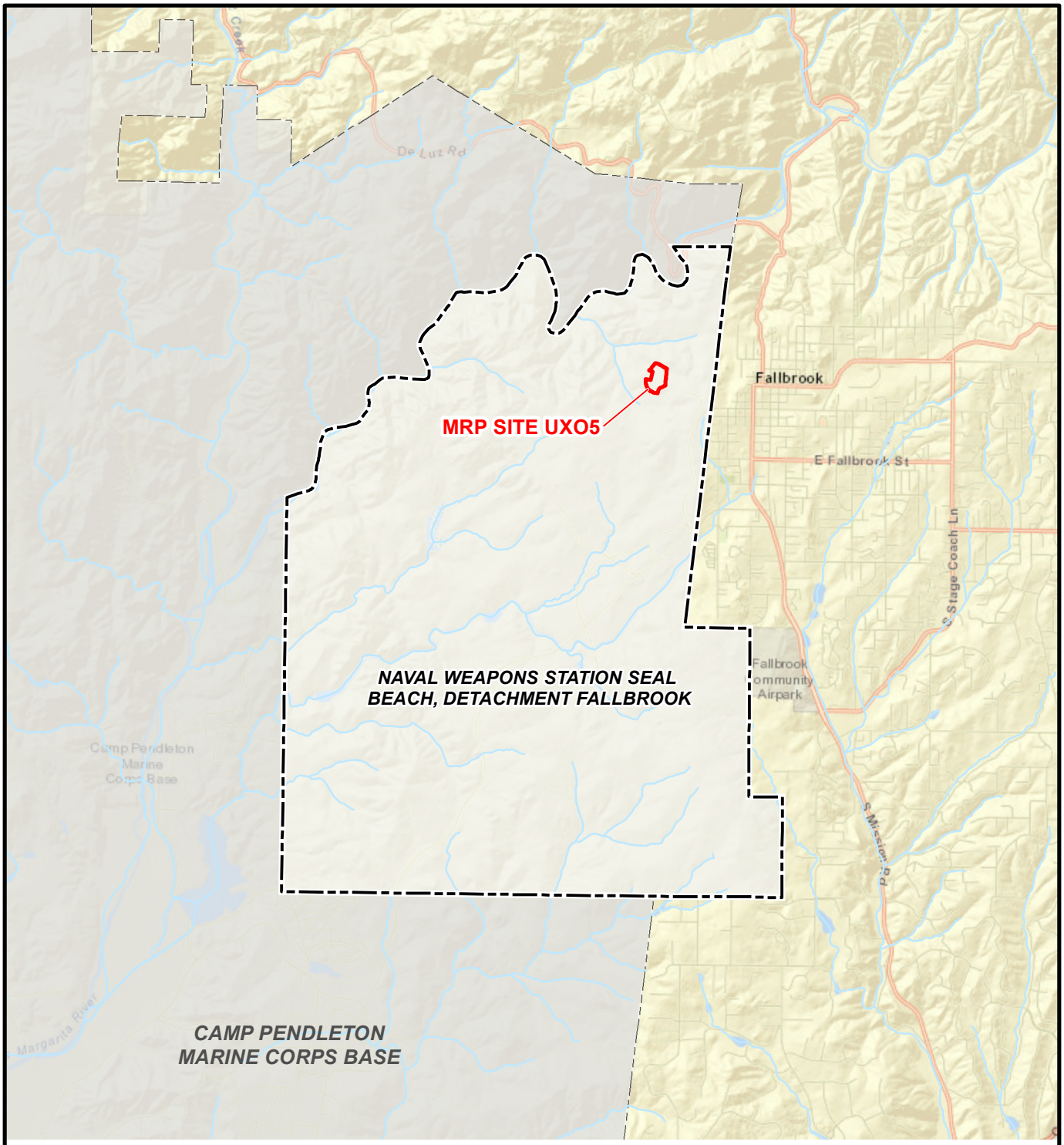

## LEGEND

MRP SITE BOUNDARY

FACILITY BOUNDARY

NOTES:
MRP = Munitions Response Program
UXO = Unexploded Ordnance
NAVWPNSTA = Naval Weapons Station

IMAGERY SOURCE:
Esri ArcGIS Online Web Service, Streets

0 0.5 1 2
Miles

## Site Location

Remedial Investigation for MRP Site UXO5
NAVWPNSTA Seal Beach Detachment Fallbrook, California

N

FIGURE
1-1

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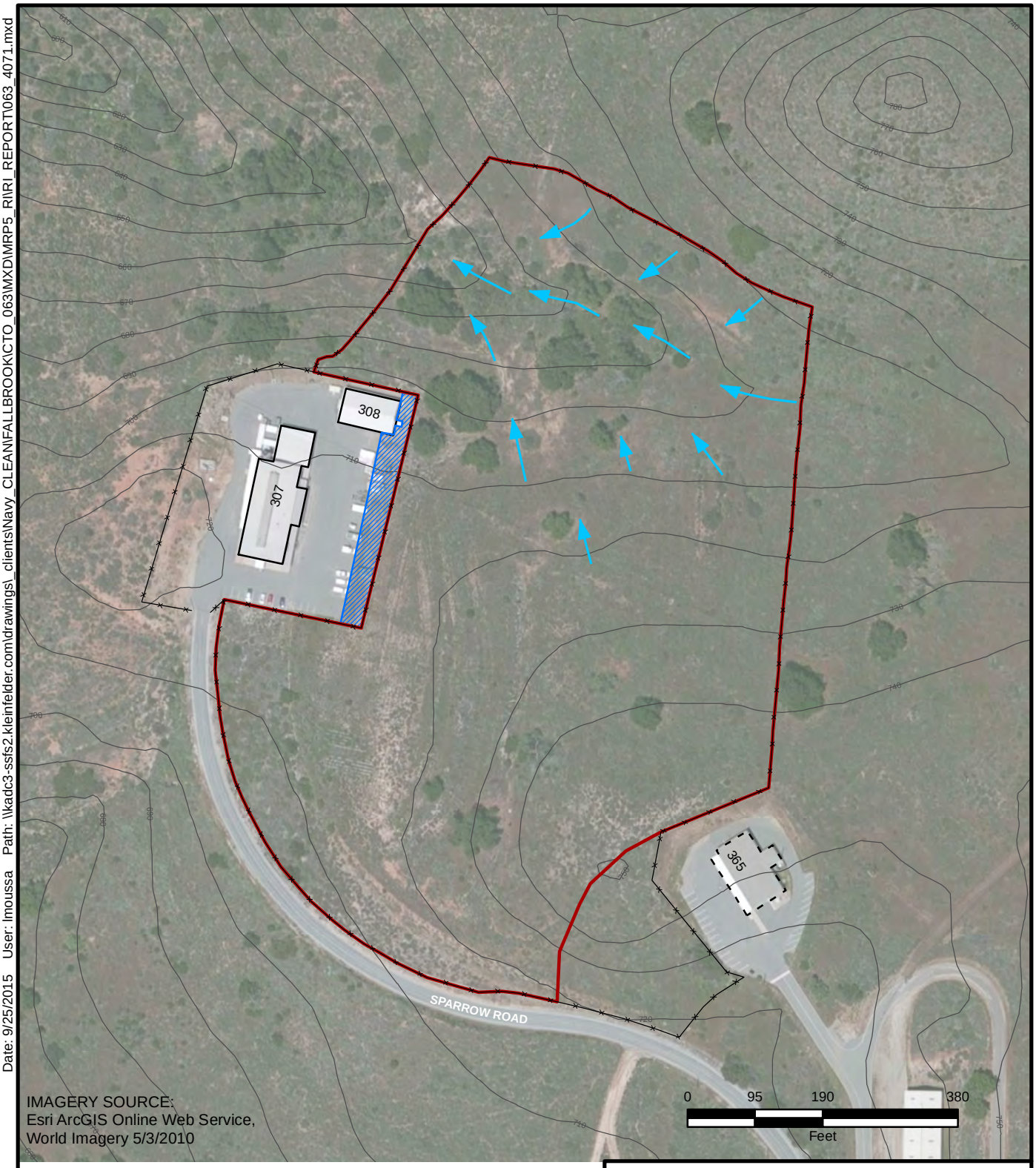


## LEGEND

- APPROXIMATE DIRECTION OF SURFACE WATER FLOW
- 10 FOOT GROUND CONTOUR
- FENCE
- EXISTING BUILDING
- DEMOLISHED BUILDING
- ADDITIONAL WORK AREA (0.24 ACRES)
- MRP SITE BOUNDARY

NOTES:
MRP = Munitions Response Program
UXO = Unexploded Ordnance
NAVWPNSTA = Naval Weapons Station

# Site Plan

Remedial Investigation for MRP Site UXO5
NAVWPNSTA Seal Beach Detachment Fallbrook, California

N

FIGURE

**1-2**

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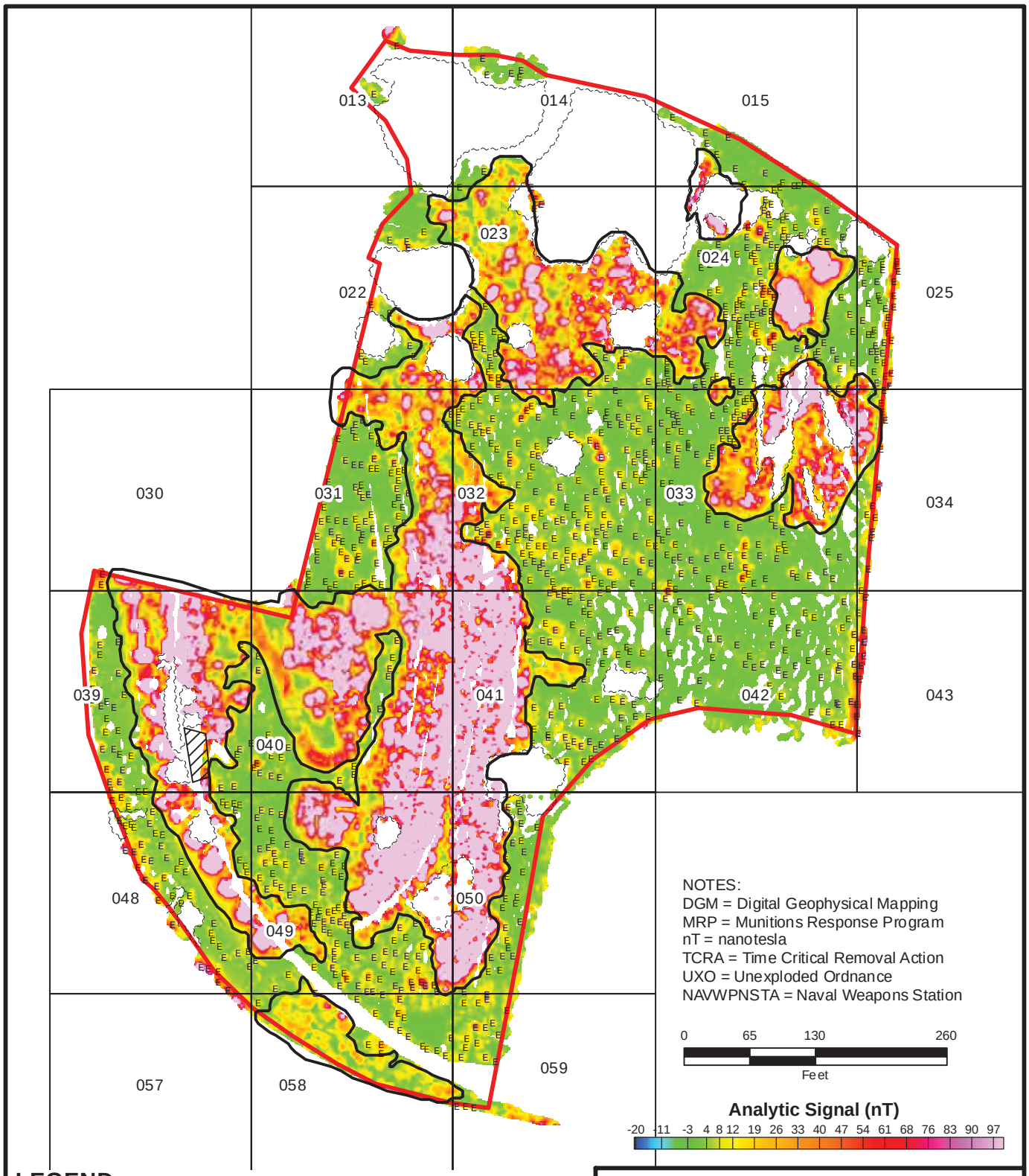


## LEGEND

- DGM TARGET
- EXPOSED BURIAL REMOVAL AREA
- INTERPRETED DISPOSAL AREA
- THICK VEGETATION/NO ACCESS AREA
- TCRA SURVEY AREA (SES-TECH, 2011)

SOURCE:
SES-TECH, 2012. Final Geophysical Report, Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach Detachment Fallbrook, California.

**2012 Geophysical Investigation Area**

Remedial Investigation for MRP Site UXO5
NAVWPNSTA Seal Beach Detachment Fallbrook, California

FIGURE

**2-1**

Date: 10/1/2015 User: lmoussa Path: \\kadc3-ssfs2.kleinfelder.com\drawings_clients\Navy_CLEAN\FALLBROOK\CTO_063\MXD\MRP5_RI\RI_REPORT\063_4072.mxd

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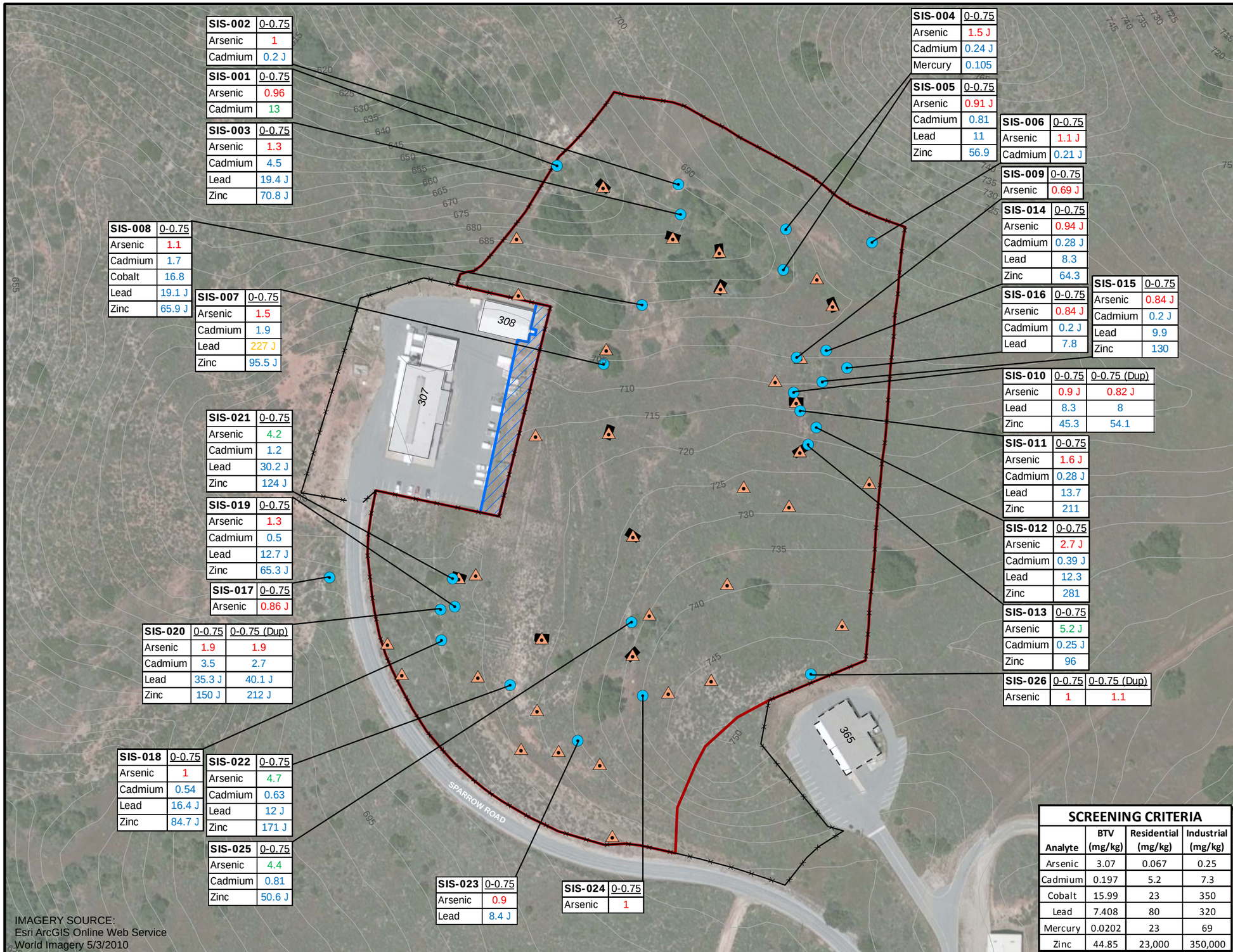


| SIS-002 | 0-0.75 |
|---|---|
| Arsenic | 1 |
| Cadmium | 0.2 J |

| SIS-001 | 0-0.75 |
|---|---|
| Arsenic | 0.96 |
| Cadmium | 13 |

| SIS-003 | 0-0.75 |
|---|---|
| Arsenic | 1.3 |
| Cadmium | 4.5 |
| Lead | 19.4 J |
| Zinc | 70.8 J |

| SIS-004 | 0-0.75 |
|---|---|
| Arsenic | 1.5 J |
| Cadmium | 0.24 J |
| Mercury | 0.105 |

| SIS-005 | 0-0.75 |
|---|---|
| Arsenic | 0.91 J |
| Cadmium | 0.81 |
| Lead | 11 |
| Zinc | 56.9 |

| SIS-006 | 0-0.75 |
|---|---|
| Arsenic | 1.1 J |
| Cadmium | 0.21 J |

| SIS-009 | 0-0.75 |
|---|---|
| Arsenic | 0.69 J |

| SIS-014 | 0-0.75 |
|---|---|
| Arsenic | 0.94 J |
| Cadmium | 0.28 J |
| Lead | 8.3 |
| Zinc | 64.3 |

| SIS-015 | 0-0.75 |
|---|---|
| Arsenic | 0.84 J |
| Cadmium | 0.2 J |
| Lead | 9.9 |
| Zinc | 130 |

| SIS-016 | 0-0.75 |
|---|---|
| Arsenic | 0.84 J |
| Cadmium | 0.2 J |
| Lead | 7.8 |

| SIS-008 | 0-0.75 |
|---|---|
| Arsenic | 1.1 |
| Cadmium | 1.7 |
| Cobalt | 16.8 |
| Lead | 19.1 J |
| Zinc | 65.9 J |

| SIS-007 | 0-0.75 |
|---|---|
| Arsenic | 1.5 |
| Cadmium | 1.9 |
| Lead | 227 J |
| Zinc | 95.5 J |

| SIS-010 | 0-0.75 | 0-0.75 (Dup) |
|---|---|---|
| Arsenic | 0.9 J | 0.82 J |
| Lead | 8.3 | 8 |
| Zinc | 45.3 | 54.1 |

| SIS-011 | 0-0.75 |
|---|---|
| Arsenic | 1.6 J |
| Cadmium | 0.28 J |
| Lead | 13.7 |
| Zinc | 211 |

| SIS-021 | 0-0.75 |
|---|---|
| Arsenic | 4.2 |
| Cadmium | 1.2 |
| Lead | 30.2 J |
| Zinc | 124 J |

| SIS-019 | 0-0.75 |
|---|---|
| Arsenic | 1.3 |
| Cadmium | 0.5 |
| Lead | 12.7 J |
| Zinc | 65.3 J |

| SIS-012 | 0-0.75 |
|---|---|
| Arsenic | 2.7 J |
| Cadmium | 0.39 J |
| Lead | 12.3 |
| Zinc | 281 |

| SIS-017 | 0-0.75 |
|---|---|
| Arsenic | 0.86 J |

| SIS-013 | 0-0.75 |
|---|---|
| Arsenic | 5.2 J |
| Cadmium | 0.25 J |
| Zinc | 96 |

| SIS-020 | 0-0.75 | 0-0.75 (Dup) |
|---|---|---|
| Arsenic | 1.9 | 1.9 |
| Cadmium | 3.5 | 2.7 |
| Lead | 35.3 J | 40.1 J |
| Zinc | 150 J | 212 J |

| SIS-026 | 0-0.75 | 0-0.75 (Dup) |
|---|---|---|
| Arsenic | 1 | 1.1 |

| SIS-018 | 0-0.75 |
|---|---|
| Arsenic | 1 |
| Cadmium | 0.54 |
| Lead | 16.4 J |
| Zinc | 84.7 J |

| SIS-022 | 0-0.75 |
|---|---|
| Arsenic | 4.7 |
| Cadmium | 0.63 |
| Lead | 12 J |
| Zinc | 171 J |

| SIS-025 | 0-0.75 |
|---|---|
| Arsenic | 4.4 |
| Cadmium | 0.81 |
| Zinc | 50.6 J |

| SIS-023 | 0-0.75 |
|---|---|
| Arsenic | 0.9 |
| Lead | 8.4 J |

| SIS-024 | 0-0.75 |
|---|---|
| Arsenic | 1 |

IMAGERY SOURCE:
Esri ArcGIS Online Web Service
World Imagery 5/3/2010

## LEGEND

- SOIL SAMPLE LOCATION - SI, 2007
- SOIL BORING/TRENCH SAMPLE - RI, 2015
- INVESTIGATIVE TRENCH - RI, 2015
- FENCE
- 5 FOOT GROUND CONTOUR
- ADDITIONAL WORK AREA (0.24 ACRES)
- BUILDING - EXISTING
- BUILDING - DEMOLISHED
- MRP SITE BOUNDARY

LOCATION ID — SAMPLE DEPTH (feet bgs)

| SIS-025 | 0-0.75 |
|---|---|
| Zinc | 50.6 J |

ANALYTE — CONCENTRATION (mg/kg) — REVIEW QUALIFIER

SAMPLE NOTES:
bgs = below ground surface
mg/kg = milligrams per kilogram
BTV = Background Threshold Value
Dup = Duplicate
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

- See Tables 6-1 and 6-2 for screening criteria sources.
- Blue text indicates the concentration is above the BTV.
- Red text indicates the concentration is above the residential and industrial screening criteria.
- Orange text indicates the concentration is above the BTV and residential screening criteria.
- Green text indicates the concentration is above the BTV and residential and industrial screening criteria.
- Only analytical results above screening criteria are shown. Full analytical results are available in Appendix A.

NOTES:
SI = Site Investigation
RI = Remedial Investigation
MRP = Munitions Response Program
UXO = Unexploded Ordnance
NAVWPNSTA = Naval Weapons Station

SOURCE:
TetraTech, Site Investigation report, 2009

0 75 150 300
Feet

**SCREENING CRITERIA**

| Analyte | BTV (mg/kg) | Residential (mg/kg) | Industrial (mg/kg) |
|---|---|---|---|
| Arsenic | 3.07 | 0.067 | 0.25 |
| Cadmium | 0.197 | 5.2 | 7.3 |
| Cobalt | 15.99 | 23 | 350 |
| Lead | 7.408 | 80 | 320 |
| Mercury | 0.0202 | 23 | 69 |
| Zinc | 44.85 | 23,000 | 350,000 |

# Site Investigation Soil Sampling Results - Selected Analytes, 2007

Remedial Investigation for MRP Site UXO5
NAVWPNSTA Seal Beach Detachment Fallbrook, California

N

KCH

FIGURE
3-1

Date: 3/24/2016 User: jpatay Path: \\kadc3-ssfs2.kleinfelder.com\drawings_clients\Navy_CLEAN\FALLBROOK\CTO_063\MXD\MRP5_RI\RI_REPORT\063_4092.mxd

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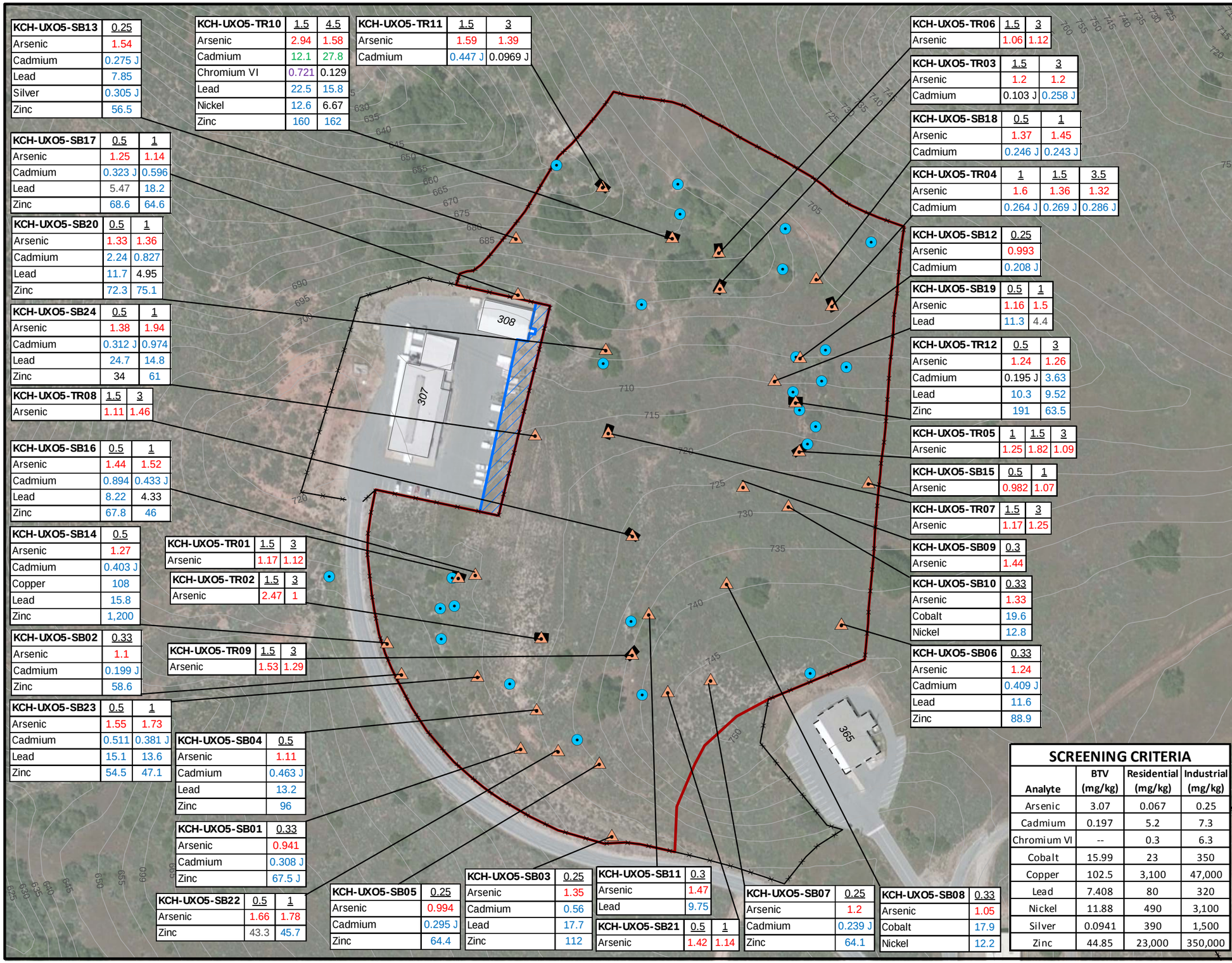


| KCH-UXO5-SB13 | 0.25 |
|---|---|
| Arsenic | 1.54 |
| Cadmium | 0.275 J |
| Lead | 7.85 |
| Silver | 0.305 J |
| Zinc | 56.5 |

| KCH-UXO5-TR10 | 1.5 | 4.5 |
|---|---|---|
| Arsenic | 2.94 | 1.58 |
| Cadmium | 12.1 | 27.8 |
| Chromium VI | 0.721 | 0.129 |
| Lead | 22.5 | 15.8 |
| Nickel | 12.6 | 6.67 |
| Zinc | 160 | 162 |

| KCH-UXO5-TR11 | 1.5 | 3 |
|---|---|---|
| Arsenic | 1.59 | 1.39 |
| Cadmium | 0.447 J | 0.0969 J |

| KCH-UXO5-TR06 | 1.5 | 3 |
|---|---|---|
| Arsenic | 1.06 | 1.12 |

| KCH-UXO5-TR03 | 1.5 | 3 |
|---|---|---|
| Arsenic | 1.2 | 1.2 |
| Cadmium | 0.103 J | 0.258 J |

| KCH-UXO5-SB18 | 0.5 | 1 |
|---|---|---|
| Arsenic | 1.37 | 1.45 |
| Cadmium | 0.246 J | 0.243 J |

| KCH-UXO5-TR04 | 1 | 1.5 | 3.5 |
|---|---|---|---|
| Arsenic | 1.6 | 1.36 | 1.32 |
| Cadmium | 0.264 J | 0.269 J | 0.286 J |

| KCH-UXO5-SB12 | 0.25 |
|---|---|
| Arsenic | 0.993 |
| Cadmium | 0.208 J |

| KCH-UXO5-SB19 | 0.5 | 1 |
|---|---|---|
| Arsenic | 1.16 | 1.5 |
| Lead | 11.3 | 4.4 |

| KCH-UXO5-TR12 | 0.5 | 3 |
|---|---|---|
| Arsenic | 1.24 | 1.26 |
| Cadmium | 0.195 J | 3.63 |
| Lead | 10.3 | 9.52 |
| Zinc | 191 | 63.5 |

| KCH-UXO5-TR05 | 1 | 1.5 | 3 |
|---|---|---|---|
| Arsenic | 1.25 | 1.82 | 1.09 |

| KCH-UXO5-SB15 | 0.5 | 1 |
|---|---|---|
| Arsenic | 0.982 | 1.07 |

| KCH-UXO5-TR07 | 1.5 | 3 |
|---|---|---|
| Arsenic | 1.17 | 1.25 |

| KCH-UXO5-SB09 | 0.3 |
|---|---|
| Arsenic | 1.44 |

| KCH-UXO5-SB10 | 0.33 |
|---|---|
| Arsenic | 1.33 |
| Cobalt | 19.6 |
| Nickel | 12.8 |

| KCH-UXO5-SB06 | 0.33 |
|---|---|
| Arsenic | 1.24 |
| Cadmium | 0.409 J |
| Lead | 11.6 |
| Zinc | 88.9 |

| KCH-UXO5-SB17 | 0.5 | 1 |
|---|---|---|
| Arsenic | 1.25 | 1.14 |
| Cadmium | 0.323 J | 0.596 |
| Lead | 5.47 | 18.2 |
| Zinc | 68.6 | 64.6 |

| KCH-UXO5-SB20 | 0.5 | 1 |
|---|---|---|
| Arsenic | 1.33 | 1.36 |
| Cadmium | 2.24 | 0.827 |
| Lead | 11.7 | 4.95 |
| Zinc | 72.3 | 75.1 |

| KCH-UXO5-SB24 | 0.5 | 1 |
|---|---|---|
| Arsenic | 1.38 | 1.94 |
| Cadmium | 0.312 J | 0.974 |
| Lead | 24.7 | 14.8 |
| Zinc | 34 | 61 |

| KCH-UXO5-TR08 | 1.5 | 3 |
|---|---|---|
| Arsenic | 1.11 | 1.46 |

| KCH-UXO5-SB16 | 0.5 | 1 |
|---|---|---|
| Arsenic | 1.44 | 1.52 |
| Cadmium | 0.894 | 0.433 J |
| Lead | 8.22 | 4.33 |
| Zinc | 67.8 | 46 |

| KCH-UXO5-SB14 | 0.5 |
|---|---|
| Arsenic | 1.27 |
| Cadmium | 0.403 J |
| Copper | 108 |
| Lead | 15.8 |
| Zinc | 1,200 |

| KCH-UXO5-TR01 | 1.5 | 3 |
|---|---|---|
| Arsenic | 1.17 | 1.12 |

| KCH-UXO5-TR02 | 1.5 | 3 |
|---|---|---|
| Arsenic | 2.47 | 1 |

| KCH-UXO5-SB02 | 0.33 |
|---|---|
| Arsenic | 1.1 |
| Cadmium | 0.199 J |
| Zinc | 58.6 |

| KCH-UXO5-TR09 | 1.5 | 3 |
|---|---|---|
| Arsenic | 1.53 | 1.29 |

| KCH-UXO5-SB23 | 0.5 | 1 |
|---|---|---|
| Arsenic | 1.55 | 1.73 |
| Cadmium | 0.511 | 0.381 J |
| Lead | 15.1 | 13.6 |
| Zinc | 54.5 | 47.1 |

| KCH-UXO5-SB04 | 0.5 |
|---|---|
| Arsenic | 1.11 |
| Cadmium | 0.463 J |
| Lead | 13.2 |
| Zinc | 96 |

| KCH-UXO5-SB01 | 0.33 |
|---|---|
| Arsenic | 0.941 |
| Cadmium | 0.308 J |
| Zinc | 67.5 J |

| KCH-UXO5-SB22 | 0.5 | 1 |
|---|---|---|
| Arsenic | 1.66 | 1.78 |
| Zinc | 43.3 | 45.7 |

| KCH-UXO5-SB05 | 0.25 |
|---|---|
| Arsenic | 0.994 |
| Cadmium | 0.295 J |
| Zinc | 64.4 |

| KCH-UXO5-SB03 | 0.25 |
|---|---|
| Arsenic | 1.35 |
| Cadmium | 0.56 |
| Lead | 17.7 |
| Zinc | 112 |

| KCH-UXO5-SB11 | 0.3 |
|---|---|
| Arsenic | 1.47 |
| Lead | 9.75 |

| KCH-UXO5-SB21 | 0.5 | 1 |
|---|---|---|
| Arsenic | 1.42 | 1.14 |

| KCH-UXO5-SB07 | 0.25 |
|---|---|
| Arsenic | 1.2 |
| Cadmium | 0.239 J |
| Zinc | 64.1 |

| KCH-UXO5-SB08 | 0.33 |
|---|---|
| Arsenic | 1.05 |
| Cobalt | 17.9 |
| Nickel | 12.2 |

## LEGEND

- SOIL BORING/TRENCH SAMPLE - RI, 2015
- SOIL SAMPLE LOCATION - SI, 2007
- INVESTIGATIVE TRENCH - RI, 2015
- FENCE
- 5 FOOT GROUND CONTOUR
- ADDITIONAL WORK AREA (0.24 ACRES)
- BUILDING - EXISTING
- BUILDING - DEMOLISHED
- MRP SITE BOUNDARY

LOCATION ID — SAMPLE DEPTH (feet bgs)

| KCH-UXO5-SB24 | 0.5 | 1 |
|---|---|---|
| Chromium VI | 0.041 U | 0.0404 U |

ANALYTE — CONCENTRATION (mg/kg) — REVIEW QUALIFIER

SAMPLE NOTES:
bgs = below ground surface
mg/kg = milligrams per kilogram
BTV = Background Threshold Value
RSL = Regional Screening Level
U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

- See Tables 6-1 and 6-2 for screening criteria sources.
- Blue text indicates the concentration is above the BTV.
- Red text indicates the concentration is above the residential and industrial screening criteria.
- Green text indicates the concentration is above the BTV and residential and industrial screening criteria.
- Purple text indicates the concentration is above the residential screening criteria.
- Only analytical results above screening criteria are shown. Full analytical results are available in Tables 5-1 and 5-2.

NOTES:
RI = Remedial Investigation
SI = Site Investigation
MRP = Munitions Response Program
UXO = Unexploded Ordnance
NAVWPNSTA = Naval Weapons Station

- Trench sample locations were placed at the geometric center of the trench. Trench extents were estimated based on a standard footprint and placed using GPS data captured in the field.

IMAGERY SOURCE:
Esri ArcGIS Online Web Service
World Imagery 5/3/2010

0 75 150 300
Feet

## SCREENING CRITERIA

| Analyte | BTV (mg/kg) | Residential (mg/kg) | Industrial (mg/kg) |
|---|---|---|---|
| Arsenic | 3.07 | 0.067 | 0.25 |
| Cadmium | 0.197 | 5.2 | 7.3 |
| Chromium VI | -- | 0.3 | 6.3 |
| Cobalt | 15.99 | 23 | 350 |
| Copper | 102.5 | 3,100 | 47,000 |
| Lead | 7.408 | 80 | 320 |
| Nickel | 11.88 | 490 | 3,100 |
| Silver | 0.0941 | 390 | 1,500 |
| Zinc | 44.85 | 23,000 | 350,000 |

# Remedial Investigation Soil Sampling Results - Selected Analytes, 2015

Remedial Investigation for MRP Site UXO5
NAVWPNSTA Seal Beach Detachment Fallbrook, California

N

KCH

FIGURE
5-1

Date: 3/24/2016 User: jpatay Path: \\kadc3-ssfs2.kleinfelder.com\drawings_clients\Navy_CLEAN\FALLBROOK\CTO_063\MXD\MRP5_RI\RI_REPORT\063_4073.mxd

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**LEGEND**

- INVESTIGATIVE TRENCH - RI, 2015
- FENCE LINE
- BUILDING - EXISTING
- BUILDING - DEMOLISHED
- ADDITIONAL WORK AREA
- SITE BOUNDARY

NOTES:
RI = Remedial Investigation
MRP = Munitions Response Program
UXO = Unexploded Ordnance
NAVWPNSTA = Naval Weapons Station

IMAGERY SOURCE:
ESRI ArcGIS Online Web Service,
World Imagery 5/3/2010

## Investigative Trench Locations

Remedial Investigation for MRP Site UXO5
NAVWPNSTA Seal Beach Detachment Fallbrook, California

N

FIGURE
**5-2**

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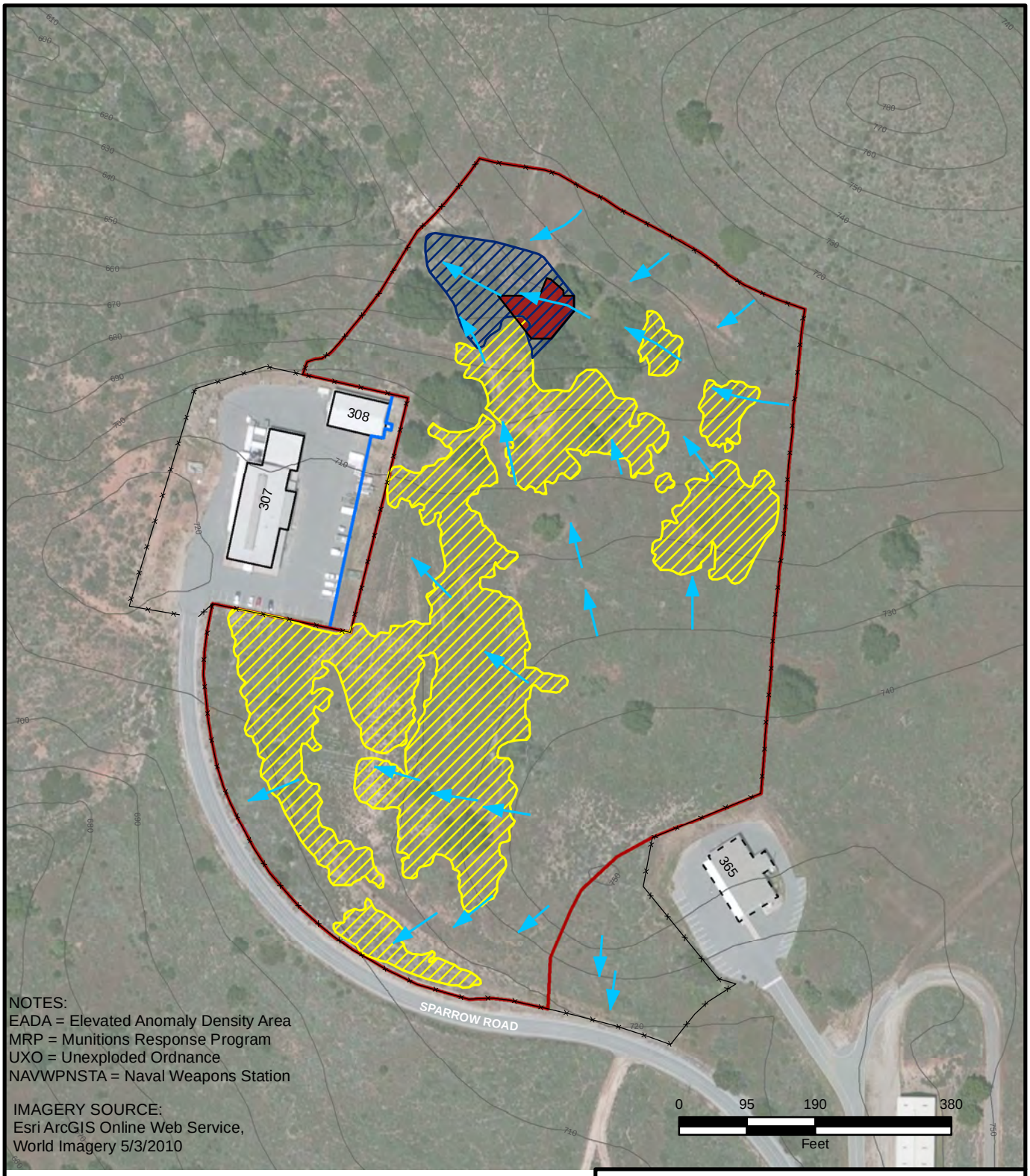


NOTES:
EADA = Elevated Anomaly Density Area
MRP = Munitions Response Program
UXO = Unexploded Ordnance
NAVWPNSTA = Naval Weapons Station

IMAGERY SOURCE:
Esri ArcGIS Online Web Service,
World Imagery 5/3/2010

## LEGEND

- SATURATED RESPONSE AREA
- EADA - DISTRIBUTED
- EADA - RAVINE
- APPROXIMATE DIRECTION OF SURFACE WATER FLOW
- 10 FOOT GROUND CONTOUR
- FENCE
- BUILDING - EXISTING
- BUILDING - DEMOLISHED
- ADDITIONAL WORK AREA (0.24 ACRES)
- MRP SITE BOUNDARY

# Elevated Anomaly Density Areas and Surface Migration Pathways

Remedial Investigation for MRP Site UXO5
NAVWPNSTA Seal Beach Detachment Fallbrook, California

N

FIGURE

**6-1**

Date: 5/9/2016 User: SWolfskill Path: \\kadc3-ssfs2.kleinfelder.com\drawings_clients\Navy_CLEAN\FALLBROOK\CTO_063\MXD\MRP5_RI\RI_REPORT\063_4487.mxd

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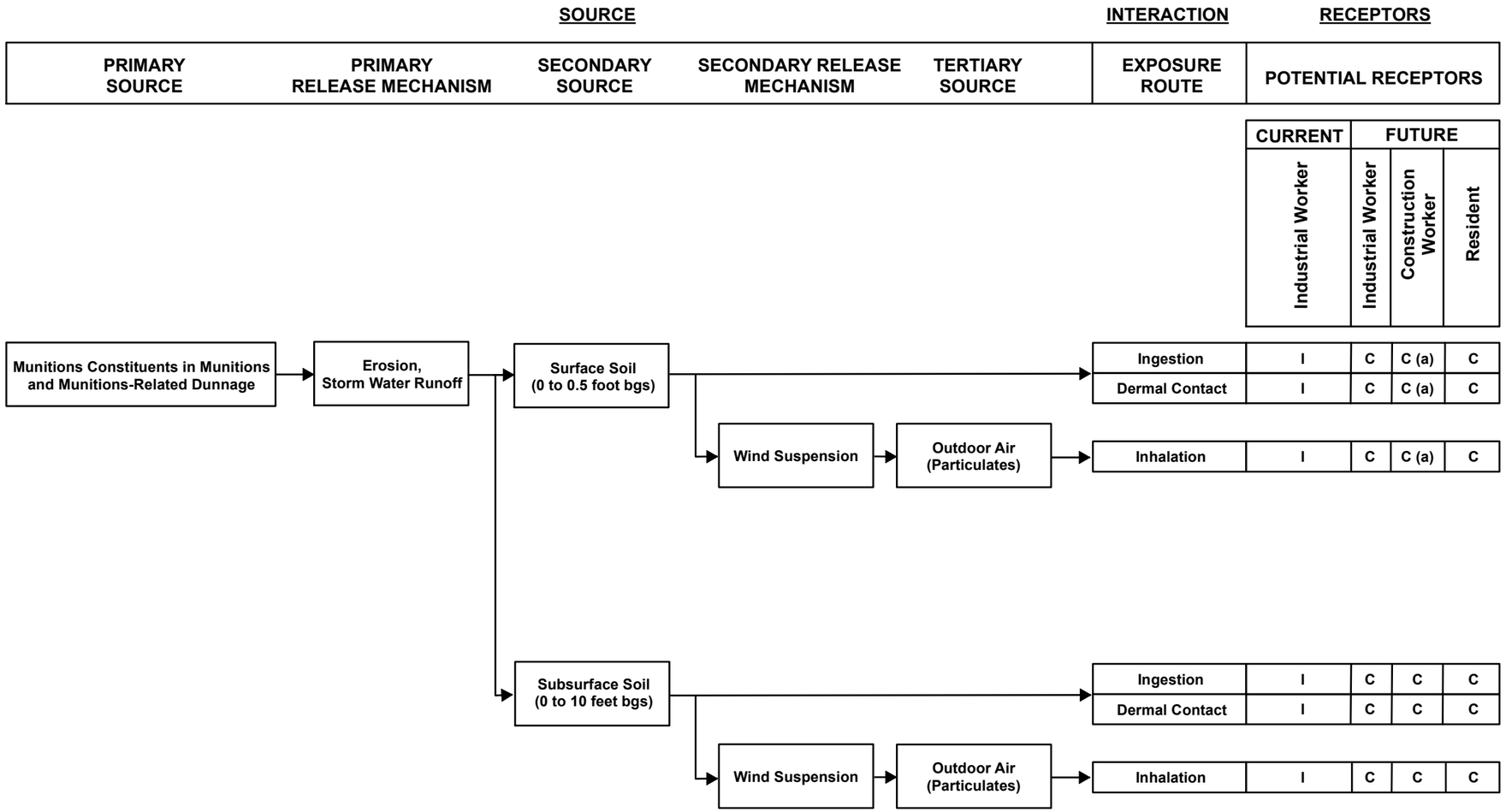


## LEGEND

I INCOMPLETE OR NEGLIGIBLE EXPOSURE PATHWAY
C POTENTIALLY COMPLETE EXPOSURE PATHWAY

NOTES:
(a) = Included in the evaluation of subsurface soil exposure pathways (not evaluated separately from subsurface soil)
bgs = below ground surface
VOC = Volatile Organic Compound
MC = Munitions Constituents
MRP = Munitions Response Program
UXO = Unexploded Ordnance
NAVWPNSTA = Naval Weapons Station

**MC Conceptual Site Exposure Model for Potential Human Receptors**

Remedial Investigation for MRP Site UXO5
NAVWPNSTA Seal Beach Detachment Fallbrook, California

FIGURE
**8-1**

Date: 10/2/2015 User: lmoussa Path: \\kadc3-ssfs2.kleinfelder.com\drawings_clients\Navy_CLEAN\FALLBROOK\CTO_063\MXD\MRP5_RI\RI_REPORT\063_4113.mxd

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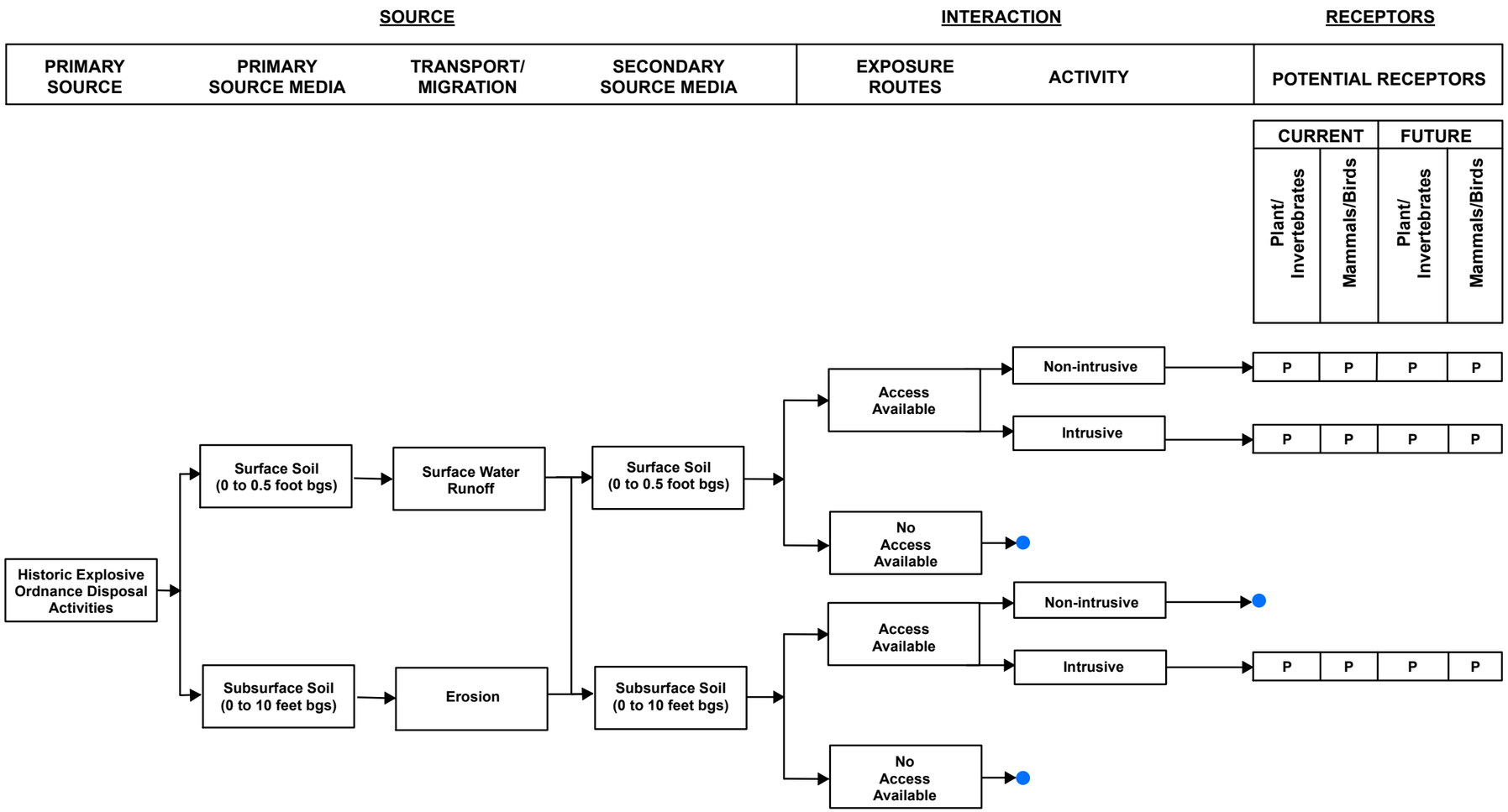


## LEGEND

P POTENTIAL RECEPTOR

● INCOMPLETE PATHWAY DUE TO LACK OF ACCESS TO POTENTIALLY CONTAMINATED MEDIA

NOTES:
bgs = below ground surface
MC = Munitions Constituents
MRP = Munitions Response Program
UXO = Unexploded Ordnance
NAVWPNSTA = Naval Weapons Station

**MC Conceptual Site Exposure Model for Potential Ecological Receptors**

Remedial Investigation for MRP Site UXO5
NAVWPNSTA Seal Beach Detachment Fallbrook, California

FIGURE
**8-2**

Date: 10/2/2015 User: lmoussa Path: \\kadc3-ssfs2.kleinfelder.com\drawings_clients\Navy_CLEAN\FALLBROOK\CTO_063\MXD\MRP5_RI\RI_REPORT\063_4075.mxd

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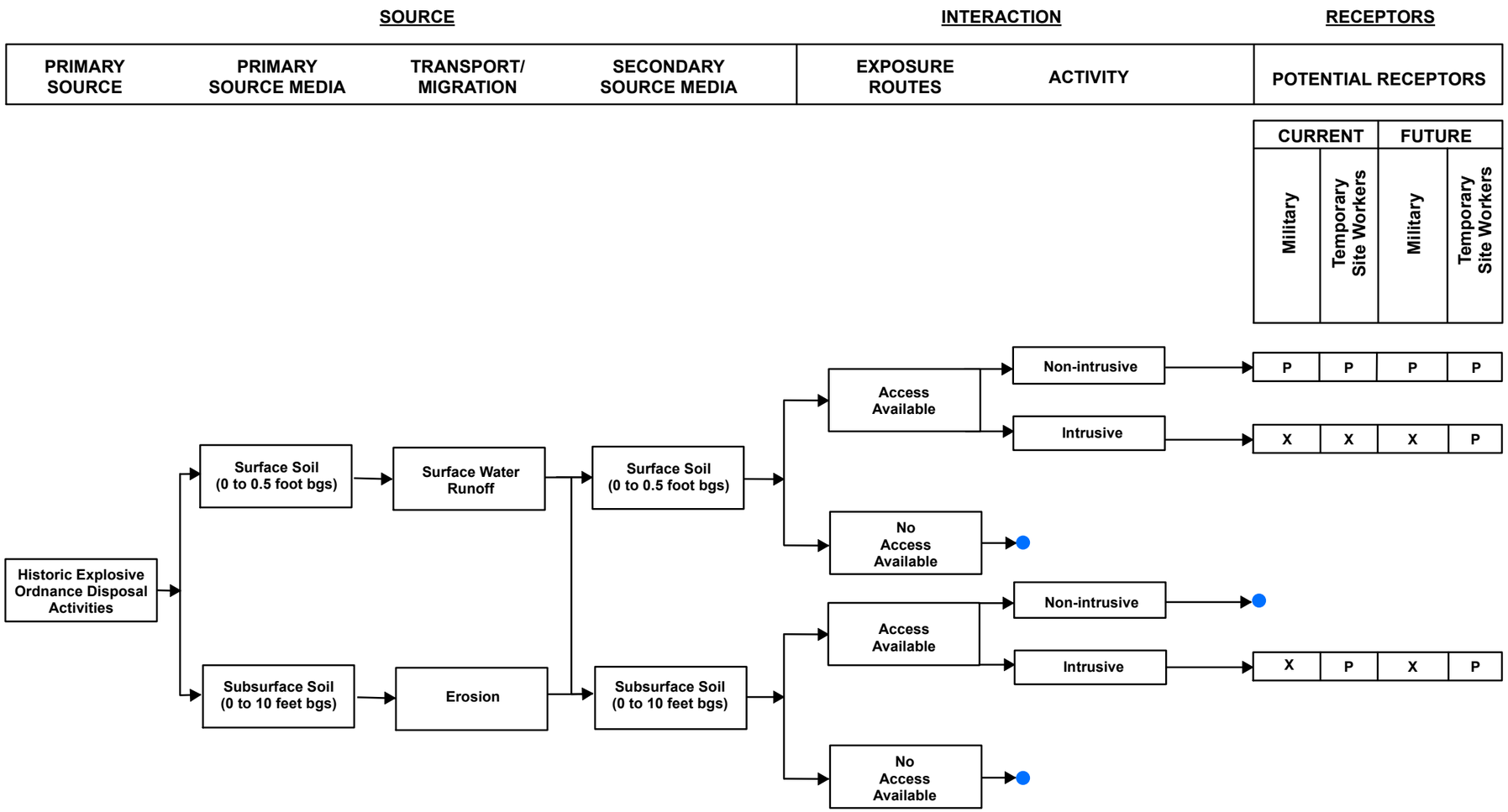


## LEGEND

- [P] POTENTIAL RECEPTOR
- [X] INCOMPLETE PATHWAY
- ● INCOMPLETE PATHWAY DUE TO LACK OF ACCESS TO POTENTIALLY CONTAMINATED MEDIA

NOTES:
bgs = below ground surface
MEC = Munitions and Explosives of Concern
MRP = Munitions Response Program
UXO = Unexploded Ordnance
NAVWPNSTA = Naval Weapons Station

**MEC Conceptual Site Exposure Model for Potential Human Receptors**

Remedial Investigation for MRP Site UXO5
NAVWPNSTA Seal Beach Detachment Fallbrook, California

FIGURE
**9-1**

Date: 10/2/2015 User: lmoussa Path: \\kadc3-ssfs2.kleinfelder.com\drawings_clients\Navy_CLEAN\FALLBROOK\CTO_063\MXD\MRP5_RI\RI_REPORT\063_4074.mxd

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# Appendix A
# Figures and Tables from SI and TCRA Reports

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## LEGEND

- MEC SIGHTING
- ROAD/PAVED SURFACE
- STREAMS
- BUILDING
- SUSPECT MEC PRESENCE
- KNOWN MEC PRESENCE
- MRP SITE UXO5

NOTES:

MEC - MUNITIONS AND EXPLOSIVES OF CONCERN

MK - MARK

MM - MILLIMETER

MRP - MUNITIONS RESPONSE PROGRAM

NAVWPNSTA - NAVAL WEAPONS STATION

UXO - UNEXPLODED ORDNANCE

MEC PRESENCE WAS DETERMINED IN PRELIMINARY ASSESSMENT REPORT (MALCOLM PIRNIE INC., 2006) THROUGH REVIEW OF HISTORICAL DOCUMENTATION, INTERVIEWS, AND VISUAL SURVEY.

100 0 100 200 Feet

Scale: 1" = 200'

N

NAVAL FACILITIES ENGINEERING COMMAND, SOUTHWEST
SAN DIEGO, CA

SITE INSPECTION REPORT

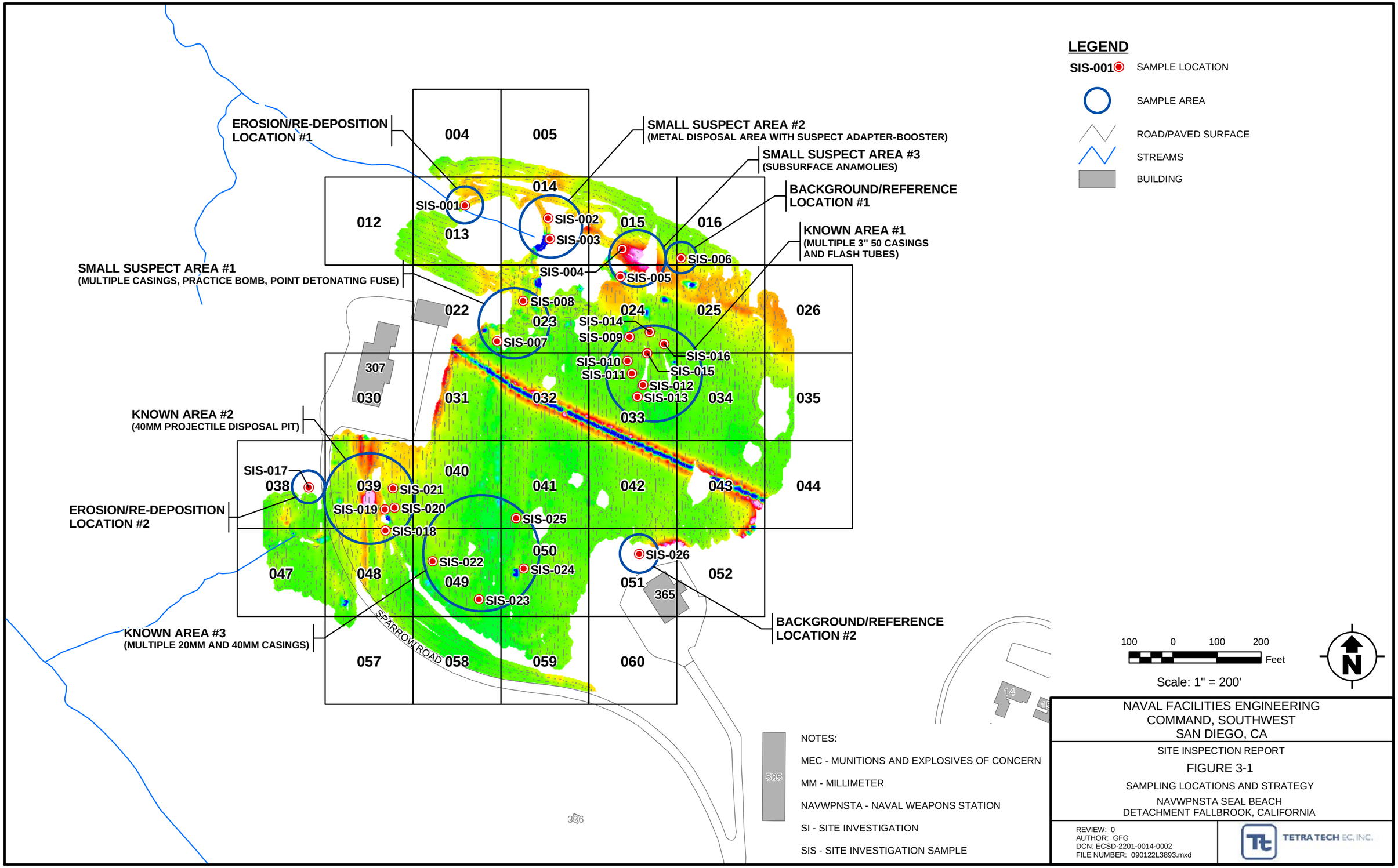
FIGURE 2-2

PRELIMINARY ASSESSMENT FINDINGS

NAVWPNSTA SEAL BEACH
DETACHMENT FALLBROOK, CALIFORNIA

REVIEW: 0
AUTHOR: GFG
DCN: ECSD-2201-0014-0002
FILE NUMBER: 090122L3892.mxd

TETRA TECH EC, INC.




NOTES:

MEC - MUNITIONS AND EXPLOSIVES OF CONCERN

MM - MILLIMETER

NAVWPNSTA - NAVAL WEAPONS STATION

SI - SITE INVESTIGATION

SIS - SITE INVESTIGATION SAMPLE

NAVAL FACILITIES ENGINEERING COMMAND, SOUTHWEST
SAN DIEGO, CA

SITE INSPECTION REPORT

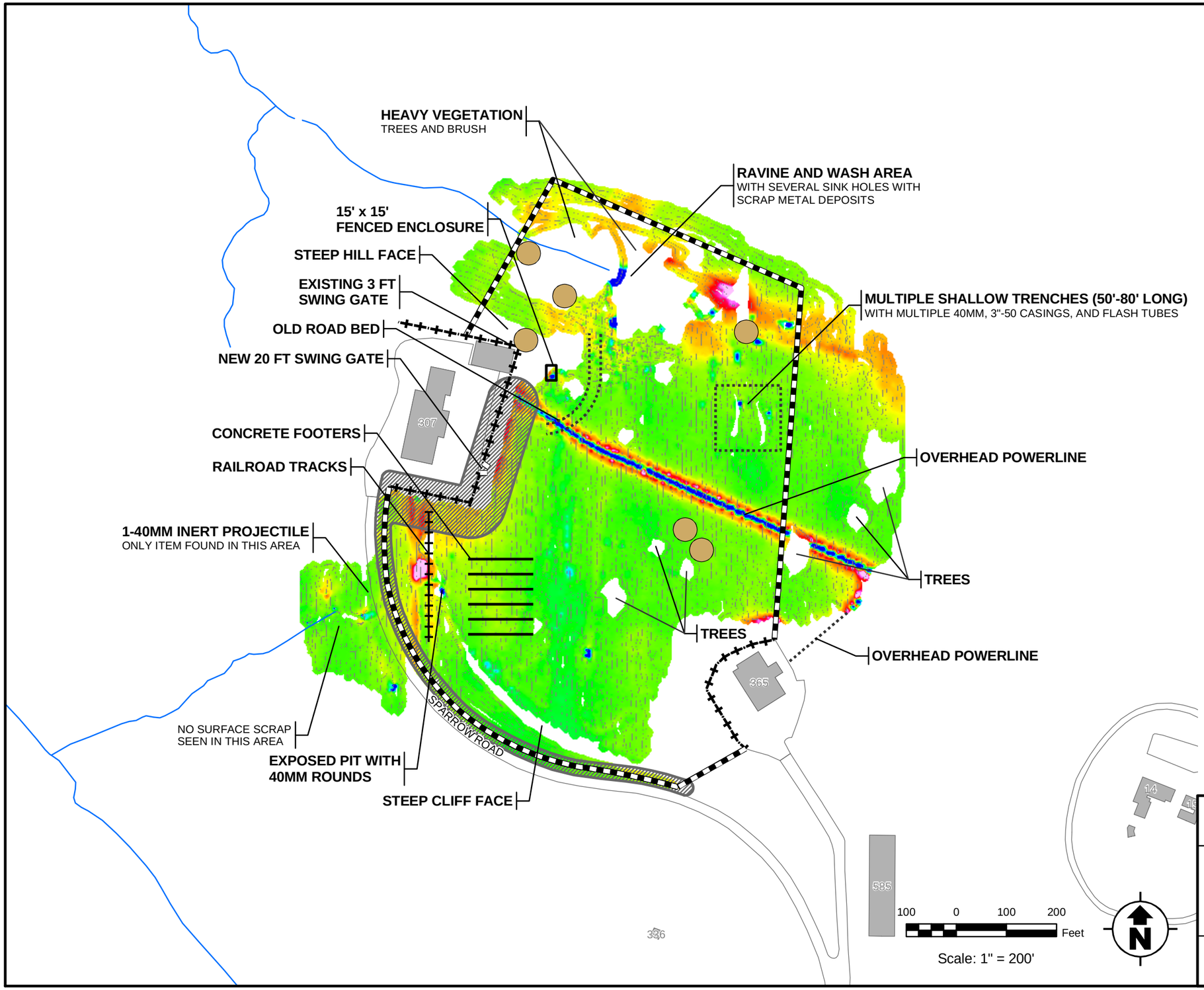
FIGURE 3-1

SAMPLING LOCATIONS AND STRATEGY

NAVWPNSTA SEAL BEACH
DETACHMENT FALLBROOK, CALIFORNIA

REVIEW: 0
AUTHOR: GFG
DCN: ECSD-2201-0014-0002
FILE NUMBER: 090122L3893.mxd

TETRA TECH EC, INC.




## LEGEND

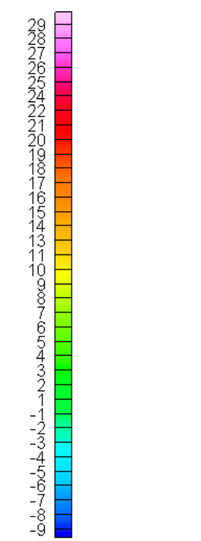
- POISON OAK (TOXICODENDRON DIVERSILOBUM)
- EXISTING BARBED WIRE FENCELINE
- NEW FENCELINE
- ROAD/PAVED SURFACE
- STREAMS
- HABITAT OF STEPHEN'S KANGAROO RAT (DIPODOMYS STEPHENSI)
- BUILDING

NOTES:

NAVWPNSTA - NAVAL WEAPONS STATION

FEATURES LISTED ON THIS MAP ARE ROUGH LOCATED AND SIZED BASED ON FIELD NOTES.

BASED ON DISCUSSIONS WITH PUBLIC WORKS DEPARTMENT AT DETACHMENT FALLBROOK, A BURIED WATER LINE (~10 FT BGS) TRAVERSES THE SITE BETWEEN BUILDING 307 AND THE HOUSING UNITS TO THE EAST.




**Apparent Conductivity**
mmho/m

NAVAL FACILITIES ENGINEERING COMMAND, SOUTHWEST
SAN DIEGO, CA

SITE INSPECTION REPORT

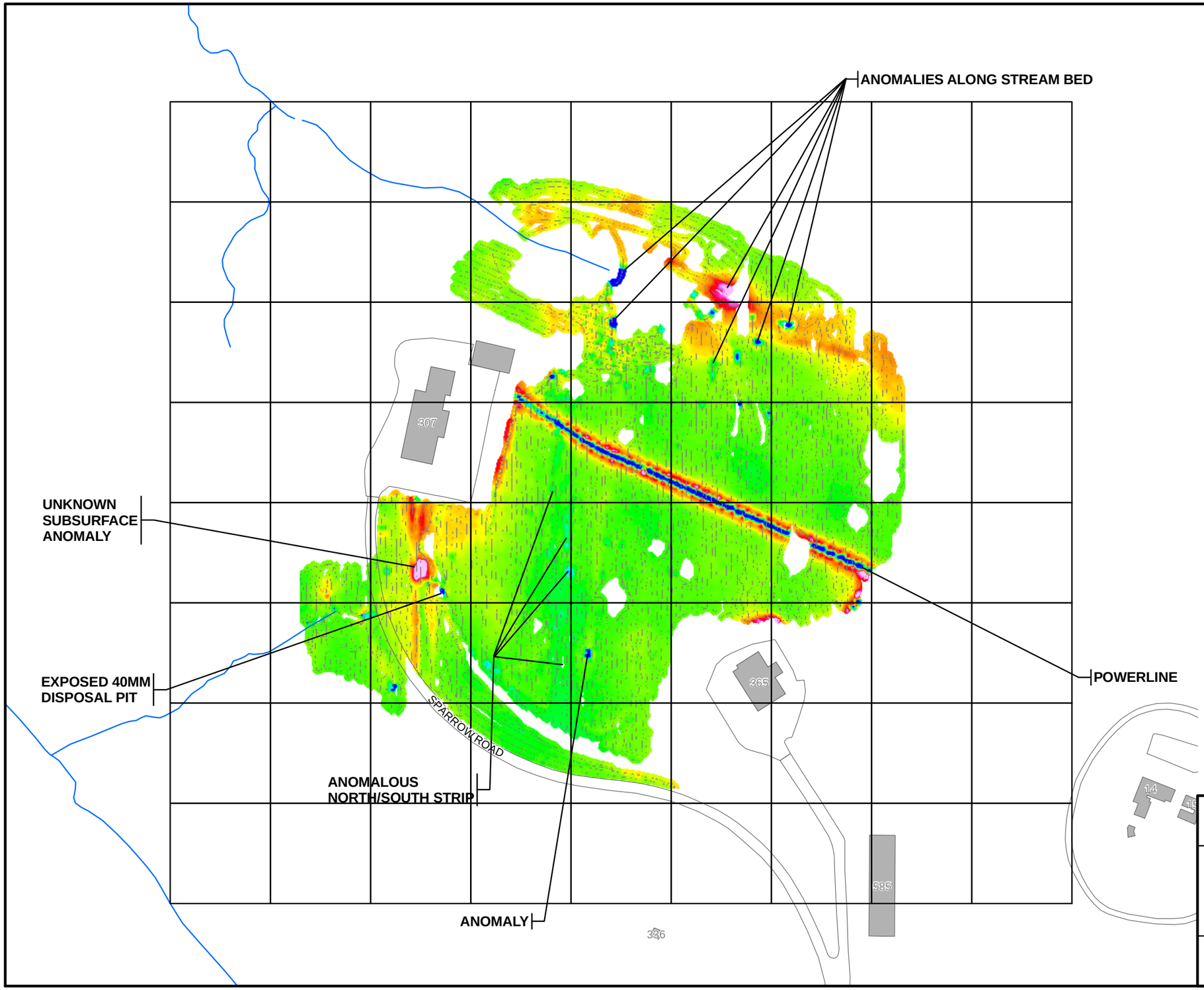
FIGURE 4-1

SITE FEATURES MAP

NAVWPNSTA SEAL BEACH
DETACHMENT FALLBROOK, CALIFORNIA

REVIEW: 0
AUTHOR: GFG
DCN: ECSD-2201-0014-0002
FILE NUMBER: 090122L3895.mxd

TETRA TECH EC, INC.




## LEGEND

ROAD/PAVED SURFACE

STREAMS

BUILDING

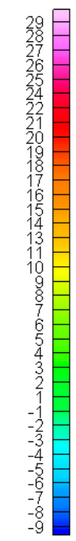
NOTES:

MM - MILLIMETER

mmho/m - MILLIMHOS PER METER

NAVWPNSTA - NAVAL WEAPONS STATION

THE CALL-OUT OF ANOMALIES ON THESE FIGURES ARE MEANT TO DRAW ATTENTIONS TO SOME SPECIFIC AREAS THAT APPEAR TO DEVIATE FROM BACKGROUND BASED ON GEOPHYSICAL DATA. THE CALL-OUTS ARE NOT MEANT TO BE A COMPREHENSIVE EVALUATION OF VARIABILITY OF GEOPHYSICAL RESPONSES AT THAT STATE.




**Apparent Conductivity**
mmho/m

100 0 100 200 Feet

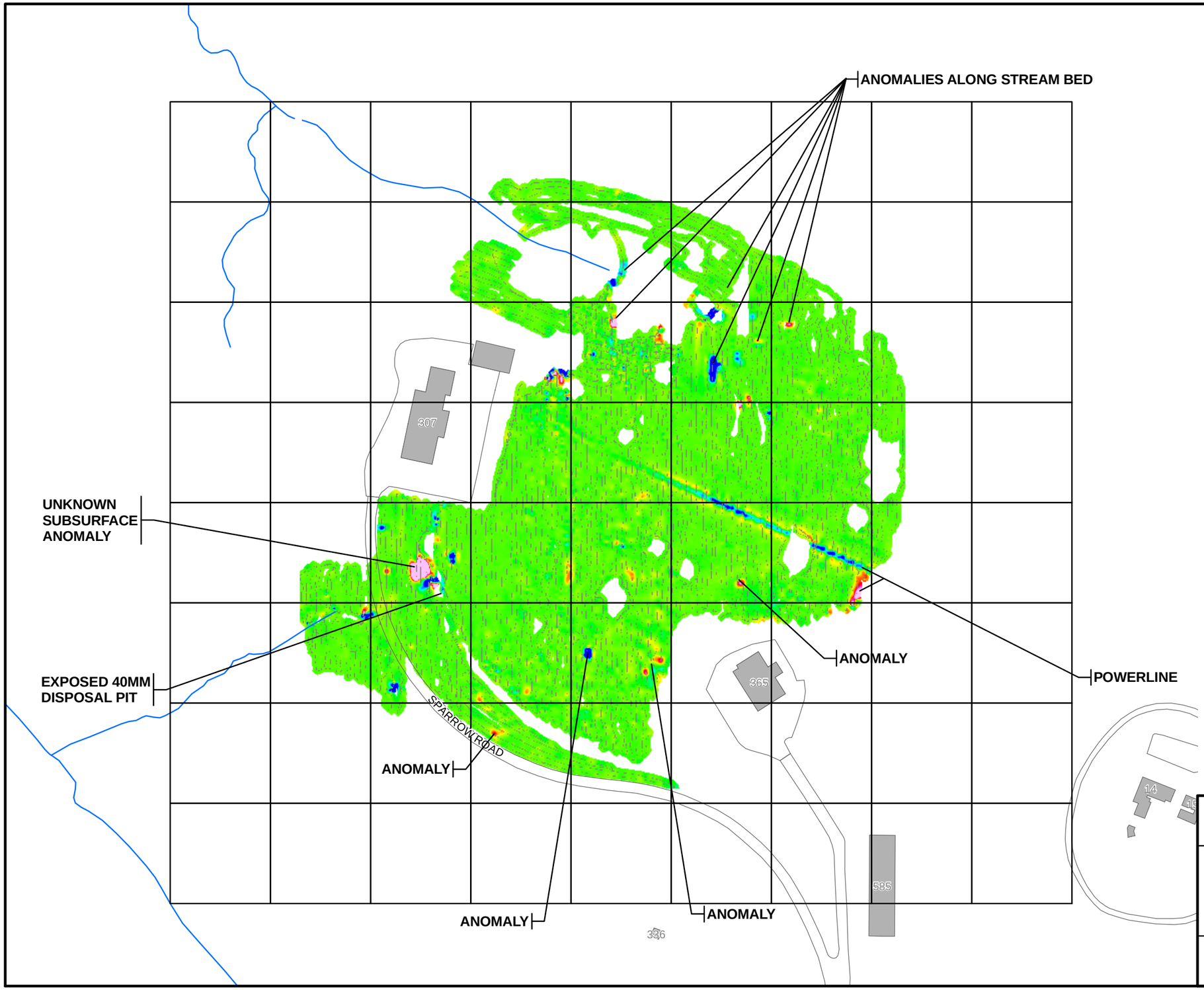
Scale: 1" = 200'

NAVAL FACILITIES ENGINEERING COMMAND, SOUTHWEST
SAN DIEGO, CA

SITE INSPECTION REPORT
FIGURE 4-2
GEOPHYSICAL SURVEY MAP
(APPARENT CONDUCTIVITY)
NAVWPNSTA SEAL BEACH
DETACHMENT FALLBROOK, CALIFORNIA

REVISION: 0
AUTHOR: GFG
DCN: ECSD-2201-0014-0002
FILE NUMBER: 090122L3896.mxd

TETRA TECH EC, INC.




## LEGEND

ROAD/PAVED SURFACE

STREAMS

BUILDING

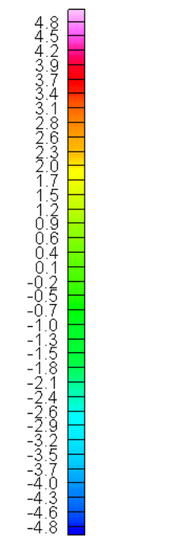
NOTES:

MM - MILLIMETER

NAVWPNSTA - NAVAL WEAPONS STATION

ppt - PARTS PER THOUSAND

THE CALL-OUT OF ANOMALIES ON THESE FIGURES ARE MEANT TO DRAW ATTENTIONS TO SOME SPECIFIC AREAS THAT APPEAR TO DEVIATE FROM BACKGROUND BASED ON GEOPHYSICAL DATA. THE CALL-OUTS ARE NOT MEANT TO BE A COMPREHENSIVE EVALUATION OF VARIABILITY OF GEOPHYSICAL RESPONSES AT THAT STATE.




100 0 100 200 Feet

Scale: 1" = 200'

NAVAL FACILITIES ENGINEERING COMMAND, SOUTHWEST
SAN DIEGO, CA

SITE INSPECTION REPORT

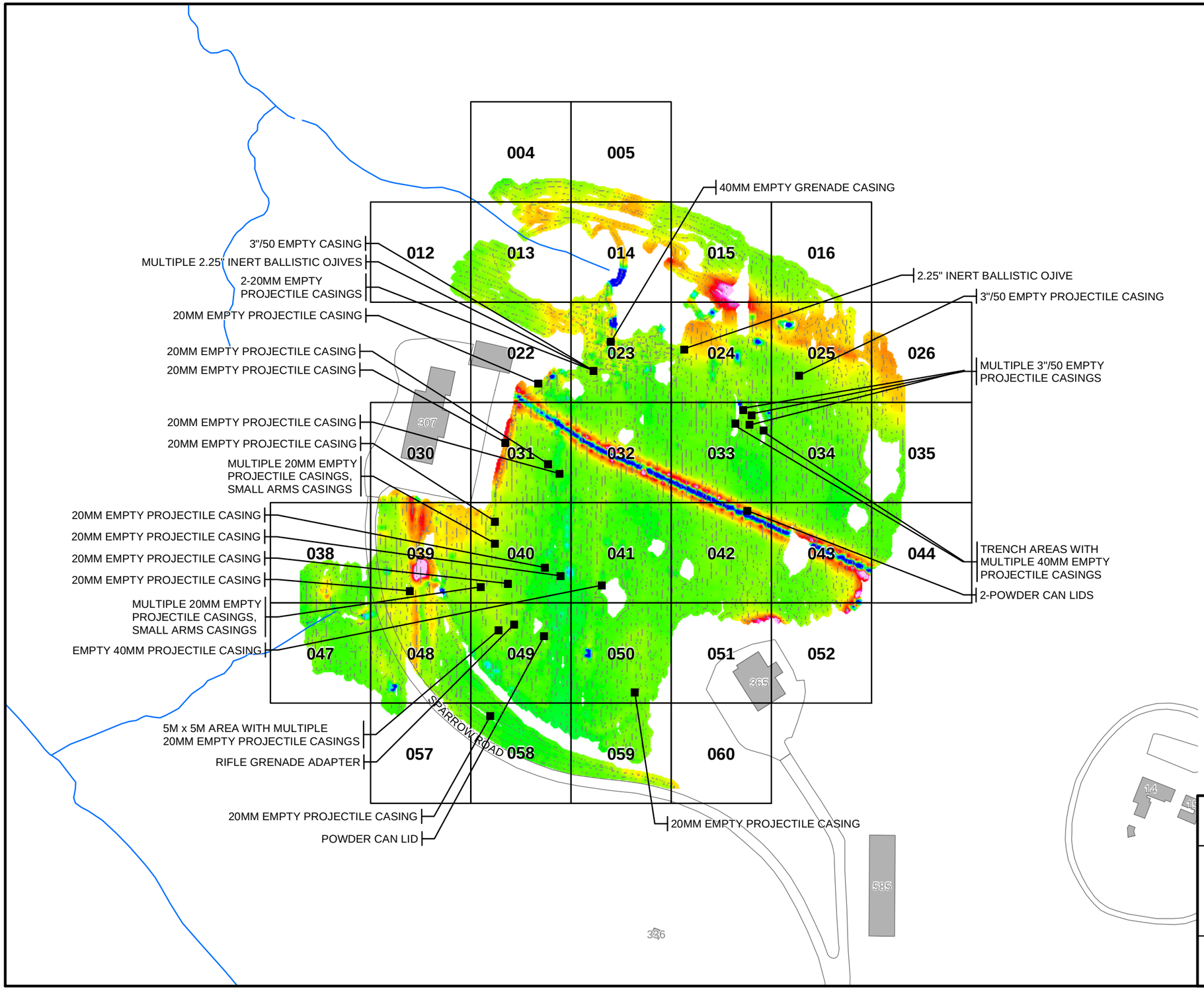
FIGURE 4-3

GEOPHYSICAL SURVEY MAP
(INPHASE RESPONSE)

NAVWPNSTA SEAL BEACH
DETACHMENT FALLBROOK, CALIFORNIA

REVISION: 0
AUTHOR: GFG
DCN: ECSD-2201-0014-0002
FILE NUMBER: 090122L3897.mxd

TETRA TECH EC, INC.




## LEGEND

- ESTIMATED MEC LOCATIONS
- ROAD/PAVED SURFACE
- STREAMS
- BUILDING

NOTES:

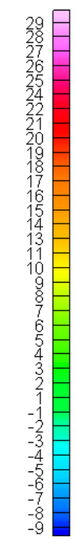
M - METER

MEC - MUNITIONS AND EXPLOSIVES OF CONCERN

MM - MILLIMETER

mmho/m - MILLIMHOS PER METER

NAVWPNSTA - NAVAL WEAPONS STATION




**Apparent Conductivity**
mmho/m

100 0 100 200 Feet

Scale: 1" = 200'

N

NAVAL FACILITIES ENGINEERING COMMAND, SOUTHWEST
SAN DIEGO, CA

SITE INSPECTION REPORT

FIGURE 4-4

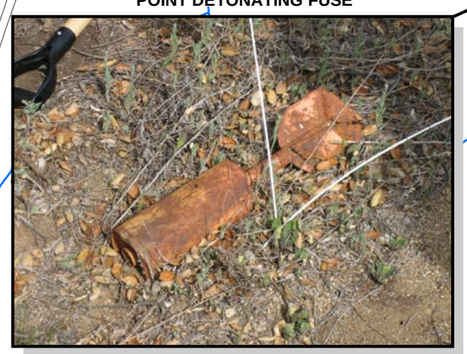
SURFACE SWEEP FINDINGS MAP
(SUSPECT INERT)
NAVWPNSTA SEAL BEACH
DETACHMENT FALLBROOK, CALIFORNIA

REVIEW: 0
AUTHOR: GFG
DCN: ECSD-2201-0014-0002
FILE NUMBER: 090122L3898.mxd

TETRA TECH EC, INC.

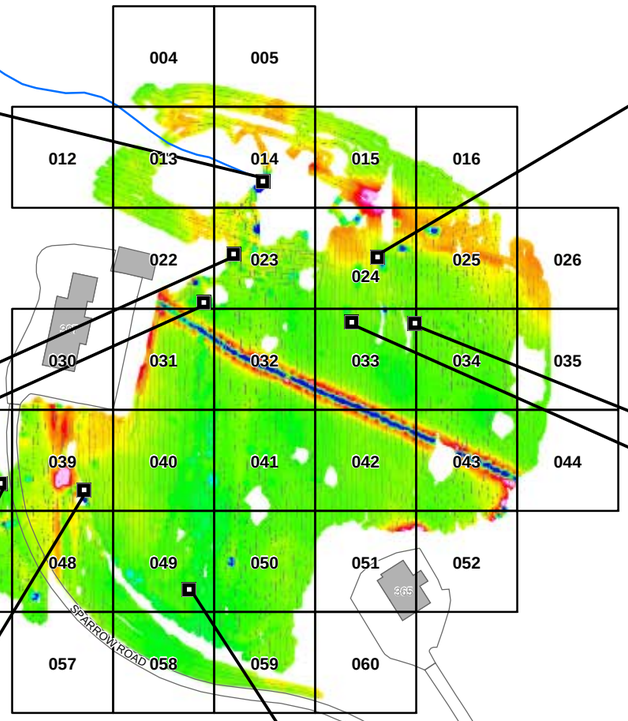
SUSPECT BASE FUSE IN SINK HOLE

POINT DETONATING FUSE



MK 106 PRACTICE BOMB

40MM ROUND (SUSPECT INERT)



SUSPECT ADAPTER-BOOSTER

MULTIPLE 3"/50 CASINGS (SUSPECT INERT)

MULTIPLE FLASH TUBES

PIT WITH NUMEROUS 40MM ROUNDS

40MM ROUNDS

## LEGEND

- MPPEH LOCATIONS (DGPS ACQUIRED DATA)
- ROAD/PAVED SURFACE
- STREAMS
- BUILDING

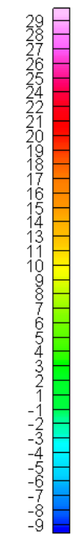
NOTES:

DGPS - DIFFERENTIAL GLOBAL POSITIONING SYSTEM

mmho/m - MILLIMHOS PER METER

MPPEH - MATERIAL POTENTIALLY PRESENTING AN EXPOSIVE HAZARD

NAVWPNSTA - NAVAL WEAPONS STATION




**Apparent Conductivity**
mmho/m

150 0 150 300
Feet

Scale: 1" = 300'

N

NAVAL FACILITIES ENGINEERING
COMMAND, SOUTHWEST
SAN DIEGO, CA

SITE INSPECTION REPORT

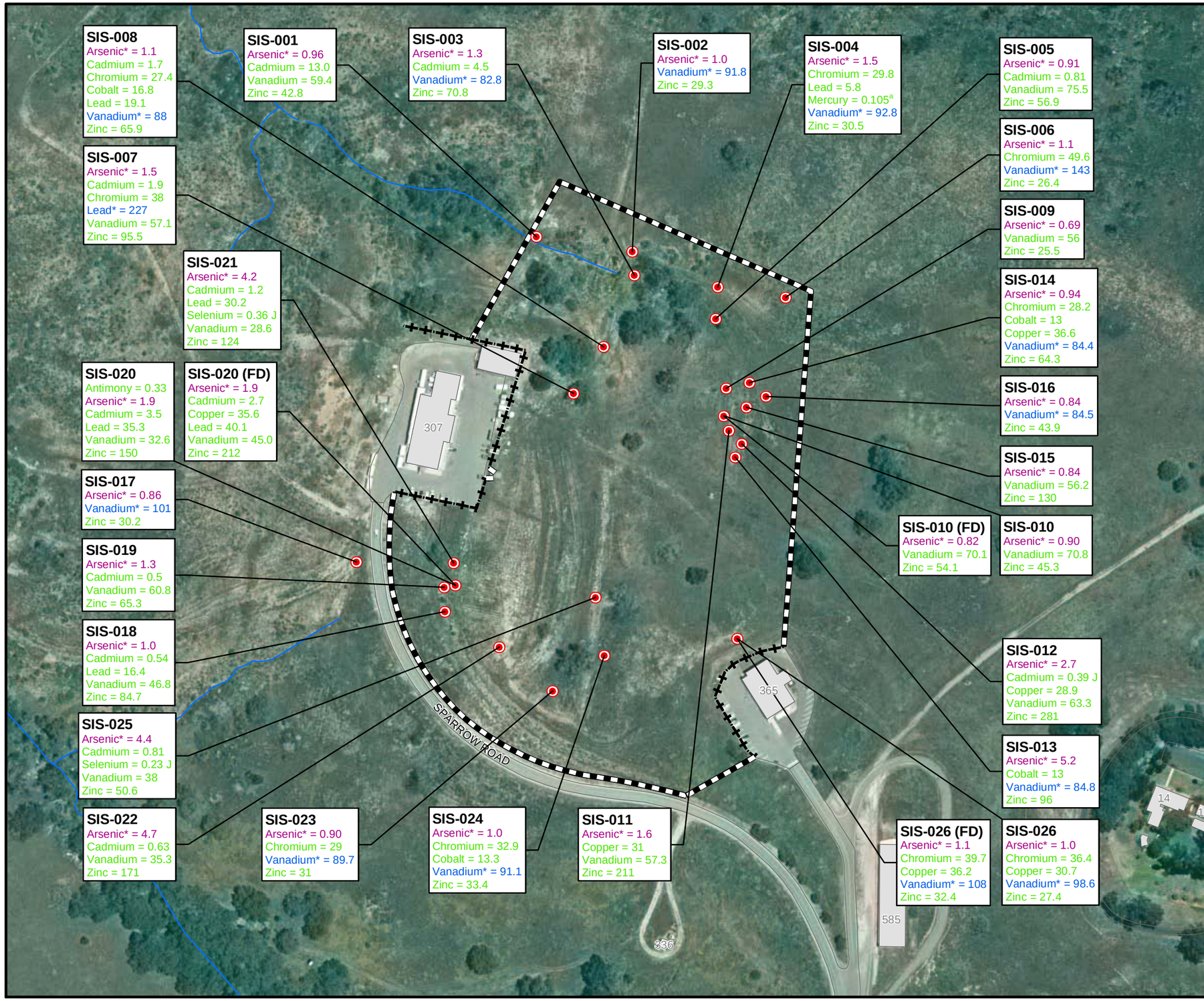
FIGURE 4-5

POTENTIAL MPPEH FINDINGS MAP
(EXPLOSIVE STATUS UNKNOWN)

NAVWPNSTA SEAL BEACH
DETACHMENT FALLBROOK, CALIFORNIA

REVIEW: 0
AUTHOR: GFG
DCN: ECSD-2201-0014-0002
FILE NUMBER: 090122L3899.mxd

TETRA TECH EC, INC.




## LEGEND

- SITE INSPECTION SAMPLE
- EXISTING BARBED WIRE FENCELINE
- NEW FENCELINE
- ROAD/PAVED SURFACE
- STREAMS
- BUILDING

SAMPLE LOCATION → **SIS-001** (METAL CONCENTRATION IN mg/kg)
Arsenic = 0.96
Cadmium = 13.0
Vanadium = 59.4
Zinc = 42.8

NOTES:

[a] - THE DETECTION LIMIT FOR MERCURY IS GREATER THAN THE ESSL. THEREFORE, THE DETECTION LIMIT (1.0 mg/kg) IS THE SCREENING LEVEL

* - EXCEEDS MORE THAN ONE SCREENING LEVEL

EPA - US ENVIRONMENTAL PROTECTION AGENCY

ESSL - ECOLOGICAL SOIL SCREENING LEVEL

FD - FIELD DUPLICATE

J - ESTIMATED VALUE

mg/kg - MILLIGRAM PER KILOGRAM

NAVWPNSTA - NAVAL WEAPONS STATION

PRG - PRELIMINARY REMEDIATION GOAL

SIS - SITE INSPECTION SAMPLE

PURPLE TEXT - INDICATES ANALYTICAL RESULTS IN EXCEEDANCE OF THE 2004 EPA INDUSTRIAL PRGs.

BLUE TEXT - INDICATES ANALYTICAL RESULTS IN EXCEEDANCE OF THE 2004 EPA RESIDENTIAL PRGs.

GREEN TEXT - INDICATES ANALYTICAL RESULTS IN EXCEEDANCE OF THE EPA ESSLs.

100 0 100 200 Feet

Scale: 1" = 200'

N

NAVAL FACILITIES ENGINEERING COMMAND, SOUTHWEST
SAN DIEGO, CA

SITE INSPECTION REPORT

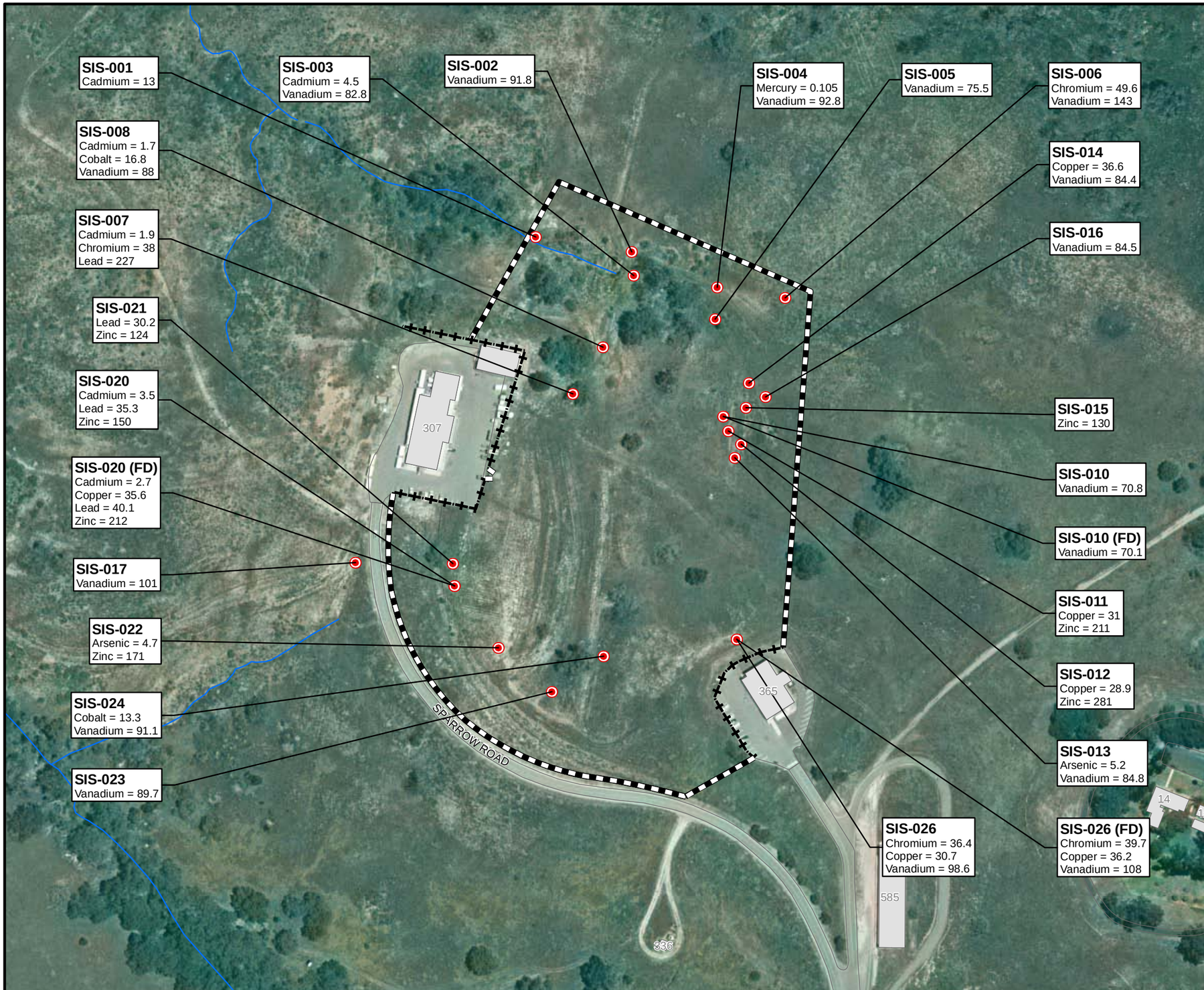
FIGURE 4-6

SITE INSPECTION SAMPLING RESULTS - METAL CONCENTRATIONS EXEEDING SCREENING LEVELS

NAVWPNSTA SEAL BEACH
DETACHMENT FALLBROOK, CALIFORNIA

REVIEW: 0
AUTHOR: GFG
DCN - ECSD-2201-0014-0002
FILE NUMBER: 090122L3900.mxd

TETRA TECH EC, INC.




## LEGEND

- SITE INSPECTION SAMPLE
- EXISTING BARBED WIRE FENCELINE
- NEW FENCELINE
- ROAD/PAVED SURFACE
- STREAMS
- BUILDING

SAMPLE LOCATION → **SIS-001** (Cadmium = 13.0) ← METAL CONCENTRATION IN mg/kg

NOTES:

FD - FIELD DUPLICATE

mg/kg - MILLIGRAM PER KILOGRAM

NAVWPNSTA - NAVAL WEAPONS STATION

SIS - SITE INSPECTION SAMPLE

100 0 100 200 Feet

Scale: 1" = 200'

N

NAVAL FACILITIES ENGINEERING
COMMAND, SOUTHWEST
SAN DIEGO, CA

SITE INSPECTION REPORT

FIGURE 4-7

SITE INSPECTION SAMPLING RESULTS -
METAL CONCENTRATIONS EXCEEDING
BACKGROUND CONCENTRATIONS
NAVWPNSTA SEAL BEACH
DETACHMENT FALLBROOK, CALIFORNIA

REVIEW: 0
AUTHOR: GFG
DCN: ECSD-2201-0014-0002
FILE NUMBER: 090122L3901.mxd

TETRA TECH EC, INC.

## LEGEND

- SITE INSPECTION SAMPLE
- EXISTING BARBED WIRE FENCELINE
- NEW FENCELINE
- ROAD/PAVED SURFACE
- STREAMS
- BUILDING

SAMPLE LOCATION → SIS-013 (1,3,5-TNB = 0.21)

CONSTITUENT CONCENTRATION IN mg/kg

NOTES:

1,3,5-TNB - 1,3,5-TRINITROBENZENE

FD - FIELD DUPLICATE

J - ESTIMATED VALUE

mg/kg - MILLIGRAM PER KILOGRAM

NAVWPNSTA - NAVAL WEAPONS STATION

SIS - SITE INSPECTION SAMPLE

100 0 100 200 Feet

Scale: 1" = 200'

N

NAVAL FACILITIES ENGINEERING COMMAND, SOUTHWEST
SAN DIEGO, CA

SITE INSPECTION REPORT

FIGURE 4-8

SITE INSPECTION SAMPLING RESULTS - MUNITIONS CONSTITUENTS DETECTIONS

NAVWPNSTA SEAL BEACH
DETACHMENT FALLBROOK, CALIFORNIA

REVIEW: 0
AUTHOR: GFG
DCN: ECSD-2201-0014-0002
FILE NUMBER: 090122L3902.mxd

TETRA TECH EC, INC.

**TABLE 4-1**

**SITE INSPECTION SAMPLE RESULTS SUMMARY**

| Sample Location | | | | | SIS-001 | SIS-002 | SIS-003 | SIS-004 | SIS-005 | SIS-006 | SIS-007 | SIS-008 | SIS-009 | SIS-010 | SIS-010 (FD) | SIS-011 | SIS-012 | SIS-013 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Date | | | | | 4/11/2007 | 4/11/2007 | 4/11/2007 | 4/12/2007 | 4/12/2007 | 4/12/2007 | 4/11/2007 | 4/11/2007 | 4/12/2007 | 4/12/2007 | 4/12/2007 | 4/12/2007 | 4/12/2007 | 4/12/2007 |
| Sample Depth (inches below ground surface) | | | | | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" |
| Sampling Number | | | | | 14-001 | 14-002 | 14-003 | 14-004 | 14-005 | 14-006 | 14-007 | 14-008 | 14-009 | 14-010 | 14-029 | 14-011 | 14-012 | 14-013 |
| **Analyte** | **Unit** | **Residential PRGs[1]** | **Industrial PRGs[1]** | **ESSLs** | | | | | | | | | | | | | | |
| *Metals* | | | | | | | | | | | | | | | | | | |
| Antimony | mg/kg | 31 | 410 | 0.29 [2] | 0.022 U | 0.022 U | 0.021 U | 0.022 U | 0.052 J | 0.023 U | 0.022 U | 0.023 U | 0.048 J | 0.023 U | 0.023 U | 0.022 U | 0.023 U | 0.023 U |
| Arsenic | mg/kg | 0.062 [4] | 0.25 | 18 [2] | 0.96 | 1.0 | 1.3 | 1.5 | 0.91 | 1.1 | 1.5 | 1.1 | 0.69 | 0.90 | 0.82 | 1.6 | 2.7 | 5.2 |
| Barium | mg/kg | 5400 | 67,000 | 330 [2] | 156 | 130 | 119 | 102 | 113 | 95.6 | 103 | 151 | 81.9 J | 102 | 103 | 84.5 J | 93.3 | 118 |
| Beryllium | mg/kg | 150 | 1,900 | 36 [2] | 0.061 J | 0.19 J | 0.054 J | 0.16 J | 0.05 J | 0.27 J | 0.044 U | 0.046 U | 0.15 J | 0.14 J | 0.19 J | 0.17 J | 0.16 J | 0.14 J |
| Cadmium | mg/kg | 37 | 450 | 0.38 [2] | 13.0 | 0.20 J | 4.5 | 0.24 J | 0.81 | 0.21 J | 1.9 | 1.7 | 0.18 J | 0.19 J | 0.17 J | 0.28 J | 0.39 J | 0.25 J |
| Chromium | mg/kg | 210 [5] | 450 | 26 [2] | 18.6 | 25.1 | 25.7 | 29.8 | 23.1 | 49.6 | 38.0 | 27.4 | 17.2 | 21.7 | 20.8 | 20.5 | 21.4 | 25.9 |
| Cobalt | mg/kg | 900 | 1,900 | 13 [2] | 7.8 | 12.4 | 12.2 | 11.8 | 12.7 | 12.4 | 10.2 | 16.8 | 9.5 | 12.0 | 11.4 | 9.9 | 10.8 | 13.0 |
| Copper | mg/kg | 3,100 | 41,000 | 28 [2] | 14.1 | 19.6 | 20.4 | 23.0 | 24.2 | 23.5 | 21.3 | 18.8 | 13.5 | 21.2 | 20.0 | 31.0 | 28.9 | 24.7 |
| Lead | mg/kg | 150 [4] | 800 | 16 [2] | 4.5 | 6.4 | 19.4 | 5.8 | 11.0 | 7.4 | 227 | 19.1 | 7.0 | 8.3 | 8.0 | 13.7 | 12.3 | 6.6 |
| Mercury | mg/kg | 23 | 310 | 0.00051 [3] | 0.104 U | 0.104 U | 0.103 U | 0.105 | 0.104 U | 0.104 U | 0.102 U | 0.105 U | 0.111 U | 0.105 U | 0.102 U | 0.103 U | 0.102 U | 0.102 U |
| Molybdenum | mg/kg | 390 | 5,100 | 2 [3] | 0.15 J | 0.087 J | 0.24 J | 0.17 J | 0.23 J | 0.28 J | 0.27 J | 0.18 J | 0.19 J | 0.21 J | 0.18 J | 0.42 J | 0.75 | 0.53 |
| Nickel | mg/kg | 1,600 | 20,000 | 30 [3] | 5.0 | 7.3 | 6.8 | 7.2 | 6.7 | 6.7 | 4.5 | 7.9 | 5.2 | 6.5 | 6.4 | 6.2 | 6.3 | 7.2 |
| Selenium | mg/kg | 390 | 5,300 | 0.21 [3] | 0.075 U | 0.077 U | 0.073 U | 0.075 U | 0.074 U | 0.078 U | 0.077 U | 0.079 U | 0.086 U | 0.079 U | 0.078 U | 0.077 U | 0.078 U | 0.079 U |
| Silver | mg/kg | 390 | 5,100 | 2 [3] | 0.036 U | 0.037 U | 0.036 U | 0.035 U | 0.037 U | 0.036 U | 0.035 U | 0.036 U | 0.038 U | 0.037 U | 0.037 U | 0.036 U | 0.036 U | 0.035 U |
| Thallium | mg/kg | 5.2 | 67 | 1 [3] | 0.13 J | 0.17 J | 0.24 J | 0.17 J | 0.22 J | 0.1 J | 0.20 J | 0.22 J | 0.17 J | 0.22 J | 0.20 J | 0.16 J | 0.16 J | 0.19 J |
| Vanadium | mg/kg | 78 | 1,000 | 7.8 [3] | 59.4 | 91.8 | 82.8 | 92.8 | 75.5 | 143 | 57.1 | 88.0 | 56.0 | 70.8 | 70.1 | 57.3 | 63.3 | 84.8 |
| Zinc | mg/kg | 23,000 | 100,000 | 8.5 [3] | 42.8 | 29.3 | 70.8 | 30.5 | 56.9 | 26.4 | 95.5 | 65.9 | 25.5 | 45.3 | 54.1 | 211 | 281 | 96.0 |
| *Explosives/Perchlorate* | | | | | | | | | | | | | | | | | | |
| HMX | mg/kg | 3,100 | 31,000 | 50 [6] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| RDX | mg/kg | 4.4 | 16 | 15 [6] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| 1,3,5-Trinitrobenzene | mg/kg | 1,800 | 18,000 | 1.38 [6] | 0.20 U | 0.20 | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.33 | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.21 |
| Nitrobenzene | mg/kg | 20 | 100 | 226 [7] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| Tetryl (Methyl-2,4,6-trinitrophyenylnitramine) | mg/kg | 610 | 6,200 | 25 [6] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| TNT | mg/kg | 16 | 57 | 30 [6] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| 4-Amino-2,6-dinitrotoluene | mg/kg | 0.2 [8] | 0.20 | 80 [6] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| 2-Amino-4,6-dinitrotoluene | mg/kg | 0.2 [8] | 0.20 | 80 [6] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| 2,6-Dinitrotoluene | mg/kg | 61 | 620 | 3.2 [9] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| 2,4-Dinitrotoluene | mg/kg | 120 | 1,200 | 3.2 [9] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| 2-Nitrotoluene | mg/kg | 0.88 | 2.2 | N/A | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| 4-Nitrotoluene | mg/kg | 12 | 30 | N/A | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| 3-Nitrotoluene | mg/kg | 730 | 1,000 | N/A | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| 1,3-Dinitrobenzene | mg/kg | 6.1 | 62 | 0.41 [6] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| Perchlorate | mg/kg [10] | 7.8 | 100 | 10 [9] | 0.01 U | 0.01 U | 0.0098 U | 0.01 U | 0.01 U | 0.01 U | 0.0094 U | 0.01 U | 0.011 U | 0.01 U | 0.01 U | 0.0098 U | 0.0099 U | 0.01 U |

**TABLE 4-1**

**SITE INSPECTION SAMPLE RESULTS SUMMARY**

***Notes:***

[1] Reference: EPA Region IX PRG Table, October 2004, http://www.epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf.

[2] Reference: EPA ESSL, http://www.epa.gov/ecotox/ecossl.

[3] Reference: Efroymson, R.A., G.W. Suter II, B.E. Sample and D.S. Jones. 1997. Preliminary Remediation Goals for Ecological Endpoints. Oak Ridge National Laboratories, Oak Ridge, TN ES/ER/TM-162/R2.

[4] The value listed is the California-EPA value that is the more stringent of the values listed in the 2004 PRG table.

[5] Listed value is for total chromium.

[6] Reference: Talmage, S.S., D.M. Opresko, C.J. Maxwell, C.J.E. Welsh, F.M. Cretella, P.H. Reno and F.B. Daniel. 1999. Nitroaromatic Munition Compounds: Environmental Effects and Screening Values. *Rev. Environ. Contam. Toxicol.* 161:1-156.

[7] Reference: Neuhauser, E.F., P.R. Durkin, M.R. Malecki, and M. Anatra. 1986. Comparative Toxicity of Ten Organic Chemicals to Four Earthworm Species. *Comp. Biochem. Physiol. C.* 83(1):197-200. ECOTOX Database.

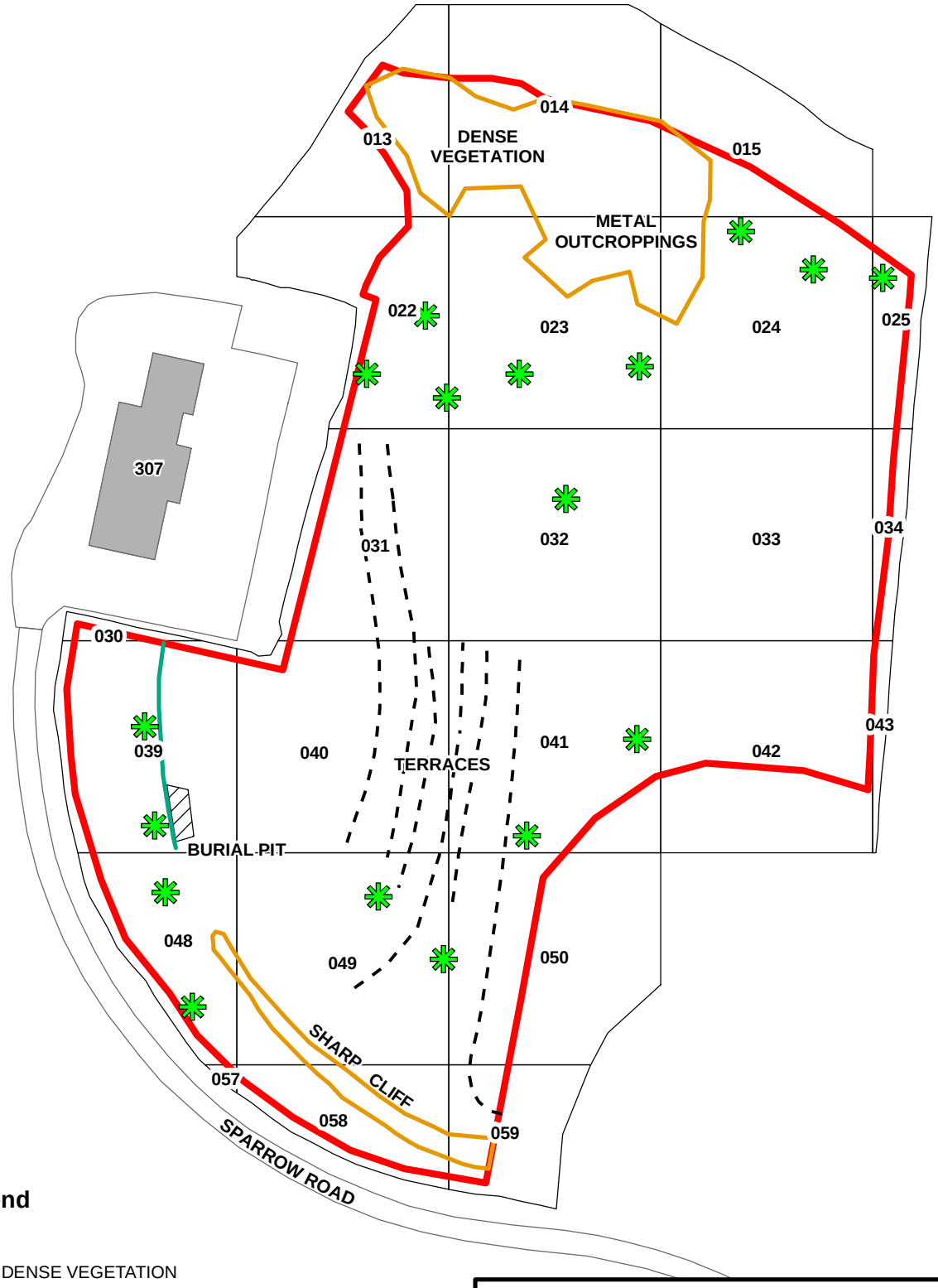
[8] No PRG value was available for this compounds, so the laboratory's analytical method quantitation limit was used.

[9] Reference: Adema, D.M.M., and L. Henzen. 1989. A Comparison of Plant Toxicities of Some Industrial Chemicals in Soil Culture and Soilless Culture. *Ecotoxicol. Environ. Saf.* (18(2):219-229. ECOTOX Database.

[10] The units in the Final Sampling and Analysis Plan (TtEC, 2007) for perchlorate in Table A.7-1 were reported incorrectly as µg/kg. The correct units are presented in this table as mg/kg.

***Abbreviations and Acronyms:***

EPA - US Environmental Protection Agency
ESSL - ecological soil screening level
FD - field duplicate
HMX - octahydro-1,2,5,7-tetranitro-1,3,5,7-tetrazocine
J - estimated value
mg/kg - milligrams per kilogram
N/A - not applicable
NC - not calculable
PRG - Preliminary Remediation Goal
RDX - hexahydro-1,3,5-trinitro-1,3,5-trazine
TNT - 2,4,6-Trinitrotoluene
U - not detected
Highlighted values exceed ESSLs
Highlighted values exceed Residential PRGs
Highlighted values exceed Industrial PRGs




**Legend**

- DENSE VEGETATION
- CONCRETE RETAINING WALL
- MRP SITE UXO5 BOUNDARY
- AREA WHERE SURFACE CLEARANCE WAS NOT CONDUCTED
- BUILDING
- ROAD

75 0 75 150 Feet

N

TIME-CRITICAL REMOVAL ACTION, SITE UXO5

FIGURE 4-1

SURFACE CLEARANCE MAP

NAVWPNSTA SEAL BEACH
DETACHMENT FALLBROOK, CALIFORNIA

REVIEW: A
AUTHOR: MS
FILE NUMBER: SEST124R7549.mxd

TETRATECH EC, INC.

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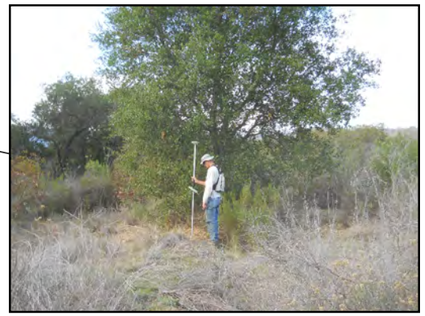
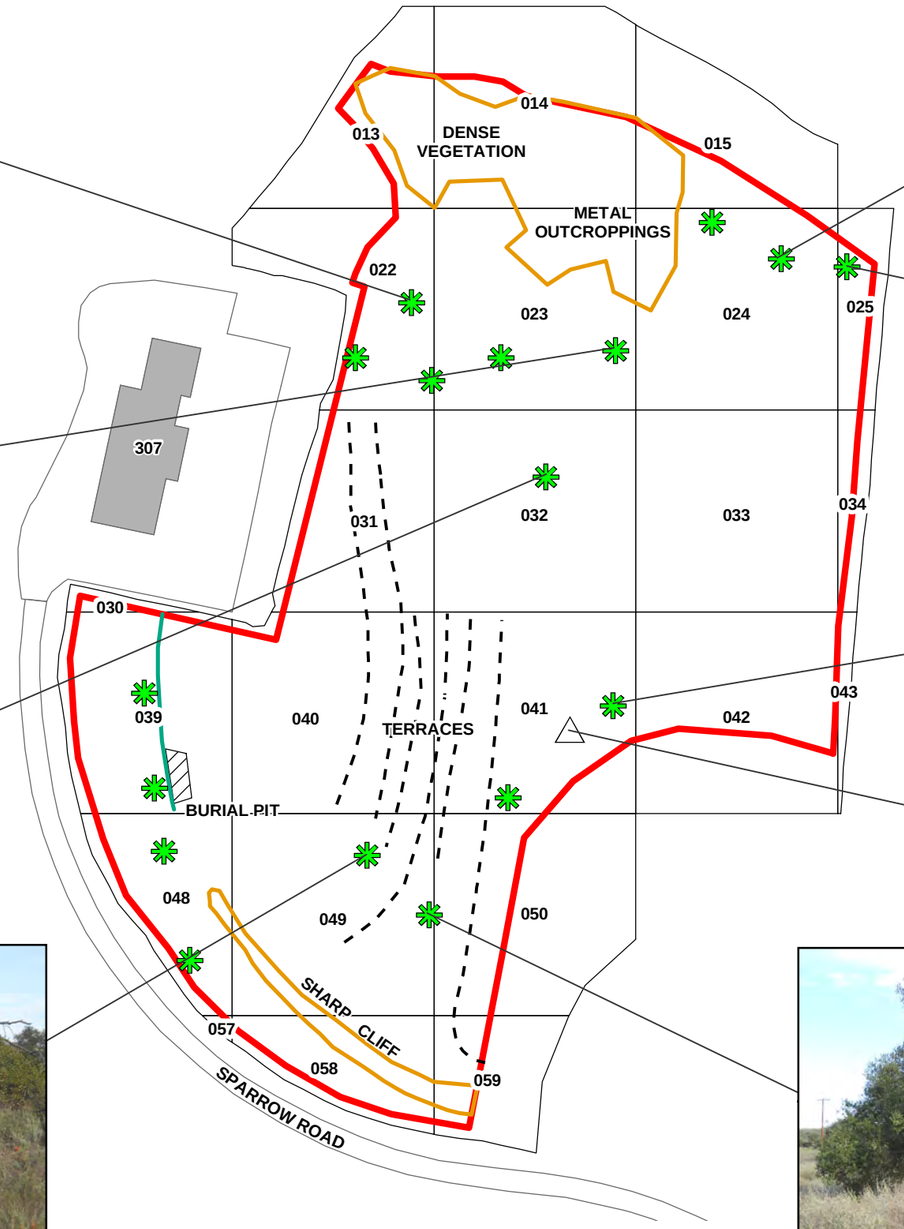





**Legend**

- TALL SHRUB AREA
- DENSE VEGETATION
- CONCRETE RETAINING WALL
- AREA WHERE SURFACE CLEARANCE WAS NOT CONDUCTED
- MRP SITE UXO5 BOUNDARY
- BUILDING
- ROAD

75 0 75 150 Feet

N

TIME-CRITICAL REMOVAL ACTION, SITE UXO5

FIGURE 4-2

VEGETATION FEATURES

NAVWPNSTA SEAL BEACH
DETACHMENT FALLBROOK, CALIFORNIA

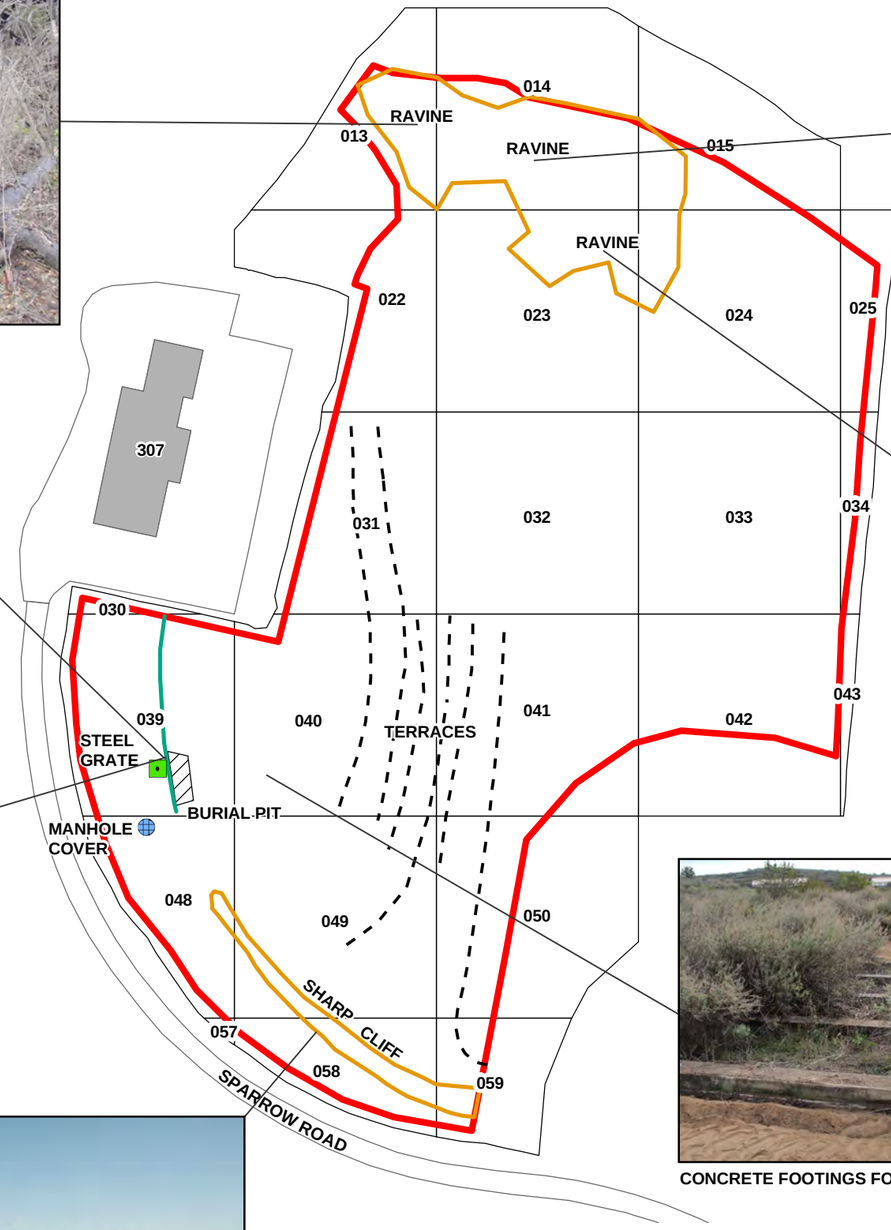
REVIEW: A
AUTHOR: MS
FILE NUMBER: SEST124R7550.mxd

TETRATECH EC, INC.

RAVINE DEBRIS

POST RESTORATION VIEW OF EXPOSED BURIAL PIT

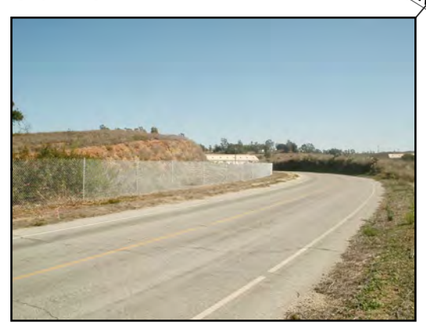
EXPOSED BURIAL PIT DURING RESTORATION



RAVINE DEBRIS

RAVINE DEBRIS

CONCRETE FOOTINGS FOR FORMER BUILDING



VIEW OF SHARP CLIFF FROM ACROSS SPARROW ROAD

**Legend**

- CONCRETE RETAINING WALL
- MRP SITE UXO5 BOUNDARY
- AREA WHERE SURFACE CLEARANCE WAS NOT CONDUCTED
- MANHOLE COVER
- STEEL GRATE
- BUILDING
- ROAD

75 0 75 150 Feet

N

TIME-CRITICAL REMOVAL ACTION, SITE UXO5

FIGURE 4-3

SITE FEATURES MAP

NAVWPNSTA SEAL BEACH
DETACHMENT FALLBROOK, CALIFORNIA

REVIEW: A
AUTHOR: MS
FILE NUMBER: SEST124R7551.mxd

TETRATECH EC, INC.

**TABLE 4-1**

**SITE INSPECTION SAMPLE RESULTS SUMMARY**

| Sample Location | | | | | SIS-014 | SIS-015 | SIS-016 | SIS-017 | SIS-018 | SIS-019 | SIS-020 | SIS-020 (FD) | SIS-021 | SIS-022 | SIS-023 | SIS-024 | SIS-025 | SIS-026 | SIS-026 (FD) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Date | | | | | 4/12/2007 | 4/12/2007 | 4/12/2007 | 4/12/2007 | 4/11/2007 | 4/11/2007 | 4/11/2007 | 4/11/2007 | 4/11/2007 | 4/11/2007 | 4/11/2007 | 4/11/2007 | 4/11/2007 | 4/11/2007 | 4/11/2007 |
| Sample Depth (inches below ground surface) | | | | | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" | 0 - 9" |
| Sampling Number | | | | | 14-014 | 14-015 | 14-016 | 14-017 | 14-018 | 14-019 | 14-020 | 14-027 | 14-021 | 14-022 | 14-023 | 14-024 | 14-025 | 14-026 | 14-028 |
| **Analyte** | **Unit** | **Residential PRGs[1]** | **Industrial PRGs[1]** | **ESSLs** | | | | | | | | | | | | | | | |
| *Metals* | | | | | | | | | | | | | | | | | | | |
| Antimony | mg/kg | 31 | 410 | 0.29 [2] | 0.024 U | 0.12 J | 0.022 U | 0.021 U | 0.052 J | 0.068 J | 0.33 J | 0.15 J | 0.09 J | 0.049 J | 0.022 U | 0.023 U | 0.020 U | 0.019 U | 0.022 U |
| Arsenic | mg/kg | 0.062 [4] | 0.25 | 18 [2] | 0.94 | 0.84 | 0.84 | 0.86 | 1.0 | 1.3 | 1.9 | 1.9 | 4.2 | 4.7 | 0.90 | 1.0 | 4.4 | 1.0 | 1.1 |
| Barium | mg/kg | 5400 | 67,000 | 330 [2] | 136 | 102 | 127 | 60.5 J | 93.8 | 172 | 84.1 | 115 | 61.3 | 56.5 | 120 | 151 | 73.6 | 114 | 147 |
| Beryllium | mg/kg | 150 | 1,900 | 36 [2] | 0.083 J | 0.10 J | 0.097 J | 0.17 J | 0.046 U | 0.045 U | 0.044 U | 0.046 U | 0.13 J | 0.072 J | 0.041 U | 0.047 U | 0.21 J | 0.062 J | 0.10 J |
| Cadmium | mg/kg | 37 | 450 | 0.38 [2] | 0.28 J | 0.20 J | 0.2 J | 0.13 J | 0.54 | 0.5 | 3.5 | 2.7 | 1.2 | 0.63 | 0.14 J | 0.17 J | 0.81 | 0.13 J | 0.16 J |
| Chromium | mg/kg | 210 [5] | 450 | 26 [2] | 28.2 | 19.1 | 24.3 | 14.1 | 14.8 | 13 | 12.4 | 14.4 | 7.8 | 9.9 | 29.0 | 32.9 | 6.8 | 36.4 | 39.7 |
| Cobalt | mg/kg | 900 | 1,900 | 13 [2] | 13.0 | 11.0 | 12.0 | 7.8 | 9.1 | 12.3 | 6.7 | 8.9 | 6.3 | 5.8 | 11.8 | 13.3 | 7.0 | 10.9 | 12.6 |
| Copper | mg/kg | 3,100 | 41,000 | 28 [2] | 36.6 | 22.7 | 24.8 | 12.4 | 20.5 | 21.6 | 23.3 | 35.6 | 22.9 | 22.7 | 18.7 | 25.8 | 7.4 | 30.7 | 36.2 |
| Lead | mg/kg | 150 [4] | 800 | 16 [2] | 8.3 | 9.9 | 7.8 | 5.4 | 16.4 | 12.7 | 35.3 | 40.1 | 30.2 | 12.0 | 8.4 | 7.3 | 6.1 | 4.5 | 5.0 |
| Mercury | mg/kg | 23 | 310 | 0.00051 [3] | 0.105 U | 0.106 U | 0.102 U | 0.101 U | 0.102 U | 0.102 U | 0.102 U | 0.102 U | 0.101 U | 0.102 U | 0.102 U | 0.103 U | 0.102 U | 0.103 U | 0.102 U |
| Molybdenum | mg/kg | 390 | 5,100 | 2 [3] | 0.14 J | 0.23 J | 0.19 J | 0.098 J | 0.25 J | 0.25 J | 0.5 | 0.43 | 0.49 | 1.4 | 0.27 J | 0.20 J | 0.34 J | 0.19 J | 0.20 J |
| Nickel | mg/kg | 1,600 | 20,000 | 30 [3] | 9.4 | 6.3 | 7.0 | 3.3 J | 4.6 | 5 | 3.9 | 5.1 | 2.5 J | 2.3 J | 6.2 | 7.8 | 2.5 J | 7.9 | 9.5 |
| Selenium | mg/kg | 390 | 5,300 | 0.21 [3] | 0.082 U | 0.082 U | 0.14 J | 0.11 J | 0.063 U | 0.067 U | 0.072 U | 0.076 J | 0.36 J | 0.15 J | 0.075 U | 0.079 U | 0.23 J | 0.066 U | 0.077 U |
| Silver | mg/kg | 390 | 5,100 | 2 [3] | 0.037 U | 0.034 U | 0.036 U | 0.035 U | 0.036 U | 0.036 U | 0.035 U | 0.036 U | 0.036 U | 0.035 U | 0.032 U | 0.037 U | 0.036 U | 0.036 U | 0.036 U |
| Thallium | mg/kg | 5.2 | 67 | 1 [3] | 0.22 J | 0.17 J | 0.21 J | 0.10 J | 0.27 J | 0.25 J | 0.23 J | 0.25 J | 0.34 J | 0.26 J | 0.22 J | 0.22 J | 0.42 | 0.11 J | 0.15 J |
| Vanadium | mg/kg | 78 | 1,000 | 7.8 [3] | 84.4 | 56.2 | 84.5 | 101 | 46.8 | 60.8 | 32.6 | 45.0 | 28.6 | 35.3 | 89.7 | 91.1 | 38 | 98.6 | 108 |
| Zinc | mg/kg | 23,000 | 100,000 | 8.5 [3] | 64.3 | 130 | 43.9 | 30.2 | 84.7 | 65.3 | 150 | 212 | 124 | 171 | 31.0 | 33.4 | 50.6 | 27.4 | 32.4 |
| *Explosives/Perchlorate* | | | | | | | | | | | | | | | | | | | |
| HMX | mg/kg | 3,100 | 31,000 | 50 [6] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| RDX | mg/kg | 4.4 | 16 | 15 [6] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| 1,3,5-Trinitrobenzene | mg/kg | 1,800 | 18,000 | 1.38 [6] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.62 | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| Nitrobenzene | mg/kg | 20 | 100 | 226 [7] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| Tetryl (Methyl-2,4,6-trinitrophyenylnitramine) | mg/kg | 610 | 6,200 | 25 [6] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| TNT | mg/kg | 16 | 57 | 30 [6] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| 4-Amino-2,6-dinitrotoluene | mg/kg | 0.2 [8] | 0.20 | 80 [6] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| 2-Amino-4,6-dinitrotoluene | mg/kg | 0.2 [8] | 0.20 | 80 [6] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| 2,6-Dinitrotoluene | mg/kg | 61 | 620 | 3.2 [9] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| 2,4-Dinitrotoluene | mg/kg | 120 | 1,200 | 3.2 [9] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| 2-Nitrotoluene | mg/kg | 0.88 | 2.2 | N/A | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| 4-Nitrotoluene | mg/kg | 12 | 30 | N/A | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| 3-Nitrotoluene | mg/kg | 730 | 1,000 | N/A | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| 1,3-Dinitrobenzene | mg/kg | 6.1 | 62 | 0.41 [6] | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| Perchlorate | mg/kg [10] | 7.8 | 100 | 10 [9] | 0.01 U | 0.01 U | 0.0098 U | 0.0092 U | 0.01 U | 0.01 U | 0.01 U | 0.0099 U | 0.0096 U | 0.01 U | 0.0095 U | 0.0099 U | 0.0098 U | 0.0098 U | 0.01 U |

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# TABLE 4-2

## METAL CONCENTRATIONS DETECTED AT MRP SITE UXO5

| Analyte | Background Concentration[a] (mg/kg) | Minimum Detected Concentration (mg/kg) | Maximum Detected Concentration (mg/kg) |
|---|---|---|---|
| Antimony | 8.76 | ND | 0.33 |
| Arsenic | 4.61 | 0.69 | 5.2 |
| Barium | 262 | 56.5 | 172 |
| Beryllium | 1.52 | ND | 0.27 |
| Cadmium | 1.58 | 0.13 | 13 |
| Chromium | 33.0 | 6.8 | 49.6 |
| Cobalt | 13.3 | 5.8 | 16.8 |
| Copper | 26.8 | 7.4 | 36.6 |
| Lead | 29.1 | 4.5 | 227 |
| Mercury | 0.08 | ND | 0.105 |
| Molybdenum | 7.36 | 0.087 | 1.4 |
| Nickel | 22.5 | 4.5 | 9.5 |
| Selenium | 0.78 | ND | 0.36 |
| Silver | 1.36 | ND | ND |
| Thallium | 1.35 | 0.10 | 0.42 |
| Vanadium | 69.4 | 28.6 | 143 |
| Zinc | 111 | 25.5 | 281 |

***Notes:***

[a] Reference: Jacobs, 1997. The source of the background values is the Santa Margarita watershed.

***Abbreviations and Acronyms:***

mg/kg – milligrams per kilogram
ND – not detected above the laboratory reporting limit

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# TABLE 5-1

## SITE INSPECTION SAMPLE RESULTS COMPARISON

| Analyte | Unit | Residential PRGs[1] | Industrial PRGs[1] | ESSLs | Background Concentrations[10] | Maximum Detection | Max Above Residential PRG? | Max Above Industrial PRG? | Max Above Screening Level? | Max Above Background? |
|---|---|---|---|---|---|---|---|---|---|---|
| *Metals* | | | | | | | | | | |
| Antimony | mg/kg | 31 | 410 | 0.29 [2] | 8.76 | 0.33 | No | No | Yes | No |
| Arsenic | mg/kg | 0.062 [4] | 0.25 | 18 [2] | 4.61 | 5.2 | Yes | Yes | No | Yes |
| Barium | mg/kg | 5400 | 67,000 | 330 [2] | 262 | 172 | No | No | No | No |
| Beryllium | mg/kg | 150 | 1,900 | 36 [2] | 1.52 | 0.27 | No | No | No | No |
| Cadmium | mg/kg | 37 | 450 | 0.38 [2] | 1.58 | 13 | No | No | Yes | Yes |
| Chromium | mg/kg | 210 [5] | 450 | 26 [2] | 33 | 49.6 | No | No | Yes | Yes |
| Cobalt | mg/kg | 900 | 1,900 | 13 [2] | 13.3 | 16.8 | No | No | Yes | Yes |
| Copper | mg/kg | 3,100 | 41,000 | 28 [2] | 27 | 36.6 | No | No | Yes | Yes |
| Lead | mg/kg | 150 [4] | 800 | 16 [2] | 29.1 | 227 | Yes | No | Yes | Yes |
| Mercury | mg/kg | 23 | 310 | 0.00051 [3] | 0.08 | 0.105 | No | No | Yes | Yes |
| Molybdenum | mg/kg | 390 | 5,100 | 2 [3] | 7.36 | 1.4 | No | No | No | No |
| Nickel | mg/kg | 1,600 | 20,000 | 30 [3] | 22.5 | 9.5 | No | No | No | No |
| Selenium | mg/kg | 390 | 5,300 | 0.21 [3] | 0.78 | 0.36 | No | No | Yes | No |
| Silver | mg/kg | 390 | 5,100 | 2 [3] | 1.36 | ND | N/A | N/A | N/A | N/A |
| Thallium | mg/kg | 5.2 | 67 | 1 [3] | 1.35 | 0.42 | No | No | No | No |
| Vanadium | mg/kg | 78 | 1,000 | 7.8 [3] | 69.4 | 143 | Yes | No | Yes | Yes |
| Zinc | mg/kg | 23,000 | 100,000 | 8.5 [3] | 111 | 281 | No | No | Yes | Yes |
| *Explosives/Perchlorate* | | | | | | | | | | |
| HMX | mg/kg | 3,100 | 31,000 | 50 [6] | N/A | ND | | N/A | N/A | N/A |
| RDX | mg/kg | 4.4 | 16 | 15 [6] | N/A | ND | N/A | N/A | N/A | N/A |
| 1,3,5-Trinitrobenzene | mg/kg | 1,800 | 18,000 | 1.38 [6] | N/A | 0.62 | No | No | No | N/A |
| Nitrobenzene | mg/kg | 20 | 100 | 226 [7] | N/A | ND | N/A | N/A | N/A | N/A |
| Tetryl (Methyl-2,4,6-trinitrophyenylnitramine) | mg/kg | 610 | 6,200 | 25 [6] | N/A | ND | N/A | N/A | N/A | N/A |
| TNT | mg/kg | 16 | 57 | 30 [6] | N/A | ND | N/A | N/A | N/A | N/A |
| 4-Amino-2,6-dinitrotoluene | mg/kg | 0.2 [8] | 0.20 | 80 [6] | N/A | ND | N/A | N/A | N/A | N/A |
| 2-Amino-4,6-dinitrotoluene | mg/kg | 0.2 [8] | 0.20 | 80 [6] | N/A | ND | N/A | N/A | N/A | N/A |
| 2,6-Dinitrotoluene | mg/kg | 61 | 620 | 3.2 [9] | N/A | ND | N/A | N/A | N/A | N/A |
| 2,4-Dinitrotoluene | mg/kg | 120 | 1,200 | 3.2 [9] | N/A | ND | N/A | N/A | N/A | N/A |
| 2-Nitrotoluene | mg/kg | 0.88 | 2.2 | N/A | N/A | ND | N/A | N/A | N/A | N/A |
| 4-Nitrotoluene | mg/kg | 12 | 30 | N/A | N/A | ND | N/A | N/A | N/A | N/A |
| 3-Nitrotoluene | mg/kg | 730 | 1,000 | N/A | N/A | ND | N/A | N/A | N/A | N/A |
| 1,3-Dinitrobenzene | mg/kg | 6.1 | 62 | 0.41 [6] | N/A | ND | N/A | N/A | N/A | N/A |
| Perchlorate | mg/kg | 7.8 | 100 | 10 [9] | N/A | ND | N/A | N/A | N/A | N/A |

***Notes:***

[1] Reference: EPA Region IX PRG Table, October 2004, http://www.epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf.
[2] Reference: EPA ESSL, http://www.epa.gov/ecotox/ecossl.
[3] Reference: Efroymson, R.A., G.W. Suter II, B.E. Sample and D.S. Jones. 1997. Preliminary Remediation Goals for Ecological Endpoints. Oak Ridge National Laboratories, Oak Ridge, TN ES/ER/TM-162/R2.
[4] The value listed is the California EPA value that is more stringent of the values listed in the 2004 PRG table.
[5] Listed value is for total chromium.
[6] Reference: Talmage, S.S., D.M. Opresko, C.J. Maxwell, C.J.E. Welsh, F.M. Cretella, P.H. Reno, and F.B. Daniel. 1999. Nitroaromatic Munition Compounds: Environmental Effects and Screening Values. *Rev. Environ. Contam. Toxicol.* 161:1-156.
[7] Reference: Neuhauser, E.F., P.R. Durkin, M.R. Malecki, and M. Anatra. 1986. Comparative Toxicity of Ten Organic Chemicals to Four Earthworm Species. *Comp. Biochem. Physiol.* C. 83(1):197-200. ECOTOX Database.
[8] No PRG value was available for this compounds, so the laboratory's analytical method quantitation limit was used.
[9] Reference: Adema, D.M.M. and L. Henzen. 1989. A Comparison of Plant Toxicities of Some Industrial Chemicals in Soil Culture and Soilless Culture. *Ecotoxicol. Environ. Saf.* (18(2):219-229. ECOTOX Database.
[10] Background concentrations are from Remedial Investigation/Feasibility Study for Group D Sites, Marine Corps Base, Camp Pendleton, CA, July 16, 1997 (Jacobs, 1997)

***Abbreviations and Acronyms:***

EPA - U.S. Environmental Protection Agency
ESSL - ecological soil screening level
HMX - octahydro-1,2,5,7-tetranitro-1,3,5,7-tetrazocine
mg/kg - milligrams per kilogram
N/A - not applicable
ND - not detected
PRG - Preliminary Remediation Goal
RDX - hexahydro-1,3,5-trinitro-1,3,5-trazine
TNT - 2,4,6-Trinitrotoluene

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# TABLE 5-2

## SAMPLE LOCATIONS AND RESULTS ASSOCIATED WITH EXCEEDANCES OF ONE OR MORE RISK-BASED SCREENING VALUES

| Compound | Risk-Based Screening Value that was Exceeded | Risk-Based Screening Value (mg/kg) | Detected Concentration (mg/kg) | Sample Location |
|---|---|---|---|---|
| Antimony | ESSL [2] | 0.29 | 0.33 | SIS-014 |
| Arsenic [4] | Residential PRG, Industrial PRG [1] | 0.062, 0.25 | 0.69 | SIS-009 |
| | | | 0.82 | SIS-010 |
| | | | 0.84 | SIS-015 |
| | | | 0.84 | SIS-016 |
| | | | 0.86 | SIS-017 |
| | | | 0.90 | SIS-010 |
| | | | 0.90 | SIS-023 |
| | | | 0.91 | SIS-005 |
| | | | 0.94 | SIS-014 |
| | | | 0.96 | SIS-001 |
| | | | 1.0 | SIS-002 |
| | | | 1.0 | SIS-018 |
| | | | 1.0 | SIS-024 |
| | | | 1.0 | SIS-026 |
| | | | 1.1 | SIS-006 |
| | | | 1.1 | SIS-008 |
| | | | 1.1 | SIS-026 |
| | | | 1.3 | SIS-003 |
| | | | 1.3 | SIS-019 |
| | | | 1.5 | SIS-004 |
| | | | 1.5 | SIS-007 |
| | | | 1.6 | SIS-011 |
| | | | 1.9 | SIS-020 |
| | | | 1.9 | SIS-020 |
| | | | 2.7 | SIS-012 |
| | | | 4.2 | SIS-021 |
| | | | 4.4 | SIS-025 |
| | | | 4.7 | SIS-022 |
| | | | 5.2 | SIS-013 |

# TABLE 5-2

## SAMPLE LOCATIONS AND RESULTS ASSOCIATED WITH EXCEEDANCES OF ONE OR MORE RISK-BASED SCREENING VALUES

| Compound | Risk-Based Screening Value that was Exceeded | Risk-Based Screening Value (mg/kg) | Detected Concentration (mg/kg) | Sample Location |
|---|---|---|---|---|
| Cadmium | ESSL [2] | 0.38 | 0.39 | SIS-012 |
| | | | 0.50 | SIS-019 |
| | | | 0.54 | SIS-018 |
| | | | 0.63 | SIS-022 |
| | | | 0.81 | SIS-005 |
| | | | 0.81 | SIS-025 |
| | | | 1.2 | SIS-021 |
| | | | 1.7 | SIS-008 |
| | | | 1.9 | SIS-007 |
| | | | 2.7 | SIS-020 |
| | | | 3.5 | SIS-020 |
| | | | 4.5 | SIS-003 |
| | | | 13.0 | SIS-001 |
| Chromium [5] | ESSL [2] | 26 | 27.4 | SIS-008 |
| | | | 28.3 | SIS-014 |
| | | | 29.0 | SIS-023 |
| | | | 29.8 | SIS-004 |
| | | | 32.9 | SIS-024 |
| | | | 36.4 | SIS-026 |
| | | | 38.0 | SIS-007 |
| | | | 39.7 | SIS-026 |
| | | | 49.6 | SIS-006 |
| Cobalt | ESSL [2] | 13 | 13.0 | SIS-013 |
| | | | 13.3 | SIS-024 |
| | | | 16.8 | SIS-008 |
| Copper | ESSL [2] | 28 | 28.9 | SIS-012 |
| | | | 30.7 | SIS-026 |
| | | | 31.0 | SIS-011 |
| | | | 35.6 | SIS-020 |
| | | | 36.2 | SIS-026 |
| | | | 36.6 | SIS-014 |
| Lead [4] | ESSL [2] | 16 | 16.4 | SIS-018 |
| | | | 19.1 | SIS-008 |
| | | | 19.4 | SIS-003 |
| | | | 30.2 | SIS-021 |
| | | | 35.3 | SIS-020 |
| | | | 40.1 | SIS-020 |
| | Residential PRG [1] | 150 | 227 | SIS-007 |

# TABLE 5-2

## SAMPLE LOCATIONS AND RESULTS ASSOCIATED WITH EXCEEDANCES OF ONE OR MORE RISK-BASED SCREENING VALUES

| Compound | Risk-Based Screening Value that was Exceeded | Risk-Based Screening Value (mg/kg) | Detected Concentration (mg/kg) | Sample Location |
|---|---|---|---|---|
| Mercury | ESSL [3] | 0.00051 | 0.105 | SIS-004 |
| Selenium | ESSL [3] | 0.21 | 0.23 | SIS-025 |
| | | | 0.36 | SIS-021 |
| Vanadium | ESSL [3] | 7.8 | 28.6 | SIS-021 |
| | | | 32.6 | SIS-020 |
| | | | 35.3 | SIS-022 |
| | | | 38.0 | SIS-025 |
| | | | 45.0 | SIS-020 |
| | | | 46.8 | SIS-018 |
| | | | 56.0 | SIS-009 |
| | | | 56.2 | SIS-015 |
| | | | 57.1 | SIS-007 |
| | | | 57.3 | SIS-011 |
| | | | 59.4 | SIS-001 |
| | | | 60.8 | SIS-019 |
| | | | 63.3 | SIS-012 |
| | | | 70.1 | SIS-010 |
| | | | 70.8 | SIS-010 |
| | | | 75.5 | SIS-005 |
| | Residential PRG [1] | 78 | 82.8 | SIS-003 |
| | | | 84.4 | SIS-014 |
| | | | 84.5 | SIS-016 |
| | | | 84.8 | SIS-013 |
| | | | 88.0 | SIS-008 |
| | | | 89.7 | SIS-023 |
| | | | 91.1 | SIS-024 |
| | | | 91.8 | SIS-002 |
| | | | 92.8 | SIS-004 |
| | | | 98.6 | SIS-026 |
| | | | 101 | SIS-017 |
| | | | 108 | SIS-026 |
| | | | 143 | SIS-006 |

# TABLE 5-2

## SAMPLE LOCATIONS AND RESULTS ASSOCIATED WITH EXCEEDANCES OF ONE OR MORE RISK-BASED SCREENING VALUES

| Compound | Risk-Based Screening Value that was Exceeded | Risk-Based Screening Value (mg/kg) | Detected Concentration (mg/kg) | Sample Location |
|---|---|---|---|---|
| Zinc | ESSL [3] | 8.5 | 25.5 | SIS-009 |
| | | | 26.4 | SIS-006 |
| | | | 27.4 | SIS-026 |
| | | | 29.3 | SIS-002 |
| | | | 30.2 | SIS-017 |
| | | | 30.5 | SIS-004 |
| | | | 31.0 | SIS-023 |
| | | | 32.4 | SIS-026 |
| | | | 33.4 | SIS-024 |
| | | | 42.8 | SIS-001 |
| | | | 43.9 | SIS-016 |
| | | | 45.3 | SIS-010 |
| | | | 50.6 | SIS-025 |
| | | | 54.1 | SIS-010 |
| | | | 56.9 | SIS-005 |
| | | | 64.3 | SIS-014 |
| | | | 65.3 | SIS-019 |
| | | | 65.9 | SIS-008 |
| | | | 70.8 | SIS-003 |
| | | | 84.7 | SIS-018 |
| | | | 95.5 | SIS-007 |
| | | | 96.0 | SIS-013 |
| | | | 124 | SIS-021 |
| | | | 130 | SIS-015 |
| | | | 150 | SIS-020 |
| | | | 171 | SIS-022 |
| | | | 211 | SIS-011 |
| | | | 212 | SIS-020 |
| | | | 281 | SIS-012 |

***Notes:***

[1] Reference: EPA Region IX PRG Table, October 2004, http://www.epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf.

[2] Reference: EPA ESSL, http://www.epa.gov/ecotox/ecossl.

[3] Reference: Efroymson, R.A., G.W. Suter II, B.E. Sample, and D.S. Jones. 1997. *PRGs for Ecological Endpoints.* Oak Ridge National Laboratories, Oak Ridge, TN ES/ER/TM-162/R2.

[4] Listed value is the Cal-EPA value, which is the more stringent of the values listed in the 2004 PRG table.

[5] The value listed is the value for total chromium.

***Abbreviations and Acronyms:***

Cal/EPA – California. Environmental Protection Agency

EPA – U.S. Environmental Protection Agency

ESSL – ecological soil screening level

mg/kg – milligrams per kilogram

PRG – Preliminary Remediation Goal

SIS – site inspection sample

# Appendix B
# Photographic Log

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Photo 1: Plexiglas shielding for mechanized equipment.

Photo 2: Plexiglas shield for observer.

Photo 3: Vegetation removal at MRP Site UXO5.

Photo 4: Surface clearance quality control Seed Items QC-01 - QC-05.

Photo 5: Detector-aided surface clearance at MRP Site UXO5 grid cell.

Photo 6: Detector-aided visual surface clearance at MRP Site UXO5 transect.

Photo 7: Location surveyors.

Photo 8: Installation of IVS at MRP Site UXO5.

Photo 9: Setting up EM61-MK2 base station for DGM surveys.

Photo 10: Testing the EM61-MK2 at the IVS.

Photo 11: Testing the EM61-MK2 at the IVS.

Photo 12: Checking EM61-MK2 with survey control points.

Photo 13: DGM survey at MRP Site UXO5 using EM61-MK2.

Photo 14: Mini-Excavator removing overburden for intrusive anomaly investigation.

Photo 15: UXO technicians completing manual intrusive investigation.

Photo 16: MPPEH M50B2 37-mm practice projectile at Anomaly T-022 00002b.

Photo 17: Setting up demolition shot of MPPEH M50B2 37-mm practice projectile.

Photo 18: Excavation at Trench 1 at MRP Site UXO5.

Photo 19: Excavation at Trench 2 at MRP Site UXO5.

Photo 20: Excavation at Trench 3 at MRP Site UXO5.

Photo 21: Soil Sampling at Trench 3 at MRP Site UXO5.

Photo 22: MRP Site UXO5 Trench 3 Scrap Metal.

Photo 23: Excavation at Trench 4 at MRP Site UXO5.

Photo 24: Inspected MDAS at Trench 5.

Photo 25: Excavation at Trench 6 at MRP Site UXO5.

Photo 26: Inspected MDAS at Trench 6.

Photo 27: MRP Site UXO5 Trench 7.

Photo 28: MRP Site UXO5 Trench 8.

Photo 29: MRP Site UXO5 Trench 9.

Photo 30: MRP Site UXO5 Trench 10.

Photo 31: MRP Site UXO5 Trench 12.

Photo 32: Drums of inspected and certified MDAS ready for shipment.

# Appendix C
# Biological Monitoring Report

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July 17, 2015

Gus L. Thrasher, P.E.
Project Manager
Environment and Nuclear Business Group
CH2M HILL
402 W. Broadway, Suite 1450
San Diego, California 92101

[via email]

**SUBJECT:** Results of California Gnatcatcher (*Polioptila californica*) monitoring at UXO5, Naval Weapons Station Seal Beach, Detachment Fallbrook located in northwestern San Diego County, California

Dear Mr. Thrasher:

From February 6 to March 31, 2015, Bloom Biological, Inc. (BBI) conducted daily biological monitoring of work activities at the UXO5 project area located at Naval Weapons Station Seal Beach, Detachment Fallbrook, located in northwestern San Diego County, California. The following letter summarizes monitoring activities, and includes information provided in our previous letter dated March 17, 2015.

## FIELD DAYS AND STAFFING

Work activities occurred at UXO4 and UXO5, with UXO5 being the only site requiring monitoring. Work activities occurred from Monday to Friday or Saturday of most weeks, depending on the type of work that was occurring and the weather conditions. All biological monitoring was conducted by biologists permitted to survey for California Gnatcatchers (*Polioptila californica*) and observe nests, though no protocol surveys were to be conducted as part of work activities. Marcus England was the monitor from February 6–23, March 4, and March 9-12. Karly Moore was the monitor from February 24-March 3 and March 5-8. Dana Kamada was the monitor from March 9-31.

## MONITORING ACTIVITIES

During early stages of the project, the biologists directly monitored work activities. Later stages of the project frequently included activities (such as trenching) with high explosive risk. As such, it was unsafe for the monitor to be present in the work area. During those days, the monitor focused on observing gnatcatcher behavior outside of the project limits.

## CALIFORNIA GNATCATCHER OBSERVATIONS

California Gnatcatcher detections within the fenced limits of UXO5 were infrequent. During the early stages of the project, England gathered information regarding the approximate use area of the one pair of California Gnatcatchers currently believed to be present. Later observations by England, particularly those from February 20-23, narrowed a focal area for potential nesting. Moore found a nest under construction

in the area identified by England on March 6. England observed that the nest was near completion on March 10. He also noted, and Moore agreed, that the nest was in a bad area (open location and immediately below powerlines frequently used as a perch by corvids) and likely would be depredated. Kamada noted a new nest under construction by the same pair nearby on March 17, using materials from the old nest. Both nest locations are shown in Figure 1 below.

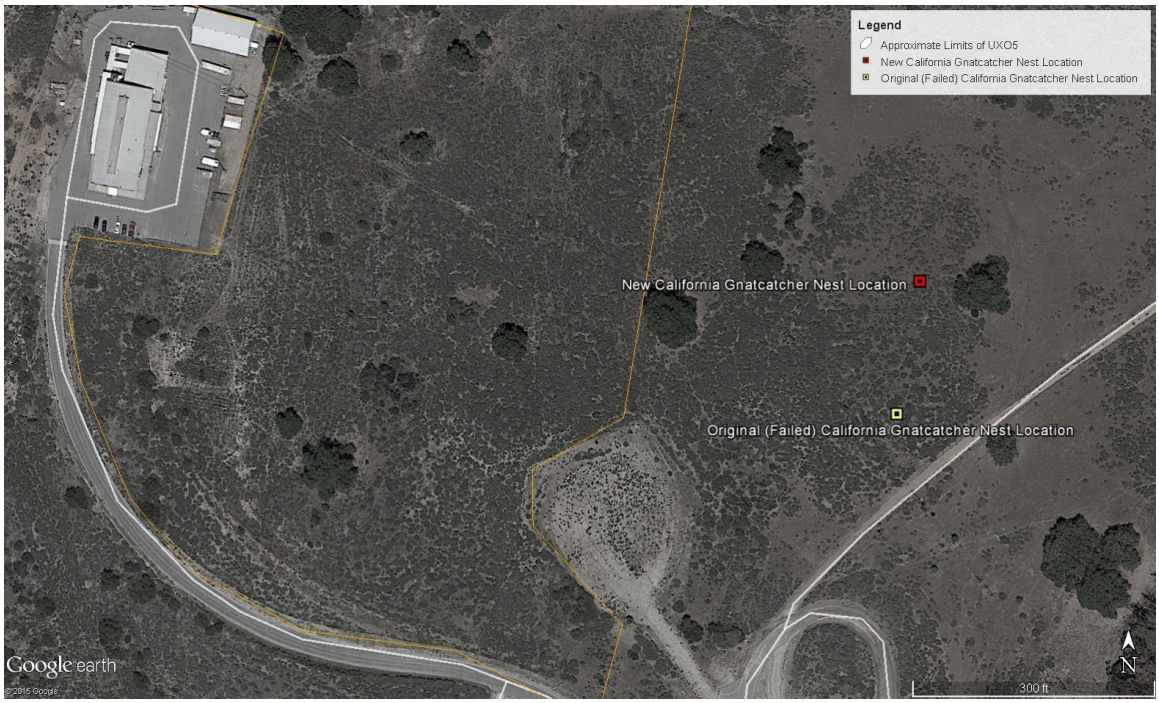


*Figure 1. California Gnatcatcher nest locations at UXO5.*

The following are the daily updates of California Gnatcatcher nesting activity provided by Kamada:

- March 17: CA Noticed the pair salvaging nest material from the abandoned 1st nest, which they were actually doing yesterday also, and carrying it to the N side of the hill. The 2nd nest is in an *Artemisia* midway down the N slope. The 2nd nest can be partially seen on the W side of a large prickly pear cactus. There is a dead branch in *Artemisia* at this observation point pointing towards (~40 degrees) the nest about 11m away. The nest is at the base of a V opening in the shrubs and looks low from that vantage point. It is tucked behind some small branches of the substrate *Artemisia* and can only be partially seen, but should be obvious if a bird is incubating. The nest is about knee to thigh high above the ground and about 95-99% complete, the birds were carrying fluffy lining to it. Inside the cup is deep and packed down. The structure appears tight and compact, much fresher than the 1st nest.
- March 18: From a distance, I watched the male perch and call about every 20-40 minutes in the general area of the 2nd nest and it appeared to be foraging during that time. The female was not positively detected. If the 2nd nest is still active, I suspect the nest is complete and the female is foraging and copulating in order to produce a clutch of eggs. I plan to avoid visiting the territory and nest area and only observe it from a distance for the rest of this week, unless there is some indication that the nest may have failed.
- March 19: Male was calling persistently in the general area of the 2nd nest. The female could be heard making occasional contact calls in response to the male. No direct flights to the nest shrub

were seen. These behaviors suggest that the pair are entering or are in the egg-laying phase of their nest cycle.

- March 20: Pair appears to still be in their egg-laying phase; male vocalizing and following female and female foraging making occasional contact calls. No indication that the 2nd nest may have failed and the pair would be building a third nest. So I think the 2nd nest is still active.
- March 23: pair is now in the incubation phase of their nest cycle for the 2nd nest location. Using binoculars at the observation waypoint on the W side of the large prickly pear, one can see eye shine and head movement through the branches. The male was incubating. About 20 minutes later the female and male made contact calls as she approached the nest. When she arrived at the nest the male departed and the female settled onto the nest to incubate.
- March 24: Gnatcatcher pair nest 2 still active. Heard nest exchange interaction between female and male in the area of the nest. The female and male made contact calls as she approached the nest. When she arrived at the nest the male departed and the female started incubating.
- March 25: Gnatcatcher pair continuing to incubate eggs at their 2nd nest.
- March 27: Gnatcatcher pair continuing to incubate eggs at their 2nd nest. Heard nest exchange vocalizations between female and male in the area of the nest.
- March 28: Gnatcatcher on the nest incubating, but I did not hear nest exchange vocalizations during the 45 minutes of observation.
- March 31: Gnatcatchers continuing to incubate. Their incubation change overs are cryptic now. The male left the nest to chase off a wrentit for five minutes. The eggs are estimated to hatch this Saturday, 4 April, +/- 1 day.

March 31 was the last of monitoring. There were no indications that work activities adversely affected California Gnatcatchers.

In addition to the gnatcatchers, 48 other species of birds were detected during monitoring. The list of these species is provided below as Attachment A.

If you have any questions or comments regarding this letter please feel free to call us at 949-272-0905.

Sincerely,

**BLOOM BIOLOGICAL, INC.**

Marcus C. England
Senior Biologist/Vice President

# ATTACHMENT A. BIRD SPECIES OBSERVED DURING MONITORING

California Quail (Callipepla californica)

Great Blue Heron (Ardea herodias)

Turkey Vulture (Cathartes aura)

Sharp-shinned Hawk (Accipiter striatus)

Cooper's Hawk (Accipiter cooperii)

Red-shouldered Hawk (Buteo lineatus)

Red-tailed Hawk (Buteo jamaicensis)

Band-tailed Pigeon (Patagioenas fasciata)

Eurasian Collared-Dove (Streptopelia decaocto)

Mourning Dove (Zenaida macroura)

Common Poorwill (Phalaenoptilus nuttallii)

Anna's Hummingbird (Calypte anna)

Acorn Woodpecker (Melanerpes formicivorus)

Nuttall's Woodpecker (Picoides nuttallii)

Northern Flicker (Colaptes auratus)

American Kestrel (Falco sparverius)

Black Phoebe (Sayornis nigricans)

Say's Phoebe (Sayornis saya)

Cassin's Kingbird (Tyrannus vociferans)

Western Scrub-Jay (Aphelocoma californica)

American Crow (Corvus brachyrhynchos)

Common Raven (Corvus corax)

Tree Swallow (Tachycineta bicolor)

Oak Titmouse (Baeolophus inornatus)

Bushtit (Psaltriparus minimus)

House Wren (Troglodytes aedon)

Bewick's Wren (Thryomanes bewickii)

Blue-gray Gnatcatcher (Polioptila caerulea)

California Gnatcatcher (Polioptila californica)

Ruby-crowned Kinglet (Regulus calendula)

Wrentit (Chamaea fasciata)

Western Bluebird (Sialia mexicana)

Hermit Thrush (Catharus guttatus)

American Robin (Turdus migratorius)

California Thrasher (Toxostoma redivivum)

European Starling (Sturnus vulgaris)

Phainopepla (Phainopepla nitens)

Orange-crowned Warbler (Oreothlypis celata)

Yellow-rumped Warbler (Setophaga coronata)

Spotted Towhee (Pipilo maculatus)

Rufous-crowned Sparrow (Aimophila ruficeps)

California Towhee (Melozone crissalis)

White-crowned Sparrow (Zonotrichia leucophrys)

Dark-eyed Junco (Junco hyemalis)

Western Meadowlark (Sturnella neglecta)

Brown-headed Cowbird (Molothrus ater)

House Finch (Haemorhous mexicanus)

Lesser Goldfinch (Spinus psaltria)

American Goldfinch (Spinus tristis)

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# Appendix D
# Utility Investigation Reports

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February 13, 2015

Gus Thrasher
CH2MHILL
P.O. Box 241329
Denver, CO 80224

**RE: Utility Investigation**
**US Naval Weapons Station**
**UXO 5 Area**
**700 Ammunition Road**
**Fallbrook, CA**

Dear Mr. Gus Thrasher

On February 13 2015, Spectrum Geophysics performed a utility investigation at the Naval Weapons Station UXO 5 Area in Fallbrook, CA. The purpose of the investigation was to locate detectable utilities in 8, 3 foot by 12 foot areas and in an area approximately 50 feet by 150 feet (the roadside wedge) in advance of proposed ground excavations.

20434 Corisco St.,
Chatsworth, CA 91311

(818) 886-4500
fax (818) 886-4511

The following is a list of equipment used to locate detectable utilities during this survey:

- Radio Detection 4000 transmitter w/ matched receiver
- Schonstedt Mac 51b hand-held magnetometer
- Fisher TW-6 M-scope - shallow focus metal detector
- Dynatel 500A transmitter w/ matched receiver

Ground Penetrating Radar was not used in the investigation because of the areas' thick brush and rugged terrain.

During the investigation Spectrum detected several utility conduits which were marked on the ground with spray paint in a color code established by the American Public Works Association.

The American Public Works Association color code for utilities is as follows:

| Utility | Color |
|---|---|
| Electric | Red |
| Telephone/Communication | Orange |
| Storm Drain/Sanitary Sewer | Green |
| Natural Gas | Yellow |
| Water | Blue |
| Unknown Conduit | Pink |

*Survey Exclusions*

- Utilities *excluded* from this scope of work include inaccessible sanitary sewer and storm drain lines.
- Utilities that originate inside inaccessible buildings, vaults or utility closet whose surface trace is only detectable by applying a direct signal or through use of an induction clamp.
- Non-metallic/Non-electrically conductive utilities which are not detectable through standard EM utility-locating methods and/or the use of the additional geophysical methods (i.e, ground penetrating radar).
- Abandoned or inaccessible utilities to which standard locating techniques may not be applied.
- Utilities whose burial depths exceed that of the detection limits of the equipment in a specific setting.
- Utilities whose detectable signal may be distorted or rendered undetectable due to reinforced concrete, steel plates or above ground interferences.
- Utilities whose surface trace cannot be determined due to the utilities' proximity to a greater conductor.
- Utilities whose proximity are so close to buildings or fences EM utility locating methods are distorted and GPR traverses cannot be performed.

- Utilities whose proximity are so close to buildings or fences EM utility locating methods are distorted and GPR traverses cannot be performed.

Thank you for the opportunity to submit this non-exclusive letter report. Please call (818-391-3010) or e-mail if I may answer any questions.

Best Regards,

Colin Embrey, Project Manager

*GPR Data Collection*

March 6, 2015

Gus Thrasher
CH2MHILL
P.O. Box 241329
Denver, CO 80224

**RE: Utility Investigation**
**US Naval Weapons Station**
**UXO 5 Area**
**700 Ammunition Road**
**Fallbrook, CA**

Dear Mr. Thrasher

On March 6, 2015, Spectrum Geophysics performed a utility investigation at the Naval Weapons Station UXO 5 Area in Fallbrook, CA. The purpose of the investigation was to locate detectable utilities in three, 3 foot by 12 foot areas (trench 10, 11 and 12) in advance of proposed ground excavations.

20434 Corisco St.,
Chatsworth, CA 91311

(818) 886-4500
fax (818) 886-4511

The following is a list of equipment used to locate detectable utilities during this survey:

- Radio Detection 4000 transmitter w/ matched receiver
- Schonstedt Mac 51b hand-held magnetometer
- Fisher TW-6 M-scope - shallow focus metal detector
- Dynatel 500A transmitter w/ matched receiver

Ground Penetrating Radar was not used in the investigation because of the areas' thick brush and rugged terrain.

During the investigation Spectrum detected several metallic anomalies which were marked on the ground with spray paint in a color code established by the American Public Works Association.

The American Public Works Association color code for utilities is as follows:

| Utility | Color |
|---|---|
| Electric | Red |
| Telephone/Communication | Orange |
| Storm Drain/Sanitary Sewer | Green |
| Natural Gas | Yellow |
| Water | Blue |
| Unknown Conduit | Pink |

*Survey Exclusions*

- Utilities *excluded* from this scope of work include inaccessible sanitary sewer and storm drain lines.
- Utilities that originate inside inaccessible buildings, vaults or utility closet whose surface trace is only detectable by applying a direct signal or through use of an induction clamp.
- Non-metallic/Non-electrically conductive utilities which are not detectable through standard EM utility-locating methods and/or the use of the additional geophysical methods (i.e, ground penetrating radar).
- Abandoned or inaccessible utilities to which standard locating techniques may not be applied.
- Utilities whose burial depths exceed that of the detection limits of the equipment in a specific setting.
- Utilities whose detectable signal may be distorted or rendered undetectable due to reinforced concrete, steel plates or above ground interferences.
- Utilities whose surface trace cannot be determined due to the utilities' proximity to a greater conductor.
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- Utilities whose proximity are so close to buildings or fences EM utility locating methods are distorted and GPR traverses cannot be performed.

Thank you for the opportunity to submit this non-exclusive letter report. Please call (818-391-3010) or e-mail me if I may answer any questions.

Best Regards,

Colin Embrey

Colin Embrey, Project Manager

20434 Corisco St.,
Chatsworth, CA 91311

(818) 886-4500
fax (818) 886-4511

March 26, 2015

Gus Thrasher
CH2MHILL
P.O. Box 241329
Denver, CO 80224

**RE: Utility Investigation**
**US Naval Weapons Station**
**UXO 5 Area**
**700 Ammunition Road**
**Fallbrook, CA**

Dear Mr. Gus Thrasher

On March 26 2015, Spectrum Geophysics performed two utility investigations at the Naval Weapons Station in Fallbrook, CA. The first area was an approximate 275 by 30 foot strip outside the gate at UXO Area 5. The second area was an approximate 150 by 150 foot area within UXO Area 4. Spectrum also investigated the perimeter of the entire 2 acre site at UXO Area 4. The purpose of the investigation was to locate detectable utilities in advance of proposed ground excavations.

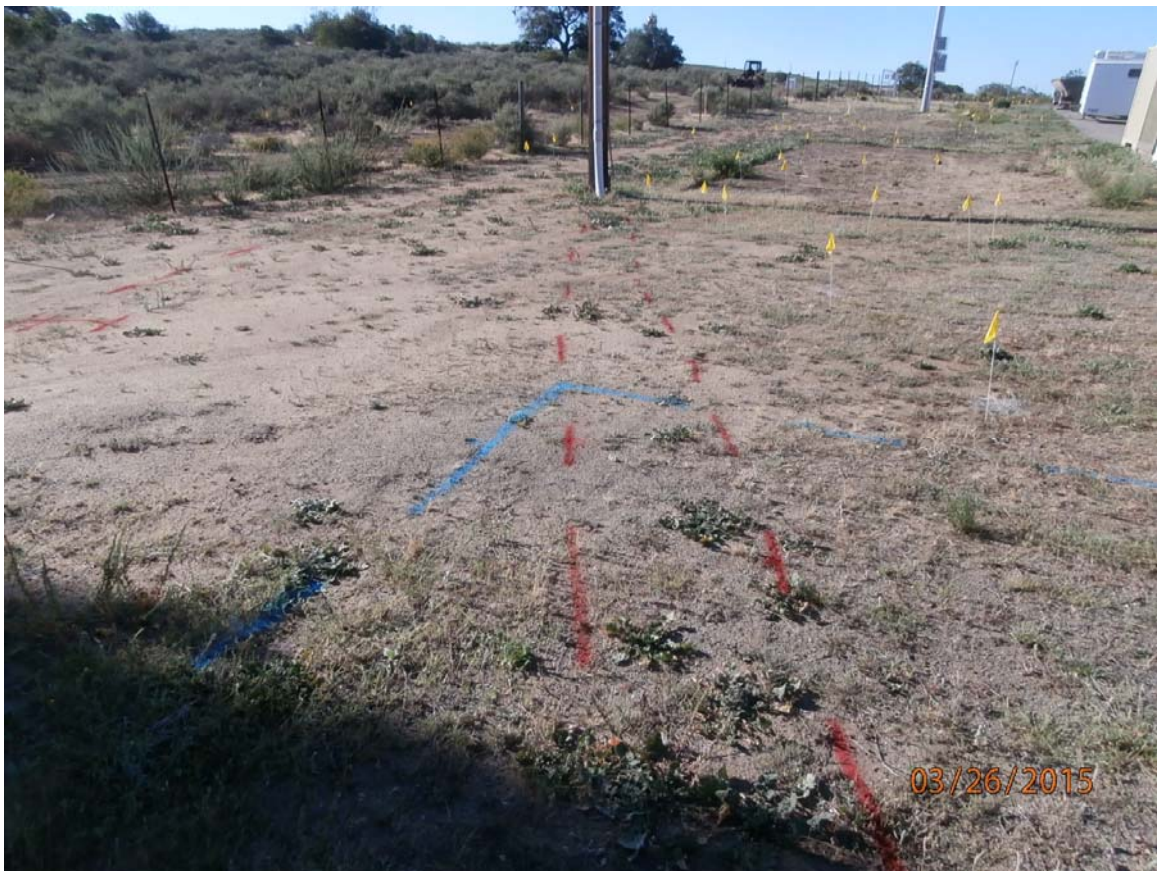
20434 Corisco St.,
Chatsworth, CA 91311

(818) 886-4500
fax (818) 886-4511

The following is a list of equipment used to locate detectable utilities during this survey:

- Radio Detection 4000 transmitter w/ matched receiver
- Schonstedt Mac 51b hand-held magnetometer
- Fisher TW-6 M-scope - shallow focus metal detector
- Sensors and Software ground penetrating radar (GPR) unit
- Dynatel 500A transmitter w/ matched receiver

Ground Penetrating Radar was not used in the investigation at UXO Area 4 due to uneven and rugged terrain.




During the investigation Spectrum detected several utility conduits which were marked on the ground with spray paint in a color code established by the American Public Works Association.

The American Public Works Association color code for utilities is as follows:

| **Utility** | **Color** |
|---|---|
| Electric | Red |
| Telephone/Communication | Orange |
| Storm Drain/Sanitary Sewer | Green |
| Natural Gas | Yellow |
| Water | Blue |
| Unknown Conduit | Pink |

*Survey Exclusions*

- Utilities *excluded* from this scope of work include inaccessible sanitary sewer and storm drain lines.
- Utilities that originate inside inaccessible buildings, vaults or utility closet whose surface trace is only detectable by applying a direct signal or through use of an induction clamp.
- Non-metallic/Non-electrically conductive utilities which are not detectable through standard EM utility-locating methods and/or the use of the additional geophysical methods (i.e, ground penetrating radar).
- Abandoned or inaccessible utilities to which standard locating techniques may not be applied.
- Utilities whose burial depths exceed that of the detection limits of the equipment in a specific setting.
- Utilities whose detectable signal may be distorted or rendered undetectable due to reinforced concrete, steel plates or above ground interferences.
- Utilities whose surface trace cannot be determined due to the utilities' proximity to a greater conductor.
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Thank you for the opportunity to submit this non-exclusive letter report. Please call (818-391-3010) or e-mail if I may answer any questions.

Best Regards,

Colin Embrey, Project Manager

*GPR Data Collection*

20434 Corisco St.,
Chatsworth, CA 91311

# Appendix E
# Instrument Verification Strip Report

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**Draft**

# Instrument Verification Strip Report

## Remedial Investigation for Munitions Response Program Sites UXO4 and UXO5

## Naval Weapons Station Seal Beach
## Detachment Fallbrook
## Fallbrook, California

**Contract Number: N62473-09-D-2622**
**Contract Task Orders: 0070 and 0063**
**Document Control Number: KCH-2622-0063-0058**

**July 2016**

Prepared for

## Department of the Navy
## Naval Facilities Engineering Command Southwest

Prepared by


**CH2M HILL Kleinfelder, A Joint Venture (KCH)**
402 West Broadway, Suite 1450
San Diego, California 92101

Gus Thrasher, PE
Task Order Manager

Tamir Klaff, PGp PG
Technical Lead

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# Acronyms and Abbreviations

| | |
|---|---|
| cm | centimeter |
| CONUS | Continental United States |
| CTO | Contract Task Order |
| DGM | digital geophysical mapping |
| GIWP | geophysical investigation work plan |
| GNSS | Global Navigation Satellite System |
| GPS | global positioning system |
| GSV | geophysical system verification |
| in. | inch |
| ISO | industry standard object |
| IVS | Instrument Verification Strip |
| KCH | CH2M HILL Kleinfelder, A Joint Venture |
| m | meter |
| MPC | measurement performance criteria |
| MQO | measurement quality objective |
| MRP | Munitions Response Program |
| mV | millivolt |
| NAD83 | North American Datum 1983 |
| NAVFAC | Naval Facilities Engineering Command |
| NAVWPNSTA | Naval Weapons Station |
| NRL | Naval Research Laboratory |
| QC | quality control |
| RI | remedial investigation |
| RTK | real-time kinematic |
| UXO | unexploded ordnance |

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# 1.0 Introduction

CH2M HILL Kleinfelder, A Joint Venture (KCH), is implementing the geophysical system verification (GSV) process for the digital geophysical mapping (DGM) survey at Munitions Response Program (MRP) Sites Unexploded Ordnance (UXO) 4 and UXO5, Naval Weapons Station (NAVWPNSTA) Seal Beach Detachment Fallbrook, located in Fallbrook, California. The GSV process compares signal strength and sensor performance to known response curves of industry standard objects (ISOs) to validate DGM systems before and during site surveys. Validation is initially performed along an Instrument Verification Strip (IVS), followed by a blind seeding program. This report presents the results for the IVS surveys conducted on February 19, 2015.

The DGM was performed in support of remedial investigations (RIs) at both sites on behalf of the United States Department of the Navy (Navy), Naval Facilities Engineering Command (NAVFAC) Southwest. Work was conducted under Contract N62473-09-D-2622, Contract Task Orders (CTOs) 0070 (MRP Site UXO4) and 0063 (MRP Site UXO5).

The DGM was performed in accordance with the *Geophysical System Verification Plan, Remedial Investigation for Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach Detachment Fallbrook, Fallbrook, California* (KCH, 2015a). A separate GSV Plan of the same name was prepared for MRP Site UXO4 (KCH, 2015b); collectively these documents are herein referred to as the GSV Plans. The GSV Plans are included as attachments to the geophysical investigation work plans (GIWPs) prepared for each RI. Information on the DGM objectives, personnel, approach, operational procedures, and quality control (QC) methods to be used during DGM are contained in the GIWPs.

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# 2.0 DGM Equipment and Control Points

KCH performed the DGM using a Geonics, Ltd. EM61-MK2 (EM61-MK2) in person-portable mode, with the coils mounted on its standard wheels. The height of the bottom coil above ground surface measured 16.5 inches (42 centimeters [cm]). The EM61-MK2 data were logged at a rate of 10 readings per second.

Positioning data were recorded at 10 Hertz using a real-time kinematic global positioning system (RTK GPS). The GPS units used for the base station and rover unit mounted to the EM61-MK2 coils were Trimble R8 Global Navigation Satellite System (GNSS) receivers. Serial numbers for the DGM and GPS equipment are provided in Table 2-1.

Temporary benchmark locations for use as control points during the DGM survey were established prior to the start of DGM by Coast Surveying, Inc., a professional land surveyor firm licensed in the State of California. Temporary benchmarks were established at MRP Sites UXO4 and UXO5, although the points at MRP Site UXO5 were used for the initial IVS surveys. The coordinates for the points at MRP Site UXO5 are provided in Table 2-2.

TABLE 2-1
DGM and GPS Equipment Serial Numbers

| Instrument | Serial Number |
|---|---|
| EM61-MK2 | 021907-3 |
| Trimble R8 GNSS Base Station Receiver | 5033444774 |
| Trimble R8 GNSS Rover Receiver | 5032443750 |
| Trimble TDL450 External Radio | 14332152 |
| Trimble TSC3 Data Collector | RS2BC46352 |

TABLE 2-2
Temporary Benchmarks at MRP Site UXO5

| Point ID | Easting (U.S. Survey Feet) | Northing (U.S. Survey Feet) | Elevation (U.S. Survey Feet) |
|---|---|---|---|
| 500 | 6251257.93 | 2085287.61 | 708.98 |
| 501 | 6251161.62 | 2084900.5 | 705.55 |
| 502 | 6251504.29 | 2084709.67 | 711.17 |
| 503 | 6251214.01 | 2085600.59 | 702.08 |
| 504 | 6251277.79 | 2085263.82 | 709.52 |
| 505 | 6251184.53 | 2085630 | 701.66 |

Note: Coordinates are California State Plane Zone 6, North American Datum 1983 (NAD83) Continental United States (CONUS).

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# 3.0 IVS Location and Construction

## 3.1 Initial Background Survey

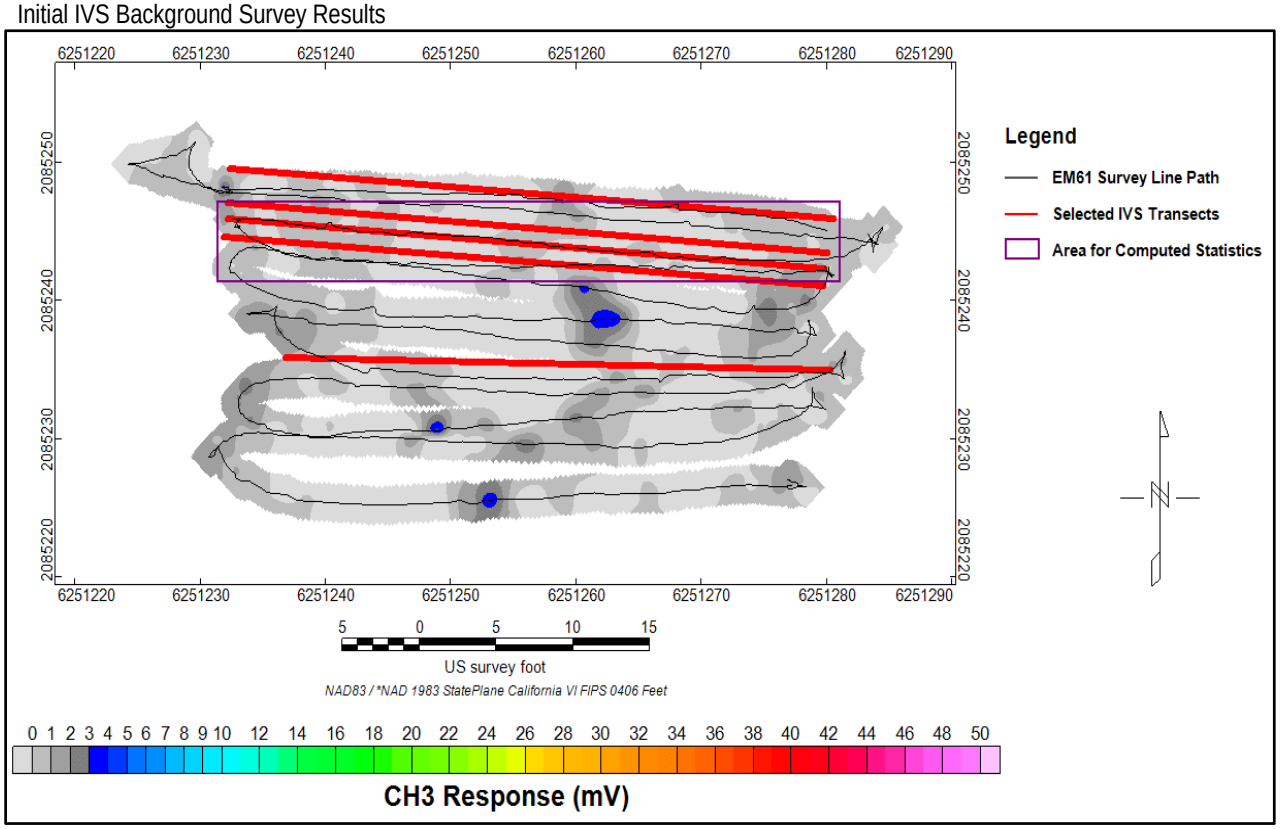
Prior to constructing the IVS, KCH performed an initial background (i.e., pre-seeded) survey of the proposed IVS location in order to assess background conditions, determine the suitability of the location (e.g., few existing anomalies), and to provide a means by which to avoid placing the IVS seed items near existing subsurface metal.

Onsite UXO personnel conducted an analog survey of the proposed IVS location using a handheld White's XLT all metals detector prior to performing vegetation clearance. The background DGM survey was completed with an intended lane spacing of 2.5 feet (0.75 meter [m]) in order to provide full coverage of a sufficiently large area to construct the IVS. RTK GPS was used to record positional data during the background survey. QC tests were conducted in accordance with the GIWPs in order to demonstrate proper EM61-MK2 functionality.

The results of the initial background survey are presented as a false color map on Figure 3-1, where background responses correspond to amplitudes less than 3 millivolts (mV) on Channel 3. Discrete geophysical anomalies with peak amplitudes greater than 3 mV are represented by blue color shading on Figure 3-1. These anomalies were avoided during layout of the IVS transect lines and seed placement.

The red lines on Figure 3-1 represent the idealized IVS transects selected from the background survey results. These transects were positioned in order to avoid discrete anomalies with amplitudes greater than the background range. The purple rectangle indicates the area from which a statistical analysis was performed to demonstrate further the suitability of this area for the IVS and placement of the seed items. The minimum Channel 3 response from within the area selected for statistical analysis (i.e., purple rectangle) was -1.35 mV, the maximum response was 2.35 mV, the mean was 0.038 mV, and the standard deviation was 0.55 mV.

FIGURE 3-1
Initial IVS Background Survey Results



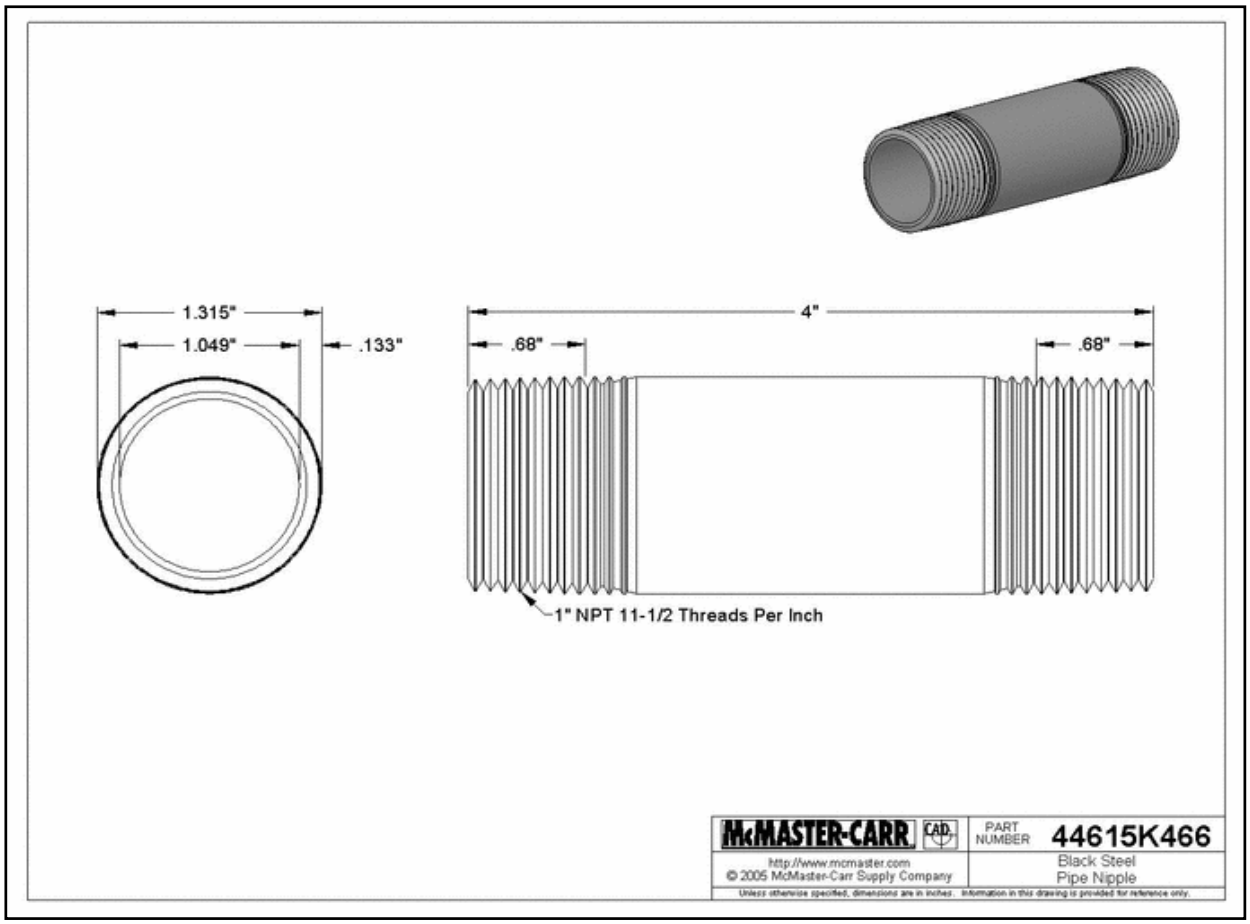

## 3.2 Industry Standard Objects

The IVS seed items consisted of small Schedule 40 ISOs depicted on Figure 3-2. The ISOs consist of 1- by 4-inch (2.54-cm by 10.16-cm) pipe segments, part number 44615K466 from the McMaster-Carr online catalog (McMaster-Carr, 2013). Additional specifications on the pipe segments are as follows:

- Shape: Straight nipple, threaded both ends
- Pipe Size: 1 inch inner diameter, 1.315 inch outside diameter (2.5 cm inner diameter, 3.34 cm outside diameter)
- Length: 4 inches (10.1 cm)
- Finish: Black welded steel

Instrument response curves for this ISO have been developed by the Naval Research Laboratory (NRL) demonstrating their standard EM61-MK2 response under their best orientation (perpendicular to the EM61-MK2 instrument plane) and worst orientation (parallel to the instrument plane) at multiple distances from the instrument's transmit/receive coil (NRL, 2009).

FIGURE 3-2
Small Schedule 40 ISOs Used as IVS Seed Items




## 3.3 IVS Construction

Figure 3-3 presents the location of the IVS and the temporary control points at MRP Site UXO5. This map also presents the sitewide grid system established by KCH during project planning stages. Figure 3-4 presents the as-built layout of the IVS. Once the five IVS transects were selected from the background survey data, KCH used RTK GPS to flag the start and end locations of the idealized transects shown on Figure 3-1. RTK GPS was used in order to avoid inadvertently placing seed items near discrete anomalies identified in the background survey area.

A tape measure was extended along the seeded transect to assist with placement of the ISOs. Two small Schedule 40 ISOs were buried at different depths and orientations in accordance with the GIWPs.

The as-flagged coordinates of the IVS transects and the seed items are presented in Table 3-1.

FIGURE 3-3
IVS and Temporary Benchmark Locations at MRP Site UXO5

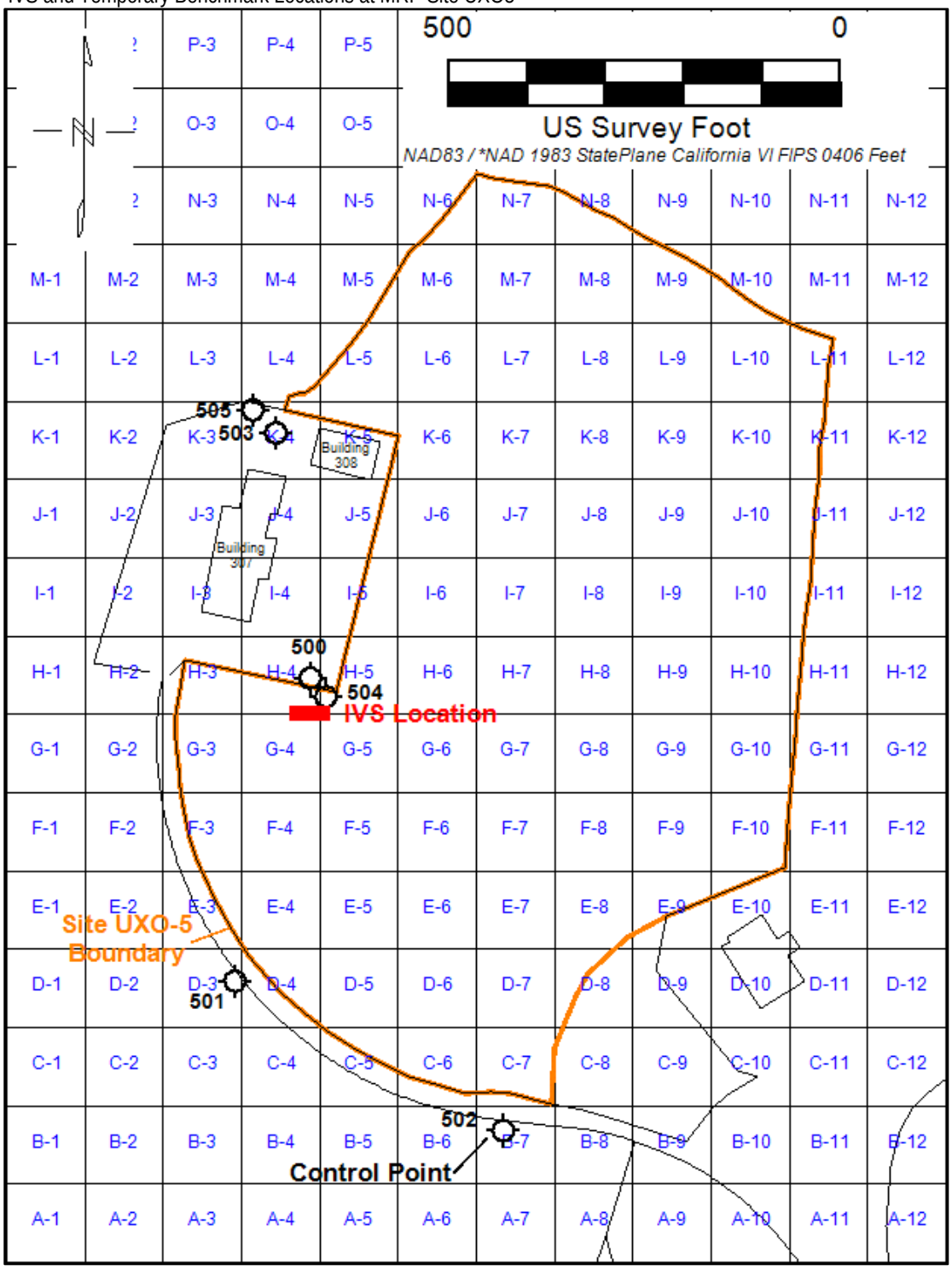


FIGURE 3-4
IVS As-Built Layout

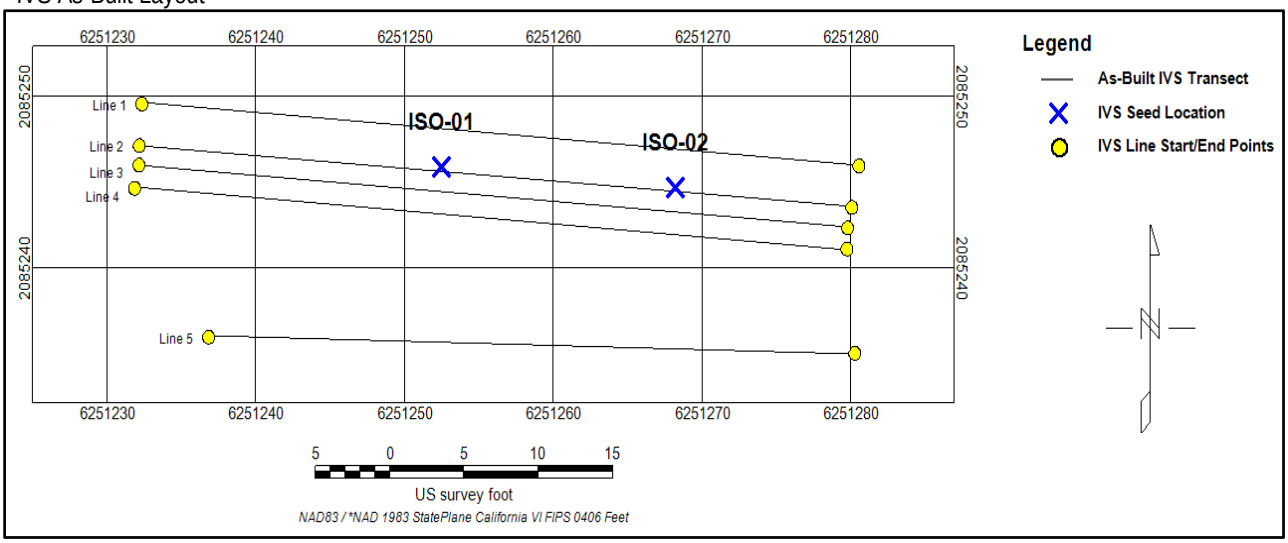



TABLE 3-1
IVS Construction Details

| Point | Easting (U.S. Survey Feet) | Northing (U.S. Survey Feet) | Depth (inches) and Orientation |
|---|---|---|---|
| ISO-01 | 6251252.46 | 2085245.89 | 9; Vertical |
| ISO-02 | 6251268.19 | 2085244.70 | 3; Horizontal (Cross-Track) |
| Line 1 East | 6251280.53 | 2085245.96 | N/A |
| Line 1 West | 6251232.34 | 2085249.58 | N/A |
| Line 2 East | 6251280.05 | 2085243.53 | N/A |
| Line 2 West | 6251232.18 | 2085247.14 | N/A |
| Line 3 East | 6251279.77 | 2085242.33 | N/A |
| Line 3 West | 6251232.16 | 2085246.01 | N/A |
| Line 4 East | 6251279.72 | 2085241.10 | N/A |
| Line 4 West | 6251231.87 | 2085244.64 | N/A |
| Line 5 East | 6251280.25 | 2085235.00 | N/A |
| Line 5 West | 6251236.83 | 2085235.95 | N/A |

Notes:
Coordinates are California State Plane Zone 6, NAD83 CONUS.
Depths reflect burial below ground surface to approximate ISO center of mass.

UXO personnel performed subsurface anomaly avoidance using handheld geophysical instruments prior to digging holes for the ISOs. The IVS seed items were affixed with labels identifying them as inert and listing the KCH Project Manager's name and phone number. Also included on the labels were the KCH contract number with NAVFAC Southwest and the CTO number. Figure 3-5 presents photos of the IVS seed items prior to and after emplacement (photos were taken using a camera for which a camera pass had been obtained from NAVWPNSTA Seal Beach Detachment Fallbrook). Once placed in the ground, KCH used RTK GPS to record the locations of the seed items before covering them with soil. Vinyl-stem flags were used to mark their locations after burial.

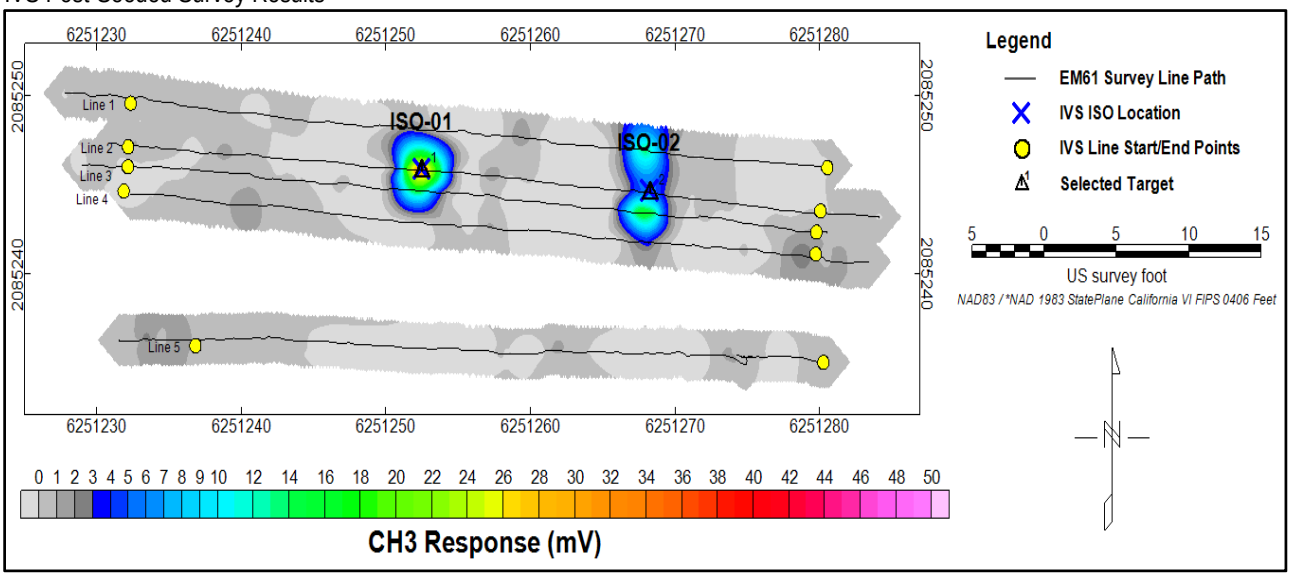
FIGURE 3-5
IVS Seed Item Photos

# 4.0 IVS Survey Results

## 4.1 IVS Five-Line Survey

After construction of the IVS, KCH performed the five-line post-seeded IVS survey, the results of which are presented on Figure 4-1.

FIGURE 4-1
IVS Post-Seeded Survey Results




Like the pre-seeded survey results, the post-seeded IVS survey results are depicted as a false-color map with background response representing amplitudes less than 3 mV on Channel 3. The line paths shown on Figure 4-1 represent the GPS track of the center of the EM61-MK2 coils as it was pulled along the IVS transects.

The anomaly response footprint of each ISO is consistent with the expected footprint for vertically and horizontally oriented ISOs in the subsurface. For the horizontal ISO, it is expected that larger amplitudes would be recorded over the two threaded ends of the pipe segment, and that the middle of the pipe segment would yield a small response by comparison. Both ISOs were detected above the background range, and the IVS measurement quality objectives (MQOs) were met for positioning, dynamic response, and data handling. The MQO performance for the positioning and dynamic response is presented in Tables 4-1 and 4-2, respectively. IVS data were provided to the KCH Project Geophysicist within 3 days of data collection, thereby meeting the Data Handling MQO. The MQOs and measurement performance criteria (MPC) for the IVS survey are provided in the GSV Plans.

A statistical analysis of the background transect (Line 5 on Figure 4-1) resulted in a minimum recorded Channel 3 response of -1.01 mV, a maximum response of 2.33 mV, a mean of 0.21 mV, and a standard deviation of 0.64 mV.

TABLE 4-1
DGM System Positioning MQO Performance

| Seed ID | Target Easting (U.S. Survey Feet) | Target Northing (U.S. Survey Feet) | Offset from Ground Truth (U.S. Survey Feet) | MQO Met (Yes/No) |
|---|---|---|---|---|
| ISO-01 | 6251252.5 | 2085245.79 | 0.11 | Yes |
| ISO-02 | 6251268.28 | 2085244.57 | 0.16 | Yes |

Notes:
Coordinates are California State Plane Zone 6, NAD83 CONUS.
Offsets relative to ground truth presented in Table 3-1.

TABLE 4-2
DGM System Munitions Detection MQO Performance

| Seed ID | Target Amplitude (mV) | Predicted Amplitude (mV) | Tolerance ±20% (mV) | MQO Met (Yes/No) |
|---|---|---|---|---|
| ISO-01 | 32.8 | 30.6 | 24.5 – 36.7 | Yes |
| ISO-02 | 5.9 | 6 | 4.8 – 7.1 | Yes |

Note:
Predicted amplitudes are from NRL, 2009, with sensor height of 16.5 inches (42 cm).

## 4.2 Quality Control

The daily QC tests, their frequency, and passing criteria are discussed in the GIWPs. QC tests included a personnel response test, cable shake (i.e., vibration) test, and static background and static spike test. The static tests were conducted prior to conducting the IVS surveys and after completion of the IVS surveys.

The DGM system passed the required QC tests. Figures 4-2 through 4-4 present the QC tests results from February 19, 2015. The static spike test, as discussed in the GIWPs, serves as the primary quantitative assessment of EM61-MK2 operation. A small Schedule 40 ISO was used for this test and was positioned in a fixed location relative to the center of the coils and at a height of 20 inches (51 cm) above the EM61-MK2 lower coil.

FIGURE 4-2
Personnel QC Test Results (2/19/2015)

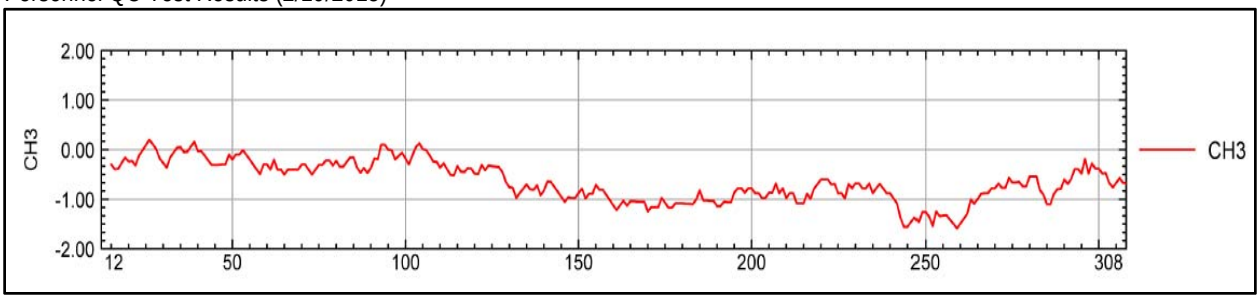



FIGURE 4-3
Cable Shake QC Test Results (2/19/2015)

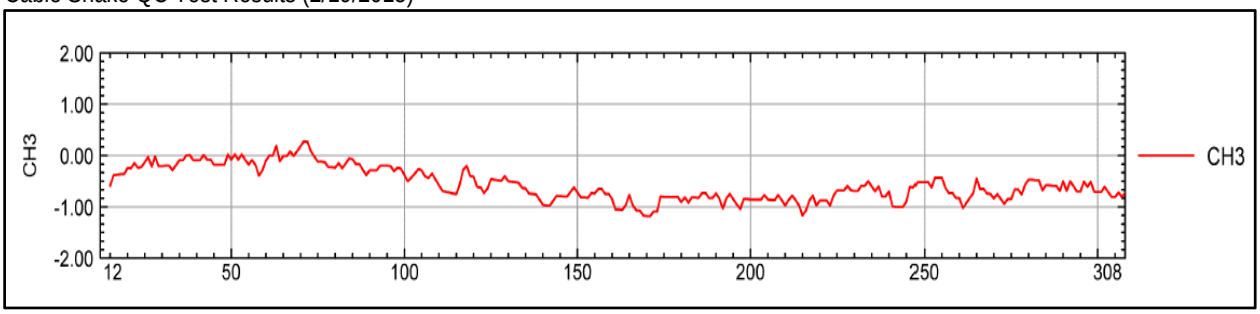
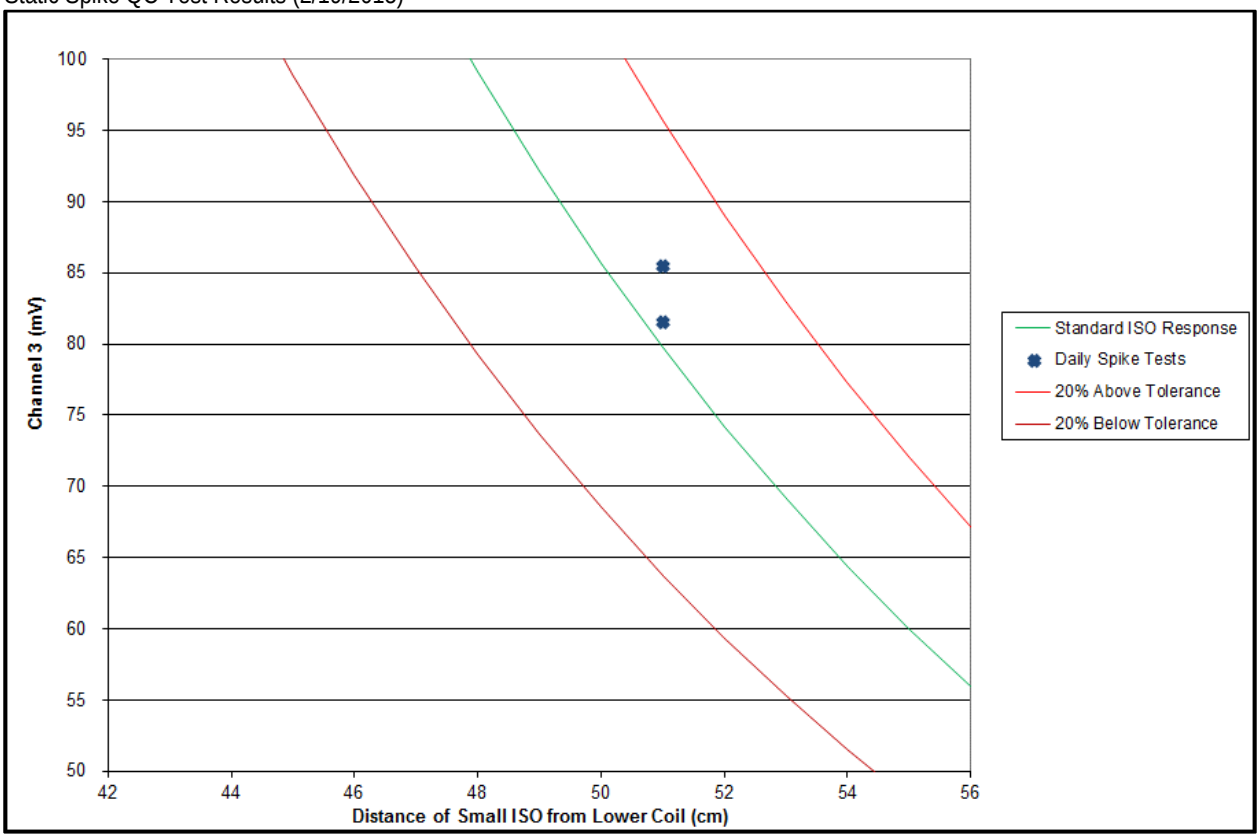



FIGURE 4-4
Static Spike QC Test Results (2/19/2015)



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# 5.0 Conclusions

IVS surveys were conducted at MRP Site UXO5 on February 19, 2015. The EM61-MK2 passed the required QC tests, and the IVS MQOs were met, thereby validating the EM61-MK2. In addition, the QC tests demonstrated that the sensor was operating properly. Furthermore, the results of the surveys presented in this report demonstrate that the location selected was suitable for an IVS.

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# 6.0 References

CH2M HILL Kleinfelder, A Joint Venture (KCH). 2015a. *Geophysical System Verification Plan, Remedial Investigation for Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach Detachment Fallbrook, Fallbrook, California*. Final. February.

CH2M HILL Kleinfelder, A Joint Venture (KCH). 2015b. *Geophysical System Verification Plan, Remedial Investigation for Munitions Response Program Site UXO4, Naval Weapons Station Seal Beach Detachment Fallbrook, Fallbrook, California*. Final. February.

McMaster-Carr. 2015. Online Catalog. http://www.mcmaster.com. Accessed on April 2, 2015.

Naval Research Laboratory (NRL). 2009. *EM61-MK2 Response of Three Surrogates*, NRL/MR/6110-09-9183. March.

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# Appendix F
# Digital Geophysical Mapping Survey Results Technical Memorandum

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TECHNICAL MEMORANDUM

# DGM Survey Results, Remedial Investigation Munitions Response Program Site UXO5, NAVWPNSTA Seal Beach Detachment Fallbrook, California

| | |
|---|---|
| PREPARED FOR: | NAVFAC Southwest |
| COPY TO: | KCH Project Team |
| PREPARED BY: | Matthew Barner/CLT |
| DATE: | September 11, 2015 |
| PROJECT NUMBER: | 473515 |
| REVISION NO.: | 0 |
| APPROVED BY: | Tamir Klaff/WDC |

This technical memorandum summarizes the findings of the digital geophysical mapping (DGM) survey conducted in support of a remedial investigation (RI) at Munitions Response Program (MRP) Site Unexploded Ordnance (UXO) 5 (herein referred to as MRP Site UXO5), Naval Weapons Station (NAVWPNSTA) Seal Beach Detachment Fallbrook, located in Fallbrook, California.

The DGM survey was conducted by CH2M HILL Kleinfelder, A Joint Venture (KCH) on behalf of the United States Department of the Navy (Navy), Naval Facilities Engineering Command (NAVFAC) Southwest. The survey was conducted under the Comprehensive Long-Term Environmental Action Navy program, Contract Number N62473-09-D-2622, Contract Task Order 0063.

The DGM was performed in accordance with the *Work Plan, Remedial Investigation for Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach Detachment Fallbrook, Fallbrook, California* (RI Work Plan) (KCH, 2015). The following appendices from the RI Work Plan pertain to the execution of the DGM survey:

- Appendix A. Quality Assurance Project Plan for Munitions and Explosives of Concern, Remedial Investigation for Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach Detachment Fallbrook, Fallbrook, California (MEC QAPP)
- Appendix C. Explosives Safety Submission for Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach Detachment Fallbrook, Fallbrook, California
- Appendix E. Geophysical Investigation Work Plan, Remedial Investigation for Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach Detachment Fallbrook, Fallbrook, California

This memorandum is submitted as an appendix to the Remedial Investigation, Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach Detachment Fallbrook,

Fallbrook, California (RI report) (KCH, in progress). This memorandum addresses the DGM survey and relevant aspects of the site as they pertain to the DGM. The RI report is referenced throughout this memorandum in order to avoid redundancy in presentation of static details regarding MRP Site UXO5. Stand-alone, external figures submitted in support of this memorandum are included in Attachment F1.

# DGM Purpose and Objective

The DGM data were gathered to assist in the determination of the nature and extent of munitions and explosives of concern/material potentially presenting an explosive hazard (MEC/MPPEH). The objective of the DGM was to identify metal potentially associated with MEC/MPPEH buried in the subsurface.

The DGM results were used to assess the lateral extent of buried metal within the mapped portion of MRP Site UXO5. A statistically representative subset of anomaly[1] locations was chosen from the DGM results for intrusive investigation in order to assess the vertical extent of buried metal and characterize the nature of the sources of the geophysical anomalies.

# Previous Investigations

Previous investigations have been performed by others at MRP Site UXO5. These investigations include various munitions response actions by the military, a preliminary assessment/site inspection, and a time-critical removal action (TCRA). The RI report provides details on the timing and findings of these investigations (KCH, in progress).

A DGM survey was conducted in 2012 by SES-TECH following the TCRA at MRP Site UXO5. The DGM survey involved mapping site areas that had undergone prior surface clearance along meandering transects extending across portions of the site. The SES-TECH DGM survey was completed using a Geometrics G-858 magnetometer, the results of which are presented in the *Geophysical Report, Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach Detachment Fallbrook, Fallbrook, California* (SES-TECH, 2012). A total of 2,680 target[2] locations was selected by SES-TECH from the G-858 magnetometer survey data. The selected target locations were not investigated as part of the survey.

During the RI work planning stages, KCH evaluated the SES-TECH interpretation of the G-858 magnetometer survey results and elected to differentiate between what appeared to be elevated anomaly density areas (EADAs) and dispersed anomaly location areas at MRP Site UXO5. SES-TECH did not make this distinction and instead selected 2,680 discrete anomalies across the entire site. It was decided that the EADAs (subsequently identified as suspected disposal features) would be investigated and characterized by KCH during the RI via excavation of trenches, and the remainder of the site would undergo DGM mapping and intrusive investigation of discrete anomaly locations. Figure F1-1 in Attachment F1 presents the locations of the suspected EADAs (totaling approximately 4.5 acres [ac] or 1.8 hectares [ha]) at MRP Site UXO5 as shaded regions.

[1] Throughout this document, the term “anomaly” indicates an anomalous geophysical response to a source (discrete metal object).

[2] The term “target” indicates a targeted location for subsequent investigation.

# Site Description

The site was used during the 1950s and 1960s as a disposal area for munitions and munitions-related dunnage. The RI report provides details on the location of NAVWPNSTA Seal Beach Detachment Fallbrook and MRP Site UXO5, its operational history, and the physical conditions (e.g., soil types, vegetation, and geology) of MRP Site UXO5.

MRP Site UXO5 is approximately 13 ac (5.3 ha). It is surrounded by a metal fence, although in the southeastern corner of the site, the fence and site boundary are not the same. Observations during the DGM fieldwork indicated variable relief across the site, with the central and southern portions of the site generally characterized by higher elevations. The majority of the area was relatively open to the sky, although the low-lying northern portions of the site were characterized by dense tree canopy cover, particularly near surface water drainage pathways carved into the landscape. Localized, deeply incised drainage channels were observed in the northern portion of the site. Metallic items were visible in these channels, protruding from the ground, and eroding out of the sides of slopes leading down to the lower-lying regions within the site.

## Smallest Munition Item of Interest at MRP Site UXO5

The Explosives Safety Submission developed for the RI at MRP Site UXO5 presents a list of munitions items that were identified or are suspected based on the findings of previous investigations at MRP Site UXO5. For purposes of planning and executing the DGM for the RI, the smallest munition item of interest was the 20-millimeter (mm) projectile. These projectiles were reportedly observed onsite during the preliminary assessment.

# Site Preparations for DGM

An operational grid was established by KCH during the project planning stages. Each grid measured approximately 100 by 100 feet (33 by 33 meters [m]). This grid system was designed to assist with data management throughout the investigation and to facilitate incorporation of additional data that may be gathered onsite during future site investigations.

Wooden stakes were set at grid corners where needed for the DGM (not needed across the entire site) by KCH's land surveying subcontractor, Coast Surveying, Inc. Additional site preparation steps included establishing temporary benchmarks onsite for use as control points during the DGM survey and recording the locations of quality control (QC) seed items emplaced by KCH. Both of these tasks were performed by Coast Surveying, Inc. The temporary control points were established around the edge of the asphalt parking lot behind Building 307; the details are provided in Table 1. Locations of the control points are presented on Figure 1, along with the MRP Site UXO5 operational grid.

USA Environmental, Inc. (USAE), the UXO subcontractor, performed vegetation clearance before the DGM survey. A combination of transect surveying and 100 percent mapping across grids was performed as part of the RI. Vegetation clearance was performed in accordance with MEC avoidance practices. A surface clearance was performed by USAE after vegetation clearance was completed. The findings of the surface clearance are discussed in the RI report.

TABLE 1
Temporary Benchmark Details

| Point ID | Easting (U.S. Feet) | Northing (U.S. Feet) | Elevation (U.S. Feet) |
|---|---|---|---|
| 500 | 6251257.9 | 2085287.6 | 709.0 |
| 501 | 6251161.6 | 2084900.5 | 705.6 |
| 502 | 6251504.3 | 2084709.7 | 711.2 |
| 503 | 6251214.0 | 2085600.6 | 702.1 |
| 504 | 6251277.8 | 2085263.8 | 709.5 |
| 505 | 6251184.5 | 2085630.0 | 701.7 |

Notes:
Coordinates are California State Plane Zone 6, North American Datum 1983 (NAD83) Continental United States (CONUS).

ID = identifier
U.S. = United States

## DGM Investigation Areas

The DGM survey was divided into three sub-areas within MRP Site UXO5:

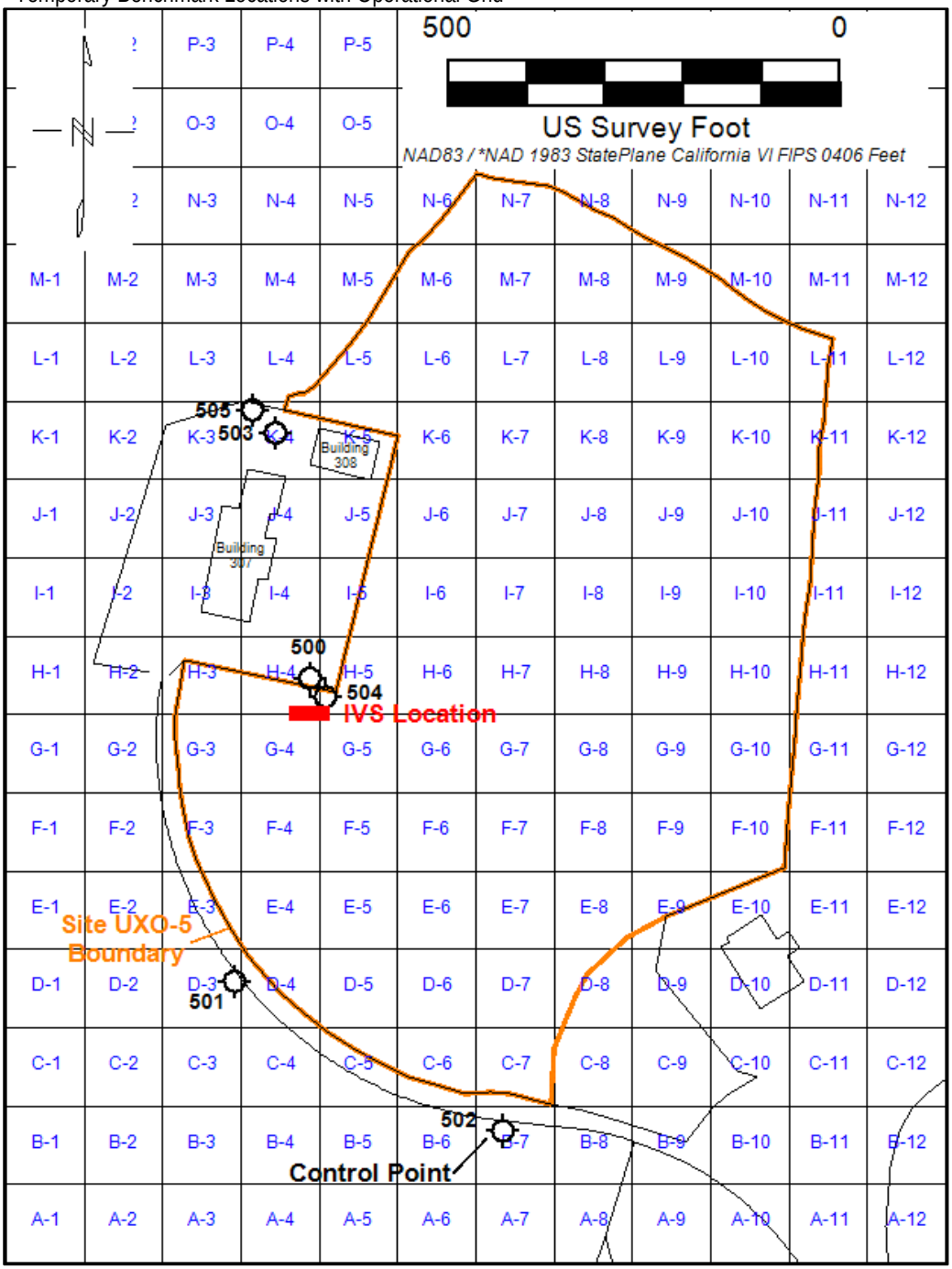
1. Additional Work Area. 100 percent effective coverage of an approximate 0.24-ac (0.1 ha) portion of the site, south of Building 308 and east of Building 307 (Figure F1-1). This area includes portions of Grids H-4, H-5, I-5, J-5, and K-5. The Additional Work Area encompasses a strip of manicured land east of the parking lot, which is east of Building 307, within which subsurface disturbance is planned by NAVFAC as part of site improvements. Although it is located outside the MRP Site UXO5 boundary fence, NAVFAC included the Additional Work Area during work planning to determine whether it should be added to the MRP site based on investigation findings.

2. Northern Grids. 100 percent effective DGM survey coverage within an approximate 0.87-ac (0.35-ha) portion of the site, located northeast of Building 308 (Figure F1-1) and not surveyed during the 2012 geophysical investigation. This area includes portions of Grids L-6, L-7, L-8, M-6, M-7, and M-8. This area was omitted from the SES-TECH G-858 magnetometer survey because of the presence of dense vegetation at the time. NAVFAC requested that this area be surveyed at 100 percent coverage during the RI. The large gap in survey coverage, primarily in Grid M-7 and extending westward into Grid M-6, is associated with a deep drainage ravine, with steeply incised sidewalls and visible metal in the ravine.

3. 10 percent effective coverage of the remainder of accessible portions of MRP Site UXO5 not characterized as EADAs from the SES-TECH DGM survey. Coverage was achieved using widely spaced transects (approximately 33 feet [10 m] on center). These transects were intended to cover the portion of MRP Site UXO5 likely characterized by a more dispersed distribution of anomaly locations.

The DGM instrument path within each sub-area is depicted on Figure F1-1.

FIGURE 1
Temporary Benchmark Locations with Operational Grid




# DGM and Positioning Technology

DGM was conducted at MRP Site UXO5 using the Geonics, Ltd. EM61-MK2. The system was operated in person-portable mode on its standard wheels (Figure 2). The EM61-MK2 is a high-resolution time-domain electromagnetic (EM) instrument designed to detect, with high spatial resolution, shallow ferrous and nonferrous metallic objects. The standard EM61-MK2 system

consists of two air-cored, 3.3-foot by 1.2-foot (1-m by 0.5-m) coils, a digital data recorder, batteries, and processing electronics. The EM61-MK2 transmitter generates a pulsed primary magnetic field, which induces eddy currents in nearby metallic objects. The EM61-MK2 receiver measures the eddy currents at three distinct time intervals in the bottom coil, or at four intervals (i.e., four-channel mode) if no top coil measurements are recorded. Earlier time gates provide enhanced detection of smaller metallic objects. Secondary voltages induced in both coils are measured in millivolts (mV). The arrangement of coils is such that a vertical separation of 16 inches (42 centimeters [cm]) lies between the transmit loop and ground surface. In order to obtain as much information about the decay of the induced EM signal as possible, the top coil will not be used at this site, and data will be recorded on four bottom coil channels. With survey-grade positioning, target resolution of approximately 20 inches (50 cm) can be achieved.

Global positioning system (GPS) satellites orbit the earth transmitting signals that can be detected with a GPS receiver. The GPS receiver uses the known locations of the satellites and the elapsed time of signal transmittal to calculate its position. Differential GPS increases the accuracy of GPS readings through the use of two receivers: a stationary receiver that acts as a base station and collects data at a known location, and a second roving receiver that makes the position measurements. The base stations can be configured to save the data for correcting positional data during post-processing or to transmit the correction data to the rover system in real-time kinematic (RTK) mode. RTK GPS instruments are ideal for field-mapping applications with adequate satellite visibility conditions because they typically provide accuracy of approximately 1 to 2 cm. The DGM at MRP Site UXO5 was performed using a Trimble R8 Global Navigation Satellite System (GNSS) receiver mounted above and centered over the EM61-MK2 coils. A second R8 GNSS receiver was used at the base station (erected at one of the points in Table 1) and a Trimble TDL450 external radio for broadcasting real-time corrections.

FIGURE 2
EM61-MK2 with R8 GNSS Receiver

KCH performed DGM with the EM61-MK2 (instead of the G-858 magnetometer because of its ability to detect both ferrous and nonferrous metal in the subsurface, its ability to resolve small caliber munitions items (e.g., 20-mm projectiles) with a high degree of spatial accuracy, and because it is less influenced by site-specific geology than the G-858 magnetometer.

# Geophysical System Verification

KCH followed the geophysical system verification (GSV) process for the DGM at MRP Site UXO5. This process compares signal strength and sensor performance to known response curves of industry standard objects (ISOs) to validate DGM systems before and during site surveys. The GSV process, the measurement quality objectives (MQOs) and measurement performance criteria (MPC) are discussed in the Final MEC QAPP, which is Appendix A to the RI Work Plan.

KCH constructed an Instrument Verification Strip (IVS) on February 19, 2015, at MRP Site UXO5 after first conducting an initial background survey to verify that the location was suitable (i.e., minimal existing geophysical anomaly locations) for construction of an IVS. The IVS location is also shown on Figure 1. The IVS data were submitted to the KCH Data Processor and subsequently reviewed by the KCH QC Geophysicist to evaluate whether the IVS MQOs were met prior to the start of the production survey. The IVS report is included as Appendix E to the RI report. It presents the IVS construction details and EM61-MK2 validation results for MRP Site UXO5.

Five blind seed items consisting of small Schedule 40 ISOs (ISO40s) were placed before the DGM began. Because the DGM was conducted using RTK GPS, and a large portion of the survey included mapping along unmarked transects, the blind seed items were marked by KCH QC personnel with vinyl-stem flags. No annotations were written on the flags. Additional collinear flags of the same color were placed in the ground, where the DGM operator was instructed to make sure the EM61-MK2 passed directly over each row of flags when encountered. The field team and the KCH data processor did not know which flags actually marked the seed items.

# DGM Survey Execution

DGM at MRP Site UXO5 was performed between February 19 and February 26, 2015.

For the two areas mapped with 100 percent coverage, a nominal lane spacing of 2.5 feet (0.75 m) was used. Localized deviations from this lane spacing within the grids were associated with stumps, large rocks, manmade obstructions, or other features that could not be easily rolled over with the EM61-MK2 or that posed a health and safety risk.

Data were recorded by the instrument at a rate of 10 readings per second, with RTK GPS positions logged at a frequency of 5 Hertz. For the transect survey, the EM61-MK2 was pulled along each transect line, with the long axis of the coil perpendicular to the along-line direction of travel. Data collection consisted of a single pass along each transect with the instrument. The EM61-MK2 operator followed the paths cleared by USAE during site preparations. Data collection was paused as the operator navigated through the vegetation to get to the next transect.

# Information Management

DGM data were collected in grid or transect "blocks," where one block was composed of several grids or transects. The block ID was one of the unit (i.e., grid or transect) IDs within that block. QC tests were conducted in between each transect block, thereby "opening" and "closing" each data collection block. This procedure allowed for effective QC of the DGM data, for the following reason: if a problem was identified, it would only negatively affect a subset of data rather than an entire day's worth of data. For presentation of final results in this memorandum, the individual blocks were compiled to generate mosaics of the survey sub-areas previously described.

Field notes (including site conditions, weather conditions, instrument file names, QC test file names) were recorded using KCH's Munitions Response Site Information Management System (MRSIMS). Rugged Toughpad field notebook computers were used by the DGM team to record information using a forms-based interface that allowed for consistent completion of daily forms or data block-specific forms. The forms were submitted via the Internet at the end of each day's data collection and placed in a secure SharePoint library associated with the project SharePoint site. The data processor subsequently imported the form data into the master MRP Site UXO5 MRSIMS project database. This master database was housed on a secure KCH server, accessible to project team members who possessed the required log-in credentials.

Raw sensor data, photos, and other relevant information from the field were posted daily to a secure, password-enabled file transfer protocol site.

# Quality Control

As a means of maintaining confidence in the sensor performance and quality of the DGM data, daily QC tests were performed on the RTK GPS and EM61-MK2 (Figure 3).

FIGURE 3
Performing QC Tests with the RTK GPS (Left) and EM61-MK2 (Right) at the IVS

## Equipment Warm Up

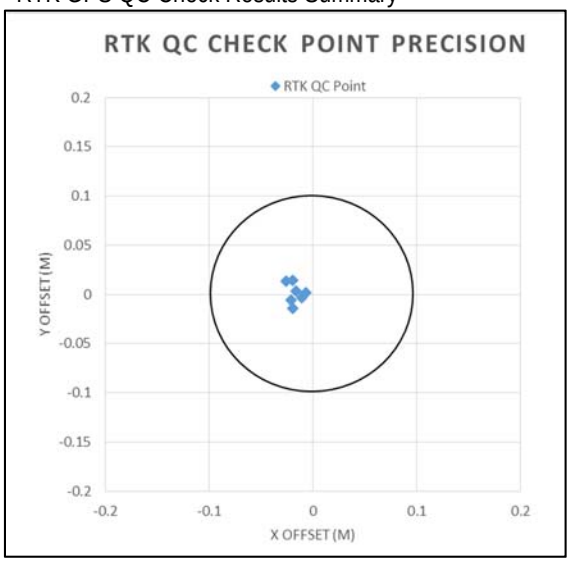
Result: Pass. The EM61-MK2 was allowed to warm up for at least 10 to 15 minutes at the start of each day it was scheduled for use. This warm-up period was necessary to allow for

minimization of sensor drift associated with stabilization of the EM61-MK2 electronics at the start of the day.

### Record Sensor Positions

Result: Pass. The R8 GNSS receiver used with the EM61-MK2 was tested each day it was scheduled for use by measuring the position of one of the temporary benchmark locations in Table 1. The measured positions were subsequently compared to the positions provided by Coast Surveying, Inc. for compliance with the required tolerance of ±4 inches (10 cm). The RTK GPS QC checks between February 19 and 26, 2015 are shown graphically on Figure 4.

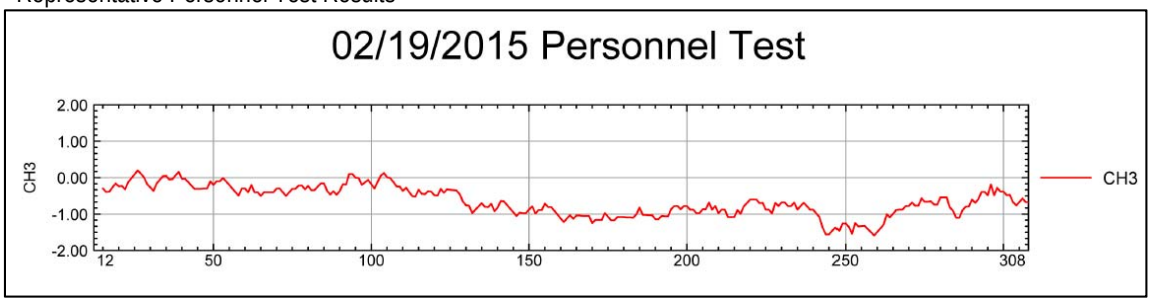
FIGURE 4
RTK GPS QC Check Results Summary




### Personnel Test

Result: Pass. A static test was conducted with the EM61-MK2 to evaluate whether a response was present in the data from the DGM operator (e.g., metal items in pockets or personnel too close to the sensor). The tolerance level was set as follows: the effect of the DGM operator would not result in responses outside ±2 mV of the mean response for the target selection channel. A representative QC output from the personnel test is provided on Figure 5.

FIGURE 5
Representative Personnel Test Results



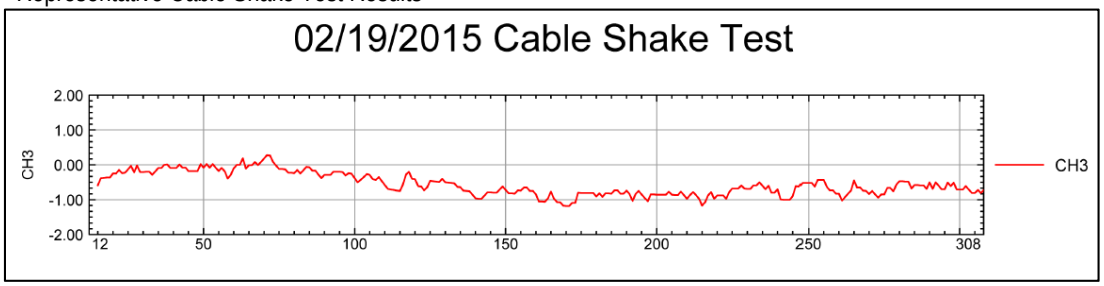
## Cable Shake Test

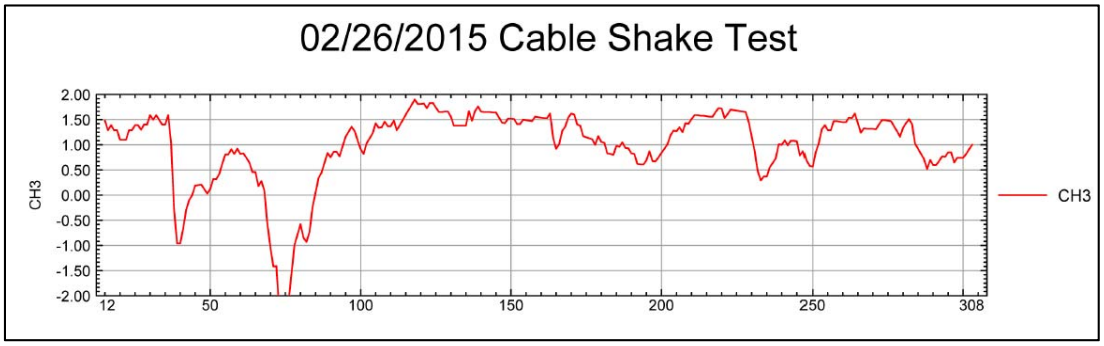
Result: Pass. A static test was conducted with the EM61-MK2 to evaluate whether vibration of the sensor cables and connectors (mimicking walking conditions during data collection) elicited a response in the data. The tolerance level in the responses is ±2 mV of the mean response for the target selection channel.

One instance of a measurement outside this tolerance level was recorded on the February 26, 2015 cable shake test (see Figure 6). A root cause analysis (RCA) was conducted by the KCH team for this instance. It was determined that the DGM operator did not follow proper procedures that day and too vigorously shook the cables when conducting the test, at which point the equipment no longer simulated normal walking conditions. Evaluation of data collected at the IVS and in the production area on that day, in addition to the other cable shake tests for the entire DGM survey, indicated no resulting adverse quality impacts or EM61-MK2 system problems. The data from the subject test indicate that the issue was a result of improper field procedures. Additional explanation of the issue is provided in the RCA document provided in Attachment F2 to this memorandum.

Representative QC outputs from the cable shake test are provided on Figure 6.

FIGURE 6
Representative Cable Shake Test Results




## Static Background and Static Spike Test

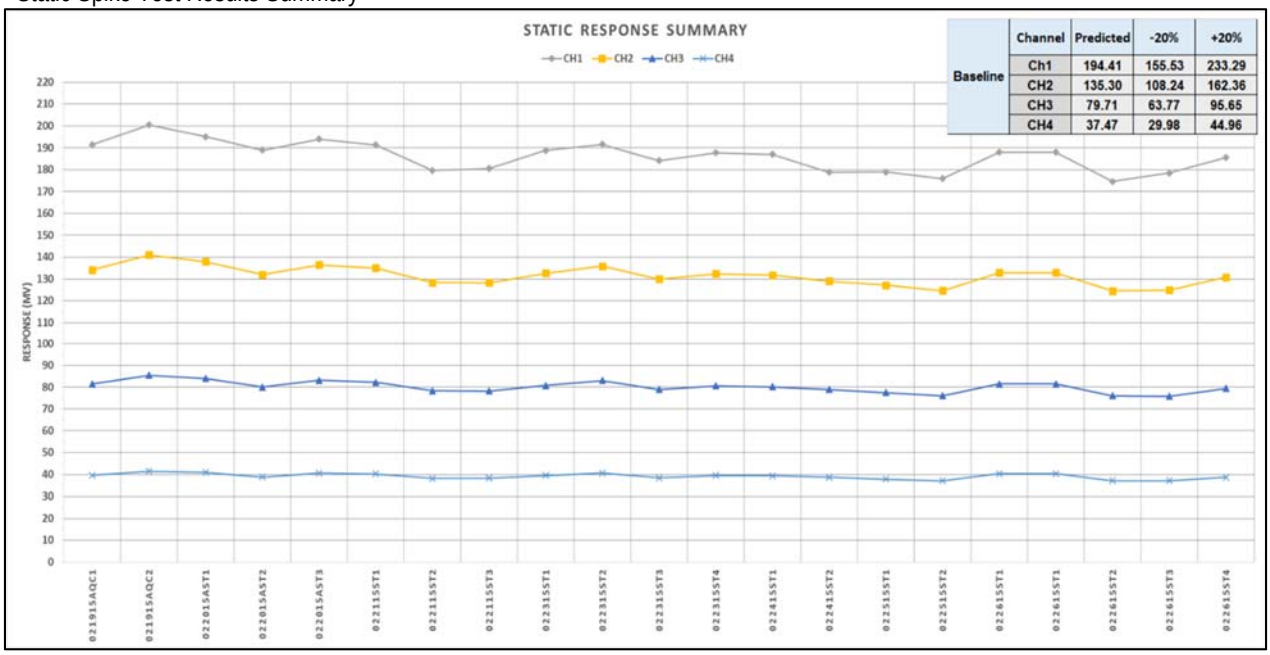
Result: Pass. A static background response and static spike test were conducted at the start and end of each day's data collection, and in between each data block. The intent of this test was to demonstrate the following:

- No unusual, inexplicable change in background response or sensor noise levels occurred during the day.

- The EM61-MK2 response, after background removal, to an ISO40 was within ±20 percent of the predicted EM61-MK2 Channel 3 response, as published by the Naval Research Laboratory (NRL) (2009).

This quantitative assessment serves as a sensor function test for the EM61-MK2 to demonstrate that the sensor responds consistently to a known object and within industry-accepted standards. The results shown on Figure 7 demonstrate that no static responses to the small ISO40 exceeded the ±20 percent tolerance.

FIGURE 7
Static Spike Test Results Summary




## Repeat Data

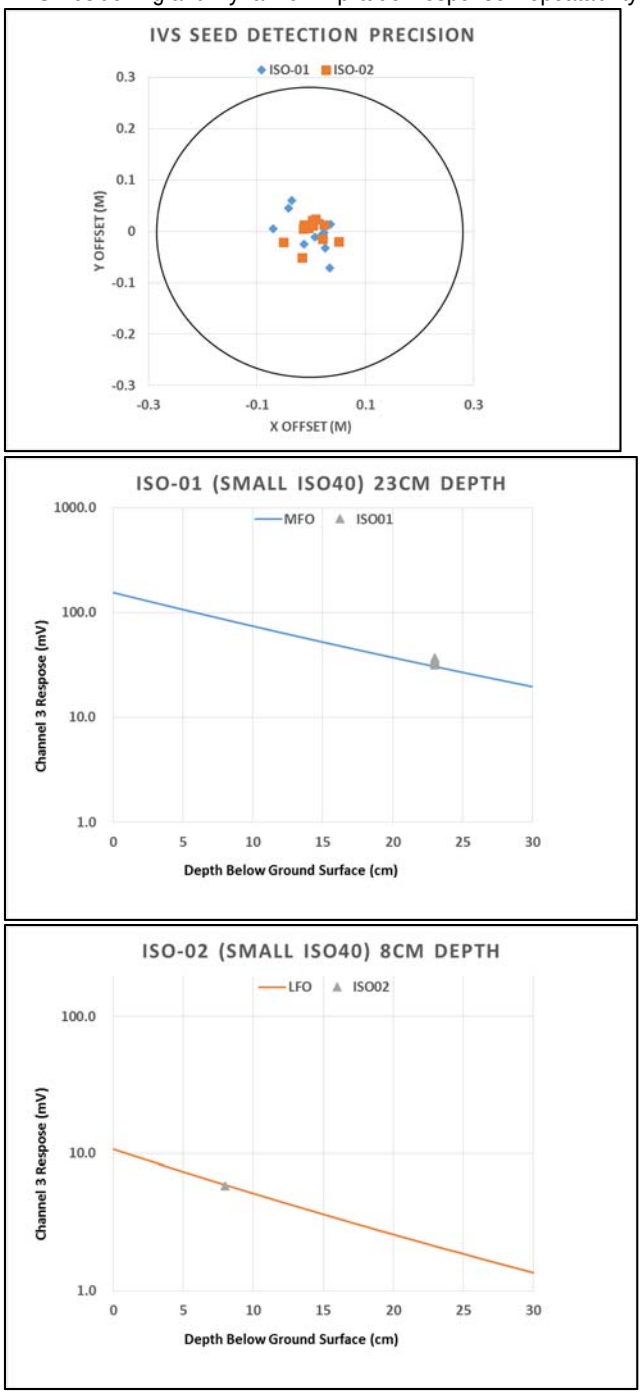
Result: Pass. Repeatability of the DGM data was assessed through evaluation of the twice daily (once at the start of the workday and once at the end of the workday) survey of the IVS with the EM61-MK2. The twice daily survey at the IVS including recording data along the seeded transect and background strip. This QC check facilitated quantitative comparison of the derived IVS seed positions from the DGM data versus the ground truth. The QC check also allowed for a qualitative comparison of the response amplitude from the seed items versus the predicted responses (NRL, 2009). IVS construction and seed details are provided in the IVS report in Appendix E of the RI report.

For data collection on February 26, 2015 (the final day for DGM at MRP Site UXO5), the DGM field team did not conduct an end-of-day survey at the IVS. An RCA was conducted by KCH as a result of this oversight, and it was determined that the DGM field team did not plan adequate time at the end of the workday to allow for this QC test. The team was transitioning to another site at NAVWPNSTA Fallbrook and inadvertently got locked behind a secure gate, further delaying their return to MRP Site UXO5 and the location of the IVS. All data quality assessments and usability assessments from this day were performed

by the KCH Data Processor and QC Geophysicist, and no data quality issues were observed as a result of not completing the end-of-day IVS survey.

Figure 8 demonstrates the IVS seed positioning precision (tolerance is ±0.82 foot [25 cm]) and the Channel 3 response from the small ISO40s during the dynamic survey of the IVS for MRP Site UXO5.

FIGURE 8
IVS Positioning and Dynamic Amplitude Response Repeatability Summary



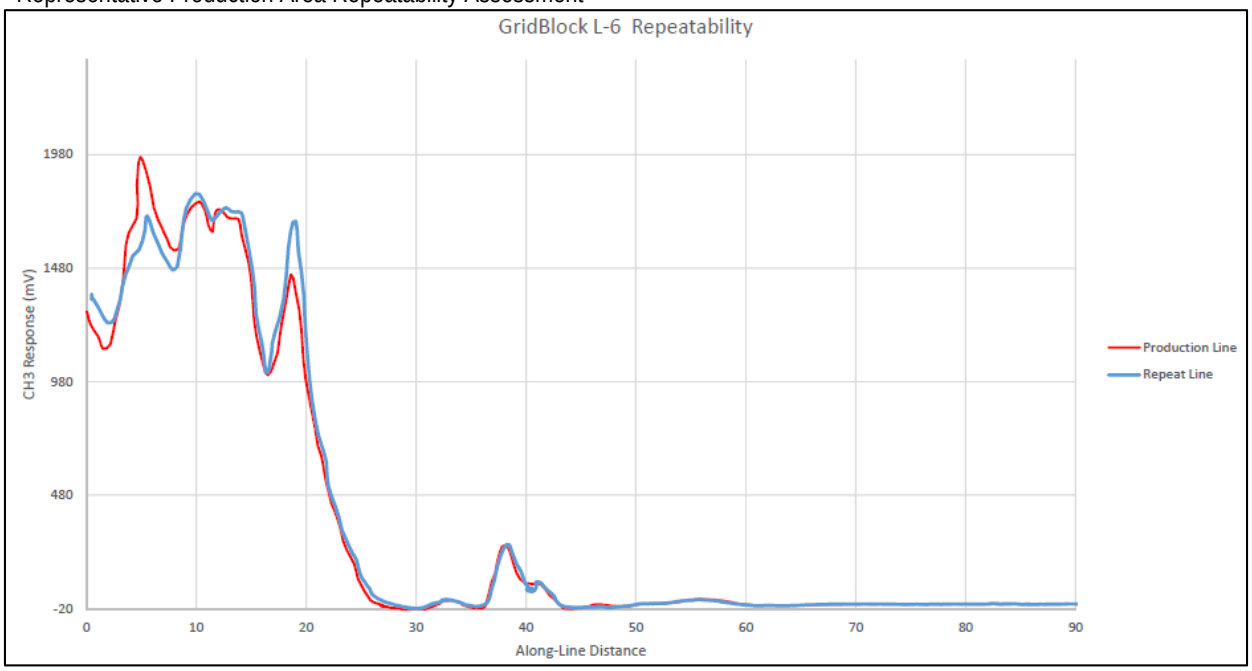

Note: MFO = Most Favorable Orientation (i.e., Vertical); LFO = Least Favorable Orientation (i.e., Horizontal)

In addition to using the IVS to assess repeatability, KCH also collected a percentage of grid or transect repeat data each day of production surveying (Figure 9). The intent of this QC test was to demonstrate that the results obtained during the DGM production survey were repeatable in terms of detected anomalies, positioning, and general amplitude response. For repeatability assessments using dynamic EM61-MK2 data (both at the IVS and in the production area), the amplitude response evaluation is qualitative because of inherent variables that cannot be strictly controlled during dynamic surveying. The following variables result in relatively small sources of error; therefore, it becomes impractical to assign a rigid quantitative pass/fail metric to this evaluation:

- Instrument bounce: As the EM61-MK2 is pulled along a survey transect, the instrument will bounce in a manner that cannot be consistently and strictly controlled
- Walking path: While the operator attempts to walk a repeat line as closely as possible to the original survey line, minor variations in the walking speed and instrument path (particularly as it passes over metal objects) will result in minor variations in the instrument response

Although these variables result in small errors, the previously discussed static spike test serves as the primary quantitative test for evaluating sensor functionality because the static spike test can be strictly controlled in terms of keeping the EM61-MK2 stationary and knowing the precise distance, orientation, and position of the ISO relative to the EM61-MK2 bottom coil.

FIGURE 9
Representative Production Area Repeatability Assessment




## Blind Seeds

The five blind seed items placed by KCH within the MRP Site UXO5 production area were successfully detected by the DGM field team and selected as targets by the KCH Data

Processor. The ground truth positions were reported by Coast Surveying, Inc. Positioning tolerance according to the RI Work Plan was ±3.3 feet (1 m). The results are presented in Table 2.

TABLE 2
DGM Blind Seed Results

| DGM Target ID | Ground Truth Easting (U.S. Feet) | Ground Truth Northing (U.S. Feet) | Target Easting (U.S. Feet) | Target Northing (U.S. Feet) | Positioning Offset (U.S. Feet) |
|---|---|---|---|---|---|
| T-010-00001 | 6251421.33 | 2084854.35 | 6251420.76 | 2084854.55 | 0.61 |
| T-013-00001 | 6251582.01 | 2085018.29 | 6251582.22 | 2085017.62 | 0.71 |
| T-031-00002 | 6251580.99 | 2085237.42 | 6251580.59 | 2085237.95 | 0.67 |
| T-084-00001 | 6251367.15 | 2085666.16 | 6251367.34 | 2085666.62 | 0.49 |
| T-085-00003 | 6251585.15 | 2085834.67 | 6251584.77 | 2085834.91 | 0.45 |

Note:
Coordinates are California State Plane Zone 6, North American Datum 1983 (NAD83) Continental United States (CONUS).

# DGM Data Processing

Data processing was completed in the following steps: QC review of DGM field forms, fiducial positioning, DGM pre-processing, and DGM final processing.

## QC of DGM Field Forms

Daily QC of the DGM field forms was completed by the KCH Data Processor. This QC process was intended to check that MRSIMS was updated each day with the required information and that the relevant field information (e.g., survey notes, QC test file names, EM61-MK2 battery levels, and weather conditions) was effectively documented.

## DGM Pre-Processing

Raw instrument files were initially pre-processed using TrackMaker61MK2 (Geomar Software, Inc.). This initial step involved formatting the files from their raw instrument format to .XYZ American Standard Code for Information Interchange (ASCII) format for further manipulation in Geosoft Oasis Montaj (Geosoft). Upon export from TrackMaker61MK2 to either Universal Transverse Mercator (UTM) or geographic (latitude/longitude) coordinates, interpolation of the RTK GPS positions is performed for the sensor data recorded at a rate of 10 readings per second, based on the time stamp logged by the GPS and EM61-MK2.

Positioned .XYZ files were subsequently imported into Geosoft for further pre-processing. DGM pre-processing steps included the following:

- Evaluation of QC tests (static, cable shake, and personnel) prior to processing DGM survey data
- Conversion of the exported UTM X,Y positons (in meters) to the California State Plane Zone 6 coordinate system (in U.S. Survey Feet)
- Application of auto leveling and instrument drift corrections for EM61-MK2 data

- Application of an appropriate lag correction (from daily seeded IVS transect collection)
- Preliminary comparison of original versus repeat data
- Identification of data gaps to submit to field team for completion
- Evaluation of results against the performance objectives listed in the RI Work Plan
- Generation of formatted ASCII files containing preprocessed data
- Generation of MRSIMS raw data delivery report

Following completion of the above steps, the pre-processed data were reviewed by the KCH QC Geophysicist.

### DGM Final Processing

Final DGM processing steps included the following:

- Incorporating gap-fill data gathered by the field team into the processing work flow
- Refinement of data leveling and lag corrections, as needed
- Gridding of all four time gates using the Geosoft minimum curvature algorithm
- Target selection from gridded data
- Generation of formatted ASCII files containing processed data
- Generation of a false-color mosaic of grid and transect DGM data
- Assigning target type categories based on field notes and observations provided by the DGM team
- Preparation of target lists
- Generation of MRSIMS Final Data Delivery Report

## DGM Target Selection

The target selection threshold is a function of the EM61-MK2 root mean square (RMS) amplitude noise (i.e., sensor noise levels) and site-specific background response. Selection of a target threshold too far into the sensor noise range will lead to a high number of "no contacts" (i.e., false positives) and also a false confidence assuming metal is detected at those signal levels (a true signal can be masked by the noise).

Because the objective of the DGM included detection of potential 20-mm projectiles, the target threshold was set to be as low as the RMS noise levels would support. For the EM61-MK2 data gathered at MRP Site UXO5, the RMS noise levels for Channel 3 ranged between 0.55 and 0.72 mV for the IVS surveys conducted between February 19 and 26, 2015. Industry-accepted practice and industry guidance suggest using a target threshold that equates to a peak amplitude response of five times (5x) the RMS noise. Channel 3 was selected because it had the highest signal-to-noise ratio (SNR) of the four channels. The corresponding targeting threshold for the reported range of RMS values in the IVS surveys using the 5x value equates

to a threshold of 3 mV on Channel 3. Initial production data gathered in the first few days of the survey demonstrated similar RMS values as those of the IVS.

Initial target selections were made using the automatic peak picking module (Blakely Test) in Geosoft's UX-Detect module to identify peak amplitude responses in the gridded Channel 3 data that appeared to be indicative of metal. Data profiles for all four channels were reviewed by the KCH Data Processor to evaluate the validity and position of the auto-selected targets. Targets found to be invalid or incorrectly located were adjusted or removed from the final selection list. This review was performed by evaluating the decay in amplitudes from a peak response and the general shapes of the response curves for each channel at the selected anomaly locations. The intent of this evaluation was to identify automatically selected targets that appear to be associated with surface debris, noise spikes, or potentially represented duplicate target selections. This review process also facilitates adding anomalies to the target selection list that may not have been automatically selected by the UX-Detect module but appear to represent metal.

Table 3 presents the target type categories used by KCH and for the DGM at MRP Site UXO5 and an explanation of each one. Target lists were generated for each grid and transect and were provided to the KCH QC Geophysicist along with the processed data for review as part of the DGM data delivery package.

TABLE 3
DGM Target Types

| Target Type | Description |
|---|---|
| 1 | Target of interest, unknown nature |
| 2 | Below target threshold (<3 mV) selection |
| 3 | Known or suspected response from observed cultural feature |
| 4 | Target associated with EM61-MK2 noise spike (suspected false positive) |
| 5 | Boundary target where location of peak response is not precisely known because of inability of EM61-MK2 to fully pass over object (i.e., along the edge of the survey area or at the end of a transect) |
| 6 | N/A (not used) |
| 7 | N/A (not used) |
| 8 | Obstruction feature defined by four vertices; represents data gap area that could not be accessed with EM61-MK2 |
| 9 | SRA defined by four vertices where precise identification of individual peak amplitudes not possible because of overlapping signatures or saturation of the dynamic recording range of the EM61-MK2 |

Notes:
N/A = not applicable
SRA = saturated response area

# Measurement Quality Objectives

MQOs and their corresponding MPC are presented in the RI Work Plan. For the DGM survey at MRP Site UXO5, the MQOs were met. Table 4 summarizes these results.

TABLE 4
DGM MQO Achievement Summary

| MQO | Result | Achieved (Yes/No) |
|---|---|---|
| DGM System Positioning | All RTK GPS positions were within ±4 inch (10 cm) tolerance (see **Figure 4**). | Yes |
| DGM System Munitions Detection | Responses to small ISO were within ±20 percent tolerance of predicted value (NRL, 2009) (see **Figure 7**). | Yes |
| Repeatability | Derived IVS seed item positions were within ±0.8 foot (25 cm) tolerance of ground truth positions; repeat data profiles from production. Survey exhibited good correlation in positioning and amplitude response (see **Figures 8 and 9**). | Yes |
| Data Density | Mean sample spacing was 0.21 foot (0.06 m). EM61-MK2 data were recorded with less than 2 percent exceeding the 0.7 foot (0.21 m) point-to-point spacing requirement. Gaps larger than 2 feet (0.61 m) were all associated with obstructions. | Yes |
| Lane Spacing | EM61-MK2 lane spacing was ±3.3 feet (1m) or less, except in areas with obstructions present. This MQO does not apply to the transect survey. | Yes |
| Data Positioning | All blind seed items were detected within ±3.3 foot (1 m) tolerance. | Yes |
| Data Handling | Data delivery was on schedule. Delays associated with delivery of initial results resulted from the need to perform gap fill surveys and incorporate those data into the results. | Yes |

# DGM Results

False-color images of the DGM responses are provided on Figures F1-2 through F1-5. In each false-color map, the grayscale shading represents the background response range (i.e., responses less than 3 mV on Channel 3).

Figure F1-2 presents the results from the 100 percent mapped Additional Work Area located adjacent to and outside the western fence line for MRP Site UXO5. Figure F1-3 presents the results from the 100 percent mapped area in the low-lying northern portion of the site. Figures F1-4 and F1-5 present the results of the EM61-MK2 transects (split into two figures for added clarity).

The number of DGM targets selected for each survey sub-area is presented by type and summed in Tables 5 through 7.

TABLE 5
Additional Work Area DGM Target Quantities

| Target Type | Quantity |
|---|---|
| 1 | 116 |
| 2 | 0 |
| 3 | 64 |
| 4 | 14 |
| 5 | 0 |
| 6 | N/A |
| 7 | N/A |
| 8 | 0 |
| 9 | 3 |
| **Total** | **197** |

TABLE 6
Northern DGM Grids Target Quantities

| Target Type | Quantity |
|---|---|
| 1 | 71 |
| 2 | 0 |
| 3 | 0 |
| 4 | 14 |
| 5 | 16 |
| 6 | N/A |
| 7 | N/A |
| 8 | 0 |
| 9 | 4 |
| **Total** | **105** |

TABLE 7
Transect DGM Survey Target Quantities

| Target Type | Quantity |
|---|---|
| 1 | 364 |
| 2 | 0 |
| 3 | 48 |
| 4 | 9 |
| 5 | 18 |
| 6 | N/A |
| 7 | N/A |
| 8 | 0 |
| 9 | 0 |
| **Total** | **439** |

Target locations derived from the EM61-MK2 data collected at MRP Site UXO5 are presented on Figure F1-6. For the RI, only the Type 1 targets were considered for follow-up investigation; therefore, Figure F1-6 presents EM61-MK2 Type 1 targets using a different symbol color than that used for the other EM61-MK2 target types. Because SRAs are defined by four vertices, they are presented on Figure F1-6 as polygons. Furthermore, as part of the data tracking and flow in MRSIMS, a polygon (Type 8 or Type 9 target) cannot extend across grid boundaries; therefore, the four SRAs shown on Figure F1-6 are, in fact, part of the same elevated response features depicted in the data shown on Figure F1-3. The location of this feature coincides with large quantities of metal observed protruding from the ground surface. It likely represents the edge of a disposal feature at MRP Site UXO5.

Figure F1-6 also presents the locations of the SES-TECH G-858 magnetometer survey targets from within the portion of MRP Site UXO5 that overlaps with the EM61-MK2 transect survey. A total of 964 magnetometer targets (out of the initial 2,680) was identified within this dispersed anomaly area. Of these 964 targets, 11 seed items were included, based on a review of the SES-TECH final report (SES-TECH, 2012). Of the 11 SES-TECH seeds in this overlapping section, 3 were targeted by the EM61-MK2 and included in the EM61-MK2 Type 1 target count.

# Target Population Assessment

In accordance with the RI Work Plan, the intrusive investigation of targets identified in the DGM data was performed on a statistically representative subset of targets in order to characterize the proportion of munitions-related items to non-munitions-related items to a 95 percent confidence level and within a ±5 percent margin of error.

The first step in the derivation of a dig list is to evaluate whether the anomaly locations comprise a single population or if they represent multiple anomaly populations. If multiple populations are evident in the data, statistical tools would have to be applied in the same manner for each population to avoid under sampling a portion of the site. For many munitions response investigations where a potential impact area, bombing target, firing position, or similar features are suspected, there are often variations in the target density (i.e., lateral extent of anomaly locations indicating the presence of metal) within these features versus in other areas of the site.

## Visual Sample Plan

For MRP Site UXO5, the distribution of discrete targets appears to be consistent with the site history as a disposal area. Target density estimations were derived using Visual Sample Plan (VSP) (Pacific Northwest National Laboratory/Battelle, 2015). The EM61-MK2 Type 1 target locations, G-858 magnetometer survey target locations, and sensor instrument paths were imported into VSP; the results are presented on Figure F1-7. For this effort, G-858 magnetometer survey targets coincident with EM61-MK2 target locations (within a 3.3-foot [1-m] radius) were removed from the VSP analysis. The Additional Work Area adjacent to the asphalt parking lot was also excluded from the VSP analysis because of the dominating effect of its cultural features and because conditions within this area are not representative of MRP Site UXO5.

It should be noted that this statistical evaluation is performed using the specific target locations derived from the geophysical data, and that the characterization pertains to the actual target population itself. In the case of transect or meandering path surveys, the statistical characterization is applied in the end to the entire investigation area footprint, with the assumption that the results are representative of the larger site based on the transect spacing, survey design, and subsequent target clustering evaluation.

The VSP results on Figure F1-7 demonstrate a target distribution consistent with the site history as a disposal area. Localized areas of higher target density in the northern portion of the site coincide with the location of known disposal features and the steeply sloped ravine with visible metal debris. Therefore, the target population assessment was based primarily on variation in site features on a micro scale. In the end, it was determined that MRP Site UXO5 was best represented by four target populations:

- Population 1: the G-858 magnetometer survey targets provided by SES-TECH
- Population 2: EM61-MK2 targets from the Additional Work Area mapped at 100 percent coverage
- Population 3: EM61-MK2 targets from the northern grids (low lying areas) mapped at 100 percent coverage
- Population 4: targets from the EM61-MK2 transect survey (dispersed anomaly area)

Population 1. Because of the inherent differences between the G-858 magnetometer survey and EM61-MK2 (all-metals detector) sensors, and because of the operational differences in how the two data sets were collected, it was determined that the G-858 magnetometer survey targets represent one target population. It is impractical to attempt to draw detailed conclusions on a target-by-target basis between the two data sets.

Population 2.The Additional Work Area was determined to be its own target population because it was not incorporated into the VSP analysis. The relatively small area had a high number of detected targets, but during DGM data analysis, it was suspected that the high number of detected targets may have been the result of effects from utilities, government trailers and vehicles parked along the edge of the asphalt lot, and small pieces of metal debris visible on the surface, consistent with parking lot debris.

Population 3. Targets derived from the EM61-MK2 data collected in the northern grids were grouped into a separate anomaly population because the survey area appeared to encroach on disposal features. In addition, metal was observed in the ravine that bisects this survey area, so it was decided that there could be increased potential of encountering munitions-related items in this area because of the localized presence of abundant metal.

Population 4. The fourth population includes targets derived from the transect survey because the portions of the site covered by transects were suspected to have been characterized as a dispersed anomaly area.

For each EM61-MK2 target population, the Type 1 targets were used as the basis for deriving the dig lists. QC seeds were removed from the statistical evaluation but were subsequently added to the final dig list to be reacquired and intrusively investigated as part of ongoing validation of the data gathering processes onsite.

## Estimating a Proportion

The Estimating a Proportion method was used to calculate the number of randomly selected DGM targets from each population that would need to be intrusively excavated to estimate, with a 95 percent confidence level and ± 5 percent sampling error, the proportion of munitions-related to non-munitions-related items within the target populations identified at MRP Site UXO5.

When a population size is large or unknown, the necessary sample size of DGM anomalies to be intrusively investigated can be estimated using the following statistical sample size formula:

$$n_0 = \frac{Z_\alpha^2 pq}{e^2}$$

| | | |
|---|---|---|
| $Z_\alpha$ | = | desired confidence level |
| p | = | proportion of DGM anomalies classified as munitions-related |
| q | = | proportion of DGM anomalies classified as non-munitions-related (q = 1-p) |
| e | = | acceptable margin of error for proportion being estimated |
| $n_0$ | = | statistical sample size for a large population |

To conservatively estimate the variance of proportional variables (munitions-related or non-munitions-related), pq (in the equation above), a population proportion of 50 percent (p=0.5) is estimated to maximize the variance, and subsequently maximize the sample size. Using a z-statistic for a 95 percent confidence level ($Z_\alpha$=1.96) and a margin of error of 5 percent (e=0.05), the solution for $n_0$ becomes:

$$n_0 = \frac{Z_\alpha^2 pq}{e^2} = \frac{1.96_\alpha^2(0.5)(0.5)}{0.05^2} = 384$$

A maximum of 384 randomly selected DGM anomalies is estimated for classifying, with a 95 percent confidence level and ± 5 percent sampling error, the proportion of munitions-related to non-munitions-related DGM anomalies in a large or unknown population.

Following the estimation of the population size above, the following finite population correction can be used to reduce the number of anomalies required to obtain the same confidence level:

$$n_1 = \frac{n_0}{1 + \left(\frac{n_0}{N}\right)}$$

$n_1$ = adjusted statistical sample size for a finite population
$n_0$ = statistical sample size for a large population
N = size of the population (number of DGM targets)

The finite population correction equation used a random number selector process and excluded non-Type 1 targets and QC seed items. This means that of the total anomalies for each population were used as "N" in the equation to calculate the finite population correction:

$$n_1 = \frac{n_0}{1+\left(\frac{n_0}{N}\right)} = \frac{384}{1+\frac{384}{953}} = 274 \text{ (Population 1)}$$

$$n_1 = \frac{n_0}{1+\left(\frac{n_0}{N}\right)} = \frac{384}{1+\frac{384}{116}} = 89 \text{ (Population 2)}$$

$$n_1 = \frac{n_0}{1+\left(\frac{n_0}{N}\right)} = \frac{384}{1+\frac{384}{71}} = 60 \text{ (Population 3)}$$

$$n_1 = \frac{n_0}{1+\left(\frac{n_0}{N}\right)} = \frac{384}{1+\frac{384}{359}} = 185 \text{ (Population 4)}$$

The results of this calculation for the four populations are summarized in Table 8.

TABLE 8
Statistical Subset Target Counts by Population

| Population | Type 1 Target Count (No QC Seeds) | Estimating a Proportion Result | Number of QC Seeds | Total Targets for Dig List |
|---|---|---|---|---|
| 1 | 953 | 274 | 8 | 282 |
| 2 | 116 | 89 | 0 | 89 |
| 3 | 71 | 60 | 0 | 60 |
| 4 | 359 | 185 | 8[1] | 193 |

Note:
The eight seeds included in the Population 4 dig list include five seeds placed by KCH and three SES-TECH seeds detected by the EM61-MK2.

# DGM Conclusions

From the population totals summarized in Table 8, the individual targets ultimately added to the dig lists were chosen from each respective population list using a random number generator. The total number of targets for all of MRP Site UXO5 selected for intrusive investigation was 624. The targets selected for intrusive investigation are presented on Figure F1-8. Dig lists were provided to the KCH project manager and UXO Quality Control

Specialist, and target locations were imported into MRSIMS for use during the intrusive investigation.

During reacquisition and flagging of dig locations by Coast Surveying, Inc., it was found that three target locations in the Additional Work Area were on the edge of the asphalt parking lot and were inaccessible for the intrusive investigation. In this case, the next three targets from the random number generator list for that population were used to replace the three inaccessible targets.

The results of the DGM survey and statistical sampling of the data met the DGM objectives for the RI at MRP Site UXO5. The MQOs were achieved and the EM61-MK2 sensor passed the required QC tests. Identifying multiple populations and applying the statistical tools to each population provides added confidence that the proportion of munitions-related items to non-munitions-related items was characterized using the data gathered and targets derived from the DGM survey.

# References

CH2M HILL Kleinfelder, A Joint Venture (KCH). 2015. Work Plan, Remedial Investigation for Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach Detachment Fallbrook, Fallbrook, California. Final. February.

CH2M HILL Kleinfelder, A Joint Venture (KCH). In progress. Remedial Investigation, Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach Detachment Fallbrook, Fallbrook, California.

Naval Research Laboratory (NRL). 2009. EM61-MK2 Response of Three Surrogates, NRL/MR/6110-09-9183. March.

Pacific Northwest National Laboratory/Battelle. 2015. Visual Sample Plan, Version 6.5. http://vsp.pnnl.gov/.

SES-TECH. 2012. Geophysical Report, Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach Detachment Fallbrook, Fallbrook, California. Final.

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# Attachment F1
# Figures

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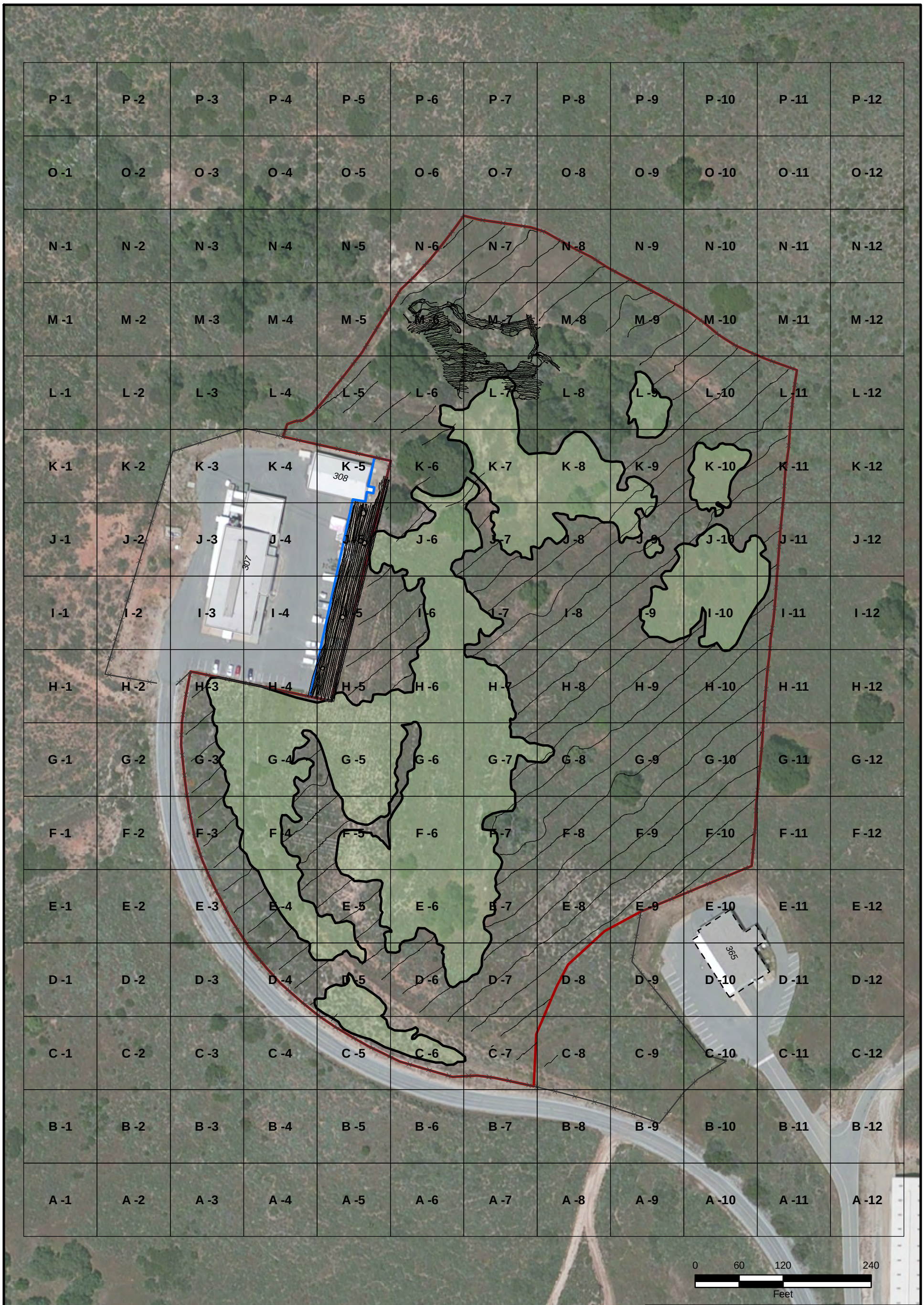


## LEGEND

- EM61-MK2 INSTRUMENT PATH
- INTERPRETED ELEVATED ANOMALY DENSITY AREA (EADA) - 4.59 ACRES
- A-1 100 FOOT GRID
- FENCE LINE
- BUILDING - EXISTING
- BUILDING - DEMOLISHED
- SITE BOUNDARY
- ADDITIONAL WORK AREA

NOTES:
DGM = Digital Geophysical Mapping
MRP = Munitions Response Program
UXO = Unexploded Ordnance
NAVWPNSTA = Naval Weapons Station

IMAGERY SOURCE:
ESRI ArcGIS Online Web Service, World Imagery 5/3/2010

**DGM Survey Coverage - EM61-MK2**

Digital Geophysical Mapping Technical Memorandum
MRP Site UXO5
NAVWPNSTA Seal Beach Detachment Fallbrook, California

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FIGURE
**F1-1**

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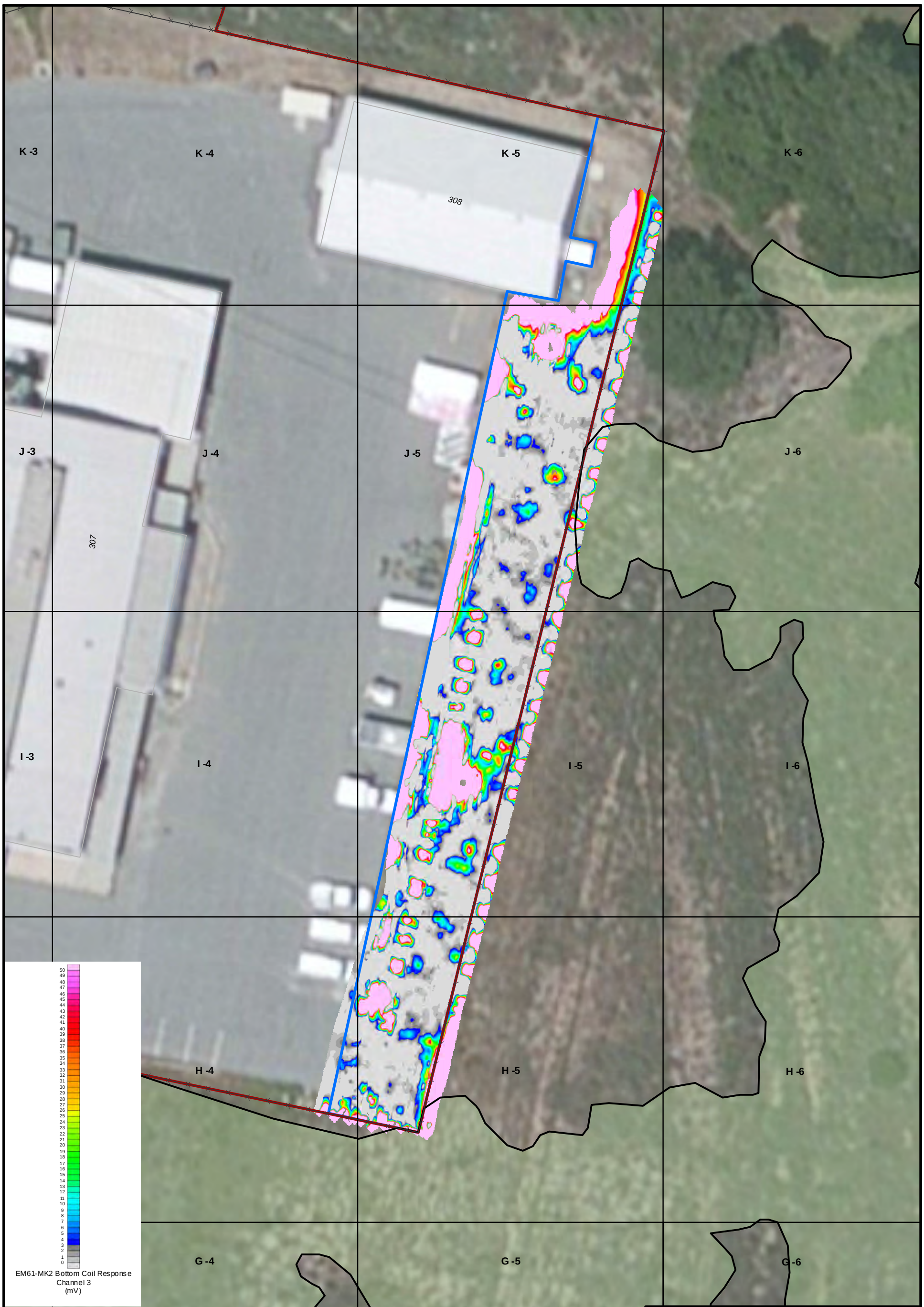


## LEGEND

- INTERPRETED ELEVATED ANOMALY DENSITY AREA (EADA) - 4.59 ACRES
- A-1 100 FOOT GRID
- BUILDING - EXISTING
- ADDITIONAL WORK AREA
- SITE BOUNDARY
- FENCE LINE

IMAGERY SOURCE:
ESRI ArcGIS Online Web Service, World Imagery 5/3/2010

0 15 30 60
Feet

NOTES:
mV = milliVolts
MRP = Munitions Response Program
UXO = Unexploded Ordnance
NAVWPNSTA = Naval Weapons Station

**EM61-MK2 Channel 3 Response**
**Additional Work Area**
Digital Geophysical Mapping Technical Memorandum
MRP Site UXO5
NAVWPNSTA Seal Beach Detachment Fallbrook, California

N

FIGURE
**F1-2**

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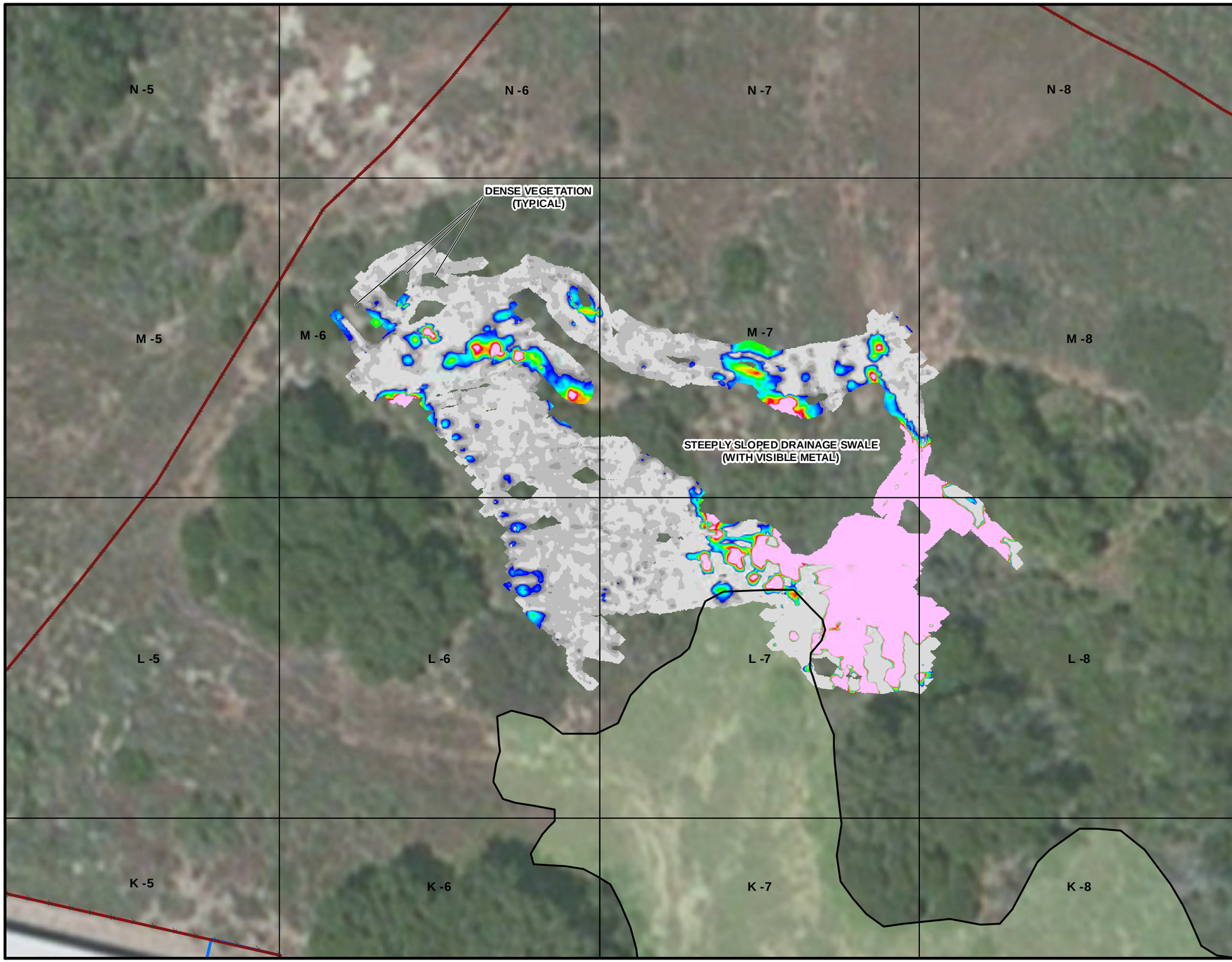
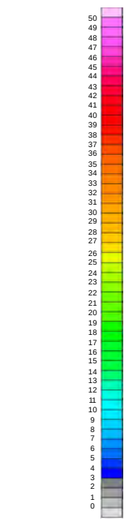



## LEGEND

- INTERPRETED ELEVATED ANOMALY DENSITY AREA (EADA) - 4.59 ACRES
- A-1 100 FOOT GRID
- ADDITIONAL WORK AREA
- SITE BOUNDARY
- FENCE LINE



EM61-MK2 Bottom Coil Response
Channel 3
(mV)

NOTES:
mV = milliVolts
MRP = Munitions Response Program
UXO = Unexploded Ordnance
NAVWPNSTA = Naval Weapons Station

IMAGERY SOURCE:
ESRI ArcGIS Online Web Service,
World Imagery 5/3/2010

0 15 30 60
Feet

**EM61-MK2 Channel 3 Response**
**Northern Grids**
Digital Geophysical Mapping Technical Memorandum
MRP Site UXO5
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N

FIGURE
**F1-3**

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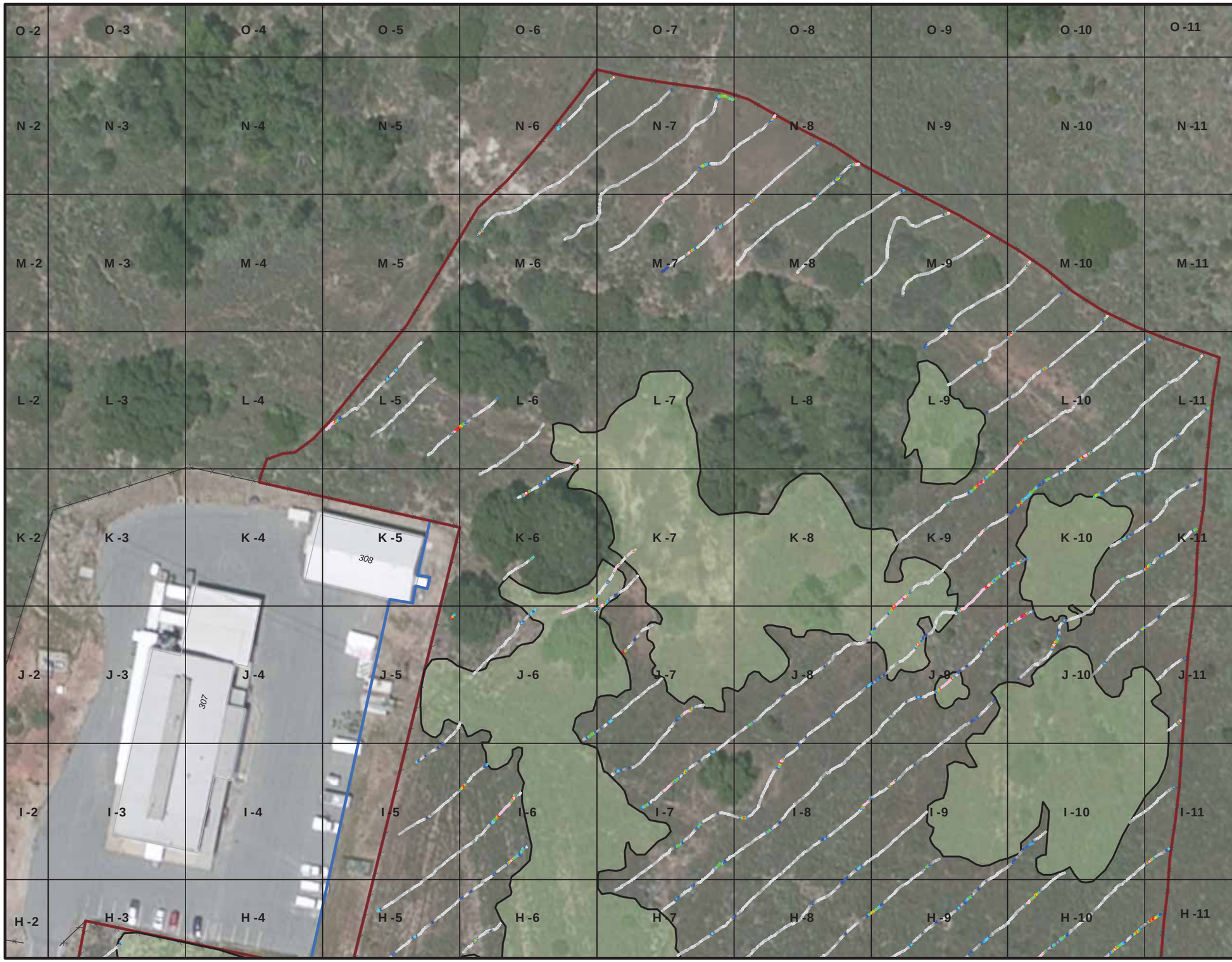
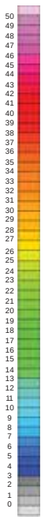



## LEGEND

- INTERPRETED ELEVATED ANOMALY DENSITY AREA (EADA) - 4.59 ACRES
- A-1 100 FOOT GRID
- BUILDING - EXISTING
- ADDITIONAL WORK AREA
- SITE BOUNDARY
- FENCE LINE



EM61-MK2 Bottom Coil Response
Channel 3
(mV)

NOTES:
mV = milliVolts
TM = Technical Memorandum
MRP = Munitions Response Program
UXO = Unexploded Ordnance
NAVWPNSTA = Naval Weapons Station

IMAGERY SOURCE:
ESRI ArcGIS Online Web Service,
World Imagery 5/3/2010

0 35 70 140
Feet

**EM61- MK2 Channel 3 Response Transects - Dispersed Anomaly Area North**

Digital Geophysical MappingTM, MRP Site UXO5
NAVWPNSTA Seal Beach Detachment Fallbrook, California

FIGURE
**F1-4**

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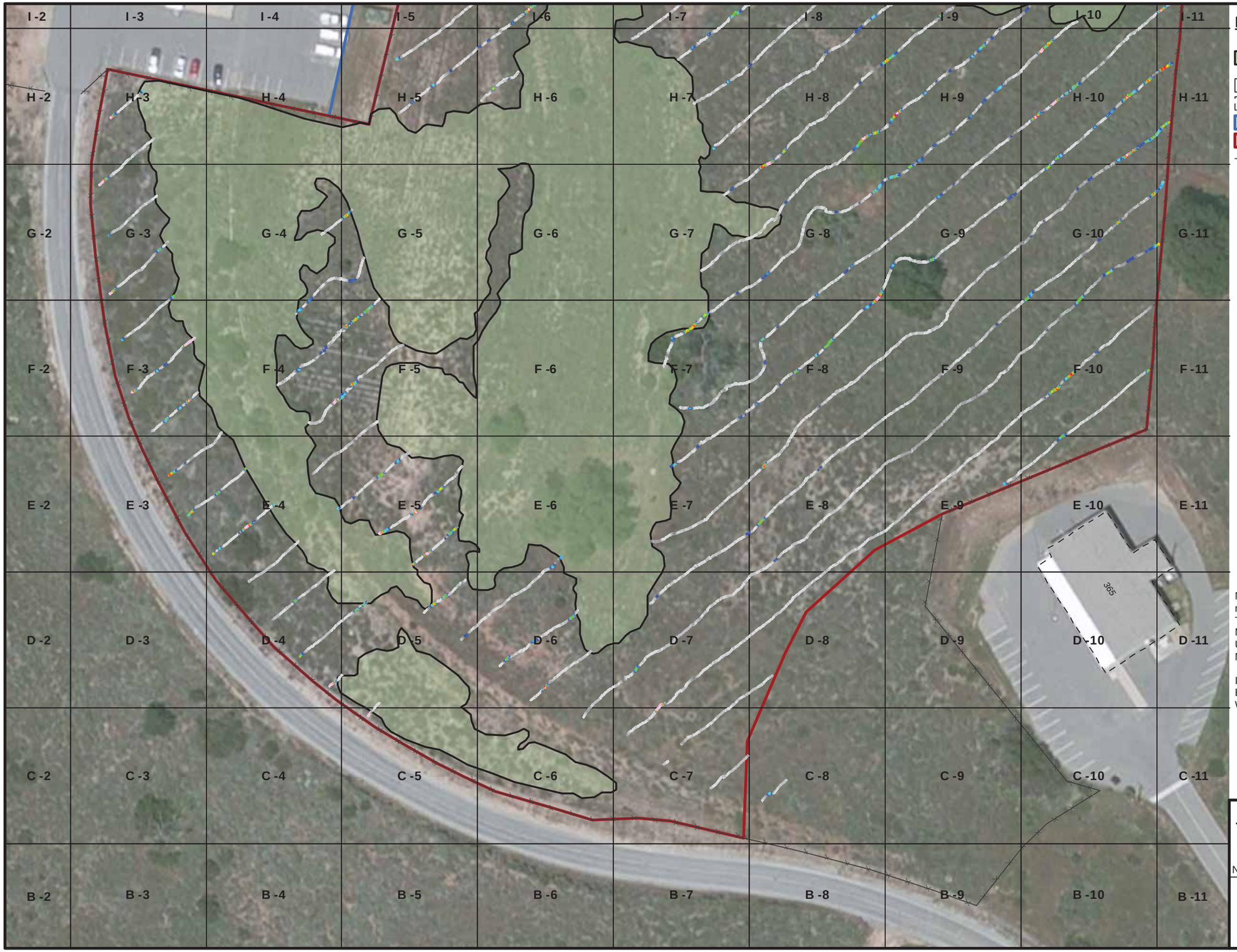


## LEGEND

- INTERPRETED ELEVATED ANOMALY DENSITY AREA (EADA) - 4.59 ACRES
- A-1 100 FOOT GRID
- BUILDING - DEMOLISHED
- ADDITIONAL WORK AREA
- SITE BOUNDARY
- FENCE LINE

EM61-MK2 Bottom Coil Response
Channel 3
(mV)

NOTES:
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TM = Technical Memorandum
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NAVWPNSTA = Naval Weapons Station

IMAGERY SOURCE:
ESRI ArcGIS Online Web Service,
World Imagery 5/3/2010

0 35 70 140
Feet

**EM61-MK2 Channel 3 Response Transects - Dispersed Anomaly Area South**

Digital Geophysical MappingTM, MRP Site UXO5
NAVWPNSTA Seal Beach Detachment Fallbrook, California

FIGURE
**F1-5**

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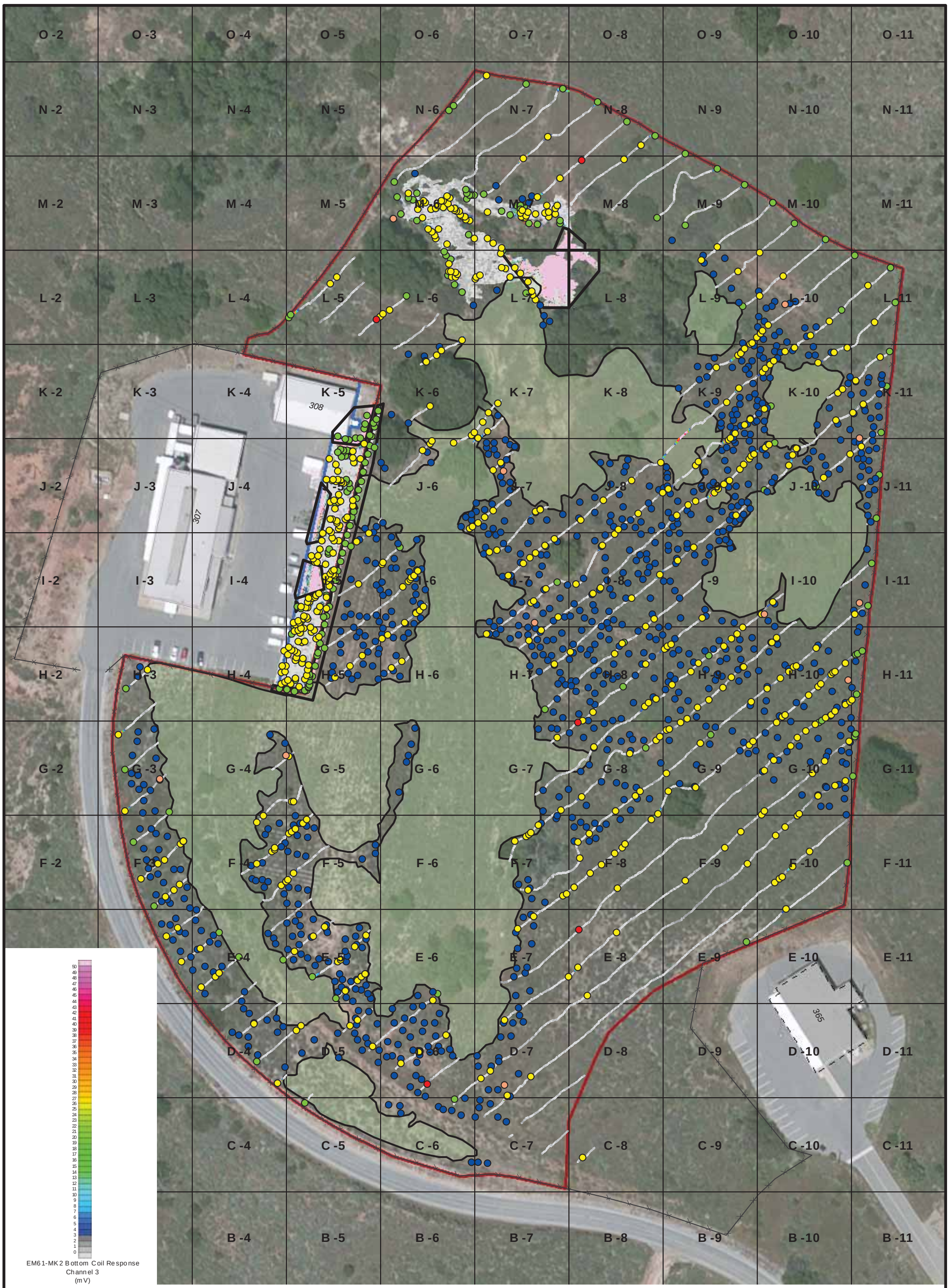


## LEGEND

### DGM TARGET LOCATIONS

- QC SEED LOCATION (KCH, 4/2015)
- QC SEED LOCATION (SES-TECH)
- G858 DISPERSED AREA TARGET (SES-TECH)
- EM61-MK2 TYPE 1 TARGET
- EM61-MK2 TYPE 3/4/5 TARGET
- SATURATED RESPONSE AREA

- INTERPRETED ELEVATED ANOMALY DENSITY AREA (EADA) - 4.59 ACRES
- A-1 100 FOOT GRID
- BUILDING - EXISTING
- BUILDING - DEMOLISHED
- ADDITIONAL WORK AREA
- SITE BOUNDARY
- FENCE LINE

NOTES:
DGM = Digital Geophysical Mapping
MRP = Munitions Response Program
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NAVWPNSTA = Naval Weapons Station

IMAGERY SOURCE:
ESRI ArcGIS Online Web Service, World Imagery 5/3/2010

**DGM Target Locations**

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MRP Site UXO5
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FIGURE
**F1-6**

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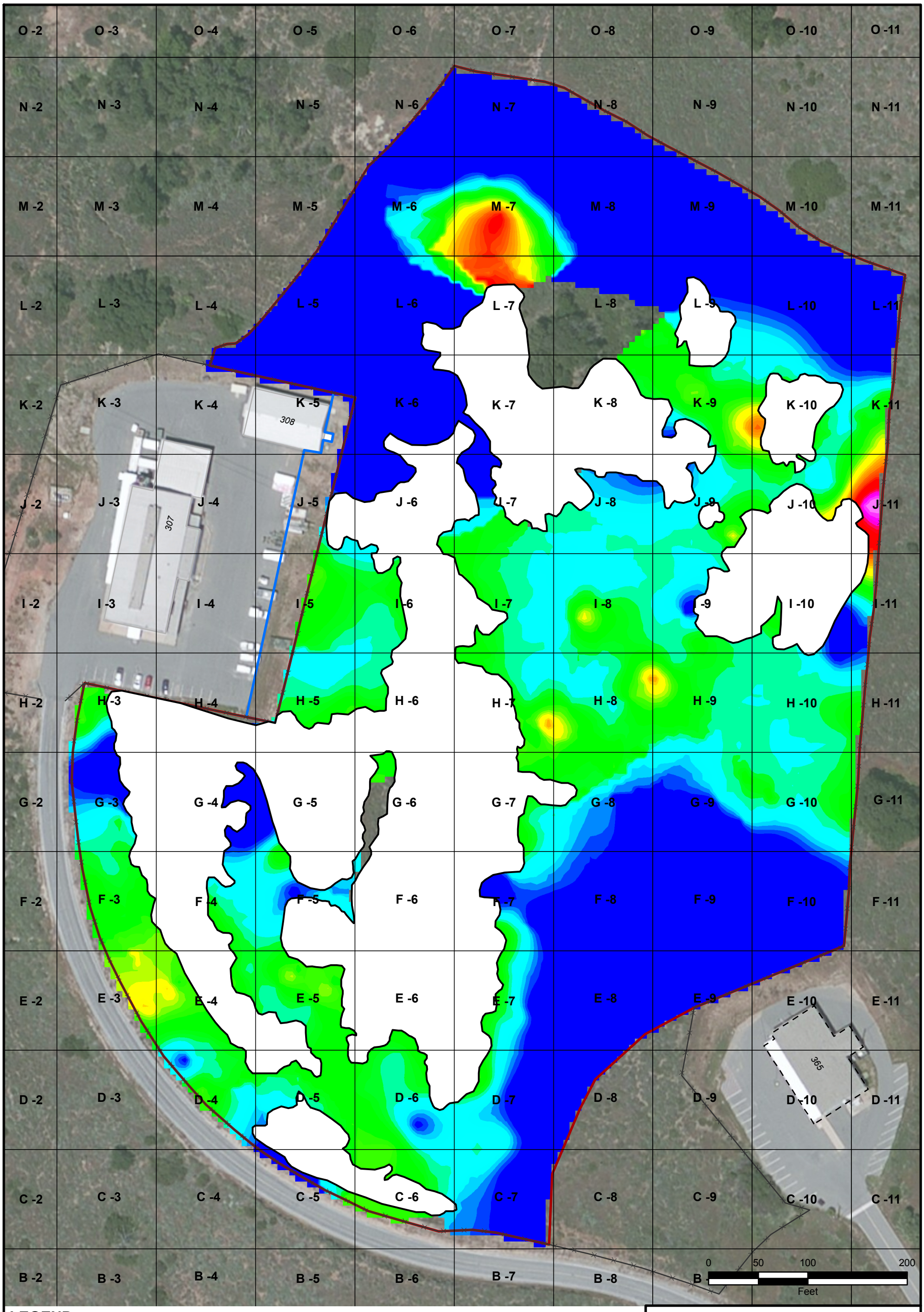


## LEGEND

- INTERPRETED ELEVATED ANOMALY DENSITY AREA (EADA) - 4.59 ACRES
- A-1 100 FOOT GRID
- BUILDING - EXISTING
- BUILDING - DEMOLISHED
- ADDITIONAL WORK AREA
- SITE BOUNDARY
- FENCE LINE

41 123 205 287 369 451 533 615 697 779 862 944 1026 1108 1190 1272 1354 1436 1518

ANOMALY DENSITY

IMAGERY SOURCE:
ESRI ArcGIS Online Web Service,
World Imagery 5/3/2010

NOTES:
VSP = Visual Sample Plan
MRP = Munitions Response Program
UXO = Unexploded Ordnance
NAVWPNSTA = Naval Weapons Station

# VSP Estimated Anomaly Density

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MRP Site UXO5
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N

KEH

FIGURE

F1-7

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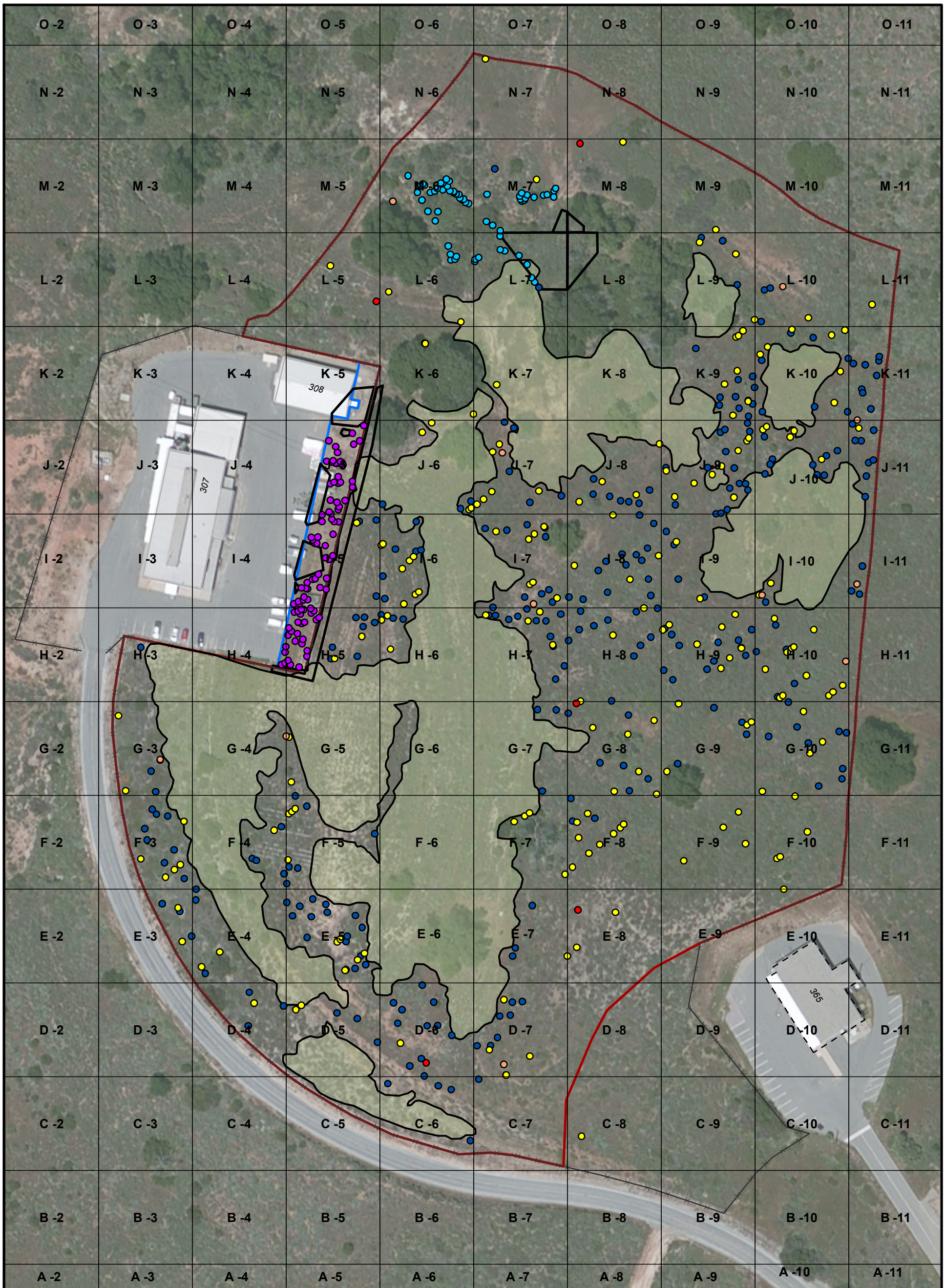


## LEGEND

**DGM TARGET LOCATIONS**

- QC SEED LOCATION (KCH, 4/2015)
- QC SEED LOCATION (SES-TECH)
- G858 DISPERSED AREA POPULATION (SES-TECH)
- EM61-MK2 TRANSECT POPULATION
- EM61-MK2 NORTH GRID POPULATION
- EM61-MK2 ADDITIONAL WORK AREA POPULATION
- SATURATED RESPONSE AREA
- INTERPRETED ELEVATED ANOMALY DENSITY AREA (EADA) - 4.59 ACRES
- A-1 100 FOOT GRID
- BUILDING - EXISTING
- BUILDING - DEMOLISHED
- ADDITIONAL WORK AREA
- SITE BOUNDARY
- FENCE LINE

NOTES:
DGM = Digital Geophysical Mapping
MRP = Munitions Response Program
UXO = Unexploded Ordnance
NAVWPNSTA = Naval Weapons Station

IMAGERY SOURCE:
ESRI ArcGIS Online Web Service, World Imagery 5/3/2010

0 50 100 200
Feet

**DGM Target Locations Selected for Intrusive Investigation**

Digital Geophysical Mapping Technical Memorandum
MRP Site UXO5
NAVWPNSTA Seal Beach Detachment Fallbrook, California

N

FIGURE
**F1-8**

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# Attachment F2
# Root Cause Analysis Report

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# Attachment F2
# Technical Memorandum, DGM Survey Results, RI MRP Site UXO5, NAVWPNSTA Seal Beach Detachment Fallbrook, California

| | |
|---|---|
| PREPARED FOR: | NAVFAC Southwest |
| PREPARED BY: | Matthew Barner/CLT |
| COPIES: | KCH Project Team |
| DATE: | September 14, 2015 |

## Background

This document is submitted in conjunction with the digital geophysical mapping (DGM) technical memorandum. The purpose of this document is to address two quality control (QC) issues identified during DGM performed in support of the remedial investigation (RI) at Munitions Response Program (MRP) Site Unexploded Ordnance 5 (MRP Site UXO5), Naval Weapons Station (NAVWPNSTA) Seal Beach Detachment Fallbrook, located in Fallbrook, California. The Geonics, Ltd. EM61-MK2 sensor was used for the DGM. In accordance with the Quality Assurance Project Plan for Munitions and Explosives of Concern, Remedial Investigation for Munitions Response Program Site UXO5 (KCH, 2015), the root cause analysis (RCA) process is undertaken when a QC testing requirement or measurement quality objective does not meet the performance criteria in the MEC QAPP or other relevant work planning documents. A corrective action, as needed, is determined as a follow up to the RCA process for immediate implementation as well as to prevent future occurrences.

## Event #1 Description and Date: Cable Shake Test Noise Threshold Exceedance (February 26, 2015)

As part of the daily QC testing requirements, a static test was conducted with the EM61-MK2 to evaluate whether vibration of the sensor cables and connectors, which were conducted to mimic walking conditions during data collection, elicited a response in the data. The performance criterion for this test is that the mean response during the test duration is within a ±2-milliVolt (mV) range. Noise spikes with peak responses outside this range may be indicative of a sensor problem, sensor component (e.g., cable) problem, or loose connection. This test is performed once at the start of each day that the sensor is used for data collection or each time a cable or connection is repaired or replaced to avoid collecting production data with a potential hardware problem or loose connection.

## Event #1 Root Cause

The root cause of this event was determined to be complacency during routine field procedures by the DGM field team. It is possible to induce noise spikes in the data if one too

vigorously shakes the cables at the connection points. When this occurs, damage to the cables and connectors is possible because the test no longer simulates data collection conditions during a person-portable survey. It is also possible to induce noise spikes when the DGM operator turns or leans too close to the sensor while wearing the backpack during the test.

The RCA process was undertaken by the CH2M HILL Kleinfelder, A Joint Venture (KCH) QC Geophysicist with support from the KCH DGM Data Processor. It was determined that this event was an outlier and was not indicative of an EM61-MK2 instrument sensor problem. Therefore, there are no adverse implications in the DGM production data collected on February 26, 2015. Figure 1 presents the results of all cable shake tests conducted for the DGM survey at Site UXO5. Note the threshold exceedance on the plot for February 26, 2015. The nature of the response at the exceedance point indicates an external noise source, either from too vigorously shaking the cable or from the operator getting too close to the coils. An EM61-MK2 sensor problem or loose connection would likely be manifested in the data as abrupt, single reading noise spikes or series of single readings with very large (positive or negative) amplitudes.

After the cable shake test was performed, the field team performed the required 2-line test at the Instrument Verification Strip (IVS). The EM61-MK2 root mean square (RMS) noise level for Channel 3 during the IVS was 0.66 mV. This RMS noise level quantifies the amount of sensor noise and would be strongly impacted by a malfunctioning sensor, sensor component, or loose connection. This RMS noise level is within proper sensor operation specifications and is consistent with data gathered in support of the RI at Site UXO5.

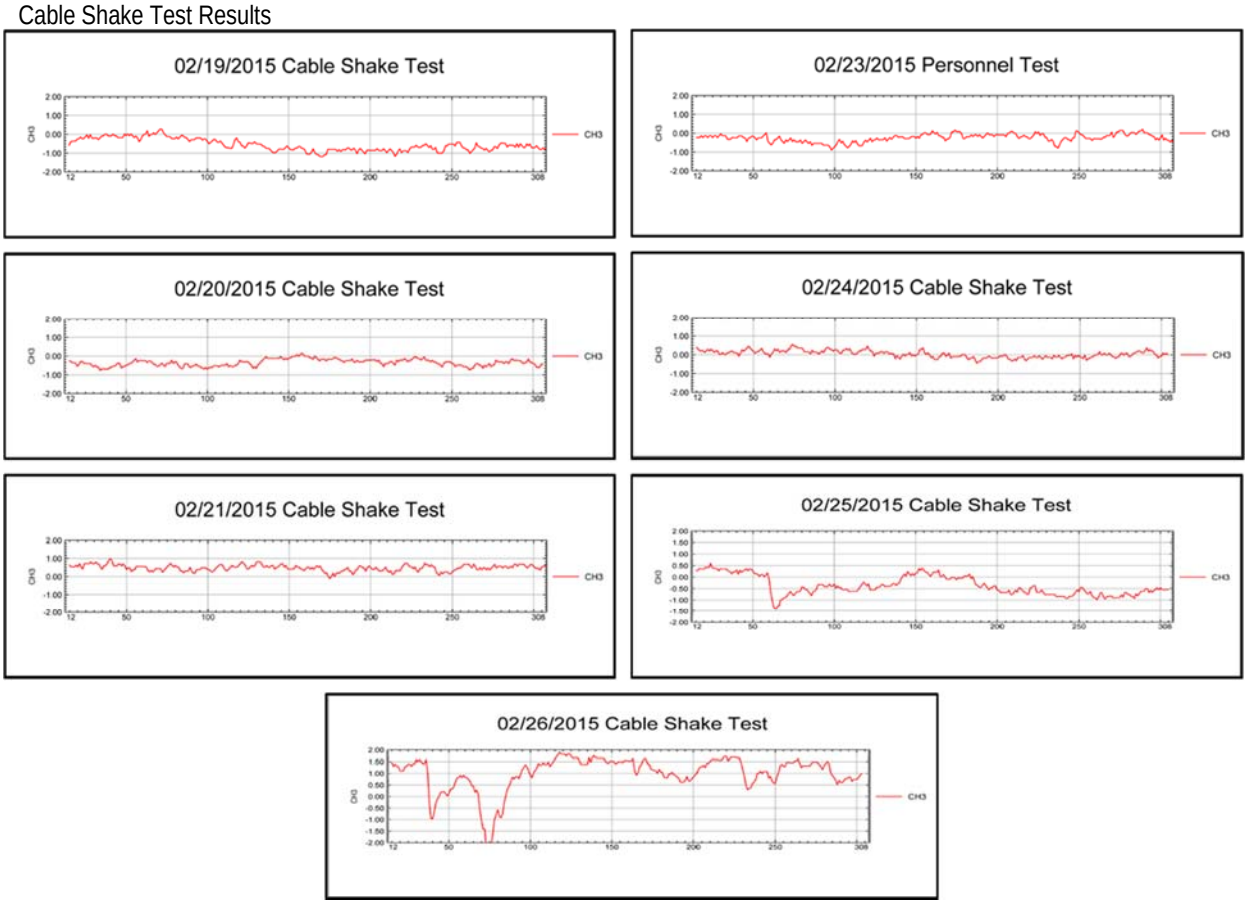
## Event #1 Contributing Factors

The primary contributing factor was complacency by the DGM field team during routine tests after collecting data for 1 week. The DGM field team leader is highly experienced, although long field days and repetitive tasks each day can lead to a sense of complacency and loss of focus. In this case, the data were not adequately reviewed in real time during the test, and the mistake went unnoticed until the QC test data had been submitted to the data processor.

## Event #1 Immediate Corrective Actions

The KCH QC Geophysicist had a phone conversation the next working day with the DGM field team leader and explained the potential ramifications of the QC test failure. The discussion included a refocus on the importance of each QC test, and not just for the purpose of passing the tests but for identifying potential issues with the sensor that could lead to rejection and recollection of production data. It was agreed by both parties that the QC tests are in place for a reason and that procedures must be followed to avoid significant loss of time associated with rework.

FIGURE 1
Cable Shake Test Results




## Event #1 Corrective Actions to Prevent Future Recurrence

During DGM survey chartering sessions or during initial field kickoff events, this specific instance will be used as a quality moment during discussions with the field teams about the importance of following proper field procedures. KCH will also revisit its standard operating procedures for conducting EM61-MK2 surveys to make sure the documents are clear and specific on how to perform the cable shake test properly.

## Event #2 Description and Date: End-of-Day 2-line IVS Survey Not Performed (February 26, 2015)

February 26, 2015, was the last day of DGM data collection at MRP Site UXO5 and the first day of data collection at MRP Site UXO4 (work at MRP Site UXO4 was conducted during the same mobilization as MRP Site UXO5). On this day, the DGM field team was transitioning between the two sites. Start-of-day QC tests and IVS tests were completed at MRP Site UXO5.

During DGM production surveys, ongoing validation of EM61-MK2 sensor responses and data positioning is performed using the IVS. This test is performed once at the beginning and once at the end of each day's operations. However, unforeseen instances may arise where an end-of-day test is not performed (e.g., bad weather). On February 26, 2015, the

DGM field team misjudged the amount of time needed to finish daily operations at MRP Site UXO4 and inadvertently were locked behind a secure facility gate. Once the gate was unlocked and the field team returned to MRP Site UXO5, they ran out of time to complete the test because of the need to download data and store the equipment for the night.

Data from the start-of-day IVS survey as well as production data gathered on this day met all performance criteria.

## Event #2 Root Cause

The root cause of this event was poor time management by the DGM field team and general lack of awareness of the time of day with regard to site security procedures (i.e., when gates would be locked).

## Event #2 Contributing Factors

Contributing factors included the distance between the two Detachment Fallbrook MRP sites and the time required to safely drive from one site to another and to properly load and unload the EM61-MK2 from the field vehicle.

## Event #2 Immediate Corrective Actions

No immediate corrective actions were implemented other than the KCH QC Geophysicist stressing the importance of allowing sufficient time to perform necessary end-of-day QC tests.

## Event #2 Corrective Actions to Prevent Future Recurrence

During DGM survey chartering sessions or during initial field kickoff events, this specific event will be used for QC training during discussions with the field teams about the importance of time management and the need to balance production survey levels, time for conducting QC tests, and end-of-day shutdown procedures such as data download and equipment storage. These discussions will stress the importance of the QC tests that are required and the implications for the data if the QC tests are not performed or not performed properly.

## Reference

CH2M HILL Kleinfelder, A Joint Venture (KCH). 2015. *Quality Assurance Project Plan for Munitions and Explosives of Concern, Remedial Investigation for Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach, Detachment Fallbrook, Fallbrook, California*. February.

# Appendix G
# Intrusive Anomaly Investigation Results Summary
# (CD only)

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# Appendix H
# Disposal Documentation

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# Bonetti Explosives, LLC

May 12, 2015

Invoice # 3129

Mr. George Mackanin
American EOD Services, Inc.
P.O. Box 1237
Spearfish, South Dakota 57783-1237

Re: MDAS sent from Fallbrook, CA by USAE / CH2MHILL

Mr. Mackanin,

This letter is to verify that Bonetti Explosives, LLC has received fifteen (15) 55 gallon drums weighing 3,680 lbs of assumed MDAS sent by USAE/CH2MHILL from Fallbrook, CA. The material was not removed from the drums and could not be verified. However, the weight of the MDAS was calculated using standard drum and pallet weights and was found to be 2,800 lbs. The material arrived on April 21, 2015 in good condition. Security seal numbers and notations are as follows:

| Drum# | Security seal #s |
|---|---|
| 1. | 629984 |
| 2. | 629505 |
| 3. | 235717 |
| 4. | 235704 |
| 5. | 629987 |
| 6. | 629989 |
| 7. | 235702 |
| 8. | 235709 |
| 9. | 235707 |
| 10. | 235701 |
| 11. | 629985 |
| 12. | 629988 |
| 13. | 629986 |
| 14. | 725922 |
| 15. | 629983 |

This shipment of MDAS has not been opened; therefore release of liability cannot be issued at this time. These drums will not be opened until a representative from the client is present as per client's request. This material is being stored in A-1 processing area until it is opened, verified with accompanying 1348, and smelted in the presence of a witness from the client. After that time, a final disposition letter will be issued.

Thank you for your Business,

Gina Barnett

Gina Barnett

303 Washington St, Columbus TX, 78934
www.Bonettiexplosives.com

(979) 739-5597
Bonetti4@yahoo.com

# Bonetti Explosives, LLC

May 29, 2015

Invoice # 3129

Mr. George Mackanin
American EOD Services, Inc.
P.O. Box 1237
Spearfish, South Dakota 57783-1237

Re: MDAS sent from Fallbrook, CA by CH2MHILL

Mr. Mackanin,

This letter is to verify that Bonetti Explosives, LLC has smelted and prepared for recycling, in the presence of a CH2MHILL representative, fifteen (15) drums weighing 2,800 lbs of MDAS which was received on April 21, 2015. The contents of the container was not sold, traded or otherwise given to another party until the contents were properly prepared for recycle and only identifiable by their basic content. On May 26, 2015, the material was dispositioned into civilian recycling in accordance with EM 200-1-15, NAVSEA OP 5, DOD 4160.28 AND DOD 4160.62; this is your final letter regarding this matter.

Thank you for your Business,

Matt Barnett

(979) 739-5597

P.O. Box 116, Columbus TX, 78934
www.Bonettiexplosives.com

(979) 739-5597
Bonetti4@yahoo.com

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

| 1 2 3 | 4 5 6 7 | 23 24 | 25 26 27 28 29 | 45 46 47 48 49 50 | 51 | 52 53 | 54 55 56 | 57 58 59 | 60 61 | 62 63 | 64 65 | 66 67 | 68 | 69 70 | 71 72 | 73 74 75 76 77 78 79 80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DOCIDENT | RI FROM M&S | UNIT ISS | QUANTITY | SER SUPPLEMENTARY ADDRESS | SIG | FUND | DISTRIBUTION | PROJECT | PRI | REQD DELL DATE | ADV | | RI | O/P | COND MGT | UNIT PRICE DOLLARS CTS |

| 1. TOTAL PRICE | | 2. SHIP FROM | 3. SHIP TO |
|---|---|---|---|
| DOLLARS | CTS | USAE Environmental<br>POC Dan Paul<br>(989)351-8633 | Daley Iron<br>POC Matt Barnett<br>(979)739-5597 |
| | | 4. MARK FOR | |

| 5. DOC DATE | 6. NMFC | 7. FRT RATE | 8. TYPE CARGO | 9. PS |
|---|---|---|---|---|
| 4/1/2015 | | | 55 Gallon Drum | |

| 10. QTY. REC'D | 11. UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC | 15. SL |
|---|---|---|---|---|---|
| | | | | | |

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE
Material Documented as Safe (MDAS)

| 18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT | 21. TOTAL CUBE |
|---|---|---|---|
| | | 220lbs | |

| 22. RECEIVED BY | 23. DATE RECEIVED |
|---|---|
| | |

PREVIOUS EDITION MAY BE USED

24. DOCUMENT NUMBER & SUFFIX (30-44)

Munitions Response Program Site UXO4/5
Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

Contract Number: N62473-09-D-2622
Contract Task Order: 0070

smelted on 5/26/15
witnessed by

25. NATIONAL STOCK NO. & ADD (8-22)

Barrel# 1

Seal # 629984

26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-58) UP (74-80)

"The material listed on this form has been inspected or processed by DDESB approved means, as required by Department of Defense policy, and to the best of my knowledge and belief does not pose an explosive hazard."

Shipped to: Daly Iron
1618 Smith Rau Road
Columbus, TX

27. ADDITIONAL DATA

Verified By

Dan Paul
USAE Environmental
Senior UXO Specialist
(989)351-8633

Certified By

Dave McDonald
CH2M Hill/Munitions Response Group
Quality Control Specialist
(949)285-0746

Adobe Designer 7.0

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

| 1 2 3 | 4 5 6 | 7 | 23 24 | 25 26 27 28 29 | 45 46 47 | 48 49 50 | 51 52 | 53 54 55 | 56 57 58 | 59 60 | 61 62 | 63 64 | 65 66 | 67 68 | 69 70 | 71 | 72 73 | 74 75 | 76 77 | 78 79 80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 1. TOTAL PRICE | | | 2. SHIP FROM | 3. SHIP TO |
|---|---|---|---|---|
| UNIT PRICE | DOLLARS | CTS | USAE Environmental<br>POC Dan Paul<br>(989)351-8633 | Daley Iron<br>POC Matt Barnett<br>(979)739-5597 |
| DOLLARS / CTS | | | 4. MARK FOR | |

PREVIOUS EDITION MAY BE USED

**24. DOCUMENT NUMBER & SUFFIX (30-44)**

Munitions Response Program Site UXO4/5
Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

Contract Number: N62473-09-D-2622
Contract Task Order: 0070

Smetell on 5/24/15
Witnessed by

**25. NATIONAL STOCK NO. & ADD (8-22)**

Barrel# 2

Seal # 629505

FINAL

**26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-56) UP (74-80)**

"The material listed on this form has been inspected or processed by DDESB approved means, as required by Department of Defense policy, and to the best of my knowledge and belief does not pose an explosive hazard."

Shipped to: Daly Iron
1618 Smith Rau Road
Columbus, TX

**27. ADDITIONAL DATA**

Verified By

Dan Paul
USAE Environmental
Senior UXO Specialist
(989)351-8633

Certified By

Dave McDonald
CH2M Hill/Munitions Response Group
Quality Control Specialist
(949)285-0746

| 5. DOC DATE | 6. NMFC | 7. FRT RATE | 8. TYPE CARGO | 9. PS |
|---|---|---|---|---|
| 4/6/15 | | | 55 Gallon Drum | |

| 10. QTY. REC'D | 11.UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC | 15. SL |
|---|---|---|---|---|---|
| | | | | | |

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE
Material Documented as Safe (MDAS)

| 18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT | 21. TOTAL CUBE |
|---|---|---|---|
| | | 276 LBS | |

| 22. RECEIVED BY | 23. DATE RECEIVED |
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Adobe Designer 7.0

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

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| | | | | | | 4. MARK FOR | |

| 5. DOC DATE | 6. NMFC | 7. FRT RATE | 8. TYPE CARGO | 9. PS |
|---|---|---|---|---|
| 4/7/15 | | | 55 Gallon Drum | |

| 10. QTY. REC'D | 11. UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC | 15. SL |
|---|---|---|---|---|---|
| | | | | | |

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE
Material Documented as Safe (MDAS)

| 18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT | 21. TOTAL CUBE |
|---|---|---|---|
| | | 165 LBS | |

| 22. RECEIVED BY | 23. DATE RECEIVED |
|---|---|
| | |

PREVIOUS EDITION MAY BE USED

24. DOCUMENT NUMBER & SUFFIX (30-44)

Munitions Response Program Site UXO4/5
Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

Contract Number: N62473-09-D-2622
Contract Task Order: 0070

smelted on 5/26/15
witnessed by

25. NATIONAL STOCK NO. & ADD (8-22)

Barrel# 3

Seal # 235717

FINAL

26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-56) UP (74-80)

"The material listed on this form has been inspected or processed by DDESB approved means, as required by Department of Defense policy, and to the best of my knowledge and belief does not pose an explosive hazard."

Shipped to: Daly Iron
1618 Smith Rau Road
Columbus, TX

27. ADDITIONAL DATA

Verified By

Dan Paul
USAE Environmental
Senior UXO Specialist
(989)351-8633

Certified By

Dave McDonald
CH2M Hill/Munitions Response Group
Quality Control Specialist
(949)285-0746

Adobe Designer 7.0

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

| 1 2 3 | 4 5 6 | 7 | 23 24 | 25 26 27 28 29 | 45 46 | 47 48 49 50 | 51 | 52 53 | 54 55 | 56 57 58 | 59 60 | 61 62 | 63 64 | 65 66 | 67 68 | 69 70 | 71 72 | 73 74 75 | 76 77 | 78 79 80 |
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| 1. TOTAL PRICE DOLLARS | CTS | 2. SHIP FROM | 3. SHIP TO |
|---|---|---|---|
| | | USAE Environmental<br>POC Dan Paul<br>(989)351-8633 | Daley Iron<br>POC Matt Barnett<br>(979)739-5597 |
| | | 4. MARK FOR | |

| 5. DOC DATE | 6. NMFC | 7. FRT RATE | 8. TYPE CARGO | 9. PS |
|---|---|---|---|---|
| 4/7/15 | | | 55 Gallon Drum | |

| 10. QTY. REC'D | 11. UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC | 15. SL |
|---|---|---|---|---|---|
| | | | | | |

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE
Material Documented as Safe (MDAS)

| 18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT | 21. TOTAL CUBE |
|---|---|---|---|
| | | 129 LBS | |

| 22. RECEIVED BY | 23. DATE RECEIVED |
|---|---|
| | |

PREVIOUS EDITION MAY BE USED

24. DOCUMENT NUMBER & SUFFIX (30-44)

Munitions Response Program Site UXO4/5
Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

Contract Number: N62473-09-D-2622
Contract Task Order: 0070

Smelted on 5/26/15
Witnessed by

25. NATIONAL STOCK NO. & ADD (8-22)

Barrel# 4

Seal # 235704

FINAL

26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-56) UP (74-80)

"The material listed on this form has been inspected or processed by DDESB approved means, as required by Department of Defense policy, and to the best of my knowledge and belief does not pose an explosive hazard."

Shipped to: Daly Iron
1618 Smith Rau Road
Columbus, TX

27. ADDITIONAL DATA

Verified By

Dan Paul
USAE Environmental
Senior UXO Specialist
(989)351-8633

Certified By

Dave McDonald
CH2M Hill/Munitions Response Group
Quality Control Specialist
(949)285-0746

Adobe Designer 7.0

FORM 1348-1A JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

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| 1. TOTAL PRICE DOLLARS | CTS | 2. SHIP FROM | 3. SHIP TO |
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| | | USAE Environmental<br>POC Dan Paul<br>(989)351-8633 | Daley Iron<br>POC Matt Barnett<br>(979)739-5597 |

4. MARK FOR

| 5. DOC DATE | 6. NMFC | 7. FRT RATE | 8. TYPE CARGO | 9. PS |
|---|---|---|---|---|
| | | | 55 Gallon Drum | |

| 10. QTY. REC'D | 11. UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC | 15. SL |
|---|---|---|---|---|---|
| 4/7/15 | | | | | |

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE

Material Documented as Safe (MDAS)

| 18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT | 21. TOTAL CUBE |
|---|---|---|---|
| | | 130 LBS | |

22. RECEIVED BY

23. DATE RECEIVED

24. DOCUMENT NUMBER & SUFFIX (30-44)

Munitions Response Program Site UXO4[redacted]
Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

Contract Number: N62473-09-D-2622
Contract Task Order: 0070

Smelted on 5/26/15
witnessed by

25. NATIONAL STOCK NO. & ADD (8-22)

Barrel# 5

Seal # 629987

FINAL

26. RIC (4-6)
UI (23-24)
QTY (25-29)
CON CODE (71)
DIST (55-56)
UP (74-80)

"The material listed on this form has been inspected or processed by DDESB approved means, as required by Department of Defense policy, and to the best of my knowledge and belief does not pose an explosive hazard."

Shipped to: Daly Iron
1618 Smith Rau Road
Columbus, TX

27. ADDITIONAL DATA

Verified By

Dan Paul
USAE Environmental
Senior UXO Specialist
(989)351-8633

Certified By

Dave McDonald
CH2M Hill/Munitions Response Group
Quality Control Specialist
(949)285-0746

PREVIOUS EDITION MAY BE USED

Adobe Designer 7.0

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

| 1 2 3 | 4 5 6 | 7 | 23 24 | 25 26 27 28 29 | 45 46 | 47 48 49 50 | 51 | 52 53 | 54 55 56 | 57 58 59 | 60 61 | 62 63 | 64 | 65 66 67 | 68 69 | 70 | 71 72 | 73 74 75 | 76 77 78 | 79 80 |
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| 1. TOTAL PRICE | | | 2. SHIP FROM | 3. SHIP TO |
|---|---|---|---|---|
| UNIT PRICE DOLLARS | CTS | DOLLARS | CTS | USAE Environmental<br>POC Dan Paul<br>(989)351-8633 | Daley Iron<br>POC Matt Barnett<br>(979)739-5597 |
| | | | | 4. MARK FOR |

| 5. DOC DATE | 6. NMFC | 7. FRT RATE | 8. TYPE CARGO | 9. PS |
|---|---|---|---|---|
| 4/8/15 | | | 55 Gallon Drum | |

| 10. QTY. REC'D | 11.UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC | 15. SL |
|---|---|---|---|---|---|
| | | | | | |

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE
Material Documented as Safe (MDAS)

| 18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT | 21. TOTAL CUBE |
|---|---|---|---|
| | | 135 LBS | |

| 22. RECEIVED BY | 23. DATE RECEIVED |
|---|---|
| | |

PREVIOUS EDITION MAY BE USED

24. DOCUMENT NUMBER & SUFFIX (30-44)

Munitions Response Program Site UXO4/5
Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

Contract Number: N62473-09-D-2622
Contract Task Order: 0070

Smelted on 5/26/15
Witnessed by

25. NATIONAL STOCK NO. & ADD (8-22)

Barrel# 6

Seal # 629989

FINAL

26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-58) UP (74-80)

"The material listed on this form has been inspected or processed by DDESB approved means, as required by Department of Defense policy, and to the best of my knowledge and belief does not pose an explosive hazard."

Shipped to: Daly Iron
1618 Smith Rau Road
Columbus, TX

27. ADDITIONAL DATA

Verified By

Dan Paul
USAE Environmental
Senior UXO Specialist
(989)351-8633

Certified By

Dave McDonald
CH2M Hill/Munitions Response Group
Quality Control Specialist
(949)285-0746

Adobe Designer 7.0

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DOC | IDENT | | RI FROM | | | M&S | UNIT | ISS | QUANTITY | | | | | SER | SUPPLEMENTARY ADDRESS | | | | | SIG | FUND | | DISTRIBUTION | | | PROJECT | | | PRI | REQD | DEL | DATE | | ADV | | | RI | | | O/P | COND | MGT | | | | | | | |

| 1. TOTAL PRICE | | | 2. SHIP FROM | 3. SHIP TO |
|---|---|---|---|---|
| UNIT PRICE | DOLLARS | CTS | USAE Environmental<br>POC Dan Paul<br>(989)351-8633 | Daley Iron<br>POC Matt Barnett<br>(979)739-5597 |
| DOLLARS / CTS | | | 4. MARK FOR | |

| 5. DOC DATE | 6. NMFC | 7. FRT RATE | 8. TYPE CARGO | 9. PS |
|---|---|---|---|---|
| 4/8/15 | | | 55 Gallon Drum | |

| 10. QTY. REC'D | 11. UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC | 15. SL |
|---|---|---|---|---|---|
| | | | | | |

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE
Material Documented as Safe (MDAS)

| 18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT | 21. TOTAL CUBE |
|---|---|---|---|
| | | 135 LBS | |

| 22. RECEIVED BY | 23. DATE RECEIVED |
|---|---|
| | |

PREVIOUS EDITION MAY BE USED

24. DOCUMENT NUMBER & SUFFIX (30-44)

Munitions Response Program Site UXO4/5
Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

Contract Number: N62473-09-D-2622
Contract Task Order: 0070

Smelted on 5/26/15
Witnessed by

25. NATIONAL STOCK NO. & ADD (8-22)

Barrel# 6

Seal # 629989

FINAL

26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-56) UP (74-80)

"The material listed on this form has been inspected or processed by DDESB approved means, as required by Department of Defense policy, and to the best of my knowledge and belief does not pose an explosive hazard."

Shipped to: Daly Iron
1618 Smith Rau Road
Columbus, TX

27. ADDITIONAL DATA

Verified By

Dan Paul
USAE Environmental
Senior UXO Specialist
(989)351-8633

Certified By

Dave McDonald
CH2M Hill/Munitions Response Group
Quality Control Specialist
(949)285-0746

Adobe Designer 7.0

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

| DOC | IDENT | RI FROM | M&S | UNIT | ISS | QUANTITY | SER | SUPPLEMENTARY ADDRESS | SIG | FUND | DISTRIBUTION | PROJECT | PRI | REQD | DEL | DATE | ADV | RI | O/P | COND | MGT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | |

| UNIT PRICE DOLLARS | CTS | DOLLARS | CTS |
|---|---|---|---|
| | | | |

1. TOTAL PRICE

2. SHIP FROM: USAE Environmental, POC Dan Paul, (989)351-8633

3. SHIP TO: Daley Iron, POC Matt Barnett, (979)739-5597

4. MARK FOR

5. DOC DATE: 4/8/15

6. NMFC

7. FRT RATE

8. TYPE CARGO: 55 Gallon Drum

9. PS

10. QTY. REC'D

11. UP

12. UNIT WEIGHT

13. UNIT CUBE

14. UFC

15. SL

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE: Material Documented as Safe (MDAS)

18. TY CONT

19. NO CONT

20. TOTAL WEIGHT: 127 LBS

21. TOTAL CUBE

22. RECEIVED BY

23. DATE RECEIVED

24. DOCUMENT NUMBER & SUFFIX (30-44)

Munitions Response Program Site UXO4/5
Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

Contract Number: N62473-09-D-2622
Contract Task Order: 0070

SMcFadden 5/26/15
Witnessed by

25. NATIONAL STOCK NO. & ADD (8-22)

Barrel# 7

Seal # 235702

FINAL

26. RIC (4-6) UI (23-24) QTY (26-29) CON CODE (71) DIST (55-58) UP (74-80)

"The material listed on this form has been inspected or processed by DDESB approved means, as required by Department of Defense policy, and to the best of my knowledge and belief does not pose an explosive hazard."

Shipped to: Daly Iron
1618 Smith Rau Road
Columbus, TX

27. ADDITIONAL DATA

Verified By

Dan Paul
USAE Environmental
Senior UXO Specialist
(989)351-8633

Certified By

Dave McDonald
CH2M Hill/Munitions Response Group
Quality Control Specialist
(949)285-0746

PREVIOUS EDITION MAY BE USED

Adobe Designer 7.0

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DOC | IDENT | | RI FROM | | | M&S | UNIT | ISS | QUANTITY | | | | | SER | SUPPLEMENTARY ADDRESS | | | | SIG | FUND | DISTRIBUTION | | PROJECT | | PRI | REQD | DEL | DATE | ADV | | RI | | | O/P | COND | MGT | | | | | | | | | | | |

| 1. TOTAL PRICE | | |
|---|---|---|
| DOLLARS | CTS | |

| UNIT PRICE | |
|---|---|
| DOLLARS | CTS |

| 2. SHIP FROM | 3. SHIP TO |
|---|---|
| USAE Environmental<br>POC Dan Paul<br>(989)351-8633 | Daley Iron<br>POC Matt Barnett<br>(979)739-5597 |

4. MARK FOR

| 5. DOC DATE | 6. NMFC | 7. FRT RATE | 8. TYPE CARGO | 9. PS |
|---|---|---|---|---|
| 4/9/15 | | | 55 Gallon Drum | |

| 10. QTY. REC'D | 11. UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC | 15. SL |
|---|---|---|---|---|---|
| | | | | | |

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE
Material Documented as Safe (MDAS)

| 18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT | 21. TOTAL CUBE |
|---|---|---|---|
| | | 140 LBS | |

| 22. RECEIVED BY | 23. DATE RECEIVED |
|---|---|
| | |

PREVIOUS EDITION MAY BE USED

24. DOCUMENT NUMBER & SUFFIX (30-44)

Munitions Response Program Site UXO4/5
Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

Contract Number: N62473-09-D-2622
Contract Task Order: 0070

Smelted on 5/26/15
Witnessed by

25. NATIONAL STOCK NO. & ADD (8-22)

Barrel# 8

Seal # E35709

FINAL

26. RIC (4-8) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-56) UP (74-80)

"The material listed on this form has been inspected or processed by DDESB approved means, as required by Department of Defense policy, and to the best of my knowledge and belief does not pose an explosive hazard."

Shipped to: Daly Iron
1618 Smith Rau Road
Columbus, TX

27. ADDITIONAL DATA

Verified By

Dan Paul
USAE Environmental
Senior UXO Specialist
(989)351-8633

Certified By

Dave McDonald
CH2M Hill/Munitions Response Group
Quality Control Specialist
(949)285-0746

Adobe Designer 7.0

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

| 1 DOC | 2 IDENT | 3 4 5 6 RI FROM | 7 M&S | 23 UNIT | 24 25 ISS | 26 27 28 29 QUANTITY | 45 SER | 46 47 48 49 50 SUPPLEMENTARY ADDRESS | 51 SIG | 52 53 FUND | 54 55 DISTRIBUTION | 56 57 58 PROJECT | 59 PRI | 60 61 REQD | 62 63 DELL | 64 DATE | 65 66 ADV | 67 68 69 RI | 70 O/P | 71 COND | 72 73 MGT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| 1. TOTAL PRICE | | | 2. SHIP FROM | 3. SHIP TO |
|---|---|---|---|---|
| UNIT PRICE | DOLLARS | CTS | USAE Environmental<br>POC Dan Paul<br>(989)351-8633 | Daley Iron<br>POC Matt Barnett<br>(979)739-5597 |
| DOLLARS / CTS | | | 4. MARK FOR | |

| 5. DOC DATE | 6. NMFC | 7. FRT RATE | 8. TYPE CARGO | 9. PS |
|---|---|---|---|---|
| 4/9/15 | | | 55 Gallon Drum | |

| 10. QTY. REC'D | 11. UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC | 15. SL |
|---|---|---|---|---|---|
| | | | | | |

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE
Material Documented as Safe (MDAS)

| 18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT | 21. TOTAL CUBE |
|---|---|---|---|
| | | 131 LBS | |

| 22. RECEIVED BY | 23. DATE RECEIVED |
|---|---|
| | |

PREVIOUS EDITION MAY BE USED

24. DOCUMENT NUMBER & SUFFIX (30-44)

Munitions Response Program Site UXO4/5
Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

Contract Number: N62473-09-D-2622
Contract Task Order: 0070

Sanctioned on 5/26/15
Witnessed by

25. NATIONAL STOCK NO. & ADD (8-22)

Barrel# 9

Seal # 235707

FINAL

26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-56) UP (74-80)

"The material listed on this form has been inspected or processed by DDESB approved means, as required by Department of Defense policy, and to the best of my knowledge and belief does not pose an explosive hazard."

Shipped to: Daly Iron
1618 Smith Rau Road
Columbus, TX

27. ADDITIONAL DATA

Verified By

Dan Paul
USAE Environmental
Senior UXO Specialist
(989)351-8633

Certified By

Dave McDonald
CH2M Hill/Munitions Response Group
Quality Control Specialist
(949)285-0746

Adobe Designer 7.0

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DOCUMENT | | | RI FROM | | | M&S | UNIT | ISS | QUANTITY | | | | | SER | SUPPLEMENTARY ADDRESS | | | | | SIG | FUND | | DISTRIBUTION | | | PROJECT | | | PRI | REQD | DELDATE | | | ADV | | | RI | | O/P | COND | MGT | | | | | | | |

1. TOTAL PRICE

UNIT PRICE: DOLLARS / CTS

DOLLARS / CTS

2. SHIP FROM: USAE Environmental, POC Dan Paul, (989)351-8633

3. SHIP TO: Daley Iron, POC Matt Barnett, (979)739-5597

4. MARK FOR

5. DOC DATE: 4/10/15

6. NMFC

7. FRT RATE

8. TYPE CARGO: 55 Gallon Drum

9. PS

10. QTY. REC'D | 11. UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC | 15. SL

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE: Material Documented as Safe (MDAS)

18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT: 130 LBS | 21. TOTAL CUBE

22. RECEIVED BY

23. DATE RECEIVED

PREVIOUS EDITION MAY BE USED

24. DOCUMENT NUMBER & SUFFIX (30-44)

Munitions Response Program Site UXO4/5
Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

Contract Number: N62473-09-D-2622
Contract Task Order: 0070

Smelted on 5/26/15
Witnessed by

25. NATIONAL STOCK NO. & ADD (8-22)

Barrel# 10

Seal # 235701

26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-56) UP (74-80)

"The material listed on this form has been inspected or processed by DDESB approved means, as required by Department of Defense policy, and to the best of my knowledge and belief does not pose an explosive hazard."

Shipped to: Daly Iron
1618 Smith Rau Road
Columbus, TX

27. ADDITIONAL DATA

Verified By

Dan Paul
USAE Environmental
Senior UXO Specialist
(989)351-8633

Certified By

Dave McDonald
CH2M Hill/Munitions Response Group
Quality Control Specialist
(949)285-0746

Adobe Designer 7.0

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DOCUMENT | | | RI FROM | | | M&S | UNIT | ISS | QUANTITY | | | | | SER | SUPPLEMENTARY ADDRESS | | | | | SIG | FUND | DISTRIBUTION | | | PROJECT | | | PRI | REQD | DEL DATE | | ADV | RI | | | | O/P | COND | MGT | | | | | | | | |

| 1. TOTAL PRICE | | | 2. SHIP FROM | 3. SHIP TO |
|---|---|---|---|---|
| UNIT PRICE DOLLARS | CTS | DOLLARS / CTS | USAE Environmental<br>POC Dan Paul<br>(989)351-8633 | Daley Iron<br>POC Matt Barnett<br>(979)739-5597 |
| | | | 4. MARK FOR | |

| 5. DOC DATE | 6. NMFC | 7. FRT RATE | 8. TYPE CARGO | 9. PS |
|---|---|---|---|---|
| 4/10/15 | | | 55 Gallon Drum | |

| 10. QTY. REC'D | 11. UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC | 15. SL |
|---|---|---|---|---|---|
| | | | | | |

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE
Material Documented as Safe (MDAS)

| 18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT | 21. TOTAL CUBE |
|---|---|---|---|
| | | 133 LBS | |

| 22. RECEIVED BY | 23. DATE RECEIVED |
|---|---|
| | |

PREVIOUS EDITION MAY BE USED

24. DOCUMENT NUMBER & SUFFIX (30-44)

Munitions Response Program Site UXO4/5
Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

Contract Number: N62473-09-D-2622
Contract Task Order: 0070

Sealed on 5/26/15
Witnessed by

25. NATIONAL STOCK NO. & ADD (8-22)

Barrel# 11

Seal # 629985

26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-56) UP (74-80)

"The material listed on this form has been inspected or processed by DDESB approved means, as required by Department of Defense policy, and to the best of my knowledge and belief does not pose an explosive hazard."

Shipped to: Daly Iron
1618 Smith Rau Road
Columbus, TX

27. ADDITIONAL DATA

Verified By

Dan Paul
USAE Environmental
Senior UXO Specialist
(989)351-8633

Certified By

Dave McDonald
CH2M Hill/Munitions Response Group
Quality Control Specialist
(949)285-0746

Adobe Designer 7.0

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

| DOCUMENT | RI FROM | M&S | UNIT | ISS | QUANTITY | SER | SUPPLEMENTARY ADDRESS | SIG | FUND | DISTRIBUTION | PROJECT | PRI | REQD | DELDATE | ADV | RI | O/P | COND | MGT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | |

| 1. TOTAL PRICE | | 2. SHIP FROM | 3. SHIP TO |
|---|---|---|---|
| UNIT PRICE DOLLARS | CTS | USAE Environmental<br>POC Dan Paul<br>(989)351-8633 | Daley Iron<br>POC Matt Barnett<br>(979)739-5597 |
| DOLLARS | CTS | 4. MARK FOR | |

| 5. DOC DATE | 6. NMFC | 7. FRT RATE | 8. TYPE CARGO | 9. PS |
|---|---|---|---|---|
| 4/10/15 | | | 55 Gallon Drum | |

| 10. QTY. REC'D | 11. UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC | 15. SL |
|---|---|---|---|---|---|
| | | | | | |

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE
Material Documented as Safe (MDAS)

| 18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT | 21. TOTAL CUBE |
|---|---|---|---|
| | | 133 LBS | |

| 22. RECEIVED BY | 23. DATE RECEIVED |
|---|---|
| | |

PREVIOUS EDITION MAY BE USED

24. DOCUMENT NUMBER & SUFFIX (30-44)

Munitions Response Program Site UXO4/5
Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

Contract Number: N62473-09-D-2622
Contract Task Order: 0070

Sealed on 5/26/15
Witnessed by

25. NATIONAL STOCK NO. & ADD (8-22)

Barrel# 11

Seal # 629985

26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-56) UP (74-80)

"The material listed on this form has been inspected or processed by DDESB approved means, as required by Department of Defense policy, and to the best of my knowledge and belief does not pose an explosive hazard."

Shipped to: Daly Iron
1618 Smith Rau Road
Columbus, TX

27. ADDITIONAL DATA

Verified By

Dan Paul
USAE Environmental
Senior UXO Specialist
(989)351-8633

Certified By

Dave McDonald
CH2M Hill/Munitions Response Group
Quality Control Specialist
(949)285-0746

Adobe Designer 7.0

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

| 1 2 3 | 4 5 6 | 7 | 23 24 | 25 26 27 28 29 | 45 46 | 47 48 49 50 | 51 | 52 53 | 54 55 56 | 57 58 59 | 60 61 | 62 63 | 64 65 | 66 67 68 | 69 | 70 71 | 72 73 | 74 75 76 77 78 79 80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DOCIDENT | RI FROM | M&S | UNIT | ISS QUANTITY | SER | SUPPLEMENTARY ADDRESS | SIG | FUND | DISTRIBUTION | PROJECT | PRI | REQD | DELDATE | ADV | RI | O/P | COND | MGT |

| 1. TOTAL PRICE | | | 2. SHIP FROM | 3. SHIP TO |
|---|---|---|---|---|
| UNIT PRICE DOLLARS | CTS | DOLLARS | CTS | USAE Environmental<br>POC Dan Paul<br>(989)351-8633 | Daley Iron<br>POC Matt Barnett<br>(979)739-5597 |
| | | | 4. MARK FOR | |

| 5. DOC DATE | 6. NMFC | 7. FRT RATE | 8. TYPE CARGO | 9. PS |
|---|---|---|---|---|
| 4/13/15 | | | 55 Gallon Drum | |

| 10. QTY. REC'D | 11. UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC | 15. SL |
|---|---|---|---|---|---|
| | | | | | |

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE

Material Documented as Safe (MDAS)

| 18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT | 21. TOTAL CUBE |
|---|---|---|---|
| | | 155 LBS | |

| 22. RECEIVED BY | 23. DATE RECEIVED |
|---|---|
| | |

PREVIOUS EDITION MAY BE USED

24. DOCUMENT NUMBER & SUFFIX (30-44)

Munitions Response Program Site UXO4/5
Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

Contract Number: N62473-09-D-2622
Contract Task Order: 0070

Smelted on 5/26/15
Witnessed by

25. NATIONAL STOCK NO. & ADD (8-22)

Barrel# 12

Seal # 629988

FINAL

26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-66) UP (74-80)

"The material listed on this form has been inspected or processed by DDESB approved means, as required by Department of Defense policy, and to the best of my knowledge and belief does not pose an explosive hazard."

Shipped to: Daly Iron
1618 Smith Rau Road
Columbus, TX

27. ADDITIONAL DATA

Verified By

Dan Paul
USAE Environmental
Senior UXO Specialist
(989)351-8633

Certified By

Dave McDonald
CH2M Hill/Munitions Response Group
Quality Control Specialist
(949)285-0746

Adobe Designer 7.0

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

| 1 2 3 | 4 5 6 | 7 | 23 24 | 25 26 27 28 29 | 45 46 47 48 49 50 | 51 | 52 53 54 | 55 56 57 58 | 59 60 | 61 62 63 | 64 65 | 66 67 68 | 69 70 | 71 72 | 73 74 75 76 77 78 79 80 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DOCUMENT | RI FROM | M&S | UNIT | ISS QUANTITY | SER SUPPLEMENTARY ADDRESS | SIG | FUND | DISTRIBUTION | PROJECT | PRI | REQD DELL DATE | ADV | RI | O/P | COND MGT |

| UNIT PRICE DOLLARS | UNIT PRICE CTS | 1. TOTAL PRICE DOLLARS | CTS |
|---|---|---|---|
| | | | |

2. SHIP FROM: USAE Environmental, POC Dan Paul, (989)351-8633

3. SHIP TO: Daley Iron, POC Matt Barnett, (979)739-5597

4. MARK FOR

| 5. DOC DATE | 6. NMFC | 7. FRT RATE | 8. TYPE CARGO | 9. PS |
|---|---|---|---|---|
| 4/13/15 | | | 55 Gallon Drum | |

| 10. QTY. REC'D | 11. UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC | 15. SL |
|---|---|---|---|---|---|
| | | | | | |

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE: Material Documented as Safe (MDAS)

| 18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT | 21. TOTAL CUBE |
|---|---|---|---|
| | | 148 LBS | |

22. RECEIVED BY

23. DATE RECEIVED

PREVIOUS EDITION MAY BE USED

24. DOCUMENT NUMBER & SUFFIX (30-44)

Munitions Response Program Site UXO4/5
Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

Contract Number: N62473-09-D-2622
Contract Task Order: 0070

Smelted on 5/24/15
Witnessed by

25. NATIONAL STOCK NO. & ADD (8-22)

Barrel# 13

Seal # 629986

FINAL

26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-56) UP (74-80)

"The material listed on this form has been inspected or processed by DDESB approved means, as required by Department of Defense policy, and to the best of my knowledge and belief does not pose an explosive hazard."

Shipped to: Daly Iron
1618 Smith Rau Road
Columbus, TX

27. ADDITIONAL DATA

Verified By

Dan Paul
USAE Environmental
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DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

| DOC IDENT | RI FROM | M&S | UNIT ISS | QUANTITY | SER | SUPPLEMENTARY ADDRESS | SIG | FUND | DISTRIBUTION | PROJECT | PRI | REQD | DELL DATE | ADV | RI | O/P | COND | MGT | UNIT PRICE DOLLARS | UNIT PRICE CTS | 1. TOTAL PRICE DOLLARS | CTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

2. SHIP FROM: USAE Environmental, POC Dan Paul, (989)351-8633

3. SHIP TO: Daley Iron, POC Matt Barnett, (979)739-5597

4. MARK FOR

5. DOC DATE: 4/14/15

6. NMFC

7. FRT RATE

8. TYPE CARGO: 55 Gallon Drum

9. PS

10. QTY. REC'D | 11. UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC | 15. SL

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE: Material Documented as Safe (MDAS)

18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT: 98 LBS | 21. TOTAL CUBE

22. RECEIVED BY | 23. DATE RECEIVED

PREVIOUS EDITION MAY BE USED

24. DOCUMENT NUMBER & SUFFIX (30-44)

Munitions Response Program Site UXO4/5
Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

Contract Number: N62473-09-D-2622
Contract Task Order: 0070

Smelted on 5/26/15
witnessed by

25. NATIONAL STOCK NO. & ADD (8-22)

Barrel# 14

Seal # 725922

FINAL

26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-56) UP (74-80)

"The material listed on this form has been inspected or processed by DDESB approved means, as required by Department of Defense policy, and to the best of my knowledge and belief does not pose an explosive hazard."

Shipped to: Daly Iron
1618 Smith Rau Road
Columbus, TX

27. ADDITIONAL DATA

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| 1. TOTAL PRICE DOLLARS | CTS | 2. SHIP FROM | 3. SHIP TO |
|---|---|---|---|
| | | USAE Environmental<br>POC Dan Paul<br>(989)351-8633 | Daley Iron<br>POC Matt Barnett<br>(979)739-5597 |
| | | 4. MARK FOR | |

| 5. DOC DATE | 6. NMFC | 7. FRT RATE | 8. TYPE CARGO | 9. PS |
|---|---|---|---|---|
| 4/14/15 | | | 55 Gallon Drum | |

| 10. QTY. REC'D | 11. UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC | 15. SL |
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| | | | | | |

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE
Material Documented as Safe (MDAS)

| 18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT | 21. TOTAL CUBE |
|---|---|---|---|
| | | 175 LBS | |

| 22. RECEIVED BY | 23. DATE RECEIVED |
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| | |

PREVIOUS EDITION MAY BE USED

24. DOCUMENT NUMBER & SUFFIX (30-44)

Munitions Response Program Site UXO4/5
Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

Contract Number: N62473-09-D-2622
Contract Task Order: 0070

Smelted on 5/26/15
Witnessed by

25. NATIONAL STOCK NO. & ADD (8-22)

Barrel# 15

Seal # 629983

FINAL

26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-56) UP (74-80)

"The material listed on this form has been inspected or processed by DDESB approved means, as required by Department of Defense policy, and to the best of my knowledge and belief does not pose an explosive hazard."

Shipped to: Daly Iron
1618 Smith Rau Road
Columbus, TX

27. ADDITIONAL DATA

Verified By

Dan Paul
USAE Environmental
Senior UXO Specialist
(989)351-8633

Certified By

Dave McDonald
CH2M Hill/Munitions Response Group
Quality Control Specialist
(949)285-0746

Adobe Designer 7.0

| 1. TOTAL PRICE | 2. SHIP FROM | 3. SHIP TO |
|---|---|---|
| DOLLARS CTS | USAE Environmental<br>POC Dan Paul<br>(989)351-8633 | Fallbroo<br>and Rec<br>(760)72 |
| | 4. MARK FOR | |

Munitions Response Program Site UXO4/5
Naval Weapons Station Seal Beach
Detachment Fallbrook
Fallbrook, California

Contract Number: N62473-09-D-2622
Contract Task Order: 0070

| 5. COG DATE | 6. NMFC | 7. FRT RATE | 8. TYPE CARGO |
|---|---|---|---|
| 4/15/2015 | | | In Pickup Truck |

| 10. QTY. REC'D | 11. UP | 12. UNIT WEIGHT | 13. UNIT CUBE | 14. UFC |
|---|---|---|---|---|
| 2 | | | | |

15. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE
Scrap Metal

| 18. TY CONT | 19. NO CONT | 20. TOTAL WEIGHT | 21. TOTAL C |
|---|---|---|---|
| | | 2090lbs | |

| 22. RECEIVED BY | 23. DATE RE |
|---|---|
| | |

"The material listed on this form has been inspected or processed by DDESB approved means, as required by Department of Defense policy, and to the best of my knowledge and belief does not pose an explosive hazard."

Shipped to: Fallbrook Waste and Recycling
550 West Aviation
Fallbrook, CA 92028

Verified By

Dan Paul
USAE Environmental
Senior UXO Specialist
(989)351-8633

Certified By

Dave McDonald
CH2M Hill/Munitions Response Group
Quality Control Specialist
(949)285-0746

Date: 04/15/15 Out: 14:35 Containers:
Route: 05610
C. CASH DRIVE UP Origin: 056 R

| odity | Units | Rate | |
|---|---|---|---|
| RESIDENTIAL REFUSE | .52 | 68.00 per TON | |

ess(In): 3.65 tons Scl#1 Tare 3.13 tons Scl#1 Net: .52 to

Net Amount

PAID CREDIT CARD

ALICIA Driver

LBROOK WASTE & RECYCLING
WEST AVIATION
LBROOK, CA 92028
0) 728-6114

In

| | | | | | |
|---|---|---|---|---|---|
| omer: | 0000 | Ticket: 30262 | In: 14:14 | Truck: | 0000 |
| | | Date: 04/15/15 | Out: 14:37 | Containers: | |
| | | | | Route: | 05610 |
| C. CASH DRIVE UP | | | | Origin: | 036 R |

| odity | Units | Rate | |
|---|---|---|---|
| RESIDENTIAL REFUSE | .57 | 68.00 per TON | |

ss(In): 3.42 tons Scl#1 Tare 2.85 tons Scl#1 Net: .57 ton

Net Amount

PAID CREDIT CARD

ALICIA Driver

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# Appendix I
# Laboratory Analytical Reports
# (CD only)

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# Appendix J
# Data Quality Assessment

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# Appendix J
# Data Quality Assessment

This appendix contains the data quality assessment (DQA) for 61 soil samples and associated field quality control (QC) samples collected by CH2M HILL Kleinfelder, A Joint Venture (KCH) from February 21, 2015 through April 7, 2015 for the Remedial Investigation (RI) for Munitions Response Program (MRP) Site Unexploded Ordnance (UXO) 5, Naval Weapons Station Seal Beach Detachment Fallbrook, Fallbrook, California. The objective of the investigation was to assess the nature and extent of the hazard/threat of munitions and explosives of concern (MEC) and munitions constituents (MC) at MRP Site UXO5.

Soil samples were collected from 12 trenches (from at least two depth intervals to 4.5 feet below ground surface [bgs]) from February 21, 2015 through March 10, 2015. From March 19, 2015 through April 7, 2015, soil samples were collected from 24 discrete soil borings at depths ranging from ground surface to 1 foot bgs.

Soil samples were analyzed for:

- Explosive residues by United States Environmental Protection Agency (USEPA) Method 8330A
- Perchlorate by USEPA Method 6850
- Metals including mercury by USEPA Methods 6020A and 7471A
- Hexavalent chromium by USEPA Method 7199

KCH submitted the soil and associated field QC samples to EMAX Laboratories, Inc. (EMAX), located in Torrance, California.

## Data Quality Assessment

The DQA process consists of a systematic review, verification, validation, and usability assessment of the data generated during this investigation. The purpose of the DQA is to evaluate and monitor the performance of the field sampling and analytical procedures, and assess the quality of the data. Data review and verification were performed by the KCH Project Chemist on 100 percent of the analytical data. MEC$^X$, located in Aurora, Colorado, performed the independent third-party data validation.

Data validation was performed on 100 percent of the data with approximately 90 percent undergoing standard (Level III) and 10 percent undergoing full (Level IV) data validation. A total of 2,704 analytical results were evaluated by MEC$^X$ during the data validation process. Of those analytical results, 100 results were flagged as not to be used, in favor of more technically sound results for the same samples and target analytes (e.g., from sample dilutions or other reanalyzes). The data were reviewed, verified, and validated consistent with the procedures presented in the following documents:

- USEPA Contract Laboratory Program, *National Functional Guidelines for Superfund Organic Data Review*, June 2008.
- USEPA Contract Laboratory Program, *National Functional Guidelines for Superfund Inorganics Data Review*, January 2010.
- United States Department of Defense, *Quality Systems Manual for Environmental Laboratories*, Version 4.2, October 2010.
- USEPA *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, Third Edition, Updates I, II, IIA, IIB, III, IIIA, IIIB, and IV, February 2007.
- KCH, Final *Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) Remedial Investigation for Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach, Detachment Fallbrook, Fallbrook, California*, February 2015.

The laboratory reported 321 analytical results qualified as estimated "J" for concentrations being reported between the detection limit (DL) and limit of quantitation (LOQ).

A total of 87 of the 2,604 usable analytical results (3.3 percent) were qualified as either estimated detects ("J" qualifier), estimated non-detects ("UJ" qualifier), or not detected due to either potential blank contamination or elevating the reporting limit due to matrix interference and qualified as non-detects ("U" qualifier) due to the data validation process. Results qualified as estimated ("J" , "UJ", or "U" qualified) are considered usable for all purposes.

Analytical results were qualified as estimated for one or more of the following reasons:

- Field blank contamination
- Raising the reporting limit
- Matrix Spike (MS)/Matrix Spike Duplicate (MSD) percent recovery outliers
- MS/MSD relative percent difference (RPD) outside acceptable criteria
- Serial dilution outliers

As a result of the data validation process, no results were rejected, except in cases where multiple results were reported as a result of dilutions or reanalysis.

# Quality Control Samples and Sample Receipt

QC samples collected during this investigation consisted of the following types:

- Equipment rinsate blank sample
- Source water blank sample
- MS/MSD samples
- Temperature blank samples

Upon sample receipt, the laboratory measured and documented each of the cooler temperatures. Temperatures were recorded to be below 6 degrees Celsius in the sample coolers submitted to EMAX for analysis.

# Data Validation Findings

The data quality indicators, otherwise known as precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS), defined in the SAP (KCH, 2015), were met for the RI, and were assessed as follows:

- **Precision** was assessed by evaluating the RPDs of the MSD, laboratory control sample duplicates, field duplicates, serial dilutions, and laboratory sample duplicates for each applicable analytical method. Approximately 1.3 percent of the usable analytical results were qualified as a result of MS/MSD RPD outliers or serial dilutions, indicating that the analytical methods were consistently precise.
- **Accuracy** was assessed by evaluating percent recoveries of MS samples, laboratory control samples, internal standard, and surrogate recoveries for each applicable analytical method. Approximately 1.2 percent of the usable analytical results were qualified as a result of percent recovery outliers in the MS/MSD samples associated with this dataset, indicating that the methods were consistently accurate.
- **Representativeness** was assessed by the use of established field and laboratory procedures and their consistent application. Representativeness was maintained by using standard operating procedures (SOPs), including chain-of-custody protocol and documentation, soil sampling, sample labeling, sample packaging and transport, as well as maintaining good condition of the samples upon receipt at the laboratory.
- **Comparability** was assessed by evaluating the use of well-documented analytical methods and SOPs, standard reference materials, and QC samples, and by reporting each data type in consistent units. The use of USEPA-approved analytical methods, specified and well-documented analyses, a California State-certified and United States Department of Defense Environmental Laboratory Accreditation Program-accredited laboratory, and a standardized DQA process gives the data a high degree of analytical comparability**.**
- **Completeness** was assessed by evaluating the validity of data obtained as a result of the DQA process (i.e., amount of valid data obtained as compared to the amount that was expected to be obtained under normal conditions). Estimated data ("J" or "UJ" qualified) are considered valid and usable; however, rejected data ("R" qualified) are considered unusable. No results were rejected, except in cases where multiple results were reported as a result of dilutions or reanalyzes. During data validation, the least technically appropriate results were rejected so that only one result per compound per sample was considered valid. Of the 2,604 analytical results considered in the analytical completeness calculation, 100 percent are considered usable, which meets the completeness goal of 90 percent defined in the SAP (KCH, 2015).
- **Sensitivity** was assessed by evaluating the use of project limits of quantitation.
  - Dilutions were required for hexavalent chromium and metals analysis.
  - Sample UXO5-SB04-0.50 was diluted twofold and sample UXO5-SB03-0.25 was diluted fourfold for hexavalent chromium due to matrix interference by USEPA Method 7199. Though the reporting limits were elevated and the results were nondetect, both results still met the project action limit (300 micrograms per kilogram).

- Samples UXO5-SB19-1.0 and UXO5-SB22-0.5 required fivefold dilutions for manganese due to the result exceeding the upper calibration limit by USEPA Method 6020A. Both manganese results were reported above the project action limit (220 milligrams per kilogram).
- The reporting limits for HMX and/or RDX (USEPA Method 8330A) for 15 samples were raised during the data validation process due an early eluting unknown peak that had the potential to mask RDX and HMX peaks. The elevated reporting limits did not exceed the project action limits.

Based on a review of the data validation reports, the following data qualifiers were applied due to QC outliers:

- Contaminants reported in field samples with less than five times the concentrations detected in the source water blank or equipment rinsate blank samples were qualified as not detected and assigned a "U," with validation code "06." Sodium was reported at a concentration above the detection limit in the source blank and equipment rinsate blank samples, potentially affecting 19 soil samples.
- A total of 32 results for antimony, beryllium, calcium, chromium, cobalt, copper, magnesium, manganese, nickel, potassium, sodium, strontium, vanadium, and zinc were qualified in six samples because of either MS and/or MSD percent recovery outliers. During data validation, these results were qualified as estimated detect ("J" qualifier) and estimated nondetect ("UJ" qualified) with validation code "08."
- Strontium was qualified in one sample and zinc was qualified in another sample because of high RPD between the MS and MSD results. Results were qualified as estimated detect ("J" qualifier) with validation code "09."
- The serial dilutions exceeded the 10 percent QC criteria in five samples. Aluminum, calcium, chromium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, sodium, and/or vanadium results were qualified as estimated detect ("J" qualifier) and estimated nondetect ("UJ" qualified) in one or more of these five samples with reason code "16."
- HMX and RDX reporting limits were elevated for 15 samples during data validation due to interfering peaks and qualified non-detect ("U" qualified) with reason code "23."

As a result of the DQA process, it has been concluded that the data quality indicators (i.e., PARCCS) were either met or exceeded for the analytical data generated during this investigation. The data validation reports, which will include the sample summary results of qualified and unqualified data, are provided on compact disc as Appendix K.

# References

CH2M HILL Kleinfelder, A Joint Venture (KCH). 2015. *Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) Remedial Investigation for Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach, Detachment Fallbrook, Fallbrook, California*. Final. February.

United States Department of Defense. 2010. *Quality Systems Manual for Environmental Laboratories*, Version 4.2. October.

United States Environmental Protection Agency (USEPA). 2007. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, Third Edition, Updates I, II, IIA, IIB, III, IIIA, IIIB, and IV. February.

United States Environmental Protection Agency (USEPA) Contract Laboratory Program. 2010. *National Functional Guidelines for Superfund Inorganics Data Review*. January.

United States Environmental Protection Agency (USEPA) Contract Laboratory Program. 2008. *National Functional Guidelines for Superfund Organic Data Review*. June.

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# Appendix K
# Data Validation Reports
# (CD only)

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# Appendix L
# MEC Hazard Assessment
# (CD only)

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# Appendix M
# Human Health Risk Assessment

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**Draft**

**Appendix M**

# Baseline Human Health Risk Assessment

# Remedial Investigation for Munitions Response Program Site UXO5

## Naval Weapons Station Seal Beach
## Detachment Fallbrook
## Fallbrook, California

**Contract Number: N62473-09-D-2622**
**Contract Task Order: 0063**
**Document Control Number: KCH-2622-0063-0058**

**July 2016**

Prepared for

## Department of the Navy
## Naval Facilities Engineering Command Southwest

Prepared by

**CH2M HILL Kleinfelder, A Joint Venture (KCH)**

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## Figure

M-1 MC Conceptual Site Exposure Model for Potential Human Receptors

# Acronyms and Abbreviations

| | |
|---|---|
| 95UCL | 95 percent upper confidence limit of the mean |
| bgs | below ground surface |
| BTV | background threshold value |
| Cal-EPA | California Environmental Protection Agency |
| COPC | chemical of potential concern |
| CSEM | conceptual site exposure model |
| DGM | digital geophysical mapping |
| DTSC | California Department of Toxic Substances Control |
| EOD | Explosive Ordnance Disposal |
| EPC | exposure point concentration |
| GI | gastrointestinal |
| HHRA | human health risk assessment |
| HI | hazard index |
| IUR | inhalation unit risk |
| J | estimated concentration (data qualifier) |
| KCH | CH2M HILL Kleinfelder, A Joint Venture |
| Kgb | Gabbro (parent rock type) |
| $m^3/kg$ | cubic meter per kilogram |
| MC | munitions constituents |
| MEC | munitions and explosives of concern |
| mg/kg | milligram per kilogram |
| mm | millimeter |
| MPPEH | material potentially presenting an explosive hazard |
| MRP | Munitions Response Program |
| Navy | United States Department of the Navy |
| NCP | National Contingency Plan |
| PEF | particulate emission factor |
| R | rejected (data qualifier) |
| RAGS | Risk Assessment Guidance for Superfund |

| | |
|---|---|
| RBC | risk-based concentration |
| RfC | reference concentration |
| RfD | reference dose |
| RI | remedial investigation |
| RSL | regional screening level |
| SF | slope factor |
| SI | site inspection |
| U | not detected (data qualifier) |
| UJ | estimated not detected (data qualifier) |
| USEPA | United States Environmental Protection Agency |
| UXO | Unexploded Ordnance |

# 1.0 Introduction

This appendix presents the baseline human health risk assessment (HHRA) for Munitions Response Program (MRP) Site Unexploded Ordnance (UXO) 5 at Seal Beach Detachment Fallbrook (Detachment Fallbrook), Fallbrook, California. The HHRA was prepared as part of the remedial investigation (RI) report for MRP Site UXO5.

HHRAs are prepared to evaluate potential health risks under current and future land use conditions. This HHRA includes five pieces of information:

- Estimates the magnitude of potential human health risks associated with current site conditions and potential future land use scenarios.
- Identifies the environmental media and chemicals that pose the primary health concerns.
- Identifies the environmental media and chemicals that pose little or no threat to human health.
- Provides a foundation for assessing the need for further consideration or response under the MRP.

The HHRA incorporates guidance issued by the United States Department of the Navy (Navy), the United States Environmental Protection Agency (USEPA), and the California Environmental Protection Agency's (Cal-EPA's) Department of Toxic Substances Control (DTSC).

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# 2.0 Site Description and Background

Detachment Fallbrook is located approximately 53 miles north of San Diego in northern San Diego County, California, approximately 9 miles inland from the Pacific Coast. MRP Site UXO5 covers approximately 13 acres and is located in the northeast corner of Detachment Fallbrook (see Figure 1-1 of the RI report). MRP Site UXO5 is just east of Building 307 and is bounded on the southwest and southeast sides by Sparrow Road (Building 307 access road) and Building 365, respectively. There are no buildings within MRP Site UXO5 boundaries.

MRP Site UXO5 was reported to be a burial area for munitions and munitions-related dunnage (Malcolm Pirnie, 2006). From 1952 through 1960, the area east of Building 307 was used to dispose of inert materials (Knight, 2004). On historical maps, the area is labeled as a storage yard starting in the 1950s and ending in the late 1960s. Records indicate that expended cartridges, primers, live projectiles, and inert anti-tank projectiles were buried in the area (Malcolm Pirnie, 2006).

In the mid-1960s, 2 pounds of smokeless powder in five partially filled cans were reportedly deposited at MRP Site UXO5 (Knight, 2004). In the late 1980s, an onsite survey was conducted and revealed other materials, including electronic parts, inert missile parts, rubber missile shipping rings, missile test stands, practice shapes, electronic test equipment, empty powder cans, metal banding, and tires (Knight, 2004). In February 2002, a brush fire exposed buried munitions at MRP Site UXO5 (Knight, 2004). Within the same month, Explosive Ordnance Disposal (EOD) reported separate incidents in which EOD technicians from Marine Corps Base Camp Pendleton were called to MRP Site UXO5 to handle suspected 20-millimeter (mm) and 40-mm projectiles and blasting caps found on the ground surface. Currently, MRP Site UXO5 is not in use and is completely fenced.

Sections 2.0 through 5.0 of the RI report provide further details on the history of Detachment Fallbrook, the historical operations at MRP Site UXO5, physical characteristics of the site and areas surrounding the site, and the nature and results of the environmental investigations for MRP Site UXO5.

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# 3.0 HHRA Methodology

The methods used to conduct the HHRA are based on the risk assessment framework developed by USEPA. The framework is documented in *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)* (USEPA, 1989). The USEPA framework consists of six basic steps:

- Step 1: Conceptual Site Exposure Model (CSEM). This step involves identifying potential exposure pathways to the chemicals of potential concern (COPC) and human populations that might be exposed to COPCs under current or future site conditions.
- Step 2: Data Evaluation and Selection of COPCs. This step consists of evaluating the analytical data for usability in the HHRA, grouping analytical data by site and by medium, and selecting COPCs in site media.
- Step 3: Exposure Assessment. This step involves (a) estimating exposure point concentrations (EPCs) for the selected COPCs and (b) using the EPCs to estimate pathway-specific intakes (doses) for hypothetical human receptors in the subsequent risk characterization.
- Step 4: Toxicity Assessment. This step consists of compiling toxicity values that characterize potential health effects from exposure to COPCs.
- Step 5: Risk Characterization. This step combines the results of the previous steps to quantitatively characterize potential risks to human health associated with exposure to COPCs at the area evaluated. Both potential cancer risks and noncancer hazard indices (HIs), a measure of the potential for adverse health effects other than cancer, are evaluated. Chemicals identified as primary risk contributors are evaluated in this HHRA to assess whether detections are attributable to Navy- or non-Navy-related conditions.
- Step 6: Uncertainty Analysis. This step discusses the major uncertainties associated with the HHRA.

Human health risks for MRP Site UXO5 are estimated using a risk-based concentration (RBC) approach, rather than the traditional forward risk calculation approach outlined in the *Risk Assessment Guidance for Superfund* (RAGS) Part A framework (USEPA, 1989). The RBC approach is a streamlined approach that combines step 3(b) through step 5. The RBC approach uses the ratio of EPCs calculated in step 3(a) to receptor- and pathway-specific RBCs to estimate health risks. The resulting health risks estimates are numerically equivalent to the estimates obtained using the "forward risk calculation methodology" outlined in the USEPA (1989) RAGS Part A framework. This RBC approach, also known as the "risk-ratio" or "ratiometric" approach, also follows the DTSC guidelines for risk assessments (DTSC, 2015; DTSC, 2016).

The remainder of this appendix presents the CSEM (Section 4.0), data evaluation and selection of COPCs (Section 5.0), estimation of EPCs (Section 6.0), risk characterization methodology (Section 7.0), HHRA findings (Section 8.0), and uncertainty analysis (Section 9.0). References are provided in Section 10.0 and tables are provided following the references.

# 4.0 Conceptual Site Exposure Model

This section presents the HHRA CSEM. The CSEM summarizes information on sources of chemicals at the site, affected environmental media, chemical release and transport mechanisms that may occur at the site, potentially exposed human receptors, and potential exposure pathways for each receptor. The CSEM is shown in Figure M-1. Components of the CSEM are discussed below.

## 4.1 Sources of Site Chemicals

Potential contaminant sources at MRP Site UXO5 are summarized in Section 2.0 of this appendix. The potential contaminant source at MRP Site UXO5 is munitions constituents (MC) in munitions and munitions-related dunnage that were deposited at the site.

## 4.2 Affected Environmental Media

Three types of investigations were completed at MRP Site UXO5 during the RI. The first type was targeted anomaly investigation of selected subsurface anomalies identified during digital geophysical mapping (DGM) of transects and 100 percent DGM coverage areas. The second type was targeted excavation of 12 trenches in elevated anomaly density areas identified during the 2012 G-858 investigation (SES-TECH, 2012) to characterize potential munitions and explosives of concern (MEC)/material potentially presenting an explosive hazard (MPPEH) and MC contamination. The third type was non-biased soil sampling to assess the nature and extent of MC in soil.

The investigation activities identified chemical impacts in surface soil (0 to 0.5 foot below ground surface [bgs]) and subsurface soil (0 to 10 feet bgs) at MRP Site UXO5 (see Sections 3.0 and 5.0 of the RI report). Note that within the subsurface soil depth interval, the deepest RI soil samples were collected at 4.5 feet bgs, which corresponded to the maximum depths of the exploratory trenches that were excavated at the site. Trenches were generally 3 feet deep; however, some trenches extended deeper until all metallic anomalies were investigated and removed.

Because of the inferred depth to groundwater (greater than 100 feet), groundwater is not considered a medium of concern at MRP Site UXO5 and is not addressed by this RI (KCH, 2015). Potential exposure to surface water is expected to negligible and is not evaluated in the HHRA. An intermittent stream located along the northern boundary of the site drains into the Santa Margarita River (located approximately 0.5 mile north of the site). However, no permanent water bodies are present within MRP Site UXO5.

## 4.3 Chemical Release and Transport Mechanisms

Potential chemical release and transport mechanisms for MRP Site UXO5 are shown in Figure M-1. Based on these transport mechanisms, chemicals detected in surface soil may migrate to ambient (outdoor) air. Outdoor air is therefore considered an additional medium

of exposure for site chemicals. Wind erosion was identified as the sole mechanism for release of chemicals to outdoor air.

## 4.4 Potentially Exposed Human Receptors

MRP Site UXO5 is not currently used and fencing prevents access. Therefore, no current potential receptors were evaluated in the HHRA.

The planned future use of Detachment Fallbrook is continued military industrial use. Therefore, an industrial worker was selected as a potential future receptor for evaluation in the HHRA. In addition, a hypothetical future resident was also evaluated as a potential future receptor. An unrestricted (residential) land use scenario generally represents the greatest potential for exposure to site chemicals and is evaluated to provide additional information to support risk management decisions for a site. The future scenarios evaluated in the HHRA assume that development of the site (excavating and regrading soils, including potential distribution of subsurface soils to the surface) would occur during future use. Therefore, a future construction worker was also evaluated. In summary, three potentially exposed receptors were evaluated in the HHRA:

- Future industrial worker
- Future construction worker
- Hypothetical future resident

## 4.5 Potentially Complete Exposure Pathways

A complete exposure pathway consists of four elements (USEPA, 1989):

- A source and mechanism of chemical release
- A retention or transport medium (or media in cases involving transfer of chemicals)
- A point of potential human contact with the contaminated medium (referred to as the exposure point)
- An exposure route (such as ingestion) at the contact point

If any of these elements is missing (except in a case where the source itself is the point of exposure), then the exposure pathway is considered incomplete. For example, if human contact with the source or transport medium does not occur, then the exposure pathway is incomplete and is not quantitatively evaluated for risk. Similarly, if human contact with an exposure medium is not possible, the exposure pathway is considered incomplete and is not evaluated.

The CSEM summarizes the information on sources of COPCs, affected environmental media, COPC release and transport mechanisms that may occur at the site, potentially exposed receptors, and potential exposure pathways for each receptor (see Figure M-1). Potentially complete exposure pathways are designated by “C” in the CSEM. Incomplete exposure pathways are designated by “I.” Health risks were estimated for exposure pathways identified in the CSEM as potentially complete.

Exposure to surface soil (0 to 0.5 foot bgs), which assumes minimal development of the site during future use, was evaluated for future industrial worker and hypothetical future resident.

Exposure to subsurface soil (0 to 10 feet bgs) was also evaluated for the future industrial worker, future resident, and future construction worker. Exposure to subsurface soil assumes intrusive development of the site during future use and excavation of site soil, thereby mixing soils throughout the soil column and making deeper soils available at the surface for contact. As discussed in Section 4.2, soil sampling at MRP Site UXO5 did not extend beyond the maximum trench depth of 4.5 feet bgs.

Three exposure pathways were identified as potentially complete for surface soil and subsurface soil:

- Incidental ingestion of soil
- Dermal contact with soil
- Inhalation of particulate chemicals released to outdoor air from wind erosion

Exposure to surface and subsurface soil from these potentially complete exposure pathways are evaluated in the HHRA for the future industrial worker and the future resident. Evaluation of potential soil exposure to the future construction worker is limited to subsurface soil exposure pathways because it is assumed this receptor is involved with intrusive excavation activities.

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# 5.0 Data Evaluation and Identification of Chemicals of Potential Concern

This section discusses the process used to evaluate, reduce, and group the analytical data for soil that were collected for MRP Site UXO5, and identify COPCs for quantitative evaluation in the HHRA. The data for soil were collected during 2007 for the site inspection (SI) and 2015 for this RI. Sections 3.0 through 5.0 of the RI report detail these sampling investigations.

## 5.1 Data Evaluation

All validated data for soil were initially considered for evaluation in the HHRA. As part of the data evaluation process, 90 percent of analytical data underwent cursory validation, and a minimum of 10 percent of the data underwent full validation to verify that they met USEPA data quality criteria for use in risk assessment (USEPA, 1992a). The laboratory analytical data were evaluated by an independent validation contractor using USEPA Contract Laboratory Program National Functional Guidelines for Inorganic and Organic Data Review (USEPA, 2008; USEPA, 2010) and the associated analytical methods.

The cursory review evaluated key quality assurance and quality control information such as holding times, calibration requirements, and spiking accuracy. The full validation evaluated additional quality assurance and quality control criteria and used the raw data to check calculations and chemical identifications. The overall objective was to verify that the analytical data met USEPA guidelines for adequacy based on precision, accuracy, representativeness, comparability, and completeness parameters. At each stage of the validation, qualifiers were assigned to the results according to USEPA guidelines (2008; 2010) and associated analytical methods.

Validated data without qualifiers and validated data qualified as estimated (J) were considered detected in the HHRA. Data validated as not detected (U) or estimated not detected (UJ) were considered not detected. Validated data qualified as rejected (R) were excluded from the HHRA. Following evaluation, the data were reduced (Section 5.2) and grouped (Section 5.3).

## 5.2 Data Reduction

In addition to the quality evaluation, additional reduction processes were implemented for the data used in the HHRA. Other, non-validated data (e.g., field screening data, investigation-derived waste data) were collected to aid in evaluating the nature and extent of contamination and for waste characterization. These data were not used in the HHRA because they do not represent an environmental medium in a human exposure pathway set forth in the exposure assessment or do not meet data quality criteria for risk assessment.

## 5.3 Data Grouping

Following the data reduction process, data for soil were grouped by the soil depth intervals selected for evaluation in the HHRA: surface soil (0 to 0.5 foot bgs) and subsurface soil (0 to 10 feet bgs). Soil data collected during the SI (Tetra Tech, 2009) included samples collected from 0 to 0.75 foot bgs (i.e., 0 to 9 inches bgs); data from these samples were included in the surface soil data grouping for this HHRA. A sampling depth of 0 to 9 inches was used in the SI because it was the depth to which the magnetometers used in the SI could detect small a MEC item with high confidence (Tetra Tech, 2009).

The HHRA data for MRP Site UXO5 consist of 29 SI samples collected between 0 and 0.75 foot bgs (included in both the surface soil and subsurface soil data groupings), 25 RI samples collected from 0 to 0.5 foot (included in both the surface soil and subsurface soil data groupings), and 35 RI samples collected at multiple depth intervals between 0.5 and 4.5 feet bgs (included in the subsurface soil data grouping).

Tables 5-1 and 5-2 of the RI report provide the individual analytical results for surface and subsurface soil samples collected during the RI. Appendix A of the RI report provides the analytical data tables for surface soil samples collected during the SI. As noted in Section 3.2 of the RI report, the analytical results for the SI shown in Appendix A of the RI report represent pre-data validation results. Several updates to analytical results and data qualifiers were identified during data validation and documented by Laboratory Data Consultants (LDC) (2007). Section 3.2 of the RI report summarizes the changes implemented to the SI data following data validation; these changes are reflected in this HHRA.

Tables M-1 and M-2 summarize the analytical data for chemicals detected in one or more samples in surface soil (0 to 0.5 foot bgs) and subsurface soil (0 to 10 feet bgs). Tables M-1 and M-2 show the range of detected concentrations, sample locations associated with the maximum detected concentration, detection frequency, range of laboratory reporting limits, risk-based residential and industrial screening levels, and the number of detected results that exceed screening levels. Comparisons to residential and industrial screening levels are provided for informational purposes only; the screening levels were not used to screen or exclude chemicals from the HHRA.

Background data for Detachment Fallbrook are available for metals in soil and were developed for four parent rock types (SES-TECH, 2012). The Gabbro (Kbg) parent rock type is applicable to MRP Site UXO5, based on its location (see Figure 2-1 of SES-TECH, 2012). Background threshold values (BTVs) for Kgb are shown in Tables M-1 and M-2; the number of detected results for metals in soil that exceed BTVs are also shown in these tables.

## 5.4 Identifying Chemicals of Potential Concern

COPCs are chemicals that are carried through the quantitative risk characterization portions of the HHRA.

COPCs were identified separately for surface soil and subsurface soil using three steps:

- **Step 1 —** The validated analytical data were tabulated and a preliminary list was developed of chemicals detected in one or more samples of surface soil and

subsurface soil, regardless of concentration. Chemicals not detected in any samples in each data grouping (surface soil, subsurface soil) were excluded from the HHRA.

- **Step 2 —** Inorganic chemicals considered to be essential human nutrients (i.e., calcium, magnesium, potassium, and sodium) were excluded as COPCs. USEPA guidance states that these nutrients may be deleted because of their low toxicities when they are detected at environmental concentrations (USEPA, 1989). Essential human nutrients are not shown in Tables M-1 and M-2.
- **Step 3 —** Metals considered naturally occurring (i.e., present at background levels) were excluded as COPCs in surface soil and subsurface soil on the basis of threshold comparisons with BTVs. BTVs are shown in Tables M-1 and M-2. Metals with one or more detections above BTVs or for which BTVs are not available were identified as COPCs. Chemicals identified as COPCs are indicated with a "Yes" in Tables M-1 and M-2. Metals for which no detections were above BTVs were excluded as COPCs.

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# 6.0 Exposure Point Concentrations

Potential exposure points are identified on the basis of present and anticipated future population activity patterns and the relationship of the activities to the presence of contaminated media. A location is identified as an exposure point if a human might contact (e.g., ingest) a contaminated medium (e.g., surface soil) at that location. MRP Site UXO5 is considered an exposure point for this HHRA. Potential exposure to COPCs in soil is assumed to occur randomly throughout the exposure point over the duration of exposure.

The concentration of a COPC in a medium (e.g., surface soil) that a receptor may be exposed to is called the EPC. The EPC for each COPC is represented by the 95 percent upper confidence limit (95UCL) of the mean or the maximum detected concentration. USEPA considers the 95UCL concentration as a conservative upper-bound estimate that is not likely to underestimate the mean concentration (USEPA, 1989; USEPA, 1992b; USEPA, 2002). 95UCLs were calculated for each COPC in surface soil and subsurface soil using the stochastic methods in the USEPA ProUCL software (USEPA, 2013).

The procedures in ProUCL identify the statistical distribution type (i.e., normal, lognormal, or nonparametric) for each COPC and data grouping (e.g., surface soil), and compute the corresponding 95UCL for the identified distribution type. The 95UCL is used as the EPC unless the calculated 95UCL is greater than the maximum detected concentration or unless the number of samples or number of detected results in the data grouping is too small (fewer than five total results or fewer than four detected results) to permit estimation of a 95UCL. If this occurs, then the maximum detected concentration is used as the EPC. Use of maximum detected concentrations for EPCs may contribute to overestimation of risk.

The EPCs calculated using ProUCL are summarized in Table M-3. For each COPC, Table M-3 shows the detection frequency, number of high censored results, arithmetic mean, distribution of the data determined by ProUCL (i.e., normal, lognormal, or gamma; data not fitting these distributions were treated as nonparametric), maximum detected concentration, and resulting EPC. Censored results that exceeded maximum detected concentrations (i.e., high censored results) were excluded from the 95UCL calculations.

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# 7.0 Risk Characterization

This section discusses the process used to characterize potential risks associated with exposure to detected chemicals. Cancer risks and noncancer health hazards are characterized separately. As discussed in Section 3.0, this HHRA uses an RBC approach (i.e., risk ratio approach) to calculate risks. Section 7.1 identifies the RBCs used to estimate risks. The methodology for estimating cancer and noncancer risks and HIs is presented in Sections 7.2 and 7.3, respectively. The methodology used to characterize risks for lead is presented in Section 7.4.

## 7.1 Risk-Based Concentrations

As discussed in Section 3.0, this baseline HHRA estimates health risks using a streamlined RBC approach. The resulting health risks estimates are numerically equivalent to the estimates obtained using the "forward risk calculation methodology" outlined in the USEPA (1989) RAGS Part A framework.

USEPA (2015) industrial and residential regional screening levels (RSLs) for soil were used as RBCs to evaluate future industrial worker and hypothetical future residential exposure to surface and subsurface soil. When available, DTSC (2016)-preferred risk-based screening levels for soil as RBCs are used in lieu of USEPA RSLs. The soil RBCs used for this HHRA are summarized in Table M-4.

Both the USEPA (2015) RSLs and DTSC (2016)-preferred screening levels are RBCs for individual chemicals that correspond to a cancer risk of $1 \times 10^{-6}$ (for carcinogens) or a hazard quotient of 1 (for noncarcinogens). The RBCs are derived from equations that combine exposure assumptions with chemical-specific toxicity values. The USEPA (2015) RSLs are derived using USEPA default assumptions for industrial and residential exposure and the USEPA-preferred hierarchy for toxicity values. The DTSC (2016)-preferred screening levels are similarly derived; DTSC uses California assumptions for residential and industrial exposure and California toxicity values, when available, to calculate the screening levels. The final list of DTSC screening levels only includes those chemicals for which the resulting screening level is at least three times more stringent than the corresponding USEPA RSL value (DTSC, 2016).

Exposure pathways that incorporated the USEPA (2015) soil RSLs and DTSC (2016)-preferred soil screening levels include incidental ingestion, dermal contact, and inhalation of chemicals released from soil to outdoor air as particulates. These pathways are consistent with the soil exposure pathways identified as potentially complete for MRP Site UXO5 (see Section 4.5).

### Construction Worker RBCs

Neither USEPA nor DTSC has established soil RBCs for construction worker exposure. Therefore, soil RBCs for construction worker exposure were calculated for this HHRA to evaluate this receptor. The construction worker RBCs were derived for carcinogenic COPCs

based on a target cancer risk of $1 \times 10^{-6}$ and for noncarcinogenic COPCs based on a target noncancer HI of 1. Both cancer-based and noncancer-based RBCs were calculated for COPCs associated with both cancer and noncancer effects. Table M-5 shows the equations and exposure assumptions for calculating RBCs for construction worker exposure to soil. Exposure assumptions were based on DTSC (2014) when available; otherwise, exposure assumptions were based on USEPA (2015). The toxicity values used to calculate the construction worker RBCs are shown in Table M-6. The hierarchy used for toxicity values follows the hierarchy that USEPA uses to calculate soil RSLs, except that California toxicity values were used when more stringent than non-California values.

Toxicity criteria are not available for the dermal exposure route. USEPA (2004) guidance recommends that oral toxicity criteria be adjusted for evaluation of dermal exposures so that criteria are based on an absorbed dose. Toxicity value adjustments are only needed when the gastrointestinal (GI) absorption fraction is less than 50 percent (USEPA, 2004). The GI absorption fractions used to adjust the oral toxicity criteria and the resulting dermal toxicity criteria are also shown in Table M-6. The GI absorption fractions were taken from USEPA (2015).

The calculated soil RBCs for construction worker exposure are summarized in Table M-7.

## 7.2 Characterization of Cancer Risks

The cancer risk estimate associated with exposure to a carcinogenic COPC is calculated as follows:

$$\textit{Cancer risk} = (EPC/RBCc) \times 10^{-6}$$

where:

EPC = Exposure point concentration in for soil in milligram per kilogram (mg/kg)

RBCc = Risk-based concentration for carcinogens (mg/kg)

Individuals may be exposed to more than one COPC at a site. The cancer risks for individual COPCs are summed by exposure pathway to calculate the cumulative cancer risk as follows:

$$\textit{Cumulative risk} = 10^{-6} \times \{EPC_1/RBCc_1 + EPC_2/RBCc_2 + \ldots + EPC_n/RBCc_n\}$$

where:

Cumulative risk = Cumulative cancer risk from exposure to carcinogenic COPCs (unitless)

USEPA guidance on exposure levels considered protective of human health is presented to aid in the interpretation of the results of the risk assessment. In the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), USEPA defined general remedial action goals for sites on the National Priorities List (Title 40 of the Code of Federal Regulations Section 300.430). The goals include a range for residual cancer risk, which is "an excess upper-bound lifetime cancer risk to an individual of between $10^{-4}$ and $10^{-6}$ or 1 in 10,000 to 1 in 1,000,000." The goals set out in the NCP are applied once a decision to

remediate a site has been made. A subsequent USEPA directive provides additional guidance on the role of the HHRA in supporting risk management decisions and, in particular, evaluating whether a response action is necessary (USEPA, 1991). Specifically, the guidance states the following:

> Where cumulative carcinogenic risk to an individual based on reasonable maximum exposure for both current and future land use is less than $10^{-4}$, and the noncancer hazard quotient (HQ) is less than 1, action generally is not warranted unless there are adverse environmental impacts.

This HHRA compares cumulative cancer risks with the USEPA range of $10^{-4}$ to $10^{-6}$ for management of cancer risk, referred to as the risk management range. Cumulative cancer risks are also compared to the lower end of the range, $1 \times 10^{-6}$, which is the DTSC point of departure for management of cancer risks. Risks that do not exceed the point of departure ($1 \times 10^{-6}$) are considered negligible and do not require action.

## 7.3 Characterization of Noncancer Hazards

The potential for receptors to develop adverse health effects from inhalation exposure to COPCs that are not classified as carcinogens and for carcinogens known to cause adverse health effects other than cancer is calculated as follows:

$$Hazard\ Index\ (HI) = EPC/RBCnc$$

where:

EPC = Exposure point concentration in soil (mg/kg)

RBCnc = Risk-based concentration for soil (mg/kg)

The HIs for individual COPCs are summed to evaluate the cumulative potential for noncancer effects from exposure to multiple COPCs, yielding a cumulative HI as shown below:

$$Cumulative\ HI = EPC_1/RBCnc_1 + EPC_2/RBCnc_2 + \ldots + EPC_n/RBCnc_n$$

where:

HI = Cumulative noncancer hazard index from exposure to noncarcinogenic COPCs (unitless)

An HI of less than 1 indicates that adverse noncancer health effects are not expected. If the total HI exceeds 1, further evaluation in the form of a segregation of the HI via a target organ analysis may be performed to assess whether the noncancer HIs are a concern (USEPA, 1989). Target organ HIs greater than 1 may indicate a potential adverse effect; target organ HIs that do not exceed 1 indicate that adverse noncancer effects are not expected.

## 7.4 Characterization of Risks from Lead

Lead was identified as a COPC in surface and subsurface soil. The HHRA evaluated the potential for health effects from exposure to lead in soil by comparing the EPC with the California-recommended screening concentration for lead of 80 mg/kg for residential

exposure and 320 mg/kg for industrial exposure (DTSC, 2016). These screening concentrations are based on a biomarker (blood lead levels); for this reason, the risks from exposure to lead were characterized separately and were not included in cumulative risk calculations.

# 8.0 Results of the HHRA

This section presents the risk characterization results for the HHRA. The risks estimated in this HHRA are considered site-related risks because estimates of risks are limited to chemicals identified as COPCs (i.e., chemicals present above naturally occurring background concentrations) rather than all detected chemicals. Tables M-8 and M-9 show the chemical-specific and cumulative risks and HIs for surface soil and subsurface soil for the future industrial and residential scenarios. Table M-10 shows the chemical-specific and cumulative risks and HIs for subsurface soil for the future construction worker scenario.

This HHRA identifies a COPC as a primary risk contributor for MRP Site UXO5 if the COPC-specific risk exceeds the DTSC point of departure for cancer risks of $1 \times 10^{-6}$ or if the COPC-specific HI exceeds the noncancer threshold level of 1.

Consistent with USEPA (1989), the cumulative risk and HI results are shown to one significant figure in this section. HI results that exceed 1 are expressed as whole numbers. However, the risk calculations in Tables M-8 through M-10 are presented to two significant figures to aid review of calculations.

Lead was identified as a COPC in surface and subsurface soil. As indicated Section 7.4, risks from exposure to lead are characterized separately by comparing the EPC for lead to screening concentrations. The risk characterization for lead is in Section 8.3.

Each of the COPCs identified as primary risk contributors was evaluated further to assess whether detections could be attributed to non-Navy-related conditions. Primary risk contributors that could be attributed to Navy site-use-related conditions are recommended for further consideration or response under the MRP. Primary risk contributors that are not attributed to Navy site-use-related conditions are not recommended for additional evaluation. The evaluation of primary risk contributors is provided in Section 8.4.

## 8.1 Surface Soil

### Future Industrial Worker

The cumulative cancer risk for future industrial worker exposure to surface soil is $7 \times 10^{-6}$ (Table M-8). The cancer risk exceeds the DTSC point of departure of $1 \times 10^{-6}$, but is within the USEPA risk management range of $10^{-4}$ to $10^{-6}$. Arsenic is the primary risk contributor, and accounts for nearly 100 percent of the cancer risk.

The cumulative noncancer HI for future industrial worker exposure to surface soil is 0.9 (Table M-8), which is less than the noncancer threshold of 1.

### Future Resident

The cumulative cancer risk for future residential exposure to surface soil is $3 \times 10^{-5}$ (Table M-8). The cancer risk exceeds the DTSC point of departure of $1 \times 10^{-6}$, but is within the USEPA risk management range of $10^{-4}$ to $10^{-6}$. Arsenic is the primary risk contributor, and accounts for nearly 100 percent of the cancer risk.

The cumulative noncancer HI for future residential exposure to surface soil is 8 (Table M-8), which exceeds the noncancer threshold of 1. Arsenic is also a primary risk contributor for noncancer effects, and accounts for 88 percent of the cumulative noncancer hazard. Segregation of the HI by target organ was not done for the residential scenario because, other than for arsenic, the sum of the HIs for other COPCs in surface soil does not exceed 1.

## 8.2 Subsurface Soil

### Future Industrial Worker

The cumulative cancer risk for future industrial worker exposure to subsurface soil is $6 \times 10^{-6}$ (Table M-9). The cancer risk exceeds the DTSC point of departure of $1 \times 10^{-6}$, but is within the USEPA risk management range of $10^{-4}$ to $10^{-6}$. Arsenic is the primary risk contributor, and accounts for nearly 100 percent of the cancer risk.

The cumulative noncancer HI for future industrial worker exposure to subsurface soil is 0.9 (Table M-9), which is less than the noncancer threshold of 1.

### Future Resident

The cumulative cancer risk for future residential exposure to subsurface soil is $2 \times 10^{-5}$ (Table M-9). The cancer risk exceeds the DTSC point of departure of $1 \times 10^{-6}$, but is within the USEPA risk management range of $10^{-4}$ to $10^{-6}$. Arsenic is the primary risk contributor and accounts for nearly 100 percent of the cancer risk.

The cumulative noncancer HI for future residential exposure to subsurface soil is 7 (Table M-9), which exceeds the noncancer threshold of 1. Arsenic is also a primary risk contributor for noncancer effects, and accounts for 86 percent of the cumulative noncancer hazard. Segregation of the HI by target organ was not done for the residential scenario because, other than for arsenic, the sum of the HIs for other COPCs in subsurface soil does not exceed 1.

### Future Construction Worker

The cumulative cancer risk for future construction worker exposure to subsurface soil is $4 \times 10^{-6}$ (Table M-10). The cancer risk exceeds the DTSC point of departure of $1 \times 10^{-6}$, but is within the USEPA risk management range of $10^{-4}$ to $10^{-6}$. Cadmium is the primary risk contributor for the construction worker scenario, and accounts for 72 percent of the cancer risk.

The cumulative noncancer HI for future construction worker exposure to subsurface soil is 4 (Table M-10), which exceeds the noncancer threshold of 1.

Segregation of the HI in the form of a target organ evaluation was completed for the construction worker scenario because the cumulative HI exceeded the threshold of 1. The analysis was limited to arsenic, cadmium, cobalt, and nickel because these four chemicals contribute to nearly all of the HI for the construction worker scenario. The HI associated with the remaining COPCs (antimony, hexavalent chromium, copper, mercury, molybdenum, silver, and zinc) is negligible (0.01).

The target organs for arsenic, cadmium, cobalt, and nickel are listed in the following table. Target organ information was obtained from the sources used to identify the noncancer toxicity values for these chemicals (see Table M-6).

| COPC | Oral Chronic Reference Dose Target Organ(s) | Inhalation Chronic Reference Concentration Target Organ(s) |
|---|---|---|
| Arsenic | Reproductive/ development, cardiovascular, nervous, respiratory, dermal[a] | Reproductive/ development, cardiovascular, nervous, respiratory, dermal[a] |
| Cadmium | Urinary[a] | Urinary[b] |
| Cobalt | Endocrine[b] | Respiratory[b] |
| Nickel | Development[a] | Hematologic, respiratory[a] |

[a] Source: Cal-EPA, 2016
[b] Source: ORNL, 2016

Based on the corresponding target organs, segregated HIs were calculated by target organ for the future construction worker scenario. More than one target organ is indicated for some metals (i.e., arsenic, cobalt, and nickel). When this occurs, the HI is applied to each target organ equally. The segregated HIs are shown in the following table.

| Target Organ | Exposure Route and COPC | | Segregated Hazard Index | | |
|---|---|---|---|---|---|
| | Oral/Dermal[a] | Inhalation | Oral/Dermal[a,b] | Inhalation[b] | Total[c] |
| Reproductive/ development | Arsenic, Nickel | Arsenic | 1.3 | 0.024 | **1** |
| Cardiovascular | Arsenic | Arsenic | 1.3 | 0.024 | **1** |
| Nervous | Arsenic | Arsenic | 1.3 | 0.024 | **1** |
| Respiratory | Arsenic | Arsenic, Cobalt, Nickel | 1.3 | 0.54 | **2** |
| Dermal | Arsenic | Arsenic | 1.3 | 0.024 | **1** |
| Urinary | Cadmium | Cadmium | 1.9 | 0.06 | **2** |
| Endocrine | Cobalt | -- | 0.11 | -- | **0.1** |
| Hematologic | -- | Nickel | -- | 0.12 | **0.1** |

-- = not applicable or not available
[a] Target organs for the oral route of exposure are used to assess the oral and dermal routes of exposure because dermal HIs are estimated using oral reference doses (adjusted by GI absorption fraction; see Section 7.1).
[b] See Table M-10.
[c] The total segregated HI is calculated by summing the segregated HIs for the oral/dermal and inhalation exposure routes. Total HIs are rounded to one significant figure (USEPA, 1989).

The target organ analysis shows that while the total, nonchemical-specific HI is 4, the highest segregated HI based on single target organ is 2. Two target organs are associated with a segregated HI of 2: the respiratory system and the urinary system. Exposure to arsenic, cobalt, and nickel contribute to an HI of 2 for the respiratory system, and exposure to cadmium contributes to an HI of 2 for the urinary system. No other HIs segregated by target organ exceed the threshold of 1. Based on these results, arsenic, cadmium, cobalt, and nickel are identified as primary risk contributors based on noncancer effects.

## 8.3 Lead

Lead was identified as a COPC in surface and subsurface soil. EPCs for lead are based on 95UCL concentrations and are 32.52 mg/kg in surface soil and 22.07 mg/kg in subsurface soil. EPCs for lead in surface and subsurface soil are less than the residential screening criterion of 80 mg/kg and the industrial screening criterion of 320 mg/kg.

Use of 95UCL concentrations for evaluation lead is appropriate provided geographically collocated areas of elevated concentrations or individual samples with elevated concentrations are not present (DTSC, 2016). Although EPCs for lead are below residential and industrial screening criteria, the maximum detected concentration of lead (227 J mg/kg at SIS-007, 0 to 0.75 foot bgs) is approximately 2.8 times higher than the residential screening criterion of 80 mg/kg, while remaining sample results for lead are two or more times lower than the screening criterion. For this reason, lead is identified as a primary risk contributor for surface and subsurface soil.

## 8.4 Evaluation of Primary Risk Contributors

Arsenic, cadmium, cobalt, lead, and nickel were identified in the HHRA as primary risk contributors. These chemicals were evaluated further to assess whether detections could be attributed to Navy-related conditions. Primary risk contributors that are not attributed to Navy site-use-related conditions are not recommended for additional evaluation. Primary risk contributors that could be attributed to Navy site-use-related conditions are recommended for further consideration or response under the MRP.

### 8.4.1 Arsenic

Arsenic was identified as a primary risk contributor for surface and subsurface soil based on cancer risks that exceed $1 \times 10^{-6}$ for the future industrial and residential scenarios and based on its contribution to a segregated noncancer HI of 2 for the future construction worker scenario. The segregated HI exceeds the threshold HI of 1 is based on effects to the respiratory system. Arsenic was detected in all 54 surface soil (0 to 0.5 foot bgs) samples and in all 89 subsurface soil (0 to 10 feet bgs) samples at concentrations ranging from 0.69 J to 5.2 J mg/kg. Both the minimum and maximum detected concentrations were estimated concentrations ("J-qualified") below the laboratory reporting limit.

Arsenic was selected as a COPC for surface and subsurface soil because the maximum detected concentration (5.2 J mg/kg) exceeds the BTV for Kgb soils of 3.07 mg/kg. However, evaluation of results for arsenic shows that only four of the 89 samples for arsenic exceed the BTV for Kgb soils and that each of the four samples was collected during the 2009 SI and analyzed using USEPA Method SW6020. Concentrations of these four samples range from 4.2 to 5.2 J mg/kg, and are only slightly above the BTV (less than a factor of two); none of the samples are collocated. Concentrations for the remaining 85 of 89 samples for arsenic are less than the BTV.

Furthermore, detected concentrations for arsenic at MRP Site UXO5 (0.69 J to 5.2 J mg/kg) are within the range of background concentrations of arsenic for Detachment Fallbrook. Background concentrations for arsenic, regardless of parent rock type, range from 0.32 to 8.2 mg/kg. This comparison shows that the range of naturally occurring background arsenic concentrations do not vary widely across Detachment Fallbrook, regardless of parent rock

type, and measured arsenic concentrations at MRP Site UXO5 are well within the range of naturally occurring concentrations.

Lastly, arsenic is not associated with munitions or munitions-related dunnage, and historical use of the MRP Site UXO5 do not indicate use or disposal of arsenic. Based on comparability to background arsenic concentrations for Detachment Fallbrook, arsenic concentrations measured at MRP Site UXO5 are likely to be naturally occurring. For these reasons, arsenic is not recommended for further evaluation.

### 8.4.2 Cadmium

Cadmium was identified as a primary risk contributor for subsurface soil (future construction worker scenario). Cadmium was detected in all 89 subsurface soil (0 to 10 feet bgs) samples at concentrations ranging from 0.0703 J to 27.8 mg/kg. The cancer risk for cadmium for the construction worker scenario is $3 \times 10^{-6}$ and the noncancer HI is 2. Segregation of the HI by target organ shows that cadmium contributes to a segregated HI of 2 for the urinary system; no other COPCs are associated with the segregated HI for this target organ. The cadmium cancer risk for the construction worker scenario ($3 \times 10^{-6}$) exceeds the cadmium risk for the hypothetical future residential (unrestricted use) scenario ($1 \times 10^{-9}$) because of (1) differences between cancer toxicity values incorporated in the USEPA RSLs (used to estimate risks for the future industrial and residential scenarios) and the more stringent DTSC cancer toxicity values used to calculate construction worker RBCs and (2) the higher DTSC (2014)-recommended particulate emission factor for the construction scenario. The cadmium HI for the construction worker scenario exceeds the cadmium HI for the hypothetical future residential scenario because of the higher DTSC (2014)-recommended particulate emission factor for the construction scenario and shorter duration for averaging noncancer exposures for the construction scenario.

Although cadmium is not identified as a primary risk contributor for the future industrial and residential scenarios, cadmium concentrations in three sample results exceed the residential and industrial RBCs of 5.2 and 7.3 mg/kg, respectively. The maximum detected cadmium concentration (27.8 mg/kg at KCH-UXO5-TR10, 4.5 feet bgs) is 5.3 times higher than the residential RBC, is collocated with maximum detected concentrations of hexavalent chromium, cobalt, and manganese, and is associated with an excavation trench from which non-munitions-related metallic debris was recovered. The maximum concentration is also collocated with the third highest detection of cadmium (12.1 mg/kg at KCH-UXO5-TR10, 1.5 feet bgs). KCH-UXO5-TR10 was sampled during the RI, and is located approximately 250 feet northeast of Building 308 in the northern portion of the site (see Figure 5-1 of the RI report). The second highest detection of cadmium (13 mg/kg, SIS-001, 0 to 0.75 foot bgs) was sampled during the SI and is also located in the northwest portion of the site, approximately 225 feet north of Building 308 (see Figure 3-1 of the RI report).

Based on geographical collocation of the sample results that exceed industrial and residential screening criteria and the level of exceedance, cadmium is recommended for further consideration under the MRP.

### 8.4.3 Cobalt

Cobalt was identified as a primary risk contributor for subsurface soil (future construction worker scenario). Cobalt was detected in all 89 subsurface soil (0 to 10 feet bgs) samples at concentrations ranging from 5.8 to 19.6 mg/kg. However, concentrations do not exceed the DTSC (2016) residential RBC for cobalt of 23 mg/kg or the construction worker RBC for cobalt calculated for this HHRA of 20 mg/kg. The lower RBC for the construction worker compared with the RBC for the residential receptor is based on use of the more stringent DTSC (2014)-recommended particulate emission factor (PEF) to estimate soil-to-outdoor air concentrations from construction-related soil activities ($1 \times 10^6$ cubic meters per kilogram [$m^3$/kg]) rather than the DTSC (2014)-recommended PEF to estimate outdoor air concentrations from non-construction activities ($1.36 \times 10^9$ $m^3$/kg).

Cobalt was identified as a primary risk contributor because it contributes to a segregated HI of 2 for the future construction worker scenario, based on a target organ analysis. The segregated HI of 2 exceeds the threshold HI of 1 and is based on effects to the respiratory system. The chemical-specific noncancer HI for cobalt for the future construction worker scenario is 0.5; noncancer HIs for arsenic and nickel compose the remainder of the segregated HI calculated for the respiratory system.

Cobalt was selected as a COPC for subsurface soil because the maximum detected concentration (19.6 mg/kg) exceeds the BTV for Kgb soils of 15.99 mg/kg. However, evaluation of results for cobalt shows that only three of the 89 samples for cobalt exceed the BTV for Kgb soils. Concentrations of these three samples range from 16.8 to 19.6 mg/kg; none of the three samples is collocated, and none of the samples was located in an investigation trench with elevated magnetic anomalies. Concentrations for the remaining 86 samples for cobalt are less than the BTV.

Furthermore, detected concentrations for cobalt at MRP Site UXO5 (5.8 to 19.6 mg/kg) are within the range of background concentrations of cobalt for Detachment Fallbrook. Background concentrations for cobalt, regardless of parent rock type, range from 1.2 to 20.4 mg/kg. Concentrations of naturally occurring background cobalt concentrations do not vary widely across Detachment Fallbrook (no greater than a factor of 3.5 between the minimum and maximum background concentration), regardless of parent rock type, and measured cobalt concentrations at MRP Site UXO5 are well within the range of naturally occurring concentrations.

Based on this information – comparability to background cobalt concentrations for Detachment Fallbrook, lack of collocation of the highest measured cobalt concentrations, relatively low chemical-specific for HI cobalt (0.5) relative to the segregated HI (2), and no exceedances of the residential cobalt RBC – cobalt is not recommended for further evaluation.

### 8.4.4 Lead

Lead was identified as a primary risk contributor for surface and subsurface soil (future residential scenarios). Lead was detected in all 54 surface soil (0 to 0.5 foot bgs) samples and in all 89 subsurface soil (0 to 10 feet bgs) samples.

The maximum detected concentration of lead (227 J mg/kg at SIS-007, 0 to 0.75 foot bgs) is the sole result of 89 samples of lead that exceeds the residential screening criterion of 80 mg/kg; no individual sample results exceed the industrial screening criterion. The maximum concentration is approximately 2.8 times higher than the residential screening criterion and the next highest concentration of lead (40.1 J mg/kg) is two times lower than the screening criterion. No other maximum concentrations, however, are collocated at SIS-007 (see Table M-2). In addition, concentrations of other metals detected at SIS-007 are either below BTVs or are below respective residential and industrial screening criteria. These comparisons indicate that the maximum detection of lead at SIS-007 is an isolated occurrence and SIS-007 is not affected by MEC-related activities. Lastly, the maximum concentration of lead is an estimated (J-qualified) concentration. Therefore, lead is not recommended for further evaluation at MRP Site UXO5.

### 8.4.5 Nickel

Nickel was identified as a primary risk contributor for subsurface soil (future construction worker scenario). Nickel was detected in all 89 subsurface soil (0 to 10 feet bgs) samples at concentrations ranging from 12.3 J to 12.8 mg/kg. However, concentrations do not exceed the DTSC (2016) residential RBC for nickel of 490 mg/kg or the construction worker RBC for nickel calculated for this HHRA of 57 mg/kg. The lower RBC for the construction worker compared with the RBC for the residential receptor is based on use of the more stringent DTSC (2014)-recommended PEF to estimate soil-to-outdoor air concentrations from construction-related soil activities ($1 \times 10^6$ $m^3$/kg) rather than the DTSC (2014)-recommended PEF to estimate outdoor air concentrations from non-construction activities ($1.36 \times 10^9$ $m^3$/kg).

Nickel was identified as a primary risk contributor because the HHRA results show that it contributes to a segregated HI of 2 for the future construction worker scenario, based on a target organ analysis. The segregated HI of 2 exceeds the threshold HI of 1 and is based on effects to the respiratory system. The chemical-specific noncancer HI for nickel for the future construction worker scenario is 0.1; noncancer HIs for arsenic and cobalt compose the remainder of the segregated HI calculated for the respiratory system.

Nickel was selected as a COPC for subsurface soil because the maximum detected concentration (12.8 mg/kg) exceeds the BTV for Kgb soils of 11.88 mg/kg. However, evaluation of results for nickel shows that only three of the 89 samples for nickel exceed the BTV for Kgb soils. Concentrations of these three samples range from 12.2 to 12.8 mg/kg; none of the three samples is collocated. Concentrations for the remaining 86 samples for nickel are less than the BTV.

Furthermore, detected concentrations for nickel at MRP Site UXO5 (12.3 J to 12.8 mg/kg) are within the range of background concentrations of nickel for Detachment Fallbrook. Background concentrations for nickel, regardless of parent rock type, range from 0.58 to 15 mg/kg. Measured nickel concentrations at MRP Site UXO5 are well within the range of naturally occurring concentrations.

Based on this information – comparability to background nickel concentrations for Detachment Fallbrook, lack of collocation of the highest measured nickel concentrations, relatively low chemical-specific for HI nickel (0.1) relative to the segregated HI (2), and no exceedances of the residential nickel RBC – nickel is not recommended for further evaluation.

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# 9.0 Uncertainty Analysis

Varying degrees of uncertainty at each stage of the HHRA arise from assumptions made in the risk assessment and the limitations of the data used to calculate risk estimates. Uncertainty and variability are inherent in the exposure assessment, toxicity values, and risk characterization. USEPA guidance (1989) states the following:

> There are several categories of uncertainties associated with risk assessments. One is the initial selection of substances used to characterize exposures and risk on the basis of the sampling data and available toxicity information. Other sources of uncertainty are inherent in the toxicity values for each substance used to characterize risk. Additional uncertainties are inherent in the exposure assessment for individual substances and individual exposures. These uncertainties are usually driven by uncertainty in the chemical monitoring data and the models used to estimate exposure concentrations in the absence of monitoring data, but can also be driven by population intake parameters. Finally, additional uncertainties are incorporated in the risk characterization when exposures to several substances across multiple pathways are summed.

USEPA defines uncertainty as a "lack of knowledge about specific factors, parameters or models," including "parameter uncertainty (measurement errors, sampling errors, and systematic errors), model uncertainty (uncertainty that results from necessary simplification of real-world processes, mis-specification of the model structure, model misuse, or use of inappropriate surrogate variables), and scenario uncertainty (descriptive errors, aggregation errors, errors in professional judgment, or incomplete analysis)." Variability is defined as "observed differences attributable to true heterogeneity or diversity in a population or exposure parameter." Variability is the result of natural random processes, such as variations in body weight, breathing rate, or drinking water consumption. Variability cannot be reduced by further study, but may be better characterized through further measurements. The following sections describe the key sources of uncertainty in the HHRA process.

## 9.1 Sampling Data and Selection of Chemicals of Potential Concern

Key uncertainties associated with identifying COPCs are associated with sampling data used to identify COPCs. These uncertainties involve errors in chemical analysis, sample size sufficiency, and laboratory reporting limits. Systematic or random errors in the chemical analysis may yield erroneous data. These errors can result in an underestimate of risk because data may be viewed as nondetected or estimated as a result of laboratory errors or assumptions in the chemical analysis. This error could also result in fewer detected results or estimated results for specific samples or analyses. The data validation (see Appendix J of the RI report) found no major problems or errors with the laboratory chemical analysis;

therefore, no under- or overestimates of risk are expected based on laboratory errors or assumptions in chemical analysis.

Lack of sufficient samples to characterize soil can result in an underestimate of risk because calculated risks for an exposure area may be based on few samples, which may or may not be representative of the area at large. However, biased and non-biased soil samples were collected to address this potential uncertainty at MRP Site UXO5, which covers approximately 13 acres. Three types of soil sampling were performed at MRP Site UXO5 during the RI. The first type was biased sampling beneath MPPEH identified by the targeted anomaly investigation that was performed based on the findings of the DGM surveys. The second type was biased sampling associated with targeted excavation of 12 trenches in elevated anomaly density areas identified during the 2012 G-858 investigation (SES-TECH, 2012) to characterize potential MEC/MPPEH and MC contamination. The third type was non-biased soil sampling to assess the nature and extent of MC in surface and subsurface soil. The three types of soil sampling performed at MRP Site UXO5 reduces the likelihood that risks are underestimated based on lack of sufficient sampling.

Selection of COPCs for evaluation in the HHRA was based on comparison of detected sample results for metals to BTVs established for Detachment Fallbrook. Metals with one or more detected results that exceeded respective BTVs were selected as COPCs. Based on the location of MRP Site UXO5, BTVs for Kgb soils were used. Use of a single parent rock type (Kgb) to represent background soils does not account for the potential for mixed soils at the site, which may occur from natural geological processes, stormwater runoff, or windblown erosion; that is, actual background concentrations may be higher or lower than the established BTVs for Kgb soils. In addition, BTVs were not established for hexavalent chromium and molybdenum; these metals were detected in site soils and selected as COPCs based on lack of BTVs.

Lastly, selection of COPCs was based on comparison of maximum concentrations to BTVs for metals established for Detachment Fallbrook, rather than use of two-population testing (i.e., Wilcoxon-Rank Sum test for comparison of central tendency; Quantile test for comparison of upper quantiles). The primary limitation of the BTV comparison approach is the potential for false positives as the number of samples collected from the site increases (DTSC, 1997). Evaluation of the data, however, indicated that use of two-population testing was unlikely to change the outcome of the background evaluation for the two primary chemicals identified as risk contributors for MRP Site UXO5 (i.e., cadmium and lead) because maximum concentrations measured for these chemicals significantly exceeded the range of background concentrations.

## 9.2 Exposure Assessment

Uncertainties were identified in association with three areas of the exposure assessment process: (1) the selection of exposure scenarios and pathways, (2) the estimation of EPCs, and (3) the selection of exposure variables used to estimate chemical intake. Uncertainties in each of these areas are discussed in the following sections.

### 9.2.1 Exposure Scenarios and Pathways

Exposure scenarios were identified based on observed and assumed land use and activity that may occur. Uncertainties are introduced to the degree that actual land use and activity patterns are not represented by those assumed. Exposure estimates developed under the future land use scenarios (e.g., residential) may overestimate risks if the site is not used for the scenarios evaluated.

Because of the restricted military use of Detachment Fallbrook, it is unlikely that offsite receptors (e.g., offsite industrial workers or offsite residents) may be exposed to contaminated onsite soil (via wind dispersion) and groundwater (via ingestion or vapor intrusion) if onsite contaminated media are transported offsite. Offsite receptors were not evaluated in this risk assessment because current offsite exposure to potential receptors is considered unlikely.

### 9.2.2 Estimating Exposure Point Concentrations

The sample collection strategy was designed as a purposive investigation so that soil samples included samples collected in areas of suspected or known contamination. EPCs based on non-random locations are likely to overestimate the concentrations at the exposure point, as well as the actual dose to the receptor.

Recommendations in USEPA (2013) were followed for calculating 95UCLs for COPCs detected in at least four samples. In some cases, the dataset for a COPC is composed of both detected and censored results. The USEPA recommendations for calculation of 95UCLs include use of censored results; although stochastic methods are used, these methods are not expected to have a significant effect on the HHRA results.

Nondetected results that exceeded maximum detected concentrations for COPCs were excluded from 95UCL calculations; these nondetected results are indicated as high censored results in Table M-3. High censored results were limited to two samples of mercury; exclusion of these results from the 95UCL calculations is not expected to result in an underestimate of risks.

The maximum detected concentration is used as the EPC for cases where the dataset for a COPC is composed of fewer than four detected results. This approach is used because current methods are considered unreliable for calculating 95UCLs when a limited number of results are detected (USEPA, 2013). This approach may result in an overestimate of risks because use of the maximum concentration as the EPC assumes that the COPC is detected at the maximum concentration throughout the exposure point, even though analytical results show that the maximum concentration was measured in only one location and that concentrations in remaining sample locations are either lower than the maximum or are not detected. Maximum concentrations were used as EPCs for hexavalent chromium and silver in surface soil and silver in subsurface soil (see Table M-3). Use of maximum concentrations for these metals is not expected to result in an overestimate of risks; neither of these metals was identified as a primary risk contributor.

As discussed in Section 5.3, SI samples collected from 0 to 0.75 foot bgs were used with RI samples collected from 0 to 0.5 foot bgs to evaluate exposure to surface soil (0 to 0.5 foot bgs). Use of the 0 to 0.75 foot bgs depth interval may add uncertainty to surface soil risk

estimates. However, the potential for under-or overestimating risks is likely to be minimal because the 0 to 0.75 foot bgs sample depth was selected for use in the SI based on the high confidence for magnetometers for detecting small MEC items at this interval. In addition, inclusion of this depth interval in the surface soil dataset provides greater areal coverage for evaluating potential exposure to surface soil COPCs.

### 9.2.3 Selecting Exposure Variables

The exposure assumptions used in the HHRA were standard, default upper-bound assumptions for most scenarios. Default assumptions are intended to provide a conservative estimate of risks, rather than to underestimate risks. However, it is possible that the exposure variables used in this evaluation do not represent actual future exposure conditions.

## 9.3 Toxicity Assessment

The primary uncertainties associated with the toxicity assessment are related to derivation of toxicity values for COPCs. Standard reference doses (RfDs), reference concentrations (RfCs), slope factors (SFs), and inhalation unit risks (IURs) developed by USEPA and Cal-EPA (2016) were used to estimate potential cancer and noncancer health effects from exposure to COPCs. RfDs, RfCs, SFs, and IURs are derived by applying conservative (health-protective) assumptions and are intended to protect the most sensitive potentially exposed individuals. These toxicity values were incorporated into the USEPA RSLs and DTSC-preferred screening levels used as RBCs to estimate risks for the future industrial and residential scenarios; toxicity values were identified in Table M-6 to derive RBCs for the future construction worker scenario.

USEPA (2015) and Cal-EPA (2016) make several assumptions to derive the toxicity values that tend to overestimate the actual hazard or risk to human health. RfDs and RfCs are typically derived from animal studies adjusted with uncertainty and modifying factors to ensure adequate protection of human health because data from human studies are generally unavailable. This approach is anticipated to result in an overestimated potential for noncancer adverse health effects for many chemicals.

SFs and IURs used to estimate cancer risk are also typically derived based on data from animal studies. These data are taken from studies that administered high doses of a test chemical to laboratory animals; the reported response is extrapolated to the much lower doses that are likely for human exposure. Little experimental data are available on the nature of the dose-response relationship at low doses. Because of this uncertainty, USEPA has selected a conservative model to estimate the low-dose relationship, and USEPA uses an upper-bound estimate (typically a 95UCL of the slope predicted by the extrapolation model) as the SF or IUR. Therefore, cancer risks calculated using SFs and IURs are upper-bound estimates.

Chronic RfDs and RfCs are developed for evaluating exposures that occur over periods of more than 7 years, and subchronic RfDs and RfCs are for exposures of less than 7 years. Although the potential exposures considered in this HHRA are for periods of from 1 to 26 years, chronic RfDs and RfCs were used to evaluate both chronic (future industrial and residential) and subchronic (future construction worker) exposures. Few subchronic RfDs

and RfCs are available, and the use of only one set of criteria based on chronic exposures simplifies the analysis. Using chronic RfDs and RfCs results in conservative estimates of potential hazards and is unlikely to affect the interpretation or conclusions of the assessment.

## 9.4 Risk Characterization

Standard USEPA (1989) methodologies were used for the risk characterization step. Using these methods, the risks from exposure to multiple carcinogens were added to estimate the total cancer risk associated with exposures. The underlying assumption with this approach is that the risks from carcinogens with different target organs are additive. This assumption contributes to the uncertainty in the risk assessment and may result in underestimated or overestimated risks, depending on whether the interactions among the COPCs are synergistic or antagonistic. Most possible interactions were not evaluated in this HHRA because information on these interactions is generally not available.

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# 10.0 References

California Department of Toxic Substances Control (DTSC). 1997. Selecting Inorganic Constituents as Chemicals of Potential Concern at Risk Assessment at Hazardous Waste Sites and Permitted Facilities. Final Policy. Human and Ecological Risk Division. February.

California Department of Toxic Substances Control (DTSC). 2014. *Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities.* Office of Human and Ecological Risk (HERO) HERO HHRA Note Number 1. September 30.

California Department of Toxic Substances Control (DTSC). 2015. *Screening Level Human Health Risk Assessments.* Human and Ecological Risk Office (HERO). HERO HHRA Note 4. October 6.

California Department of Toxic Substances Control (DTSC). 2016. *DTSC-Modified Screening Levels (DTSC SLs).* Human and Ecological Risk Office (HERO). HERO HHRA Note Number 3. January.

California Environmental Protection Agency (Cal-EPA). 2016. Office of Environmental Health Hazard Assessment (OEHHA) Toxicity Criteria Database. http://www.oehha.ca.gov/risk/chemicalDB/index.asp. Accessed January 16.

CH2M HILL Kleinfelder, A Joint Venture (KCH). 2015. *Work Plan Remedial Investigation for Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach, Detachment Fallbrook, Fallbrook, California*. February.

Knight, Robert N. 2004. Site and Species Description for IRP MRP Site UXO5, Naval Weapons Station Seal Beach Detachment Fallbrook (Ser N45WK/0096). From Conservation Program Manager, Department of the Navy, Naval Weapons Station Seal Beach Detachment Fallbrook. Recipient: Karen Goebel, Assistant Field Supervisor, U.S. Fish and Wildlife Service. June 1.

Laboratory Data Consultants (LDC). 2007. Detachment Fallbrook, Data Validation, LDC Project #16842. June 8.

Malcolm Pirnie, Inc. (Malcom Pirnie). 2006. *Final Preliminary Assessment for the Munitions Response Program, Naval Weapons Station Seal Beach Detachment Fallbrook, California*. June.

Oak Ridge National Laboratory (ORNL). 2016. *The Risk Assessment Information System.* On-line database. Accessed January 16.

SES-TECH. 2012. *Final Basewide Metals Background Soil Study Report, Naval Weapons Stations Seal Beach, Detachment Fallbrook, Fallbrook, California.* November.

Tetra Tech EC, Inc. (Tetra Tech). 2009. *Final Site Inspection Report, Naval Weapons Station Seal Beach, Detachment Fallbrook, Munitions Response Program Site UXO5, Salvage Yard Burial Area, Fallbrook, California*. Prepared for Naval Facilities Engineering Command Southwest. February 4.

United States Environmental Protection Agency (USEPA). 1989. *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A).* Interim Final. Office of Emergency and Remedial Response (OERR). EPA/540/1-89/002.

United States Environmental Protection Agency (USEPA). 1991. *Memorandum Regarding the Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions.* From Ron R. Clay, Assistant Administrator. To Directors, Various Divisions. April 22.

United States Environmental Protection Agency (USEPA). 1992a. *Guidance for Data Usability in Risk Assessment (Part A).* Office of Solid Waste and Emergency Response (OSWER Directive 9285.7-09A). June 2.

United States Environmental Protection Agency (USEPA). 1992b. *Supplemental Guidance to RAGS: Calculating the Concentration Term.* Intermittent Bulletin, Volume 1, No. 1. Publication 9285.7-081.

United States Environmental Protection Agency (USEPA). 2002. *Calculating Exposure Point Concentrations at Hazardous Waste Sites.* OSWER 9285.6-10. Office of Emergency and Remedial Response. Washington, DC. December.

United States Environmental Protection Agency (USEPA). 2004. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).* Final. Office of Superfund Remediation and Technology Innovation. EPA/540/R/99/005. July.

United States Environmental Protection Agency (USEPA). 2008. *National Functional Guidelines for Superfund Organic Methods Data Review.* USEPA-540-R-08-01. June.

United States Environmental Protection Agency (USEPA). 2010. *National Functional Guidelines for Inorganic Superfund Data Review.* USEPA Contract Laboratory Program. USEPA 540-R-10-011. January.

United States Environmental Protection Agency (USEPA). 2013. *ProUCL Version 5.0.00 Technical Guide.* Prepared by A. Singh and R. Maichle for USEPA Office of Research and Development. EPA/600/R-07/041. September.

United States Environmental Protection Agency (USEPA). 2015. *Regional Screening Levels for Chemical Contaminants at Superfund Sites.* November.

# Tables

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TABLE M-1

Summary of Analytical Results for Surface Soil (0 to 0.5 foot bgs)

*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

| Analytical Group | CAS Number | Chemical | Minimum Detected Concentration (Qualifier) | Maximum Detected Concentration (Qualifier) | Location of Maximum Detected Concentration | Detection Frequency | Range of Detection Limits | Background Threshold Value (BTV) (a) | Number of Detections Above BTV | Industrial Screening Criteria (b) | Number of Detections Above Industrial Screening Criteria | Residential Screening Criteria (b) | Number of Detections Above Residential Screening Criteria | Identify Chemical as a COPC? (c) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TMETAL | 7429-90-5 | Aluminum | 11,100 | 26,500 J | KCH-UXO5-SB22 | 25 / 25 | NA - NA | 28,333 | 0 | 1,100,000 | 0 | 77,000 | 0 | No |
| TMETAL | 7440-36-0 | Antimony | 0.115 J | 5.94 | KCH-UXO5-SB03 | 20 / 54 | 0.019 - 0.33 | -- | -- | 470 | 0 | 31 | 0 | Yes |
| TMETAL | 7440-38-2 | Arsenic | 0.69 J | 5.2 J | SIS-013 (d) | 54 / 54 | NA - NA | 3.07 | 4 | 0.25 | 54 | 0.067 | 54 | Yes |
| TMETAL | 7440-39-3 | Barium | 56.5 J | 257 | KCH-UXO5-SB09 | 54 / 54 | NA - NA | 502.8 | 0 | 220,000 | 0 | 15,000 | 0 | No |
| TMETAL | 7440-41-7 | Beryllium | 0.0775 J | 0.258 J | KCH-UXO5-SB22 | 25 / 54 | 0.041 - 0.27 | 0.716 | 0 | 210 | 0 | 15 | 0 | No |
| TMETAL | 7440-43-9 | Cadmium | 0.0921 J | 13 | SIS-001 | 54 / 54 | NA - NA | 0.197 | 37 | 7.3 | 1 | 5.2 | 1 | Yes |
| TMETAL | 7440-47-3 | Chromium | 7.8 J | 49.6 | SIS-006 | 53 / 53 | NA - NA | 58.9 | 0 | 170,000 | 0 | 36,000 | 0 | No |
| TMETAL | 18540-29-9 | Chromium VI | 0.0965 J | 0.165 | KCH-UXO5-SB23 | 2 / 25 | 0.041 - 0.16 | -- | -- | 6.3 | 0 | 0.3 | 0 | Yes |
| TMETAL | 7440-48-4 | Cobalt | 5.8 | 19.6 | KCH-UXO5-SB10 | 54 / 54 | NA - NA | 15.99 | 3 | 350 | 0 | 23 | 0 | Yes |
| TMETAL | 7440-50-8 | Copper | 7.4 | 108 | KCH-UXO5-SB14 | 54 / 54 | NA - NA | 102.5 | 1 | 47,000 | 0 | 3,100 | 0 | Yes |
| TMETAL | 7439-89-6 | Iron | 19,200 | 30,000 | KCH-UXO5-SB10 | 25 / 25 | NA - NA | 43,815 | 0 | 820,000 | 0 | 55,000 | 0 | No |
| TMETAL | 7439-92-1 | Lead | 2.12 | 227 J | SIS-007 | 54 / 54 | NA - NA | 7.408 | 30 | 320 | 0 | 80 | 1 | Yes |
| TMETAL | 7439-96-5 | Manganese | 201 | 319 J | KCH-UXO5-SB22 | 25 / 25 | NA - NA | 479.9 | 0 | 6,900 | 0 | 1,800 | 0 | No |
| TMETAL | 7439-97-6 | Mercury | 0.0104 J | 0.105 | SIS-004 | 7 / 54 | 0.02 - 0.11 | 0.0202 | 1 | 69 | 0 | 23 | 0 | Yes |
| TMETAL | 7439-98-7 | Molybdenum | 0.337 J | 1.4 J | SIS-022 | 28 / 54 | 0.087 - 0.5 | -- | -- | 5,800 | 0 | 390 | 0 | Yes |
| TMETAL | 7440-02-0 | Nickel | 2.3 J | 12.8 | KCH-UXO5-SB10 | 54 / 54 | NA - NA | 11.88 | 2 | 3,100 | 0 | 490 | 0 | Yes |
| TMETAL | 7782-49-2 | Selenium | 0.0523 J | 0.36 J | SIS-021 | 24 / 54 | 0.063 - 0.13 | 0.477 | 0 | 5,800 | 0 | 390 | 0 | No |
| TMETAL | 7440-22-4 | Silver | 0.0514 J | 0.305 J | KCH-UXO5-SB13 | 2 / 54 | 0.032 - 0.13 | 0.0941 | 1 | 1,500 | 0 | 390 | 0 | Yes |
| TMETAL | 7440-24-6 | Strontium | 14 | 51.7 | KCH-UXO5-SB09 | 25 / 25 | NA - NA | 144.8 | 0 | 700,000 | 0 | 47,000 | 0 | No |
| TMETAL | 7440-28-0 | Thallium | 0.142 J | 0.398 J | KCH-UXO5-SB14 | 29 / 54 | 0.1 - 0.42 | 0.595 | 0 | 12 | 0 | 0.78 | 0 | No |
| TMETAL | 7440-62-2 | Vanadium | 28.6 | 143 | SIS-006 | 54 / 54 | NA - NA | 216.4 | 0 | 1000 | 0 | 390 | 0 | No |
| TMETAL | 7440-66-6 | Zinc | 23.6 | 1,200 | KCH-UXO5-SB14 | 54 / 54 | NA - NA | 44.85 | 32 | 350,000 | 0 | 23,000 | 0 | Yes |

Notes:

Concentrations in milligram per kilogram.

a BTVs are installation-specific upper tolerance limits developed in SES-TECH (2012). BTVs for the Kgb (Gabbro) parent rock type are used, based on the prevalence of this rock type where UXO5 is located.

b Residential and industrial screening criteria based on USEPA (2015), unless otherwise indicated in DTSC (2016). See Table M-3 for basis of criteria (lowest between cancer and noncancer values are shown on this table). Screening criteria are provided for informational purposes only, and are not used to identify COPCs.

c Chemicals are identified as COPCs if one or more detections are above the BTV or if a BTV is not available.

d The 2007 Site Inspection soil samples (collected from 0 to 0.75 foot bgs) are considered surface soil samples.

-- not applicable or not available

| | | | |
|---|---|---|---|
| bgs | below ground surface | MRP | Munitions Response Program |
| BTV | background threshold value | NA | Not Applicable |
| CAS | Chemical Abstracts Service | NAVWPNSTA | Naval Weapons Station |
| COPC | chemical of potential concern | TMETAL | total metal |
| DTSC | California Department of Toxic Substances Control | USEPA | United States Environmental Protection Agency |
| J | estimated concentration | UXO | unexploded ordnance |

Sources:

California Department of Toxic Substances Control (DTSC). 2016. *DTSC-Modified Screening Levels (DTSC-SLs)*. Human and Ecological Risk Office (HERO). HERO HHRA Note Number 3. January.

SES-TECH. 2012. Final Basewide Metals Background Soil Study Report, Naval Weapons Stations Seal Beach, Detachment Fallbrook, Fallbrook, California. November.

United States Environmental Protection Agency (USEPA). 2015. Regional Screening Levels for Chemical Contaminants at Superfund Sites. November.

TABLE M-2

Summary of Analytical Results for Subsurface Soil (0 to 10 feet bgs)

*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

| Analytical Group | CAS Number | Chemical | Minimum Detected Concentration (Qualifier) | Maximum Detected Concentration (Qualifier) | Location of Maximum Detected Concentration | Detection Frequency | Range of Detection Limits | Background Threshold Value (BTV) (a) | Number of Detections Above BTV | Industrial Screening Criteria (b) | Number of Detections Above Industrial Screening Criteria | Residential Screening Criteria (b) | Number of Detections Above Residential Screening Criteria | Identify Chemical as a COPC? (c) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TMETAL | 7429-90-5 | Aluminum | 10,000 | 26,800 | KCH-UXO5-SB22 | 60 / 60 | NA - NA | 28,333 | 0 | 1,100,000 | 0 | 77,000 | 0 | No |
| TMETAL | 7440-36-0 | Antimony | 0.114 J | 5.94 | KCH-UXO5-SB03 | 37 / 89 | 0.019 - 0.33 | -- | -- | 470 | 0 | 31 | 0 | Yes |
| TMETAL | 7440-38-2 | Arsenic | 0.69 J | 5.2 J | SIS-013 | 89 / 89 | NA - NA | 3.07 | 4 | 0.25 | 89 | 0.067 | 89 | Yes |
| TMETAL | 7440-39-3 | Barium | 56.5 J | 257 | KCH-UXO5-SB09 | 89 / 89 | NA - NA | 502.8 | 0 | 220,000 | 0 | 15,000 | 0 | No |
| TMETAL | 7440-41-7 | Beryllium | 0.0775 J | 0.271 J | KCH-UXO5-SB22 | 60 / 89 | 0.041 - 0.27 | 0.716 | 0 | 210 | 0 | 15 | 0 | No |
| TMETAL | 7440-43-9 | Cadmium | 0.0703 J | 27.8 | KCH-UXO5-TR10 | 89 / 89 | NA - NA | 0.197 | 50 | 7.3 | 3 | 5.2 | 3 | Yes |
| TMETAL | 7440-47-3 | Chromium | 7.8 J | 49.6 | SIS-006 | 88 / 88 | NA - NA | 58.9 | 0 | 170,000 | 0 | 36,000 | 0 | No |
| TMETAL | 18540-29-9 | Chromium VI | 0.0881 J | 0.721 | KCH-UXO5-TR10 | 9 / 60 | 0.04 - 0.16 | -- | -- | 6.3 | 0 | 0.3 | 1 | Yes |
| TMETAL | 7440-48-4 | Cobalt | 5.8 | 19.6 | KCH-UXO5-SB10 | 89 / 89 | NA - NA | 15.99 | 3 | 350 | 0 | 23 | 0 | Yes |
| TMETAL | 7440-50-8 | Copper | 7.4 | 108 | KCH-UXO5-SB14 | 89 / 89 | NA - NA | 102.5 | 1 | 47,000 | 0 | 3,100 | 0 | Yes |
| TMETAL | 7439-89-6 | Iron | 15,900 | 36,400 | KCH-UXO5-TR10 | 60 / 60 | NA - NA | 43,815 | 0 | 820,000 | 0 | 55,000 | 0 | No |
| TMETAL | 7439-92-1 | Lead | 1.44 | 227 J | SIS-007 | 89 / 89 | NA - NA | 7.408 | 36 | 320 | 0 | 80 | 1 | Yes |
| TMETAL | 7439-96-5 | Manganese | 121 | 365 | KCH-UXO5-TR10 | 60 / 60 | NA - NA | 479.9 | 0 | 6,900 | 0 | 1,800 | 0 | No |
| TMETAL | 7439-97-6 | Mercury | 0.0104 J | 0.105 | SIS-004 | 10 / 89 | 0.02 - 0.11 | 0.0202 | 1 | 69 | 0 | 23 | 0 | Yes |
| TMETAL | 7439-98-7 | Molybdenum | 0.224 J | 1.4 J | SIS-022 | 63 / 89 | 0.087 - 0.5 | -- | -- | 5,800 | 0 | 390 | 0 | Yes |
| TMETAL | 7440-02-0 | Nickel | 2.3 J | 12.8 | KCH-UXO5-SB10 | 89 / 89 | NA - NA | 11.88 | 3 | 3,100 | 0 | 490 | 0 | Yes |
| TMETAL | 7782-49-2 | Selenium | 0.0523 J | 0.36 J | SIS-021 | 58 / 89 | 0.063 - 0.13 | 0.477 | 0 | 5,800 | 0 | 390 | 0 | No |
| TMETAL | 7440-22-4 | Silver | 0.0514 J | 0.305 J | KCH-UXO5-SB13 | 2 / 89 | 0.032 - 0.13 | 0.0941 | 1 | 1,500 | 0 | 390 | 0 | Yes |
| TMETAL | 7440-24-6 | Strontium | 12.2 | 51.7 | KCH-UXO5-SB09 | 60 / 60 | NA - NA | 144.8 | 0 | 700,000 | 0 | 47,000 | 0 | No |
| TMETAL | 7440-28-0 | Thallium | 0.125 J | 0.431 J | KCH-UXO5-TR02 | 64 / 89 | 0.1 - 0.42 | 0.595 | 0 | 12 | 0 | 0.78 | 0 | No |
| TMETAL | 7440-62-2 | Vanadium | 28.6 | 143 | SIS-006 | 89 / 89 | NA - NA | 216.4 | 0 | 1,000 | 0 | 390 | 0 | No |
| TMETAL | 7440-66-6 | Zinc | 23.6 | 1,200 | KCH-UXO5-SB14 | 89 / 89 | NA - NA | 44.85 | 41 | 350,000 | 0 | 23,000 | 0 | Yes |

Notes:

Concentrations in milligram per kilogram.

a BTVs are installation-specific upper tolerance limits developed in SES-TECH (2012). BTVs for the Kgb (Gabbro) parent rock type are used, based on the prevalence of this rock type where UXO5 is located.

b Residential and industrial screening criteria based on USEPA (2015), unless otherwise indicated in DTSC (2016). See Table M-3 for basis of criteria (lowest between cancer and noncancer values are shown on this table). Screening criteria are provided for informational purposes only, and are not used to identify COPCs.

c Chemicals are identified as COPCs if one or more detections are above the BTV or if a BTV is not available.

-- not applicable or not available

bgs below ground surface

BTV background threshold value

CAS Chemical Abstracts Service

COPC chemical of potential concern

DTSC California Department of Toxic Substances Control

J estimated concentration

MRP Munitions Response Program

NA Not Applicable

NAVWPNSTA Naval Weapons Station

TMETAL total metal

USEPA United States Environmental Protection Agency

UXO unexploded ordnance

Sources:

California Department of Toxic Substances Control (DTSC). 2016. *DTSC-Modified Screening Levels (DTSC-SLs)*. Human and Ecological Risk Office (HERO). HERO HHRA Note Number 3. January.

SES-TECH. 2012. Final Basewide Metals Background Soil Study Report, Naval Weapons Stations Seal Beach, Detachment Fallbrook, Fallbrook, California. November.

United States Environmental Protection Agency (USEPA). 2015. Regional Screening Levels for Chemical Contaminants at Superfund Sites. November.

TABLE M-3

Exposure Point Concentrations for Soil

*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

| Soil Depth Interval | Analytical Group | COPC (a) | Detection Frequency | Number of High Censored Results (b) | Arithmetic Mean of Detected Results | 95UCL (Distribution)(c) | | Maximum Concentration (Qualifier) | | Exposure Point Concentration (d) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Value | Statistic | Method (e) |
| Surface (0 to 0.5-foot bgs) | TMETAL | Antimony | 20 / 54 | 0 | 1.08E+00 | 0.817 | G | 5.94 | | 0.817 | 95UCL | (1) |
| | TMETAL | Arsenic | 54 / 54 | 0 | 1.48E+00 | 1.709 | N | 5.2 | J | 1.709 | 95UCL | (2) |
| | TMETAL | Cadmium | 54 / 54 | 0 | 8.23E-01 | 1.949 | NP | 13 | | 1.949 | 95UCL | (3) |
| | TMETAL | Chromium VI | 2 / 25 | 0 | NA | NA | | 0.165 | | 0.165 | Max | (4) |
| | TMETAL | Cobalt | 54 / 54 | 0 | 1.05E+01 | 11.14 | N | 19.6 | | 11.14 | 95UCL | (5) |
| | TMETAL | Copper | 54 / 54 | 0 | 2.49E+01 | 28.14 | N | 108 | | 28.14 | 95UCL | (2) |
| | TMETAL | Lead | 54 / 54 | 0 | 1.44E+01 | 32.52 | NP | 227 | J | 32.52 | 95UCL | (3) |
| | TMETAL | Mercury | 7 / 54 | 2 | 2.67E-02 | 0.0193 | NP | 0.105 | | 0.0193 | 95UCL | (6) |
| | TMETAL | Molybdenum | 28 / 54 | 0 | 5.01E-01 | 0.374 | NP | 1.4 | J | 0.374 | 95UCL | (6) |
| | TMETAL | Nickel | 54 / 54 | 0 | 6.69E+00 | 7.169 | N | 12.8 | | 7.169 | 95UCL | (2) |
| | TMETAL | Silver | 2 / 54 | 0 | NA | NA | | 0.305 | J | 0.305 | Max | (4) |
| | TMETAL | Zinc | 54 / 54 | 0 | 9.37E+01 | 190.2 | NP | 1,200 | | 190.2 | 95UCL | (3) |
| Subsurface (0 to 10 feet bgs) | TMETAL | Antimony | 37 / 89 | 0 | 7.52E-01 | 0.55 | G | 5.94 | | 0.55 | 95UCL | (1) |
| | TMETAL | Arsenic | 89 / 89 | 0 | 1.46E+00 | 1.604 | N | 5.2 | J | 1.604 | 95UCL | (2) |
| | TMETAL | Cadmium | 89 / 89 | 0 | 1.07E+00 | 2.676 | NP | 27.8 | | 2.676 | 95UCL | (3) |
| | TMETAL | Chromium VI | 9 / 60 | 0 | 1.82E-01 | 0.0827 | NP | 0.721 | | 0.0827 | 95UCL | (6) |
| | TMETAL | Cobalt | 89 / 89 | 0 | 1.01E+01 | 10.53 | N | 19.6 | | 10.53 | 95UCL | (5) |
| | TMETAL | Copper | 89 / 89 | 0 | 2.21E+01 | 24.16 | N | 108 | | 24.16 | 95UCL | (2) |
| | TMETAL | Lead | 89 / 89 | 0 | 1.08E+01 | 22.07 | NP | 227 | J | 22.07 | 95UCL | (3) |
| | TMETAL | Mercury | 10 / 89 | 2 | 2.26E-02 | 0.0168 | NP | 0.105 | | 0.0168 | 95UCL | (7) |
| | TMETAL | Molybdenum | 63 / 89 | 0 | 4.49E-01 | 0.401 | G | 1.4 | J | 0.401 | 95UCL | (8) |
| | TMETAL | Nickel | 89 / 89 | 0 | 6.74E+00 | 7.069 | N | 12.8 | | 7.069 | 95UCL | (2) |
| | TMETAL | Silver | 2 / 89 | 0 | NA | NA | | 0.305 | J | 0.305 | Max | (4) |
| | TMETAL | Zinc | 89 / 89 | 0 | 7.48E+01 | 134.8 | NP | 1,200 | | 134.8 | 95UCL | (3) |

Notes:

Concentrations in milligram per kilogram.

a The COPCs listed are those for which maximum concentrations exceed BTVs or those for which a BTV is not available.

b Number of censored (nondetect) results that exceeded the maximum detected concentration. These results were excluded from the statistical calculations.

c The three data distributions considered in ProUCL 5.0 include the normal, lognormal, and the gamma distributions. Shapiro-Wilk (n ≤ 50) and Lilliefors (n > 50) test statistics are used to test for normality or lognormality of a data set. A 5 percent level of significance was used in all tests. Distribution tests were only conducted for samples with at least four detected results. Distributions not confirmed as normal, lognormal, or gamma, or not tested, were treated as nonparametric in all statistical calculations.

Distribution Codes: G = gamma, LN = lognormal, N = normal, NP = nonparametric

d The 95UCL is not calculated when there are fewer than five total results or four detected results. If this occurs, then the maximum detected concentration is used as the EPC. The maximum concentrations is also used as the EPC if the 95 UCL exceed the maximum.

TABLE M-3

Exposure Point Concentrations for Soil

*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

e All methods follow USEPA (2002, 2013).

Method (Statistic) Codes are defined as follows, and indicated the basis for the EPC:

(1) 95% Gamma Approximate KM-UCL

(2) 95% Modified-t UCL

(3) 95% Chebyshev(Mean, Sd) UCL

(4) Maximum detected concentration

(5) 95% Student's-t UCL

(6) 95% KM (Percentile Bootstrap) UCL

(7) 95% KM (t) UCL

(8) 95% KM (BCA) UCL

95UCL One-sided 95 percent upper confidence limit of the mean. Following USEPA (2002, 2013), this may be estimated by either a 95, 97.5, or 99 percent UCL depending on sample size, skewness, and degree of censorship.

| | | | |
|---|---|---|---|
| BCA | bias-corrected accelerated | MRP | Munitions Response Program |
| bgs | below ground surface | NA | not applicable |
| BTV | background threshold value | NAVWPNSTA | Naval Weapons Station |
| COPC | chemical of potential concern | Sd | standard deviation |
| EPC | exposure point concentration | TMETAL | total metal |
| J | estimated concentration below the laboratory reporting limit | UCL | upper confidence limit |
| KM | Kaplan-Meier | UXO | unexploded ordnance |
| Max | maximum detected concentration | | |

Sources:

United States Environmental Protection Agency (USEPA). 2002. *Calculating Exposure Point Concentrations at Hazardous Waste Sites.* OSWER 9285.6-10. Office of Emergency and Remedial Response. Washington, DC. December.

United States Environmental Protection Agency (USEPA). 2013. *ProUCL Version 5.0.00 Technical Guide.* Prepared by Singh, A. and R. Maichle for USEPA Office of Research and Development. EPA/600/R-07/041. September.

TABLE M-4

Risk-Based Concentrations for Soil - Residential and Industrial Scenarios

*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

| Analytical Group | CAS Number | Chemical | | Residential | | | | | | Industrial | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Cancer | | Noncancer | | Lowest | | Cancer | | Noncancer | | Lowest | |
| ANION | 14797-73-0 | Perchlorate | | -- | -- | 5.5E+01 | b | 5.5E+01 | b | -- | -- | 8.2E+02 | b | 8.2E+02 | b |
| TMETAL | 7429-90-5 | Aluminum | | -- | -- | 7.7E+04 | b | 7.7E+04 | b | -- | -- | 1.1E+06 | b | 1.1E+06 | b |
| TMETAL | 7440-36-0 | Antimony | | -- | -- | 3.1E+01 | b | 3.1E+01 | b | -- | -- | 4.7E+02 | b | 4.7E+02 | b |
| TMETAL | 7440-38-2 | Arsenic | | 6.7E-02 | c | 2.5E-01 | c | 6.7E-02 | c | 2.5E-01 | c | 3.0E+00 | c | 2.5E-01 | c |
| TMETAL | 7440-39-3 | Barium | | -- | -- | 1.5E+04 | b | 1.5E+04 | b | -- | -- | 2.2E+05 | b | 2.2E+05 | b |
| TMETAL | 7440-41-7 | Beryllium | | 1.6E+03 | b | 1.5E+01 | c | 1.5E+01 | c | 6.9E+03 | b | 2.1E+02 | c | 2.1E+02 | c |
| TMETAL | 7440-43-9 | Cadmium | | 2.1E+03 | b | 5.2E+00 | c | 5.2E+00 | c | 9.3E+03 | b | 7.3E+00 | c | 7.3E+00 | c |
| TMETAL | 7440-47-3 | Chromium | a | -- | -- | 3.6E+04 | c | 3.6E+04 | c | -- | -- | 1.7E+05 | c | 1.7E+05 | c |
| TMETAL | 18540-29-9 | Chromium VI | | 3.0E-01 | b | 2.3E+02 | b | 3.0E-01 | b | 6.3E+00 | b | 3.5E+03 | b | 6.3E+00 | b |
| TMETAL | 7440-48-4 | Cobalt | | 4.2E+02 | b | 2.3E+01 | b | 2.3E+01 | b | 1.9E+03 | b | 3.5E+02 | b | 3.5E+02 | b |
| TMETAL | 7440-50-8 | Copper | | -- | -- | 3.1E+03 | b | 3.1E+03 | b | -- | -- | 4.7E+04 | b | 4.7E+04 | b |
| TMETAL | 7439-89-6 | Iron | | -- | -- | 5.5E+04 | b | 5.5E+04 | b | -- | -- | 8.2E+05 | b | 8.2E+05 | b |
| TMETAL | 7439-92-1 | Lead | | -- | -- | 8.0E+01 | c | 8.0E+01 | c | -- | -- | 3.2E+02 | c | 3.2E+02 | c |
| TMETAL | 7439-96-5 | Manganese | | -- | -- | 1.8E+03 | b | 1.8E+03 | b | -- | -- | 6.9E+03 | c | 6.9E+03 | c |
| TMETAL | 7439-97-6 | Mercury | a | -- | -- | 2.3E+01 | b | 2.3E+01 | b | -- | -- | 6.9E+01 | c | 6.9E+01 | c |
| TMETAL | 7439-98-7 | Molybdenum | | -- | -- | 3.9E+02 | b | 3.9E+02 | b | -- | -- | 5.8E+03 | b | 5.8E+03 | b |
| TMETAL | 7440-02-0 | Nickel | | 1.5E+04 | b | 4.9E+02 | c | 4.9E+02 | c | 6.4E+04 | b | 3.1E+03 | c | 3.1E+03 | c |
| TMETAL | 7782-49-2 | Selenium | | -- | -- | 3.9E+02 | b | 3.9E+02 | b | -- | -- | 5.8E+03 | b | 5.8E+03 | b |
| TMETAL | 7440-22-4 | Silver | | -- | -- | 3.9E+02 | b | 3.9E+02 | b | -- | -- | 1.5E+03 | c | 1.5E+03 | c |
| TMETAL | 7440-28-0 | Thallium | | -- | -- | 7.8E-01 | b | 7.8E-01 | b | -- | -- | 1.2E+01 | b | 1.2E+01 | b |
| TMETAL | 7440-62-2 | Vanadium | | -- | -- | 3.9E+02 | b | 3.9E+02 | b | -- | -- | 1.0E+03 | c | 1.0E+03 | c |
| TMETAL | 7440-66-6 | Zinc | | -- | -- | 2.3E+04 | b | 2.3E+04 | b | -- | -- | 3.5E+05 | b | 3.5E+05 | b |
| TMETAL | 7440-24-6 | Strontium | | -- | -- | 4.7E+04 | b | 4.7E+04 | b | -- | -- | 7.0E+05 | b | 7.0E+05 | b |
| TMETAL | 7440-31-5 | Tin | | -- | -- | 4.7E+04 | b | 4.7E+04 | b | -- | -- | 7.0E+05 | b | 7.0E+05 | b |

Notes:

Units are in milligram per kilogram.

a The following chemicals were used as surrogate chemicals for risk-based concentrations:
- Trivalent chromium for chromium
- Mercuric chloride for mercury

b USEPA, 2015

c DTSC, 2016

-- Not available or not applicable

MRP Munitions Response Program

NAVWPNSTA Naval Weapons Station

TMETAL total metal

UXO unexploded ordnance

Sources:

California Department of Toxic Substances Control (DTSC). 2016. *DTSC-Modified Screening Levels (DTSC SLs)* . Human and Ecological Risk Office (HERO). HERO HHRA Note Number 3. January.

United States Environmental Protection Agency (USEPA). 2015. Regional Screening Levels for Chemical Contaminants at Superfund Sites. November.

TABLE M-5
Risk-Based Concentration Equations for Soil – Construction Worker Scenario
*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

| **Incidental Ingestion Exposure** | |
|---|---|
| **Cancer Effects** | **Noncancer Effects** |
| $RBC_c\text{ - INGESTION} = \frac{TR \times ATC_{ING} \times BW}{SFO \times IRS \times RBA \times EF \times ED \times CFS}$ | $RBC_{nc}\text{ - INGESTION} = \frac{THQ \times BW \times ATNC_{ING} \times RFD}{IRS \times RBA \times EF \times ED \times CFS}$ |
| **Inhalation Exposure** | |
| **Cancer Effects** | **Noncancer Effects** |
| $RBC_c\text{ - INHALATION} = \frac{TR \times ATC_{INH}}{IUR \times EF \times ED \times ET \times MCF \times \frac{1}{PEF}}$ | $RBC_{nc}\text{ - INHALATION} = \frac{THQ \times ATNC_{INH} \times RFC}{EF \times ED \times ET \times \frac{1}{PEF}}$ |
| **Dermal Exposure** | |
| **Cancer Effects** | **Noncancer Effects** |
| $RBC_c\text{ - DERMAL} = \frac{TR \times ATC_D \times BW}{SFO \times SA \times EF \times ED \times CFS \times ABS \times AF}$ | $RBC_{nc}\text{ - DERMAL} = \frac{THQ \times BW \times ATNC_D \times RFD}{SA \times EF \times ED \times CFS \times ABS \times AF}$ |
| $Multi\text{-}Pathway\ RBC = \frac{1}{\frac{1}{RBC_{ingestion}} + \frac{1}{RBC_{inhalation}} + \frac{1}{RBC_{dermal}}}$ | |

**Definitions and Values for Equation Parameters**

| Parameter | Value | Basis |
|---|---|---|
| $RBC_c$ - INGESTION = Risk-based concentration for soil, carcinogens (mg/kg) | Chemical-specific | Calculated; see Table M-7 |
| $RBC_{nc}$ - INGESTION = Risk-based concentration for soil, noncarcinogens (mg/kg) | Chemical-specific | Calculated; see Table M-7 |
| $RBC_c$ - INHALATION = Risk-based concentration for soil, carcinogens (mg/kg) | Chemical-specific | Calculated; see Table M-7 |
| $RBC_{nc}$ - INHALATION = Risk-based concentration for soil, noncarcinogens (mg/kg) | Chemical-specific | Calculated; see Table M-7 |
| $RBC_c$ - DERMAL = Risk-based concentration for soil, carcinogens (mg/kg) | Chemical-specific | Calculated; see Table M-7 |
| $RBC_{nc}$ - DERMAL = Risk-based concentration for soil, noncarcinogens (mg/kg) | Chemical-specific | Calculated; see Table M-7 |
| TR = Target cancer risk | $10^{-6}$ | USEPA, 2015 |
| THQ = Target hazard quotient | 1 | USEPA, 2015 |
| IUR = Inhalation unit risk $(\mu g/m^3)^{-1}$ | Chemical-specific | See Table M-6 |
| RFC = Inhalation reference concentration $(mg/m^3)$ | Chemical-specific | See Table M-6 |
| SFO = Oral slope factor $(mg/kg\text{-}day)^{-1}$ | Chemical-specific | See Table M-6 |
| RFD = Oral reference dose (mg/kg-day) | Chemical-specific | See Table M-6 |
| RBA = Relative bioavailability, ingestion route only (unitless) | 0.6 = arsenic, 1 = all other chemicals | USEPA, 2015 |
| $ATC_{ING}$ = Averaging time - ingestion, carcinogens (days) | 25,500 | 70 years x 365 days/year (USEPA, 2015) |

TABLE M-5
Risk-Based Concentration Equations for Soil – Construction Worker Scenario
*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

| Parameter | | | Value | Basis |
|---|---|---|---|---|
| $ATNC_{ING}$ | = | Averaging time - ingestion, noncancer (days) | 365 | ED x 365 days/year (USEPA, 2015) |
| $ATC_{INH}$ | = | Averaging time - inhalation, carcinogens (hours) | 613,200 | 70 years x 365 days/year x 24 hours/day (USEPA, 2009) |
| $ATNC_{INH}$ | = | Averaging time - inhalation, noncancer (hours) | 8,760 | ED x 365 days/year x 24 hours/day (USEPA, 2009) |
| $ATC_D$ | = | Averaging time - dermal, carcinogens (days) | 25,500 | 70 years x 365 days/year (USEPA, 2015) |
| $ATNC_D$ | = | Averaging time - dermal, noncancer (days) | 365 | ED x 365 days/year (USEPA, 2015) |
| IRS | = | Ingestion rate, soil (mg/day) | 330 | DTSC, 2014 |
| PEF | = | Particulate emission factor, soil ($m^3$/kg) | $1x10^6$ | DTSC, 2014 |
| SA | = | Exposed surface area ($cm^2$) | 6,032 | DTSC, 2014 |
| ABS | = | Chemical-absorption fraction (unitless) | Chemical-specific | See Table M-6 |
| AF | = | Soil adherence factor (mg/$cm^2$) | 0.8 | DTSC, 2014 |
| EF | = | Exposure frequency (days/year) | 250 | DTSC, 2014 |
| ED | = | Exposure duration (year) | 1 | DTSC, 2014 |
| ET | = | Exposure time (hours/day) | 8 | DTSC, 2014 |
| BW | = | Body weight, adult (kg) | 80 | DTSC, 2014 |
| MCF | = | Mass conversion factor, air (µg/mg) | 1,000 | Not applicable |
| CFS | = | Conversion factor, soil (kg/mg) | $1x10^{-6}$ | Not applicable |

Notes:

| | |
|---|---|
| µg/$m^3$ | microgram per cubic meter |
| µg/mg | microgram per milligram |
| $cm^2$ | square centimeter |
| DTSC | California Department of Toxic Substances Control |
| kg | kilogram |
| kg/mg | kilogram per milligram |
| $m^3$/kg | cubic meter per kilogram |
| mg/$cm^2$ | milligram per square centimeter |
| mg/day | milligram per day |
| mg/kg | milligram per kilogram |
| mg/kg-day | milligram per kilogram per day |
| mg/$m^3$ | milligram per cubic meter |
| RBC | risk-based concentration |
| USEPA | United States Environmental Protection Agency |

Sources:

California Department of Toxic Substances Control (DTSC). 2014. *Recommended DTSC Default Exposure Factors for Use in Risk Assessment at California Hazardous Waste Sites and Permitted Facilities*. Office of Human and Ecological Risk (HERO) HERO HHRA Note Number 1. September 30.

United States Environmental Protection Agency (USEPA). 2009. *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manua*l (Part F, Supplemental Guidance for Inhalation Risk Assessment). January. http://www.epa.gov/oswer/riskassessment/ragsf/.

United States Environmental Protection Agency (USEPA). 2015. *Regional Screening Levels for Chemical Contaminants at Superfund Sites.* November.

TABLE M-6

Toxicity Criteria Used to Calculate Construction Worker Soil Risk-Based Concentrations

*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

| | | | Cancer Toxicity Criteria | | | | Noncancer Toxicity Criteria - Chronic Exposure | | | | | Cancer Toxicity Criteria | Noncancer Cancer Toxicity Criteria |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Analytical Group** | **CAS Number** | **Chemical of Potential Concern** | **Oral Slope Factor $(mg/kg\text{-}day)^{-1}$** | **Source** | **Inhalation Unit Risk $(\mu g/m^3)^{-1}$** | **Source** | **Oral Reference Dose (mg/kg-day)** | **Source** | **Inhalation Reference Concentration $(mg/m^3)$** | **Source** | **Gastrointestinal Absorption Fraction (GIABS) (a)** | **Dermal Slope Factor $(mg/kg\text{-}day)^{-1}$ (b)** | **Dermal Reference Dose (mg/kg-day) (c)** |
| TMETAL | 7440-36-0 | Antimony | -- | | -- | | 4.0E-04 | I | -- | | 0.15 | -- | 6.0E-05 |
| TMETAL | 7440-38-2 | Arsenic | 9.5E+00 | C | 4.3E-03 | I | 3.5E-06 | C | 1.5E-05 | C | 1 | 9.5E+00 | 3.5E-06 |
| TMETAL | 7440-43-9 | Cadmium | 1.5E+01 | C | 4.2E-03 | C | 6.3E-06 | C | 1.0E-05 | A | 0.025 | 6.0E+02 | 1.6E-07 |
| TMETAL | 18540-29-9 | Chromium VI | 5.0E-01 | J | 1.5E-01 | C | 3.0E-03 | I | 1.0E-04 | I | 0.025 | 2.0E+01 | 7.5E-05 |
| TMETAL | 7440-48-4 | Cobalt | -- | | 9.0E-03 | P | 3.0E-04 | P | 6.0E-06 | P | 1 | -- | 3.0E-04 |
| TMETAL | 7440-50-8 | Copper | -- | | -- | | 4.0E-02 | H | -- | | 1 | -- | 4.0E-02 |
| TMETAL | 7439-97-6 | Mercury | -- | | -- | | 1.6E-04 | C | 3.0E-05 | C | 0.07 | -- | 1.1E-05 |
| TMETAL | 7439-98-7 | Molybdenum | -- | | -- | | 5.0E-03 | I | -- | | 1 | -- | 5.0E-03 |
| TMETAL | 7440-02-0 | Nickel | -- | | 2.6E-04 | C | 1.1E-02 | C | 1.4E-05 | C | 0.04 | -- | 4.4E-04 |
| TMETAL | 7440-22-4 | Silver | -- | | -- | | 5.0E-03 | I | -- | | 0.04 | -- | 2.0E-04 |
| TMETAL | 7440-66-6 | Zinc | -- | | -- | | 3.0E-01 | I | -- | | 1 | -- | 3.0E-01 |

Notes:

a USEPA, 2015

b Dermal slope factor = Oral slope factor / GIABS

c Dermal reference dose = Oral reference dose x GIABS

-- Not available or not applicable

A = Agency for Toxic Substances and Disease Registry (as cited in USEPA, 2015)

C = California Environmental Protection Agency (Cal-EPA, 2015)

CAS = Chemical Abstracts Service

GIABS = gastrointestinal absorption fraction

H = Health Effects Assessment Summary Tables (as cited in USEPA, 2015)

I = Integrated Risk Information System (as cited in USEPA, 2015)

J = New Jersey Department of Environmental Protection (as cited in USEPA, 2015)

mg/kg-day = milligram per kilogram per day

MRP = Munitions Response Program

$mg/m^3$ = milligram per cubic meter

NAVWPNSTA = Naval Weapons Station

P = Provisional Peer-Reviewed Toxicity Value (as cited in USEPA, 2015)

RfD = reference dose

TMETAL = total metal

$\mu g/m^3$ = microgram per cubic meter

USEPA = United States Environmental Protection Agency

UXO = unexploded ordnance

**Sources:**

California Environmental Protection Agency (Cal-EPA). 2016. Office of Environmental and Health Hazard Assessment (OEHHA). OEHHA On-Line Toxicity Criteria Database. Accessed January 16.

United States Environmental Protection Agency (USEPA). 2015. *Regional Screening Levels for Chemical Contaminants at Superfund Sites*. June.

TABLE M-7

Risk-Based Concentrations for Soil - Construction Worker Scenario

*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

| Analytical Group | CAS Number | Chemical | Risk-Based Concentration (mg/kg) - Construction Worker Soil Exposure | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Ingestion | | Dermal | | Inhalation | | Multi-Pathway RBC (Combined Ingestion, Dermal, and Inhalation) | |
| | | | Cancer | Noncancer | Cancer | Noncancer | Cancer | Noncancer | Cancer | Noncancer |
| TMETAL | 7440-36-0 | Antimony | -- | 1.4E+02 | -- | 1.5E+02 | -- | -- | -- | 7.2E+01 |
| TMETAL | 7440-38-2 | Arsenic | 4.3E+00 | 2.1E+00 | 5.9E+00 | 2.8E+00 | 9.3E+01 | 6.6E+01 | 2.4E+00 | 1.2E+00 |
| TMETAL | 7440-43-9 | Cadmium | 1.7E+00 | 2.2E+00 | 2.8E+00 | 3.8E+00 | 7.3E+01 | 4.4E+01 | 1.0E+00 | 1.4E+00 |
| TMETAL | 18540-29-9 | Chromium VI | 5.0E+01 | 1.1E+03 | -- | -- | 2.0E+00 | 4.4E+02 | 2.0E+00 | 3.1E+02 |
| TMETAL | 7440-48-4 | Cobalt | -- | 1.1E+02 | -- | 7.3E+02 | 3.4E+01 | 2.6E+01 | 3.4E+01 | 2.0E+01 |
| TMETAL | 7440-50-8 | Copper | -- | 1.4E+04 | -- | 9.7E+04 | -- | -- | -- | 1.2E+04 |
| TMETAL | 7439-97-6 | Mercury | -- | 5.7E+01 | -- | 2.7E+01 | -- | 1.3E+02 | -- | 1.6E+01 |
| TMETAL | 7439-98-7 | Molybdenum | -- | 1.8E+03 | -- | 1.2E+04 | -- | -- | -- | 1.5E+03 |
| TMETAL | 7440-02-0 | Nickel | -- | 3.9E+03 | -- | 1.1E+03 | 1.2E+03 | 6.1E+01 | 1.2E+03 | 5.7E+01 |
| TMETAL | 7440-22-4 | Silver | -- | 1.8E+03 | -- | 4.8E+02 | -- | -- | -- | 3.8E+02 |
| TMETAL | 7440-66-6 | Zinc | -- | 1.1E+05 | -- | 7.3E+05 | -- | -- | -- | 9.3E+04 |

Notes:

Concentrations are in milligrams per kilogram (mg/kg).

| | |
|---|---|
| -- | not applicable |
| CAS | Chemical Abstracts Service |
| mg/kg | milligram per kilogram |
| MRP | Munitions Response Program |
| NAVWPNSTA | Naval Weapons Station |
| RBC | risk-based concentration |
| TMETAL | total metal |
| UXO | unexploded ordnance |

TABLE M-8

Cancer Risks and Noncancer Hazards for Surface Soil (0 to 0.5 foot-bgs) - Future Industrial and Residential Exposure Scenarios

*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

| Analytical Group | CAS Number | COPC | EPC (mg/kg) (a) | Future Industrial Exposure Scenario | | | | Future Residential Exposure Scenario | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | RBC (mg/kg) (b) | | Cancer Risk | Noncancer Hazard | RBC (mg/kg) (b) | | Cancer Risk | Noncancer Hazard |
| | | | | Cancer | Noncancer | | | Cancer | Noncancer | | |
| TMETAL | 7440-36-0 | Antimony | 0.817 | -- | 4.7E+02 | -- | 1.7E-03 | -- | 3.1E+01 | -- | 2.6E-02 |
| TMETAL | 7440-38-2 | Arsenic | 1.709 | 2.5E-01 | 3.0E+00 | 6.8E-06 | 5.7E-01 | 6.7E-02 | 2.5E-01 | 2.6E-05 | 6.8E+00 |
| TMETAL | 7440-43-9 | Cadmium | 1.949 | 9.3E+03 | 7.3E+00 | 2.1E-10 | 2.7E-01 | 2.1E+03 | 5.2E+00 | 9.3E-10 | 3.7E-01 |
| TMETAL | 18540-29-9 | Chromium VI | 0.165 | 6.3E+00 | 3.5E+03 | 2.6E-08 | 4.7E-05 | 3.0E-01 | 2.3E+02 | 5.5E-07 | 7.2E-04 |
| TMETAL | 7440-48-4 | Cobalt | 11.14 | 1.9E+03 | 3.5E+02 | 5.9E-09 | 3.2E-02 | 4.2E+02 | 2.3E+01 | 2.7E-08 | 4.8E-01 |
| TMETAL | 7440-50-8 | Copper | 28.14 | -- | 4.7E+04 | -- | 6.0E-04 | -- | 3.1E+03 | -- | 9.1E-03 |
| TMETAL | 7439-92-1 | Lead | 32.52 | -- | 3.2E+02 | -- | (c) | -- | 8.0E+01 | -- | (c) |
| TMETAL | 7439-97-6 | Mercury | 0.0193 | -- | 6.9E+01 | -- | 2.8E-04 | -- | 2.3E+01 | -- | 8.4E-04 |
| TMETAL | 7439-98-7 | Molybdenum | 0.374 | -- | 5.8E+03 | -- | 6.4E-05 | -- | 3.9E+02 | -- | 9.6E-04 |
| TMETAL | 7440-02-0 | Nickel | 7.169 | 6.4E+04 | 3.1E+03 | 1.1E-10 | 2.3E-03 | 1.5E+04 | 4.9E+02 | 4.8E-10 | 1.5E-02 |
| TMETAL | 7440-22-4 | Silver | 0.305 | -- | 1.5E+03 | -- | 2.0E-04 | -- | 3.9E+02 | -- | 7.8E-04 |
| TMETAL | 7440-66-6 | Zinc | 190.2 | -- | 3.5E+05 | -- | 5.4E-04 | -- | 2.3E+04 | -- | 8.3E-03 |
| | | | | | | | | | | | |
| **Cumulative Cancer Risk and Noncancer Hazard** | | | | **Future Industrial** | | 7E-06 | 9E-01 | **Future Residential** | | 3E-05 | 8E+00 |

Notes:

Concentrations are in milligrams per kilogram (mg/kg).

| | |
|---|---|
| -- | not applicable |
| a | See Table M-3 for basis of EPCs. |
| b | See Table M-4 for basis of RBCs. |
| c | See Section 8.3 of Appendix M for evaluation of lead. |
| -- | not applicable |
| bgs | below ground surface |
| CAS | Chemical Abstracts Service |
| COPC | chemical of potential concern |
| EPC | exposure point concentration |
| mg/kg | milligram per kilogram |
| MRP | Munitions Response Program |
| NAVWPNSTA | Naval Weapons Station |
| RBC | risk-based concentration |
| TMETAL | total metal |
| UXO | unexploded ordnance |

TABLE M-9

Cancer Risks and Noncancer Hazards for Subsurface Soil (0 to 10 feet bgs) - Future Industrial and Residential Exposure Scenarios

*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

| Analytical Group | CAS Number | COPC | EPC (mg/kg) (a) | Future Industrial Exposure Scenario | | | | Future Residential Exposure Scenario | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | RBC (mg/kg) (b) | | Cancer Risk | Noncancer Hazard | RBC (mg/kg) (b) | | Cancer Risk | Noncancer Hazard |
| | | | | Cancer | Noncancer | | | Cancer | Noncancer | | |
| TMETAL | 7440-36-0 | Antimony | 0.55 | -- | 4.7E+02 | -- | 1.2E-03 | -- | 3.1E+01 | -- | 1.8E-02 |
| TMETAL | 7440-38-2 | Arsenic | 1.604 | 2.5E-01 | 3.0E+00 | 6.4E-06 | 5.3E-01 | 6.7E-02 | 2.5E-01 | 2.4E-05 | 6.4E+00 |
| TMETAL | 7440-43-9 | Cadmium | 2.676 | 9.3E+03 | 7.3E+00 | 2.9E-10 | 3.7E-01 | 2.1E+03 | 5.2E+00 | 1.3E-09 | 5.1E-01 |
| TMETAL | 18540-29-9 | Chromium VI | 0.0827 | 6.3E+00 | 3.5E+03 | 1.3E-08 | 2.4E-05 | 3.0E-01 | 2.3E+02 | 2.8E-07 | 3.6E-04 |
| TMETAL | 7440-48-4 | Cobalt | 10.53 | 1.9E+03 | 3.5E+02 | 5.5E-09 | 3.0E-02 | 4.2E+02 | 2.3E+01 | 2.5E-08 | 4.6E-01 |
| TMETAL | 7440-50-8 | Copper | 24.16 | -- | 4.7E+04 | -- | 5.1E-04 | -- | 3.1E+03 | -- | 7.8E-03 |
| TMETAL | 7439-92-1 | Lead | 22.07 | -- | 3.2E+02 | -- | (c) | -- | 8.0E+01 | -- | (c) |
| TMETAL | 7439-97-6 | Mercury | 0.0168 | -- | 6.9E+01 | -- | 2.4E-04 | -- | 2.3E+01 | -- | 7.3E-04 |
| TMETAL | 7439-98-7 | Molybdenum | 0.401 | -- | 5.8E+03 | -- | 6.9E-05 | -- | 3.9E+02 | -- | 1.0E-03 |
| TMETAL | 7440-02-0 | Nickel | 7.069 | 6.4E+04 | 3.1E+03 | 1.1E-10 | 2.3E-03 | 1.5E+04 | 4.9E+02 | 4.7E-10 | 1.4E-02 |
| TMETAL | 7440-22-4 | Silver | 0.305 | -- | 1.5E+03 | -- | 2.0E-04 | -- | 3.9E+02 | -- | 7.8E-04 |
| TMETAL | 7440-66-6 | Zinc | 134.8 | -- | 3.5E+05 | -- | 3.9E-04 | -- | 2.3E+04 | -- | 5.9E-03 |
| | | | | | | | | | | | |
| **Cumulative Cancer Risk and Noncancer Hazard** | | | | **Future Industrial** | | 6E-06 | 9E-01 | **Future Residential** | | 2E-05 | 7E+00 |

Notes:

Concentrations are in milligrams per kilogram (mg/kg).

| | |
|---|---|
| -- | not applicable |
| a | See Table M-3 for basis of EPCs. |
| b | See Table M-4 for basis of RBCs. |
| c | See Section 8.3 of Appendix M for evaluation of lead. |
| -- | not applicable |
| bgs | below ground surface |
| CAS | Chemical Abstracts Service |
| COPC | chemical of potential concern |
| EPC | exposure point concentration |
| mg/kg | milligram per kilogram |
| MRP | Munitions Response Program |
| NAVWPNSTA | Naval Weapons Station |
| RBC | risk-based concentration |
| TMETAL | total metal |
| UXO | unexploded ordnance |

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TABLE M-10

Cancer Risks and Noncancer Hazards for Subsurface Soil (0 to 10 foot bgs) - Future Construction Worker Scenario

*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

| | | | | Risk-Based Concentrations | | | | | | | | Cancer Risks and Noncancer Hazards - Future Construction Worker Exposure Scenario | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ingestion | | Dermal | | Inhalation | | Multi-Pathway (Combined Ingestion, Dermal, and Inhalation) | | Ingestion | | Dermal | | Inhalation | | Multi-Pathway (Combined Ingestion, Dermal, and Inhalation) | |
| Analytical Group | CAS Number | COPC | EPC (mg/kg) (a) | Cancer | Noncancer | Cancer | Noncancer | Cancer | Noncancer | Cancer | Noncancer | Cancer Risk | Noncancer HI | Cancer Risk | Noncancer HI | Cancer Risk | Noncancer HI | Cancer Risk | Noncancer HI |
| TMETAL | 7440-36-0 | Antimony | 0.55 | -- | 1.4E+02 | -- | 1.5E+02 | -- | -- | -- | 7.2E+01 | -- | 3.9E-03 | -- | 3.8E-03 | -- | -- | -- | 7.7E-03 |
| TMETAL | 7440-38-2 | Arsenic | 1.604 | 4.3E+00 | 2.1E+00 | 5.9E+00 | 2.8E+00 | 9.3E+01 | 6.6E+01 | 2.4E+00 | 1.2E+00 | 3.7E-07 | 7.8E-01 | 2.7E-07 | 5.7E-01 | 1.7E-08 | 2.4E-02 | 6.6E-07 | 1.4E+00 |
| TMETAL | 7440-43-9 | Cadmium | 2.676 | 1.7E+00 | 2.2E+00 | 2.8E+00 | 3.8E+00 | 7.3E+01 | 4.4E+01 | 1.0E+00 | 1.4E+00 | 1.6E-06 | 1.2E+00 | 9.5E-07 | 7.0E-01 | 3.7E-08 | 6.1E-02 | 2.6E-06 | 2.0E+00 |
| TMETAL | 18540-29-9 | Chromium VI | 0.0827 | 5.0E+01 | 1.1E+03 | -- | -- | 2.0E+00 | 4.4E+02 | 2.0E+00 | 3.1E+02 | 1.7E-09 | 7.8E-05 | -- | -- | 4.0E-08 | 1.9E-04 | 4.2E-08 | 2.7E-04 |
| TMETAL | 7440-48-4 | Cobalt | 10.53 | -- | 1.1E+02 | -- | 7.3E+02 | 3.4E+01 | 2.6E+01 | 3.4E+01 | 2.0E+01 | -- | 9.9E-02 | -- | 1.5E-02 | 3.1E-07 | 4.0E-01 | 3.1E-07 | 5.1E-01 |
| TMETAL | 7440-50-8 | Copper | 24.16 | -- | 1.4E+04 | -- | 9.7E+04 | -- | -- | -- | 1.2E+04 | -- | 1.7E-03 | -- | 2.5E-04 | -- | -- | -- | 2.0E-03 |
| TMETAL | 7439-92-1 | Lead | 22.07 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | (c) |
| TMETAL | 7439-97-6 | Mercury | 0.0168 | -- | 5.7E+01 | -- | 2.7E+01 | -- | 1.3E+02 | -- | 1.6E+01 | -- | 3.0E-04 | -- | 6.2E-04 | -- | 1.3E-04 | -- | 1.0E-03 |
| TMETAL | 7439-98-7 | Molybdenum | 0.401 | -- | 1.8E+03 | -- | 1.2E+04 | -- | -- | -- | 1.5E+03 | -- | 2.3E-04 | -- | 3.3E-05 | -- | -- | -- | 2.6E-04 |
| TMETAL | 7440-02-0 | Nickel | 7.069 | -- | 3.9E+03 | -- | 1.1E+03 | 1.2E+03 | 6.1E+01 | 1.2E+03 | 5.7E+01 | -- | 1.8E-03 | -- | 6.6E-03 | 6.0E-09 | 1.2E-01 | 6.0E-09 | 1.2E-01 |
| TMETAL | 7440-22-4 | Silver | 0.305 | -- | 1.8E+03 | -- | 4.8E+02 | -- | -- | -- | 3.8E+02 | -- | 1.7E-04 | -- | 6.3E-04 | -- | -- | -- | 8.0E-04 |
| TMETAL | 7440-66-6 | Zinc | 134.8 | -- | 1.1E+05 | -- | 7.3E+05 | -- | -- | -- | 9.3E+04 | -- | 1.3E-03 | -- | 1.9E-04 | -- | -- | -- | 1.5E-03 |
| | | | | | | | | | | | | | | | | | | | |
| **Cumulative Cancer Risk and Noncancer Hazard** | | | | | | | | | | | | 2.0E-06 | 2.1E+00 | 1.2E-06 | 1.3E+00 | 4.1E-07 | 6.0E-01 | 4E-06 | 4E+00 |

Notes:

Concentrations are in milligrams per kilogram (mg/kg).

| | |
|---|---|
| a | See Table M-3 for basis of EPCs. |
| b | See Table M-7 for basis of RBCs. |
| c | See Section 8.3 of Appendix M for evaluation of lead. |
| -- | not applicable |
| bgs | below ground surface |
| CAS | Chemical Abstracts Service |
| COPC | chemical of potential concern |
| EPC | exposure point concentration |
| HI | hazard index |
| mg/kg | milligram per kilogram |
| MRP | Munitions Response Program |
| NAVWPNSTA | Naval Weapons Station |
| RBC | risk-based concentration |
| TMETAL | total metal |
| UXO | unexploded ordnance |

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# Figure

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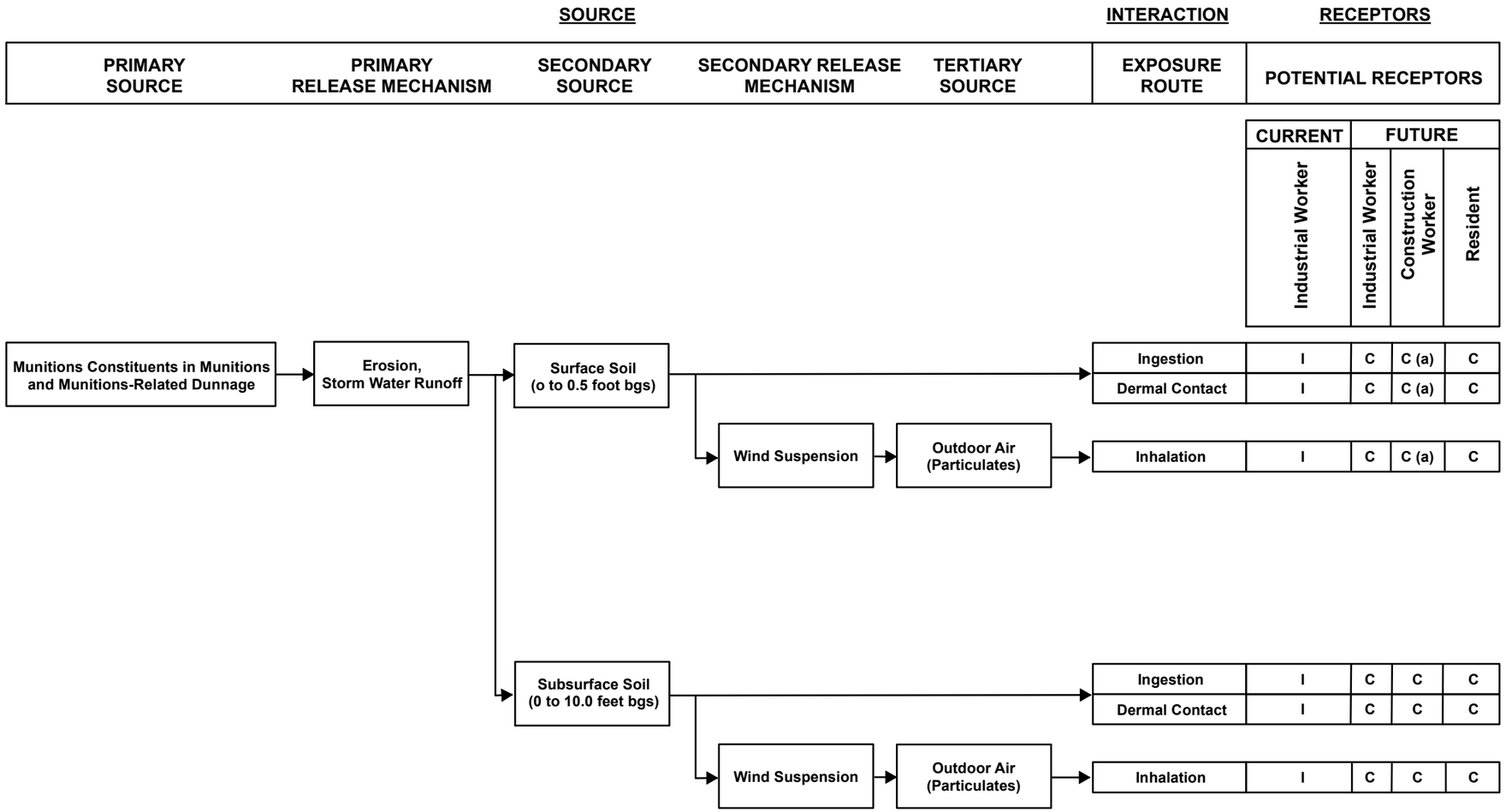


## LEGEND

I INCOMPLETE OR NEGLIGIBLE EXPOSURE PATHWAY
C POTENTIALLY COMPLETE EXPOSURE PATHWAY

NOTES:
(a) = Included in the evaluation of subsurface soil exposure pathways (not evaluated separately from subsurface soil)
bgs = below ground surface
VOC = Volatile Organic Compound
MC = Munitions Constituents
MRP = Munitions Response Program
UXO = Unexploded Ordnance
NAVWPNSTA = Naval Weapons Station

**MC Conceptual Site Exposure Model for Potential Human Receptors**

Remedial Investigation for MRP Site UXO5
NAVWPNSTA Seal Beach Detachment Fallbrook, California

FIGURE
**M-1**

Date: 10/2/2015 User: lmoussa Path: \\kadc3-ssfs2.kleinfelder.com\drawings_clients\Navy_CLEAN\FALLBROOK\CTO_063\MXD\MRP5_RI\RI_REPORT\063_4115.mxd

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# Appendix N
# Ecological Risk Assessment

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Appendix N

# Ecological Risk Assessment

# Remedial Investigation for Munitions Response Program Site UXO5

## Naval Weapons Station Seal Beach
## Detachment Fallbrook
## Fallbrook, California

**Contract Number: N62473-09-D-2622**
**Contract Task Order: 0063**
**Document Control Number: KCH-2622-0063-0058**

**July 2016**

Prepared for

## Department of the Navy
## Naval Facilities Engineering Command Southwest

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# Acronyms and Abbreviations

| | |
|---|---|
| 95UCL | 95 percent upper confidence limit |
| BAF | bioaccumulation factor |
| BERA | baseline ecological risk assessment |
| bgs | below ground surface |
| BTAG | Biological Technical Assistance Group |
| BTV | background threshold value |
| CAGN | California gnatcatcher (*Polioptila californica*) |
| Cal-EPA | California Environmental Protection Agency |
| COPEC | chemical of potential ecological concern |
| CSEM | conceptual site exposure model |
| DTSC | California Department of Toxic Substances Control |
| Eco-SSL | USEPA Ecological Soil Screening Level |
| EcoUpdate | USEPA Ecological Update |
| EPC | exposure point concentration |
| ERA | ecological risk assessment |
| ESV | ecological screening value |
| HERD | Human and Ecological Risk Division |
| KCH | CH2M HILL Kleinfelder, A Joint Venture |
| Kgb | Gabbro (parent rock type) |
| LOAEL | lowest observed adverse effect level |
| mg/kg | milligram per kilogram |
| MRP | Munitions Response Program |
| Navy | United States Department of the Navy |
| NOAEL | no observed adverse effect level |
| RI | remedial investigation |
| SI | site inspection |
| SKR | Stephens' kangaroo rat (*Dipodomys stephensi*) |
| SLERA | screening-level ecological risk assessment |
| TRV | toxicity reference value |
| USEPA | United States Environmental Protection Agency |
| UXO | unexploded ordnance |

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# 1.0 Introduction

This appendix provides the results of the ecological risk assessment (ERA) for Munitions Response Program (MRP) Site Unexploded Ordnance (UXO) 5 at Naval Weapons Station Seal Beach Detachment Fallbrook (Detachment Fallbrook), Fallbrook, California. This ERA is prepared as part of the remedial investigation (RI) report for MRP Site UXO5. The ERA seeks to determine the nature, magnitude, and probability of actual or potential harm to the environment by the threatened or actual release of hazardous substances. The assessment identifies and characterizes the toxicity of the chemicals of potential ecological concern (COPECs), the potential exposure pathways, the potential ecological receptors, and the likelihood and extent of impact or threat under current and reasonably anticipated future land use conditions.

This ERA was conducted in accordance with the guidelines published by the United States Environmental Protection Agency (USEPA) and the California Environmental Protection Agency (Cal-EPA). The overall objective of this ERA is to quantitatively and qualitatively evaluate baseline or existing exposure and risks to ecological receptors, and to provide risk managers with information needed to achieve their ecological management goals and help determine remedial decisions, if necessary.

## 1.1 Approach

This ERA was conducted in phases as recommended by the United States Department of the Navy (Navy) policy for conducting ERAs (Navy, 1999; Navy, 2003) and is consistent with USEPA (1997 and 1998) and California Department of Toxic Substances Control (DTSC) (1996) guidance for conducting ERAs. Each phase is more detailed and focused than the preceding phase, and data from one phase are used to determine whether further studies are needed to meet the objectives of the assessment. There are three phases:

- **Tier 1 Screening-level ERA (SLERA).** The Tier 1 SLERA represents Steps 1 and 2 of the Navy policy (Navy, 1999; Navy, 2003). It is analogous to Steps 1 and 2 of the Superfund guidance (USEPA, 1997) and the Scoping and Phase I Predictive Assessments of the DTSC (1996) guidance. The Tier 1 SLERA employs existing data and conservative assumptions regarding contaminant exposure to develop a screening-level problem formulation, ecological conceptual model, exposure evaluation, toxicity evaluation, and risk calculations.

- **Tier 2 Baseline ERA (BERA).** The Tier 2 BERA consists of several steps designed to refine exposure and risk estimates in a scientifically defensible manner. Steps may include refinement of conservative exposure assumptions and considerations such as background, bioavailability, and data distribution (Step 3a), or collection and evaluation of additional data (Steps 3b through 7).

- **Tier 3 Evaluation of Remedial Alternatives.** Tier 3 is initiated when the results of the Tier 2 BERA indicate that site-related chemicals of ecological concern pose unacceptable risks to one or more assessment endpoints. Remedial alternatives, including a no-action

alternative, are developed and evaluated with the goal of reducing ecological risks to an acceptable level. A preferred remedy is selected based on effectiveness in reducing risks, potential ecological impacts related to the remedy, and residual risks. The preferred remedy also will be selected to balance both human health and ecological concerns.

At the conclusion of each tier, a risk management decision is made regarding site status. The decision criteria identify three possible outcomes for the site:

- The site does not pose an unacceptable risk and no further action is warranted.
- The site poses a potentially unacceptable risk that requires additional evaluation.
- The site poses a potentially unacceptable risk and accelerated site remediation is warranted. The evaluation of remedial alternatives is completed in a Tier 3 ERA.

This ERA for MRP Site UXO5 includes both a Tier 1 SLERA (hereafter referred to as the Tier 1 assessment) and Step 3a of the Tier 2 BERA (refinement of conservative exposure assumptions; hereafter referred to as the Tier 2 assessment). Analyte/receptor pairs that show potential risks in the Tier 1 assessment (SLERA) are automatically carried forth and evaluated in the Tier 2 assessment (BERA, Step 3a).

## 1.2 Guidance

This ERA was performed in general accordance with ten guidance documents:

- *Chief of Naval Operations. Memorandum: Navy Policy for Conducting Ecological Risk Assessments* (Navy, 1999)
- *Navy Guidance for Conducting Ecological Risk Assessments* (Navy, 2003)
- *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments*, Interim Final (USEPA, 1997)
- *Final Guidelines for Ecological Risk Assessment* (USEPA, 1998)
- *Ecological Risk Assessment and Risk Management Principles for Superfund Sites* (USEPA, 1999)
- *The Role of Screening-level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments* (USEPA, 2001)
- USEPA Ecological Update (EcoUpdate) Series (USEPA, 1991a; 1991b; 1992a; 1992b; 1992c; 1994a; 1994b; 1994c; 1994d; 1996a; 1996b; 2001)
- *Guidance for Data Usability in Risk Assessment* (USEPA, 1992d)
- *Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities* (DTSC, 1996)
- Cal-EPA, Department of Toxic Substances Control Human and Ecological Risk Division (HERD) Ecological Risk Assessment Notes (Cal-EPA, 2000; Cal-EPA, 2002)

## 1.3 Assumptions

The MRP Site UXO5 ERA was conducted under assumptions and constraints, which are typical for the current state-of-practice:

- Evaluation of current exposures is derived from existing conditions.
- Future land use at MRP Site UXO5 is assumed to remain the same as current use.
- Medium of potential concern is soil.
- Current chemical concentrations in the source media are present at a steady state and will not change with time.
- Chemicals not detected or analyzed are not present or evaluated.
- Each chemical is as bioavailable as the chemical on which the toxicity information is based when used for estimating direct exposure.
- Bioaccumulation of chemicals is estimated using bioaccumulation factors (BAFs) or models available from literature.
- Toxicological information used represents information currently available from literature and database searches.

The uncertainties associated with the ERA conclusions are discussed in Section 5.0.

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# 2.0 Tier 1 Screening-Level Ecological Risk Assessment

This section provides the results of Tier 1 of the ERA process, the SLERA. The SLERA consists of two steps: Step 1, the screening-level problem formulation (Section 2.1), and Step 2, the screening-level ecological effects characterization (Section 2.2) and screening-level risk characterization (Section 2.3).

## 2.1 Screening-Level Problem Formulation (Step 1)

The screening-level problem formulation is part of Step 1 of the SLERA and evaluates available site information to focus the assessment on the most relevant exposures. The end product of this problem formulation is the ecological conceptual site exposure model (CSEM) that describes the site location and ecological setting (habitats, potential receptors, and threatened and endangered species); identifies contaminant sources, transport mechanisms, and COPECs; evaluates potential exposure pathways and routes; and identifies the representative species that were used to assess potential ecological risk to site-related receptors.

### 2.1.1 Site Location and Description

Detachment Fallbrook is located approximately 53 miles north of San Diego in northern San Diego County, California, approximately 9 miles inland from the Pacific Coast (see Figure 1-1 of the RI Report). Detachment Fallbrook is bordered on the west by Marine Corps Base Camp Pendleton and is south of the Santa Margarita River. The base currently occupies 8,852 acres, but only 274 acres are developed. The remaining acreage is mostly open space that falls within Explosive Safety Quantity Distance arcs required for the magazines.

MRP Site UXO5 covers approximately 13 acres and is located in the northeast corner of Detachment Fallbrook (see Figure 1-2 of the RI Report). MRP Site UXO5 is just east of Building 307 and is bounded on the southwest and southeast sides by Sparrow Road (Building 307 access road) and Building 365, respectively. There are no buildings within MRP Site UXO5 boundaries.

#### 2.1.1.1 Ecological Habitats

A significant portion of the vegetation within MRP Site UXO5 burned in February 2002 as a result of the Gavilan fire that started near Gavilan Mountain southeast of De Luz Road (off Detachment Fallbrook) (SES-TECH, 2012a). In the subsequent years, vegetation growth has advanced through patterns typical of post-burn seral plant ecology.

The vegetative communities associated with MRP Site UXO5 include California sagebrush (*Artemisa californica*), California buckwheat (*Eriogonum fasciculatum*), deer weed (*Lotus scoparius*), and a few individual occurrences of white sage (*Salvia apiana*) along the southern extremes (SES-TECH, 2012). When MRP Site UXO5 was inspected in 2004, more than 98 percent of the vegetative material was less than 1 meter in height, and it was determined that it provided limited components of the Critical Habitat Code of Federal Regulations

identified constituent elements (Knight, 2004). Since that time, it has been noted that the vegetation has grown, and special-status species such as the California gnatcatcher (*Polioptila californica*) (CAGN) have been observed using the area. MRP Site UXO5 is within designated Critical Habitat for the CAGN, and constituent elements exist on MRP Site UXO5.

#### 2.1.1.2 Special-Status Species

Special-status species are those plant and animal species that are classified as threatened, endangered, or of-concern by state or federal agencies, and that are known to occur or have the potential to occur in the terrestrial or aquatic habitats in the general vicinity of Detachment Fallbrook. Federally listed species that have a potential to occur at the site include: CAGN, Stephens' kangaroo rat (SKR) (*Dipodomys stephensi*), arroyo toad (*Bufo californicus*), and Least Bell's Vireo (*Verio bellii pusillus*).

Prior to conducting the RI sampling, MRP Site UXO5 was monitored for SKR and CAGN. The results of the SKR trapping event and CAGN surveys were detailed in the Biological Avoidance and Minimization Plan (BAMP) that was included as Appendix D of the RI work plan (KCH, 2015). The SKR trapping survey conducted on 5 nights between December 6 and 12, 2013 captured no SKR. Based on habitat conditions, the preponderance of historical surveys (see Section 2.2.2 of RI Report), and the most recent December 2013 trapping effort, SKR do not appear to be present on or in the vicinity of MRP Site UXO5.

Additionally, nine focused CAGN surveys were previously conducted from June to December 2013. Surveys were conducted at least 2 weeks apart on June 27, July 16, July 30, August 13, September 13, October 11, October 25, November 8, and December 6, 2013. Surveys were conducted between the hours of 6:00 a.m. and 12:00 p.m. Surveys were performed during the breeding and nonbreeding seasons. Based on the CAGN surveys, the habitat quality of MRP Site UXO5 was considered high and was occupied by at least one pair (one territory) of CAGN, which were heard calling on July 30, 2013. One single female was heard or observed on August 13, September 13, October 11, October 25, and November 8, 2013 (KCH, 2015).

Upon review of the BAMP, the United States Fish and Wildlife Service required that an appropriately permitted biological monitor be present onsite and "responsible for overseeing project implementation to ensure compliance with the conservation measures and for preventing unanticipated impacts to federally listed species" (KCH, 2015). As a result, a biological monitor provider (Bloom Biological Inc.) was subcontracted by KCH to provide appropriate CAGN monitoring during RI field activities at MRP Site UXO5. Detections of CAGN within the fenced limits of MRP Site UXO5 were reported to be infrequent. Observations from February 20 through 23, 2015 narrowed a focal area for potential nesting, and a nest under construction was identified on March 6, 2015. Observations indicated the CAGN nest was near completion on March 10, 2015. However, the nest was located in an open area and immediately below power lines frequently used as a perch by ravens and any young likely would be depredated. A new nest by the same pair was discovered nearby on March 17, 2015. CAGN monitoring was continued through completion of the RI field activities at MRP Site UXO5 on March 31, 2015. There were no indications that the work activities at MRP Site UXO5 adversely affected CAGNs. In addition to gnatcatchers, 48 other species of birds were detected during monitoring.

Other species that are federally listed as endangered or threatened that could potentially occur at MRP Site UXO5 (based on their presence in similar areas in San Diego County and initial surveys conducted by the United States Fish and Wildlife Service on Detachment Fallbrook in March and April 1990) include the quino checkerspot butterfly (*Euphydryas editha quino*), and thread-leaved brodiaea (*Brodiaea filifolia*). These species have never been documented on Detachment Fallbrook and are considered unlikely to be present at the site.

Several unlisted, yet sensitive, bird species are also known to occur in Detachment Fallbrook and include the rufus-crowned sparrow (*Aimophila ruficeps*), grasshopper sparrow (*Ammodramus savannarum*), and protected raptors, such as the Cooper's hawk (*Accipter cooperii*) and Golden Eagle (*Aquila chrysaetos*). These species are known to occur on Detachment Fallbrook but have not been specifically recorded at MRP Site UXO5. These species were not observed at the site at the time of field activities.

### 2.1.2 Source Evaluation

MRP Site UXO5 was reported to be a burial area for munitions and munitions-related dunnage (Malcolm Pirnie, 2006). From 1952 through 1960, the area east of Building 307 was used to dispose of inert materials (Knight, 2004). On historical maps, starting in the 1950s and ending in the late 1960s, the area is labeled as a storage yard. Records indicate that expended cartridges, primers, live projectiles, and inert anti-tank projectiles were buried in the area (Malcolm Pirnie, 2006). In the late 1980s, an onsite survey was conducted and revealed other materials in the disposal area, including electronic parts, inert missile parts, rubber missile shipping rings, missile test stands, practice shapes, electronic test equipment, empty powder cans, metal banding, and tires (Knight, 2004).

Sample data evaluated for this ERA are those collected in 2007 for the site inspection (SI) and in 2015 for this RI. These data are considered representative of current conditions at this site. Soil data from 0 to 0.5 foot below ground surface (bgs) and 0 to 6 feet bgs were included because these depth intervals are considered relevant for typical surface and fossorial ecological receptors, respectively, at MRP Site UXO5. Soil data collected during the SI (Tetra Tech, 2009) included samples collected from 0 to 0.75 foot bgs (i.e., 0 to 9 inches bgs); data from these samples were included in the surface soil data grouping for this ERA.

### 2.1.3 Exposure Pathway Analysis

Exposure pathway analysis evaluates the potential for contact between the chemical compounds reported in soil at MRP Site UXO5 and the ecological receptors that are present or have the potential to occur at the site. Potential exposure pathways must meet specific criteria for an exposure to occur. Aside from necessary habitat for ecological receptors, a complete exposure pathway must include five elements:

- Contaminant source (e.g., disposed plating waste or sandblast grit)
- Primary or secondary mechanisms for contaminant release and transport
- Exposure point (e.g., soil)
- Feasible route of exposure (e.g., ingestion)
- Receptor (e.g., bird or mammal)

#### 2.1.3.1 Soil Pathways

Exposure to plants and soil invertebrates occurs by direct contact with contaminated soil. Exposure of birds and mammals by direct ingestion of soil and forage or prey that have accumulated COPECs is assumed to be most significant, whereas dermal contact and inhalation are expected to be minor exposure routes for these receptor types.

The direct exposure to soil and indirect exposure through food web exposure via consumption of contaminated prey/forage were quantitatively evaluated pathways. These pathways were assumed to be potentially complete for this ERA and are depicted in the CSEM (see Figure 8-2 of the RI Report).

#### 2.1.3.2 Identification of COPECs

Analytical data used for this ERA at MRP Site UXO5 were collected at the locations identified on Figures 3-1 and 5-1 of the RI Report. Data processing was completed using standard protocols (USEPA, 1992d; USEPA, 2000) and included standardization of analyte names, matrices, and units; removal of duplicated data; resolution of native/field duplicate pairs; and reduction of analytes reported under multiple methods.

Native/field duplicates and results from multiple methods were resolved so that only one result per sample was retained as follows:

- If both results were detects, the higher value was retained.
- If one result was a detect and one was a nondetect, the detected value was retained.
- If both results were nondetect, the lower nondetected value (the method detection limit) was retained.

COPECs were identified as all chemicals meeting three criteria:

- Those chemicals detected at least once in soil samples
- Metals detected at maximum levels exceeding background levels (defined below)
- Chemicals detected at maximum levels exceeding the most conservative USEPA Ecological Soil Screening Level (Eco-SSLs) (USEPA, 2007a)

DTSC guidance indicates that chemicals present in soil at concentrations elevated with respect to local background conditions become COPECs and should be carried forward into a risk evaluation (DTSC, 1997). Background data for Detachment Fallbrook are available for metals in soil and were developed for four parent rock types (SES-TECH, 2012). The Gabbro (Kbg) parent rock type is applicable to MRP Site UXO5, based on its location (see Figure 2-1 of SES-TECH, 2012). Background threshold values (BTVs) for Kgb soils were used to evaluate data for the ERA.

**0 to 0.5 Foot bgs Soil**: As indicated in Table N-1, a comparison of maximum soil concentrations for soil 0 to 0.5 foot bgs at MRP Site UXO5 with corresponding background levels indicates that levels of antimony, arsenic, cadmium, cobalt, copper, lead, mercury, molybdenum, nickel, silver, and zinc have been found present at levels exceeding their respective soil background, or do not have available background levels (such that exceedance of background is conservatively assumed), whereas all other metals are below

background. Further screening against the most conservative USEPA Ecological Soil Screening Levels (when available) as the third step in the COPEC selection process indicates that arsenic, hexavalent chromium, nickel, and silver are below respective screening levels. The COPECs identified for 0 to 0.5 foot bgs soil include antimony, cadmium, cobalt, copper, lead, mercury, molybdenum, and zinc.

**0 to 6 Feet bgs Soil**: A comparison of maximum soil concentrations for soil 0 to 6 feet bgs with corresponding background levels indicates that levels of antimony, arsenic, cadmium, cobalt, copper, lead, mercury, molybdenum, nickel, silver, and zinc have been found present at levels exceeding their respective soil background, or do not have available background levels, whereas other metals are below background. Further screening against the most conservative USEPA Eco-SSLs (when available) as the third step in the COPEC selection process indicates that arsenic, hexavalent chromium, nickel, and silver are below respective screening levels. The COPECs identified for 0 to 6 feet bgs soil include antimony, cadmium, cobalt, copper, lead, mercury, molybdenum, and zinc.

Table N-1 provides the results of the selection of COPECs for MRP Site UXO5. A total of 8 of the 22 chemicals detected in 0 to 0.5 foot bgs soil and a total of 8 of the 22 chemicals detected in 0 to 6 feet bgs was identified as COPECs.

### 2.1.4 Assessment and Measurement Endpoints

Assessment endpoints are an expression of the important ecological values that should be protected at a site (USEPA, 1997). The assessment endpoints are developed according to known information concerning the contaminants present, the study area, and the ecological management goals. The assessment endpoints for this site are adverse effects on receptor populations and communities for nonthreatened and nonendangered species, and individuals for threatened and endangered species, when applicable.

Adverse effects on these assessment endpoints are predicted from measurement endpoints. Measurement endpoints were selected for each assessment endpoint. Assessment and measurement endpoints are listed in Table N-2. The measurement endpoint evaluations for this site are the effects of chemical exposure on reproduction, survival, and growth, which can be used to predict effects at individual, population, and community levels of organization for each bird and mammal receptor group. These factors were considered in the identification and evaluation of appropriate toxicity information.

### 2.1.5 Ecological Conceptual Site Exposure Model

The ecological CSEM integrates the component evaluations of the screening-level problem formulation. Investigations at MRP Site UXO5 have identified the presence of COPECs in soil. Ecological habitats at the site are of sufficient quality to support wildlife use. Thus, it is plausible that ecological receptors may be present or occur intermittently at the site.

MRP Site UXO5 investigations show that the constituents that have been reported in remaining soil include metals. Transfer of COPECs to wildlife (e.g., birds and mammals) occurs through incidental ingestion of soil and through ingestion of food (forage or prey) that has accumulated COPECs from the site.

Representative terrestrial receptors for MRP Site UXO5 were selected based on a conservative review of current site conditions and potential habitat. These receptors are

common across California and are anticipated to be representative of other birds and mammals of the same feeding guild that typically forage in upland areas. Generally, the same mammal or bird toxicity information (from literature) is used irrespective of the specific species selected. Six representative species were evaluated:

- Insectivorous mammals are represented by the deer mouse (*Peromyscus maniculatus*).
- Herbivorous mammals are represented by the California ground squirrel (*Spermophilus beecheyi*).
- Carnivorous mammals are represented by the American badger (*Taxidea taxus*).
- Insectivorous birds are represented by the California gnatcatcher (*Polioptila californica*).
- Herbivorous birds represented by the mourning dove (*Zenaida macrocura*).
- Carnivorous birds (raptors) are represented by the red-tailed hawk (*Buteo jamaicensis*).

The ecological CSEM is shown on Figure 8-2 of the RI report.

## 2.2 Screening-Level Ecological Effects Characterization (Step 2)

The screening-level ecological effects characterization is part of Step 2 of the SLERA and consists of an evaluation of available toxicity or other effects information that can be used to link the exposure estimates to a likelihood of adverse effects. Stressor-response (i.e., effects) data that can be used to evaluate ecological risks resulting from chemical exposures comprise three general categories: literature-derived or site-specific single-chemical toxicity data, site-specific ambient media toxicity tests, and site-specific field surveys (Suter et al., 2000). Site-specific toxicity studies or quantitative field surveys were not conducted for this ERA. Therefore, single-chemical toxicity data found in the literature were used as the basis for deriving ecological screening values (ESVs). ESVs are concentrations of chemicals in media (soil) corresponding to reported effects levels, and are reported in milligrams per kilogram (mg/kg).

### 2.2.1 Toxicity Values for Birds and Mammals

Toxicity values for birds and mammals are typically represented as a dosage (the amount of an analyte per unit body weight per day) that has been reported to result in an adverse effect (i.e., toxicity reference values [TRVs]). The TRVs for birds and mammals were selected using the following hierarchy of sources:

- Region 9 Navy Biological Technical Assistance Group (BTAG) bird and mammal TRVs (Cal-EPA, 2009)
- USEPA Eco-SSLs (2003a; 2003b; 2005a; 2005b; 2005c; 2005d; 2005e; 2005f; 2005g; 2005h; 2007b; 2007c; 2007d; 2007e, 2007f; 2008)
- *Toxicological Benchmarks for Wildlife: 1996 Revision* (Sample et al., 1996)
- Peer-reviewed literature

TRVs were classified into two categories: Low TRVs and High TRVs. Low TRVs include no observed adverse effect levels (NOAELs) and Low BTAG values. These values reflect the

highest exposure that has been demonstrated to exert no adverse effect. High TRVs reflect a mid-range at which adverse effects may occur to a segment of the test population from chronic or subchronic exposure. High TRVs include lowest observed adverse effect levels (LOAELs) and High BTAG values. Other toxicity endpoints may be used such as the lethal dose to 50 percent of a test population ($LD_{50}$), but they are only used in the absence of other more appropriate endpoints. TRVs selected for birds and mammals are provided in Table N-3 and Table N-4, respectively.

### 2.2.2 Derivation of Ecological Screening Values

For each of the COPECs identified for 0 to 6 bgs soil, site-specific ESVs were derived for those ecological receptors considered representative at Detachment Fallbrook. The ESVs were derived using food-chain models that consider transfer of COPECs to upper tropic levels (e.g., birds and mammals) through incidental ingestion of soil and through ingestion of food (forage or prey) that has accumulated COPECs from the site. Food-chain uptake models for birds and mammals require input of species-specific exposure factors and chemical-specific bioaccumulation/bioconcentration factors. Species-specific life history factors include body weight, food, and abiotic media ingestion rates; dietary composition; and respective proportion of each dietary component.

#### 2.2.2.1 Exposure Model for Birds and Mammals

The food-chain uptake model for terrestrial birds and mammals uses dosage-based TRVs and includes ingestion of soil and food (forage/prey). The food-chain uptake exposure estimates for terrestrial birds and mammals are generated using the following generalized exposure model, modified from Suter et al. (2000):

$$E = [Soil \bullet P_s \bullet FIR] + [\sum_{i=1}^{N} B_i \bullet P_i \bullet FIR]$$

$$Where:$$

$$Bi \quad = \quad Soil \bullet BAF$$

Where:

| | | |
|---|---|---|
| E | = | total exposure (milligrams per kilogram per day) |
| Soil | = | concentration of chemical in soil (mg/kg) |
| $P_s$ | = | proportion of diet that is soil (unitless) |
| FIR | = | food ingestion rate normalized to body weight (kilograms per kilogram per day) |
| $B_i$ | = | concentration of chemical in biota type (i) (mg/kg) |
| $P_i$ | = | proportion of diet that is biota type (i) |
| BAF | = | bioaccumulation factor (liters per kilogram, dry weight) |

#### 2.2.2.2 Bioaccumulation Factors

The measurement or estimation of concentrations of COPECs in wildlife food is necessary to evaluate how much of a receptor's exposure is through food versus direct uptake of contaminated media. Although the preferred data are direct measurements of concentrations in biota samples collected from the site, such data were not available for MRP Site UXO5. Therefore, literature-reported values or uptake models are used to estimate bioaccumulation. BAFs reported in the open literature were used to model uptake of COPECs from soil to forage/prey items.

The wildlife exposure assumptions and TRVs, and the calculated site-specific ESVs based on the Low TRVs and High TRVs are provided in Table N-5. The site-specific ESVs used for this ERA are considered conservative for larger home-range receptors because the screening levels assume that these receptors obtain their forage entirely from the site.

### 2.2.3 Exposure Point Concentrations

The exposure point concentrations (EPCs) used for this ERA were dependent on the tier of assessment being performed. For the Tier 1 SLERA, the maximum detected concentrations were used. For the Tier 2 (BERA, Step 3a), the 95 percent upper confidence limit (95UCL) on the mean was used. The 95UCLs were computed using the process described in Appendix M, Section 6.0.

## 2.3 Screening-Level Risk Characterization (Step 2)

The risk characterization is part of Step 2 of the SLERA and evaluates the evidence linking exposures to COPECs with their potential for ecological effects on the representative species identified for MRP Site UXO5. For each COPEC and receptor, maximum concentrations in soil are compared with the Low TRV-based ESVs (referred to as Low ESVs). COPECs with maximum concentrations exceeding the Low ESV in the Tier 1 assessment were retained for further evaluation in the Tier 2 assessment. COPECs with EPCs less than the Low ESV were considered to not pose a risk to ecological receptors and were not carried forward to Tier 2.

### 2.3.1 Tier 1 Ecological Risk Characterization Results

The results of the ecological screening evaluation are provided in Table N-6. The results indicate that maximum concentrations exceed Low ESVs for at least one of the receptors for antimony (for the deer mouse), cadmium (for the American badger, deer mouse, ground squirrel, and CAGN), copper (for the deer mouse and CAGN), lead (for the deer mouse, CAGN, mourning dove, and red-tailed hawk), mercury (for the CAGN), and zinc (for the deer mouse, ground squirrel, and CAGN). These COPECs were retained for further evaluation in the Tier 2 assessment.

# 3.0 Tier 2 Baseline Ecological Risk Assessment (Step 3a)

This section constitutes Step 3a of Tier 2 (BERA), providing a refinement of the screening-level, conservative exposure assumptions included in the SLERA (Section 2.0). The use of refined exposure assumptions provides added reality to the exposure and risk estimates for ecological receptors, allowing for more informed risk management decisions for MRP Site UXO5. The Tier 2 assessment included the following refinements, when compared with the Tier 1 assessment:

- Use of the 95UCL to estimate exposure (EPC)
- Consideration of both Low ESVs and High ESVs

The results of Tier 2 Step 3a for terrestrial birds and mammals potentially using MRP Site UXO5 are provided in Table N-6 and summarized as follows:

**0 to 0.5 Foot bgs Soil Interval –** Using the sitewide 95UCL from the 0 to 0.5 foot bgs soil interval to estimate exposure, Low TRV-based ESVs are exceeded for four receptors:

- Deer mouse – antimony, cadmium, lead, and zinc
- CAGN – cadmium, copper, lead, and zinc
- Mourning dove – lead
- Red-tailed hawk – lead

There were no individual COPECs present in 0 to 0.5 foot bgs soil with a sitewide 95UCL exceeding the High TRV-based ESVs.

**0 to 6 Feet bgs Soil Interval –** Using the sitewide 95UCL from the 0 to 6 feet bgs soil interval to estimate exposure, Low TRV-based ESVs are exceeded for four receptors:

- Deer mouse – cadmium, lead, and zinc
- CAGN – cadmium, copper, lead, and zinc
- Mourning dove – lead
- Red-tailed hawk – lead

There were no individual COPECs present in 0 to 6 feet bgs soil with a sitewide 95UCL exceeding the High TRV-based ESVs.

The results of this ERA indicate that concentrations of COPECs found in MRP Site UXO5 soil during the SI and RI sampling are below levels that might be expected to pose ecological risk (as indicated by the High TRV-based ESVs) to receptor populations and communities for nonthreatened and nonendangered species. However, given that the CAGN was found to be present at the site, the results using the Low TRV-based ESVs are considered most appropriate for assessing the potential for adverse effects on this special-status species. Concentrations of cadmium, lead, and zinc in site soil are above the Low ESV for the CAGN, indicating a potential for risk. Although site concentrations of copper

(95UCL of 28.1 mg/kg) also exceed the Low ESV for the CAGN of 13.5 mg/kg, background concentrations of copper (95UCL of 22.4 mg/kg) also exceed the Low ESV. The incremental copper concentration (site minus background) is 5.7 mg/kg, which is below the Low ESV. Therefore, copper is not identified as a risk driver at MRP Site UXO5.

# 4.0 Summary and Conclusions from the ERA

In accordance with Navy, USEPA, and Cal-EPA guidance, this ERA used a tiered approach designed to focus the evaluation on those receptor types and COPECs considered of greatest concern. The Tier 1 SLERA used conservative assumptions to determine the chemicals, receptors, and exposure pathways to carry forward to the site-specific Tier 2 assessment and included the maximum detected concentration and Low ESVs. Tier 2 included use of refined exposure assumptions (e.g., use of areal average concentrations as represented by the 95UCL and consideration of High TRV-based ESLs) to provide more realistic estimates of exposure and risk.

Risks were estimated for terrestrial birds and mammals. These estimates were conducted under the hypothetical assumption that soil at MRP Site UXO5 is readily accessible for exposure by these receptors. Potential risks to terrestrial birds and mammals were estimated using the dosage-based food-chain uptake model and Low and High TRVs to derive ESVs.

Low TRV-based ESVs are used to estimate potential risks to special-status species. Prior to conducting the RI sampling, MRP Site UXO5 was monitored for CAGN and SKR and of these, the CAGN was found to be present at the site. Given this finding, the results using the Low TRV-based ESVs are considered most appropriate for assessing the potential for adverse effects on the CAGN and the High TRV-based ESVs are considered most appropriate for assessing the receptor populations and communities for nonthreatened and nonendangered species.

The results of this ERA indicate that concentrations of COPECs found in MRP Site UXO5 soil during the SI and RI sampling are below levels that might be expected to pose ecological risk (as indicated by the High TRV-based ESVs) to receptor populations and communities for nonthreatened and nonendangered species. However, concentrations of cadmium, lead, and zinc in site soil are above the Low ESV for the CAGN, indicating a potential for risk. Although site concentrations of copper (95UCL of 28.1 mg/kg) also exceed the Low ESV for the CAGN of 13.5 mg/kg, background concentrations of copper (95UCL of 22.4 mg/kg) also exceed the Low ESV. The incremental copper concentration (site minus background) is 5.7 mg/kg, which is below the Low ESV. Therefore, copper is not identified as a risk driver at MRP Site UXO5.

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# 5.0 Uncertainty Analysis

Full characterization of ecological risks requires that numerical estimates of ecological health risks be accompanied by a discussion of the uncertainties inherent in the assumptions used to estimate risks. Uncertainties in risk assessment methods may result in understating or overstating the ecological risks.

Risk estimates are subject to uncertainty from a variety of sources, including the following:

- Sampling, analysis, and data evaluation
- Fate and transport estimation
- Exposure estimation
- Toxicological data

These uncertainties are discussed in more detail in the following sections.

## 5.1 Sampling, Analysis, and Data Evaluation

Uncertainty associated with sampling and analysis includes the inherent variability (standard error) in the analysis, representativeness of the samples, sampling errors, and heterogeneity of the sample matrix. The quality assurance/quality control program used in the investigation serves to reduce these errors, but it cannot eliminate errors associated with sampling and analysis. The degree to which sample collection and analyses reflect real EPCs partly determines the reliability of the risk estimates.

## 5.2 Fate and Transport

This ERA makes simplifying assumptions about environmental fate and transport of COPECs; specifically, it assumes that no chemical loss or transformation occurs and that the chemical concentrations detected in site media remain constant. However, in the case of MRP Site UXO5, the COPECs in soil are metals. Therefore, natural attenuation processes are not expected to be important relative to typical wildlife exposure durations, and the analytical data chosen to represent EPCs are not likely to overstate actual long-term exposure levels.

## 5.3 Exposure

The estimation of exposure requires many assumptions that describe potential exposure situations. There are uncertainties regarding the likelihood of exposure, frequency of contact with contaminated media, the concentration of contaminants at exposure points, and the time period of exposure. The assumptions used tend to simplify and approximate actual site conditions and may overestimate or underestimate the actual risks. In general, these assumptions are intended to be conservative and yield an overestimate of the true risk or hazard.

The process for estimation of ecological exposure to birds and mammals assumes that the majority of exposure occurs via oral intake of contaminated abiotic media and from uptake

through the food web. Other routes such as dermal contact and inhalation are anticipated to contribute a smaller portion of the total overall exposure, compared to the oral route.

Bioaccumulation factors used to estimate exposure from soil are generally based on available literature-based animal studies where both collocated tissue and soil concentrations have been measured. The extent to which these studies represent the types of receptors evaluated in the ERA will affect the reliability of resulting exposure estimates.

## 5.4 Toxicological Data

Uncertainties in toxicological data can also influence the reliability of risk management decisions. Data on contaminants and their toxicity to wildlife are limited. In addition, the usefulness of existing toxicity information in assessing ecological impacts is constrained by several factors. Most wildlife toxicity information is generated by laboratory studies with selected test species. These studies frequently evaluate domestic animals under controlled laboratory conditions, with few tests involving native wildlife. Basic toxicity information can be extrapolated to native species in the wild, but consideration must be given to the species involved and specific site conditions. Where toxicity information on a particular contaminant is available for a species found onsite, consideration was given to the type of data available. In addition, because the toxicity of many elements is greatly influenced by the chemical state in which they occur in an animal's food, total concentrations of these elements in soil may not be accurate indicators of potentially toxic exposure.

The toxicity values used for quantifying risk in this assessment have varying levels of confidence that will affect how useful the resulting risk estimates are. Uncertainty factors were used for extrapolation between toxicity endpoints (e.g., NOAELs and LOAELs) during the derivation of BTAG toxicity factors and Eco-SSLs. The use of uncertainty factors in the derivation of final screening levels while striving for protectiveness may result in an overestimation of risk.

This ERA included use of both Low TRVs and High TRVs. Per DTSC guidance, exposures at or below the Low TRV dose would not be expected to produce an adverse effect and are protective of an individual special-status species or a wildlife population, while exposures above the High TRV dose would be expected to produce an adverse effect to an individual or a population of organisms. Exposures occurring within the gray area between the Low and High TRVs represent an area of some uncertainty. However, based on the results of this ERA, wildlife populations are considered within the regulatory limits (and remedial actions are therefore not warranted) because (1) wildlife exposure levels do not exceed the DTSC- and BTAG-recommended High TRVs, and (2) the Tier 2 ERA uses conservative assumptions like 100 percent bioavailability and 95UCLs.

Site-specific bioavailability data were unavailable for detected chemicals. This assessment conservatively assumes that bioavailability from soil is the same as that in the toxicological studies from which the toxicity values were derived. Depending on whether the chemical form at the site is less or more bioavailable than assumed, actual risk would be proportionately lower or higher, respectively.

# 6.0 References

Baes, C.F. III, R.D. Sharp, A.L. Sjoreen, and R.W. Shor. 1984. *A review and analysis of parameters for assessing transport of environmentally released radionuclides through agriculture.* Oak Ridge National Laboratory. ORNL-5786. 148 pp.

Bechtel Jacobs. 1998. *Empirical models for the uptake of inorganic chemicals from soil by plants.* Prepared for U.S. Department of Energy. BJC/OR-133. September 1998.

Beyer, W.N., E.E. Connor, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. *Journal of Wildlife Management*. 58:375-382.

California Department of Toxic Substances Control (DTSC). 1996. *Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities*. July 4.

California Department of Toxic Substances Control (DTSC). 1997. *Selecting Inorganic Constituents as Chemicals of Potential Concern at Risk Assessments at Hazardous Waste Sites and Permitted Facilities*. Final Policy. February.

California Environmental Protection Agency (Cal-EPA). 2000. HERD ERA Note Number 4: Use of Navy/U.S. Environmental Protection Agency Region 9 Biological Technical Assistance Group (BTAG) Toxicity Reference Values for Ecological Risk Assessment. State of California, California Environmental Protection Agency, Department of Toxic Substances Control, Human and Ecological Risk Division. December 8.

California Environmental Protection Agency (Cal-EPA). 2002. HERD ERA Note Number 5: Revised U.S. Environmental Protection Agency Region 9 Biological Technical Assistance Group (BTAG) Mammalian Toxicity Reference Value for Lead: Justification and Rationale. State of California, California Environmental Protection Agency, Department of Toxic Substances Control, Human and Ecological Risk Division. November 21.

California Environmental Protection Agency (Cal-EPA). 2009. *Currently Recommended United States Environmental Protection Agency Region 9 Biological Technical Assistance Group Mammalian and Avian Toxicity Reference Values*. State of California, California Environmental Protection Agency, Department of Toxic Substances Control. February 24.

CH2M HILL Kleinfelder, A Joint Venture (KCH). 2015. *Work Plan Remedial Investigation for Munitions Response Program Site UXO5, Naval Weapons Station Seal Beach, Detachment Fallbrook, Fallbrook, California*. February.

Gerstl, Z. 1990. Estimation of organic chemical sorption by soils. J. Contam. Hydrology 6:357-375.

Knight, Robert N. 2004. Site and Species Description for IRP MRP Site UXO5, Naval Weapons Station Seal Beach Detachment Fallbrook (Ser N45WK/0096). From Conservation Program Manager, Department of the Navy, Naval Weapons Station Seal Beach Detachment Fallbrook. Recipient: Karen Goebel, Assistant Field Supervisor, U.S. Fish and Wildlife Service. June 1.

Malcolm Pirnie, Inc. (Malcolm Pirnie). 2006. *Final Preliminary Assessment for the Munitions Response Program, Naval Weapons Station Seal Beach Detachment Fallbrook, California*. June.

Nagy, K. A. 2001. Food requirements of wild animals: predictive equations for free-living mammals, reptiles, and birds. *Nutrition Abstracts and Reviews. Series B.* 71:21R-31R.

Sample, B.E., C.M., Opresko, and G.W. Suter II. 1996. *Toxicological Benchmarks for Wildlife: 1996 Revision*. Oak Ridge National Laboratory, Oak Ridge, TN. 227 pp., ES/ER/TM-86/R3.

Sample, B.E., J.J. Beauchamp, R.A. Efroymson, G.W. Suter II, and T.L. Ashwood. 1998a. *Development and validation of bioaccumulation models for earthworms.* Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-220.

Sample, B.E., J.J. Beauchamp, R.A. Efroymson, and G.W. Suter II. 1998b. *Development and validation of bioaccumulation models for small mammals.* Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-219.

SES-TECH. 2012. *Final Basewide Metals Background Soil Study Report, Naval Weapons Stations Seal Beach, Detachment Fallbrook, Fallbrook, California.* November.

Suter II, G.W., R.A. Efroymson, B.E. Sample, and D.S. Jones. 2000. *Ecological Risk Assessment for Contaminated Sites*. CRC Press LLC, Lewis Publishers.

Tetra Tech EC, Inc. (Tetra Tech). 2009. *Final Site Inspection Report, Naval Weapons Station Seal Beach, Detachment Fallbrook, Munitions Response Program Site UXO5, Salvage Yard Burial Area, Fallbrook, California*. Prepared for Naval Facilities Engineering Command Southwest. February 4.

United States Department of the Navy (Navy). 1999. *Chief of Naval Operations. Memorandum: Navy Policy for Conducting Ecological Risk Assessments*. April 5.

United States Department of the Navy (Navy). 2003. *Navy Guidance for Conducting Ecological Risk Assessments*. Originally published April 5, 1999. Web site version last updated February 28, 2003: http://web.ead.anl.gov/ecorisk/process/pdf/index.cfm.

United States Environmental Protection Agency (USEPA). 1991a. *The Role of BTAGs in Ecological Assessment.* Office of Solid Waste and Emergency Response, EcoUpdate. Vol. 1, No. 1. Publication 9345.0-05I. September.

United States Environmental Protection Agency (USEPA). 1991b. *Ecological Assessment of Superfund Sites: an Overview.* Office of Solid Waste and Emergency Response, EcoUpdate. Vol. 1, No. 2. Publication 9345.0-05I. December.

United States Environmental Protection Agency (USEPA). 1992a. *The Role of the Natural Resource Trustees in the Superfund Process.* Office of Solid Waste and Emergency Response, EcoUpdate. Vol. 1, No. 3. Publication 9345.0-05I. March.

United States Environmental Protection Agency (USEPA). 1992b. *Developing a Work Scope for Ecological Assessments.* Office of Solid Waste and Emergency Response, EcoUpdate. Vol. 1, No. 4. Publication 9345.0-05I. May.

United States Environmental Protection Agency (USEPA). 1992c. *Briefing the BTAG: Initial Description of Setting, History, and Ecology of a Site.* Office of Solid Waste and Emergency Response, EcoUpdate. Vol. 1, No. 5. Publication 9345.0-05I. August.

United States Environmental Protection Agency (USEPA). 1992d. *Guidance for Data Usability in Risk Assessment.* Office of Solid Waste and Emergency Response. Washington D.C.

United States Environmental Protection Agency (USEPA). 1994a. *Using Toxicity Tests in Ecological Risk Assessment.* Office of Solid Waste and Emergency Response, ECO Update. Vol. 2, No. 1. Publication 9345.0-05I, EPA 540-F-94-012. September.

United States Environmental Protection Agency (USEPA). 1994b. *Catalog of Standard Toxicity Tests for Ecological Risk Assessment.* Office of Solid Waste and Emergency Response, ECO Update. Vol. 2, No. 2. Publication 9345.0-05I, EPA 540-F-94-013. September.

United States Environmental Protection Agency (USEPA). 1994c. *Field Studies for Ecological Risk Assessment.* Office of Solid Waste and Emergency Response, EcoUpdate. Vol. 2, No. 3. Publication 9345.0-05I, EPA 540-F-94-014. September.

United States Environmental Protection Agency (USEPA). 1994d. *Selecting and Using Reference Information in Superfund Ecological Risk Assessments.* Office of Solid Waste and Emergency Response, EcoUpdate. Vol. 2, No. 4. Publication 9345.0-05I, EPA 540-F-94-050. September.

United States Environmental Protection Agency (USEPA). 1996a. *Ecological Significance and Selection of Candidate Assessment Endpoints.* Office of Solid Waste and Emergency Response, EcoUpdate. Vol. 3, No. 1. Publication 9345.0-05I, EPA 540/F-95/037. January.

United States Environmental Protection Agency (USEPA). 1996b. *Ecotox Thresholds.* Office of Solid Waste and Emergency Response, EcoUpdate. Vol. 3, No. 2. Publication 9345.0-05I, EPA 540/F-95/038. January.

United States Environmental Protection Agency (USEPA). 1997. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final.* EPA/540/R-97/006. OSWER 9285.7-25. June.

United States Environmental Protection Agency (USEPA). 1998. *Final Guidelines for Ecological Risk Assessment.* Risk Assessment Forum, USEPA, Washington D.C. USEPA/630/R-95/ 002F. April.

United States Environmental Protection Agency (USEPA). 1999. *Ecological Risk Assessment and Risk Management Principles for Superfund Sites*. OSWER Directive 92857.7-28P. October.

United States Environmental Protection Agency (USEPA). 2000. *Guidance for Data Quality Assessment. Practical Methods for Data Analysis*. Office of Research and Development. Washington D.C.

United States Environmental Protection Agency (USEPA). 2001. *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments*. Office of Solid Waste and Emergency Response. EcoUpdate EPA 540/ F-01/014. June.

United States Environmental Protection Agency (USEPA). 2003a. *Ecological Soil Screening Levels for Aluminum*. Interim Final. OSWER Directive 9285.7-60. Office of Solid Waste and Emergency Response. November.

United States Environmental Protection Agency (USEPA). 2003b. *Ecological Soil Screening Levels for Iron*. Interim Final. OSWER Directive 9285.7-69, Revised. Office of Solid Waste and Emergency Response. November.

United States Environmental Protection Agency (USEPA). 2005a. *Ecological Soil Screening Levels for Antimony*. Interim Final. OSWER Directive 92857-61, Revised. Office of Solid Waste and Emergency Response. February.

United States Environmental Protection Agency (USEPA). 2005b. *Ecological Soil Screening Levels for Arsenic. Interim Final*. OSWER Directive 9285.7-62, Revised. Office of Solid Waste and Emergency Response. March.

United States Environmental Protection Agency (USEPA). 2005c. *Ecological Soil Screening Levels for Barium*. Interim Final. OSWER Directive 9285.7-63, Revised. Office of Solid Waste and Emergency Response. February.

United States Environmental Protection Agency (USEPA). 2005d. *Ecological Soil Screening Levels for Beryllium*. Interim Final. OSWER Directive 9285.7-63, Revised. Office of Solid Waste and Emergency Response. February.

United States Environmental Protection Agency (USEPA). 2005e. *Ecological Soil Screening Levels for Cadmium*. Interim Final. OSWER Directive 92857-65, Revised. Office of Solid Waste and Emergency Response. March.

United States Environmental Protection Agency (USEPA). 2005f. *Ecological Soil Screening Levels for Cobalt. Interim Final*. OSWER Directive 92857-67, Revised. Office of Solid Waste and Emergency Response. March.

United States Environmental Protection Agency (USEPA). 2005g. *Ecological Soil Screening Levels for Lead*. Interim Final. OSWER Directive 92857-70, Revised. Office of Solid Waste and Emergency Response. March.

United States Environmental Protection Agency (USEPA). 2005h. *Ecological Soil Screening Levels for Vanadium*. Interim Final. OSWER Directive 9285.7-75, Revised. Office of Solid Waste and Emergency Response. April.

United States Environmental Protection Agency (USEPA). 2007a. *Guidance for Developing Ecological Soil Screening Levels, OSWER Directive 9285.7-55, Office of Solid Waste and Emergency Response, United States Environmental Protection Agency, Washington, D.C.* Issued November 2003, revised April 2007.

United States Environmental Protection Agency (USEPA). 2007b. *Ecological Soil Screening Levels for Copper*. Interim Final. OSWER Directive 9285.7-68, Revised. Office of Solid Waste and Emergency Response. February.

United States Environmental Protection Agency (USEPA). 2007c. *Ecological Soil Screening Levels for Manganese*. Interim Final. OSWER Directive 9285.7-71, Revised. Office of Solid Waste and Emergency Response. April.

United States Environmental Protection Agency (USEPA). 2007d. *Ecological Soil Screening Levels for Nickel*. Interim Final. OSWER Directive 9285.7-76, Revised. Office of Solid Waste and Emergency Response. March.

United States Environmental Protection Agency (USEPA). 2007e. *Ecological Soil Screening Levels for Selenium*. Interim Final. OSWER Directive 9285.7-72, Revised. Office of Solid Waste and Emergency Response. July.

United States Environmental Protection Agency (USEPA). 2007f. *Ecological Soil Screening Levels for Zinc*. Interim Final. OSWER Directive 9285.7-73, Revised. Office of Solid Waste and Emergency Response. June.

United States Environmental Protection Agency (USEPA). 2008. *Ecological Soil Screening Levels for Chromium. Interim Final. OSWER Directive 9285.7-66, Revised*. Office of Solid Waste and Emergency Response. April.

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# Tables

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TABLE N-1

Selection of Chemicals of Potential Ecological Concern

*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

| Analyte | 0 to 0.5 feet bgs Maximum Concentration (mg/kg) | 0 to 6 feet bgs Maximum Concentration (mg/kg) | Background Threshold Value[a] | Ecological Soil Screening Level (Eco-SSL) Plant (mg/kg) | Soil Invert. (mg/kg) | Birds (mg/kg) | Mammals (mg/kg) | Source | Selected as COPEC? 0 to 0.5 feet bgs | 0 to 6 feet bgs |
|---|---|---|---|---|---|---|---|---|---|---|
| Aluminum | 26,500 J | 26,800 | 28,333 | Narrative statement[b] | | | | USEPA, 2003a | No | No |
| Antimony | 5.94 | 5.94 | NA | NA | 78 | N/A | 0.27 | USEPA 2005a | **Yes** | **Yes** |
| Arsenic | 5.2 J | 5.2 J | 3.07 | 18 | N/A | 43 | 46 | USEPA, 2005b | No | No |
| Barium | 257 | 257 | 503 | NA | 330 | N/A | 2,000 | USEPA, 2005c | No | No |
| Beryllium | 0.26 J | 0.27 J | 0.72 | NA | 40 | N/A | 21 | USEPA, 2005d | No | No |
| Cadmium | 13.0 | 27.8 | 0.20 | 32 | 140 | 0.77 | 0.36 | USEPA, 2005e | **Yes** | **Yes** |
| Chromium | 49.6 | 49.6 | 58.9 | NA | N/A | 26 | 34 | USEPA, 2008 | No | No |
| Chromium VI | 0.17 | 0.72 | NA | NA | N/A | N/A | 130 | USEPA, 2008 | No | No |
| Cobalt | 19.6 | 19.6 | 16.0 | 13 | N/A | 120 | 230 | USEPA, 2005f | **Yes** | **Yes** |
| Copper | 108 | 108 | 103 | 70 | 80 | 28 | 49 | USEPA, 2007b | **Yes** | **Yes** |
| Iron | 30,000 | 36,400 | 43,815 | Narrative statement[b] | | | | USEPA, 2003b | No | No |
| Lead | 227 J | 227 J | 7.41 | 120 | 1,700 | 11 | 56 | USEPA, 2005g | **Yes** | **Yes** |
| Manganese | 319 J | 365 | 480 | 220 | 450 | 4,300 | 4,000 | USEPA, 2007c | No | No |
| Mercury | 0.105 | 0.105 | 0.020 | NA | NA | NA | NA | NA | **Yes** | **Yes** |
| Molybdenum | 1.40 J | 1.40 J | NA | NA | NA | NA | NA | NA | **Yes** | **Yes** |
| Nickel | 12.8 | 12.8 | 11.9 | 38 | 280 | 210 | 130 | USEPA, 2007d | No | No |
| Selenium | 0.36 J | 0.36 J | 0.48 | 0.52 | 4.1 | 1.2 | 0.63 | USEPA, 2007e | No | No |
| Silver | 0.31 J | 0.31 J | 0.094 | 560 | NA | 4.2 | 14.0 | USEPA, 2006 | No | No |
| Strontium | 51.7 | 51.7 | 145 | NA | NA | NA | NA | NA | No | No |
| Thallium | 0.40 J | 0.43 J | 0.60 | NA | NA | NA | NA | NA | No | No |
| Vanadium | 143 | 143 | 216 | NA | NA | 7.8 | 280 | USEPA, 2005h | No | No |
| Zinc | 1,200 | 1,200 | 44.9 | 160 | 120 | 46 | 79 | USEPA, 2007f | **Yes** | **Yes** |

Notes:

[a] BTVs are installation-specific upper tolerance limits developed in SES-TECH (2012). BTVs for the Kgb (Gabbro) parent rock type are used, based on the prevalence of this rock type where MRP Site UXO5 is located.

[b] Soil pH conditions at the site make ecological exposure and risk from these metals unlikely.

bgs = below ground surface

BTV = background threshold value

ECO-SSL = Ecological Soil Screening Level

COPEC = constituent of potential ecological concern

J = The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram per kilogram

MRP = Munitions Response Program

ND = not detected

NA = not available

NAVWPNSTA = Naval Weapons Station

Shaded = below background

USEPA = United States Environmental Protection Agency

UXO = unexploded ordnance

TABLE N-1

Selection of Chemicals of Potential Ecological Concern

*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

Sources:

United States Environmental Protection Agency (USEPA). 2003a. Ecological Soil Screening Levels for Aluminum. Interim Final. OSWER Directive 9285.7-60. Office of Solid Waste and Emergency Response. November.

United States Environmental Protection Agency (USEPA). 2003b. Ecological Soil Screening Levels for Iron. Interim Final. OSWER Directive 9285.7-69, Revised. Office of Solid Waste and Emergency Response. November.

United States Environmental Protection Agency (USEPA). 2005a. Ecological Soil Screening Levels for Antimony. Interim Final. OSWER Directive 92857-61, Revised. Office of Solid Waste and Emergency Response. February.

United States Environmental Protection Agency (USEPA). 2005b. Ecological Soil Screening Levels for Arsenic. Interim Final. OSWER Directive 9285.7-62, Revised. Office of Solid Waste and Emergency Response. March.

United States Environmental Protection Agency (USEPA). 2005c. Ecological Soil Screening Levels for Barium. Interim Final. OSWER Directive 9285.7-63, Revised. Office of Solid Waste and Emergency Response. February.

United States Environmental Protection Agency (USEPA). 2005d. Ecological Soil Screening Levels for Beryllium. Interim Final. OSWER Directive 9285.7-63, Revised. Office of Solid Waste and Emergency Response. February.

United States Environmental Protection Agency (USEPA). 2005e. Ecological Soil Screening Levels for Cadmium. Interim Final. OSWER Directive 92857-65, Revised. Office of Solid Waste and Emergency Response. March.

United States Environmental Protection Agency (USEPA). 2005f. Ecological Soil Screening Levels for Cobalt. Interim Final. OSWER Directive 92857-67, Revised. Office of Solid Waste and Emergency Response. March.

United States Environmental Protection Agency (USEPA). 2005g. Ecological Soil Screening Levels for Lead. Interim Final. OSWER Directive 92857-70, Revised. Office of Solid Waste and Emergency Response. March.

United States Environmental Protection Agency (USEPA). 2005h. Ecological Soil Screening Levels for Vanadium. Interim Final. OSWER Directive 9285.7-75, Revised. Office of Solid Waste and Emergency Response. April.

United States Environmental Protection Agency (USEPA). 2006. Ecological Soil Screening Levels for Silver. Interim Final. OSWER Directive 9285.7-75, Revised. Office of Solid Waste and Emergency Response. September.

United States Environmental Protection Agency (USEPA). 2007b. Ecological Soil Screening Levels for Copper. Interim Final. OSWER Directive 9285.7-68, Revised. Office of Solid Waste and Emergency Response. February.

United States Environmental Protection Agency (USEPA). 2007c. Ecological Soil Screening Levels for Manganese. Interim Final. OSWER Directive 9285.7-71, Revised. Office of Solid Waste and Emergency Response. April.

United States Environmental Protection Agency (USEPA). 2007d. Ecological Soil Screening Levels for Nickel. Interim Final. OSWER Directive 9285.7-76, Revised. Office of Solid Waste and Emergency Response. March.

United States Environmental Protection Agency (USEPA). 2007e. Ecological Soil Screening Levels for Selenium. Interim Final. OSWER Directive 9285.7-72, Revised. Office of Solid Waste and Emergency Response. July.

United States Environmental Protection Agency (USEPA). 2007f. Ecological Soil Screening Levels for Zinc. Interim Final. OSWER Directive 9285.7-73, Revised. Office of Solid Waste and Emergency Response. June.

United States Environmental Protection Agency (USEPA). 2008. Ecological Soil Screening Levels for Chromium. Interim Final. OSWER Directive 9285.7-66, Revised. Office of Solid Waste and Emergency Response. April.

TABLE N-2
Ecological Endpoints and Measures of Exposure and Effect for the Ecological Risk Assessment
*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

| Functional Group | Assessment Endpoint | Representative Endpoints | Measure of Exposure | Measure of Effect |
|---|---|---|---|---|
| Herbivorous Birds | Survival and health of herbivorous birds using areas with suitable habitat, and potentially exposed to constituents in soil and forage items | Mourning dove (*Zenaida macrocura*) | Measured constituent levels in soil; modeled constituent levels in food items | Literature-based chronic LOAEL for bird populations and NOAEL for T&E species |
| Insectivorous/ Omnivorous Birds | Survival and health of insectivorous/omnivorous birds using areas with suitable habitat, and potentially exposed to constituents in soil and forage/prey items | California gnatcatcher (*Polioptila californica*) | Measured constituent levels in soil; modeled constituent levels in food items | Literature-based chronic NOAEL for T&E species |
| Upland Raptors | Survival and health of raptors using onsite areas with suitable habitat, and potentially exposed to constituents in soil and prey items | Red-tailed hawk (*Buteo jamaicensis*) | Measured constituent levels in soil; modeled constituent levels in food items | Literature-based chronic LOAEL for bird populations and NOAEL for T&E species |
| Small Herbivorous Mammals (fossorial) | Survival and health of herbivorous mammals using onsite areas with suitable habitat, and potentially exposed to constituents in soil and forage items | California ground squirrel (*Spermophilus beecheyi*) | Measured constituent levels in soil; modeled constituent levels in food items | Literature-based chronic LOAEL for mammal populations and NOAEL for T&E species |
| Small Insectivorous/ Omnivorous Mammals | Survival and health of insectivorous/omnivorous mammals using onsite areas with suitable habitat, and potentially exposed to constituents in soil and prey/forage items | Deer mouse (*Peromyscus maniculatus*) | Measured constituent levels in soil; modeled constituent levels in food items | Literature-based chronic LOAEL for mammal populations and NOAEL for T&E species |
| Carnivorous Mammals (fossorial) | Survival and health of carnivorous mammals using onsite areas with suitable habitat, and potentially exposed to constituents in soil and prey items | American badger (*Taxidea taxus*) | Measured constituent levels in soil; modeled constituent levels in food items | Literature-based chronic LOAEL for mammal populations and NOAEL for T&E species |

Notes:
LOAEL = lowest observed adverse effect level
MRP = Munitions Response Program
NAVWPNSTA = Naval Weapons Station
NOAEL = no observed adverse effect level
T&E = threatened and endangered
UXO = unexploded ordnance

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TABLE N-3
Toxicity Reference Values for Birds - Ingestion of Soil and Food Chain Uptake
*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

| | | Derivation of Low TRV | | | | | | | | | | | | Derivation of High TRV | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Toxicity Information | | | | | | | | Conversion Factors | | | | Toxicity Information | | | | | | | | Conversion Factors | | |
| **Chemical** | **CAS#** | **Test Species** | **Exposure Duration** | **Toxicity Value (mg/kg-d)** | **Endpoint** | **Type** | **Effects** | **Comments** | **Citation** | **Acute $LD_{50}$ to chronic NOAEL UF** | **LOAEL to NOAEL UF** | **Subchronic-to-Chronic UF** | **Final Low TRV (mg/kg-d)** | **Test Species** | **Exposure Duration** | **Toxicity Value (mg/kg-d)** | **Study Endpoint** | **Type** | **Effects** | **Comments** | **Citation** | **$LD_{50}$ to LOAEL UF** | **Subchronic-to-Chronic UF** | **Final High TRV (mg/kg-d)** |
| Antimony | 7440360 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Cadmium | 7440439 | Wood Duck | -- | 0.7 | Low TRV | -- | Kidney histology | -- | Cal-EPA, 2009 | 1 | 1 | 1 | 0.70 | Mallard Duck | -- | 10.4 | High TRV | -- | Kidney histology | -- | Cal-EPA, 2009 | 1 | 1 | 10.4 |
| Cobalt | 7440484 | Chicken and duck | Various | 7.61 | NOAEL | -- | Growth | geometric mean of five studies | USEPA Eco-SSLs for Cobalt (USEPA, 2005f) | 1 | 1 | 1 | 7.61 | chicken/ duck | Various | 18.00 | LOAEL | -- | Growth and Reproduction | Geometric mean of LOAEL for reproduction and growth | USEPA Eco-SSLs for Cobalt (USEPA, 2005f) | 1 | 1 | 18 |
| Copper | 7440508 | Chicken | -- | 2.3 | Low TRV | -- | Growth | -- | Cal-EPA, 2009 | 1 | 1 | 1 | 2.3 | Chicken | -- | 52.3 | High TRV | -- | Growth, gizzard erosion | -- | Cal-EPA, 2009 | 1 | 1 | 52.3 |
| Lead | 7439921 | Quail | -- | 0.014 | Low TRV | -- | Reproduction | -- | Cal-EPA, 2009 | 1 | 1 | 1 | 0.014 | Chicken | -- | 8.75 | High TRV | -- | Reproduction | -- | Cal-EPA, 2009 | 1 | 1 | 8.75 |
| Mercury | 7439976 | Mallard Duck | -- | 0.039 | NOAEL | -- | Reproductive | -- | Cal-EPA, 2009 | 1 | 1 | 1 | 0.039 | Mallard duck | -- | 0.18 | LOAEL | -- | Mortality, neurological | -- | Cal-EPA, 2009 | 1 | 1 | 0.18 |
| Molybdenur | 7439987 | Chicken | 21 days | 3.5 | NOAEL | chronic | Reproduction - embryonic viability | during critical lifestage | Sample et al., 1996 | 1 | 1 | 1 | 3.53 | Chicken | 21 days | 35.3 | LOAEL | chronic | Reproduction - embryonic viability | critical lifestage | Sample et al., 1996 | 1 | 1 | 35.3 |
| Zinc | 7440666 | Mallard Duck | -- | 17.2 | Low TRV | -- | Growth, reproduction, multiple organs | -- | Cal-EPA, 2009 | 1 | 1 | 1 | 17.2 | Mallard Duck | -- | 172 | High TRV | -- | Growth, reproduction, multiple organs | -- | Cal-EPA, 2009 | 1 | 1 | 172 |

Notes:
-- not available, could not be located, or not applicable
Cal-EPA = California Environmental Protection Agency
CAS = Chemical Abstracts Service
Eco-SSL = ecological soil screening level
LOAEL = lowest observed adverse effect level
$LD_{50}$ = lethal dose to 50 percent of a test population
mg/kg-d = milligrams per kilogram body weight per day
MRP = Munitions Response Program
NAVWPNSTA = Naval Weapons Station
NOAEL = no observed adverse effect level
TRV = toxicity reference value
UF = uncertainty factor
USEPA = United States Environmental Protection Agency
UXO = unexploded ordnance
Sources:
California Environmental Protection Agency (Cal-EPA). 2009. Currently Recommended United States Environmental Protection Agency Region 9 Biological Technical Assistance Group Mammalian and Avian Toxicity Reference Values. State of California, California Environmental Protection Agency, Department of Toxic Substances Control. February 24.
Sample, B.E., C.M., Opresko, and G.W. Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. 227 pp., ES/ER/TM-86/R3.
United States Environmental Protection Agency (USEPA). 2005f. Ecological Soil Screening Levels for Cobalt. Interim Final. OSWER Directive 92857-67, Revised. Office of Solid Waste and Emergency Response. March.

TABLE N-4

Toxicity Reference Values for Mammals - Ingestion of Soil and Food Chain Uptake

*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

| | | Derivation of Low TRV | | | | | | | | | | | | Derivation of High TRV | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Toxicity Information | | | | | | | | Conversion Factors | | | | Toxicity Information | | | | | | | | | Conversion Factors | | |
| **Chemical** | **CAS#** | **Test Species** | **Exposure Duration** | **Low Toxicity Value (mg/kg-d)** | **Endpoint** | **Type** | **Effects** | **Comments** | **Citation** | **$LD_{50}$ to Chronic NOAEL** | **LOAEL-to-NOAEL UF** | **Subchronic-to-Chronic UF** | **Final Low TRV (mg/kg-d)** | **Test Species** | **Body Weight** | **Duration** | **High Toxicity Value (mg/kg-d)** | **Endpoint** | **Type** | **Effects** | **Additional Comments** | **Citation** | **$LD_{50}$ to LOAEL** | **Subchronic-to-Chronic UF** | **Final High TRV (mg/kg-d)** |
| Antimony | 7440360 | Rat | 31 days gestation | 0.0590 | NOAEL | Chronic | Reproduction - progeny weight | -- | USEPA Eco-SSLs for Antimony (USEPA, 2005a) | 1 | 1 | 1 | 0.0590 | Rat/mouse | -- | various | 2.8 | LOAEL | -- | Growth and Reproduction | Geometric mean of LOAEL for reproduction and growth | USEPA Eco-SSLs for Antimony (USEPA, 2005a) | 1 | 1 | 2.8 |
| Cadmium | 7440439 | Mouse | -- | 0.06 | Low TRV | -- | Reproduction | -- | Cal-EPA, 2009 | 1 | 1 | 1 | 0.06 | Mouse | -- | -- | 2.64 | High TRV | -- | Reproductive | -- | Cal-EPA, 2009 | 1 | 1 | 2.64 |
| Cobalt | 7440484 | Rat | -- | 1.2 | Low TRV | -- | reproduction | -- | Cal-EPA, 2009 | 1 | 1 | 1 | 1.2 | Rat | -- | -- | 20 | High TRV | -- | Reproductive | -- | Cal-EPA, 2009 | 1 | 1 | 20 |
| Copper | 7440508 | Mouse | -- | 2.67 | Low TRV | -- | Immunotoxicity | -- | Cal-EPA, 2009 | 1 | 1 | 1 | 2.67 | Mouse | -- | -- | 632 | High TRV | -- | Mortality, growth, water consumption | -- | Cal-EPA, 2009 | 1 | 1 | 632 |
| Lead | 7439921 | Rat | -- | 1.0 | Low TRV | -- | Kidney | -- | Cal-EPA, 2009 | 1 | 1 | 1 | 1 | Mouse | -- | -- | 241 | High TRV | -- | Growth, liver, kidney | -- | Cal-EPA, 2009 | 1 | 1 | 241 |
| Mercury | 7439976 | Rat | -- | 0.25 | Low TRV | -- | Reproductive, developmental | -- | Cal-EPA, 2009 | 1 | 1 | 1 | 0.25 | Rat | -- | -- | 4 | LOAEL | -- | Reproductive, developmental | -- | Cal-EPA, 2009 | 1 | 1 | 4 |
| Molybdenum | 7439987 | Mouse | 3 generations | 0.26 | NOAEL | Chronic | Reduced reproductive success | NOAEL not determined in study; LOAEL adjusted to NOAEL in Sample et al. | Sample et al., 1996 | 1 | 1 | 1 | 0.26 | Mouse | 0.03 | 3 generations | 2.6 | LOAEL | Chronic | Reduced reproductive success | -- | Sample et al., 1996 | 1 | 1 | 2.6 |
| Zinc | 7440666 | Mouse | -- | 9.60 | Low TRV | -- | Pancreatic, adrenal cortex | -- | Cal-EPA, 2009 | 1 | 1 | 1 | 9.6 | Rat | -- | -- | 411 | High TRV | -- | Developmental | -- | Cal-EPA, 2009 | 1 | 1 | 411 |

Notes:

-- not available, could not be located, or not applicable

Cal-EPA = California Environmental Protection Agency

CAS = Chemical Abstracts Service

Eco-SSL = ecological soil screening level

LOAEL = lowest observed adverse effect level

$LD_{50}$ = lethal dose to 50 percent of a test population

mg/kg-d = milligrams per kilogram body weight per day

MRP = Munitions Response Program

NAVWPNSTA = Naval Weapons Station

NOAEL = no observed adverse effect level

TRV = toxicity reference value

UF = uncertainty factor

USEPA = United States Environmental Protection Agency

UXO = unexploded ordnance

Sources:

California Environmental Protection Agency (Cal-EPA). 2009. Currently Recommended United States Environmental Protection Agency Region 9 Biological Technical Assistance Group Mammalian and Avian Toxicity Reference Values. State of California, California Environmental Protection Agency, Department of Toxic Substances Control. February 24.

Sample, B.E., C.M., Opresko, and G.W. Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. 227 pp., ES/ER/TM-86/R3.

United States Environmental Protection Agency (USEPA). 2005a. Ecological Soil Screening Levels for Antimony. Interim Final. OSWER Directive 92857-61, Revised. Office of Solid Waste and Emergency Response. February.

TABLE N-5
TRV-Based ESVs for Chemicals of Potential Ecological Concern
*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

| | | Life History Parameters | | | Exposure and Uptake Values | | | | | | | | | | Uptake by Plants | | Uptake by Invertebrates | | Uptake by Small Mammals | | Incidental Soil Ingestion | | | TRVs | | Target HQ | | Receptor-specific ESVs (mg/kg) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | Receptor | Body Weight (kg) | Food Intake (mg/kg-day)[a] | Area Use Factor | Plant BAF/ Regression | Source | Plant Concentration Estimated from BAF | Invertebrate BAF/ Regression | LogKow | Source | Estimated Invertebrate Concentration | Small mammal BAF/ Regression | Source | Estimated Small Mammal Concentration | Diet Proportion | Dosage from Plants (mg/kg-day) | Diet Proportion | Dosage from Invertebrates (mg/kg-day) | Diet Proportion | Dosage from Small Mammals (mg/kg-day) | Diet Proportion | Incidental Soil Dosage (mg/kg-day) | Total Daily Dosage (mg/kg-day) | Low TRV (mg/kg-day) | High TRV (mg/kg-day) | Low TRV-based HQ | High TRV-based HQ | Low ESV | High ESV |
| Antimony | American badger | 4 | 0.033 | 1 | =EXP(-3.233+0.938*LN(Cs)) | USEPA, 2007a | 1.1E+00 | 1.0 | 0.73 | Default | 3.4E+01 | 0.05x[diet] | USEPA, 2005a | 3.5E-02 | -- | -- | -- | -- | 1.0 | 1.15E-03 | 0.052 | 5.79E-02 | 5.90E-02 | 0.059 | 2.8 | 1.0 | 1.0 | 33.7 | 1,020 |
| | Deer mouse | 0.0193 | 0.170 | 1 | =EXP(-3.233+0.938*LN(Cs)) | USEPA, 2007a | 2.2E-02 | 1.0 | 0.73 | Default | 5.5E-01 | 0.05x[diet] | USEPA, 2005a | 9.2E-06 | 0.4 | 1.52E-03 | 0.6 | 5.56E-02 | -- | -- | 0.02 | 1.85E-03 | 5.90E-02 | 0.059 | 2.8 | 1.0 | 1.0 | 0.55 | 26.0 |
| | Ground squirrel | 0.16 | 0.034 | 1 | =EXP(-3.233+0.938*LN(Cs)) | USEPA, 2007a | 6.8E-01 | 1.0 | 0.73 | Default | 2.1E+01 | 0.05x[diet] | USEPA, 2005a | 1.3E-02 | 1.0 | 2.28E-02 | -- | -- | -- | -- | 0.052 | 3.62E-02 | 5.90E-02 | 0.059 | 2.8 | 1.0 | 1.0 | 20.8 | 1,076 |
| | California gnatcatcher | 0.006 | 0.318 | 1 | =EXP(-3.233+0.938*LN(Cs)) | USEPA, 2007a | 3.2E-03 | 1.0 | 0.73 | Default | 6.9E-02 | 0.05x[diet] | USEPA, 2005a | 1.5E-07 | -- | -- | 1.0 | 2.19E-02 | -- | -- | 0.020 | 4.37E-04 | 2.23E-02 | -- | -- | -- | -- | -- | -- |
| | Mourning dove | 0.091 | 0.054 | 1 | =EXP(-3.233+0.938*LN(Cs)) | USEPA, 2007a | 2.5E-02 | 1.0 | 0.73 | Default | 6.2E-01 | 0.05x[diet] | USEPA, 2005a | 1.2E-05 | 1.0 | 1.35E-03 | -- | -- | -- | -- | 0.061 | 2.03E-03 | 3.39E-03 | -- | -- | -- | -- | -- | -- |
| | Red-tailed hawk | 0.96 | 0.084 | 1 | =EXP(-3.233+0.938*LN(Cs)) | USEPA, 2007a | 7.5E-04 | 1.0 | 0.73 | Default | 1.5E-02 | 0.05x[diet] | USEPA, 2005a | 6.7E-09 | -- | -- | -- | -- | 1.0 | 5.59E-10 | 0.024 | 2.95E-05 | 2.95E-05 | -- | -- | -- | -- | -- | -- |
| Cadmium | American badger | 4 | 0.033 | 1 | =EXP(-0.475+0.546*LN(Cs)) | USEPA, 2007a | 2.7E+00 | =EXP(2.114+0.795*LN(Cs)) | -0.07 | USEPA, 2007a | 7.2E+01 | =EXP(-1.2571+0.4723*LN(Cs)) | USEPA, 2007a | 1.0E+00 | -- | -- | -- | -- | 1.0 | 3.39E-02 | 0.052 | 2.61E-02 | 6.00E-02 | 0.06 | 2.64 | 1.0 | 1.0 | 15.2 | 1,372 |
| | Deer mouse | 0.0193 | 0.170 | 1 | =EXP(-0.475+0.546*LN(Cs)) | USEPA, 2007a | 9.4E-02 | =EXP(2.114+0.795*LN(Cs)) | -0.07 | USEPA, 2007a | 5.2E-01 | =EXP(-1.2571+0.4723*LN(Cs)) | USEPA, 2007a | 5.5E-02 | 0.4 | 6.36E-03 | 0.6 | 5.36E-02 | -- | -- | 0.02 | 1.06E-04 | 6.00E-02 | 0.06 | 2.64 | 1.0 | 1.0 | 0.031 | 3.99 |
| | Ground squirrel | 0.16 | 0.034 | 1 | =EXP(-0.475+0.546*LN(Cs)) | USEPA, 2007a | 1.5E+00 | =EXP(2.114+0.795*LN(Cs)) | -0.07 | USEPA, 2007a | 3.0E+01 | =EXP(-1.2571+0.4723*LN(Cs)) | USEPA, 2007a | 6.2E-01 | 1.0 | 5.10E-02 | -- | -- | -- | -- | 0.052 | 8.98E-03 | 6.00E-02 | 0.06 | 2.64 | 1.0 | 1.0 | 5.15 | 997 |
| | California gnatcatcher | 0.006 | 0.318 | 1 | =EXP(-0.475+0.546*LN(Cs)) | USEPA, 2007a | 2.5E-01 | =EXP(2.114+0.795*LN(Cs)) | -0.07 | USEPA, 2007a | 2.2E+00 | =EXP(-1.2571+0.4723*LN(Cs)) | USEPA, 2007a | 1.3E-01 | -- | -- | 1.0 | 6.99E-01 | -- | -- | 0.020 | 1.20E-03 | 7.00E-01 | 0.7 | 10.4 | 1.0 | 1.0 | 0.19 | 5.6 |
| | Mourning dove | 0.091 | 0.054 | 1 | =EXP(-0.475+0.546*LN(Cs)) | USEPA, 2007a | 7.4E+00 | =EXP(2.114+0.795*LN(Cs)) | -0.07 | USEPA, 2007a | 3.0E+02 | =EXP(-1.2571+0.4723*LN(Cs)) | USEPA, 2007a | 2.4E+00 | 1.0 | 3.96E-01 | -- | -- | -- | -- | 0.061 | 3.04E-01 | 7.00E-01 | 0.7 | 10.4 | 1.0 | 1.0 | 92.5 | 2,445 |
| | Red-tailed hawk | 0.96 | 0.084 | 1 | =EXP(-0.475+0.546*LN(Cs)) | USEPA, 2007a | 1.1E+01 | =EXP(2.114+0.795*LN(Cs)) | -0.07 | USEPA, 2007a | 5.6E+02 | =EXP(-1.2571+0.4723*LN(Cs)) | USEPA, 2007a | 3.5E+00 | -- | -- | -- | -- | 1.0 | 2.93E-01 | 0.024 | 4.07E-01 | 7.00E-01 | 0.7 | 10.4 | 1.0 | 1.0 | 202 | 4,531 |
| Cobalt | American badger | 4 | 0.033 | 1 | 0.0075 | USEPA, 2007a | 2.3E+00 | 0.122 | 0.23 | USEPA, 2007a | 3.7E+01 | =EXP(-4.4669+1.307*LN(Cs)) | USEPA, 2007a | 2.0E+01 | -- | -- | -- | -- | 1.0 | 6.74E-01 | 0.052 | 5.26E-01 | 1.20E+00 | 1.2 | 20 | 1.0 | 1.0 | 306 | 3,207 |
| | Deer mouse | 0.0193 | 0.170 | 1 | 0.0075 | USEPA, 2007a | 5.5E-01 | 0.122 | 0.23 | USEPA, 2007a | 8.9E+00 | =EXP(-4.4669+1.307*LN(Cs)) | USEPA, 2007a | 3.1E+00 | 0.4 | 3.74E-02 | 0.6 | 9.13E-01 | -- | -- | 0.02 | 2.49E-01 | 1.20E+00 | 1.2 | 20 | 1.0 | 1.0 | 73.4 | 1,223 |
| | Ground squirrel | 0.16 | 0.034 | 1 | 0.0075 | USEPA, 2007a | 4.5E+00 | 0.122 | 0.23 | USEPA, 2007a | 7.3E+01 | =EXP(-4.4669+1.307*LN(Cs)) | USEPA, 2007a | 4.9E+01 | 1.0 | 1.51E-01 | -- | -- | -- | -- | 0.052 | 1.05E+00 | 1.20E+00 | 1.2 | 20 | 1.0 | 1.0 | 602 | 10,033 |
| | California gnatcatcher | 0.006 | 0.318 | 1 | 0.0075 | USEPA, 2007a | 1.3E+00 | 0.122 | 0.23 | USEPA, 2007a | 2.1E+01 | =EXP(-4.4669+1.307*LN(Cs)) | USEPA, 2007a | 9.3E+00 | -- | -- | 1.0 | 6.54E+00 | -- | -- | 0.020 | 1.07E+00 | 7.61E+00 | 7.61 | 18 | 1.0 | 1.0 | 168 | 398 |
| | Mourning dove | 0.091 | 0.054 | 1 | 0.0075 | USEPA, 2007a | 1.5E+01 | 0.122 | 0.23 | USEPA, 2007a | 2.5E+02 | =EXP(-4.4669+1.307*LN(Cs)) | USEPA, 2007a | 2.5E+02 | 1.0 | 8.33E-01 | -- | -- | -- | -- | 0.061 | 6.78E+00 | 7.61E+00 | 7.61 | 18 | 1.0 | 1.0 | 2,064 | 4,882 |
| | Red-tailed hawk | 0.96 | 0.084 | 1 | 0.0075 | USEPA, 2007a | 6.0E+00 | 0.122 | 0.23 | USEPA, 2007a | 9.8E+01 | =EXP(-4.4669+1.307*LN(Cs)) | USEPA, 2007a | 7.1E+01 | -- | -- | -- | -- | 1.0 | 6.00E+00 | 0.024 | 1.61E+00 | 7.61E+00 | 7.61 | 18 | 1.0 | 1.0 | 800 | 1,595 |
| Copper | American badger | 4 | 0.033 | 1 | =EXP(0.668+0.394*LN(Cs)) | USEPA, 2007a | 3.1E+01 | 0.515 | -0.57 | USEPA, 2007a | 5.9E+02 | =EXP(2.042+0.1444*LN(Cs)) | USEPA, 2007a | 2.1E+01 | -- | -- | -- | -- | 1.0 | 7.04E-01 | 0.052 | 1.97E+00 | 2.67E+00 | 2.67 | 632 | 1.0 | 1.0 | 1,146 | 366,935 |
| | Deer mouse | 0.0193 | 0.170 | 1 | =EXP(0.668+0.394*LN(Cs)) | USEPA, 2007a | 8.2E+00 | 0.515 | -0.57 | USEPA, 2007a | 1.9E+01 | =EXP(2.042+0.1444*LN(Cs)) | USEPA, 2007a | 1.3E+01 | 0.4 | 5.55E-01 | 0.6 | 1.99E+00 | -- | -- | 0.02 | 1.29E-01 | 2.67E+00 | 2.67 | 632 | 1.0 | 1.0 | 37.8 | 11,195 |
| | Ground squirrel | 0.16 | 0.034 | 1 | =EXP(0.668+0.394*LN(Cs)) | USEPA, 2007a | 2.9E+01 | 0.515 | -0.57 | USEPA, 2007a | 5.0E+02 | =EXP(2.042+0.1444*LN(Cs)) | USEPA, 2007a | 2.1E+01 | 1.0 | 9.81E-01 | -- | -- | -- | -- | 0.052 | 1.69E+00 | 2.67E+00 | 2.67 | 632 | 1.0 | 1.0 | 969 | 356,693 |
| | California gnatcatcher | 0.006 | 0.318 | 1 | =EXP(0.668+0.394*LN(Cs)) | USEPA, 2007a | 5.4E+00 | 0.515 | -0.57 | USEPA, 2007a | 7.0E+00 | =EXP(2.042+0.1444*LN(Cs)) | USEPA, 2007a | 1.1E+01 | -- | -- | 1.0 | 2.21E+00 | -- | -- | 0.020 | 8.60E-02 | 2.30E+00 | 2.3 | 52.3 | 1.0 | 1.0 | 13.5 | 307 |
| | Mourning dove | 0.091 | 0.054 | 1 | =EXP(0.668+0.394*LN(Cs)) | USEPA, 2007a | 2.0E+01 | 0.515 | -0.57 | USEPA, 2007a | 1.9E+02 | =EXP(2.042+0.1444*LN(Cs)) | USEPA, 2007a | 1.8E+01 | 1.0 | 1.08E+00 | -- | -- | -- | -- | 0.061 | 1.22E+00 | 2.30E+00 | 2.3 | 52.3 | 1.0 | 1.0 | 371 | 14,516 |
| | Red-tailed hawk | 0.96 | 0.084 | 1 | =EXP(0.668+0.394*LN(Cs)) | USEPA, 2007a | 2.0E+01 | 0.515 | -0.57 | USEPA, 2007a | 2.0E+02 | =EXP(2.042+0.1444*LN(Cs)) | USEPA, 2007a | 1.8E+01 | -- | -- | -- | -- | 1.0 | 1.53E+00 | 0.024 | 7.72E-01 | 2.30E+00 | 2.3 | 52.3 | 1.0 | 1.0 | 383 | 24,564 |
| Lead | American badger | 4 | 0.033 | 1 | =EXP(-1.328+0.561*LN(Cs)) | USEPA, 2007a | 6.7E+00 | =EXP(-0.218+0.807*LN(Cs)) | 0.73 | USEPA, 2007a | 8.4E+01 | =EXP(0.0761+0.4422*LN(Cs)) | USEPA, 2007a | 1.4E+01 | -- | -- | -- | -- | 1.0 | 4.55E-01 | 0.052 | 5.44E-01 | 9.99E-01 | 1.0 | 241 | 1.0 | 1.0 | 317 | 136,498 |
| | Deer mouse | 0.0193 | 0.170 | 1 | =EXP(-1.328+0.561*LN(Cs)) | USEPA, 2007a | 1.3E+00 | =EXP(-0.218+0.807*LN(Cs)) | 0.73 | USEPA, 2007a | 8.3E+00 | =EXP(0.0761+0.4422*LN(Cs)) | USEPA, 2007a | 3.9E+00 | 0.4 | 9.13E-02 | 0.6 | 8.47E-01 | -- | -- | 0.02 | 6.14E-02 | 1.00E+00 | 1.0 | 241 | 1.0 | 1.0 | 18.0 | 14,540 |
| | Ground squirrel | 0.16 | 0.034 | 1 | =EXP(-1.328+0.561*LN(Cs)) | USEPA, 2007a | 7.9E+00 | =EXP(-0.218+0.807*LN(Cs)) | 0.73 | USEPA, 2007a | 1.1E+02 | =EXP(0.0761+0.4422*LN(Cs)) | USEPA, 2007a | 1.6E+01 | 1.0 | 2.64E-01 | -- | -- | -- | -- | 0.052 | 7.36E-01 | 1.00E+00 | 1.0 | 241 | 1.0 | 1.0 | 423 | 134,451 |
| | California gnatcatcher | 0.006 | 0.318 | 1 | =EXP(-1.328+0.561*LN(Cs)) | USEPA, 2007a | 3.5E-02 | =EXP(-0.218+0.807*LN(Cs)) | 0.73 | USEPA, 2007a | 4.3E-02 | =EXP(0.0761+0.4422*LN(Cs)) | USEPA, 2007a | 2.2E-01 | -- | -- | 1.0 | 1.38E-02 | -- | -- | 0.020 | 1.71E-04 | 1.40E-02 | 0.014 | 8.75 | 1.0 | 1.0 | 0.027 | 74.3 |
| | Mourning dove | 0.091 | 0.054 | 1 | =EXP(-1.328+0.561*LN(Cs)) | USEPA, 2007a | 2.2E-01 | =EXP(-0.218+0.807*LN(Cs)) | 0.73 | USEPA, 2007a | 6.0E-01 | =EXP(0.0761+0.4422*LN(Cs)) | USEPA, 2007a | 9.2E-01 | 1.0 | 1.17E-02 | -- | -- | -- | -- | 0.061 | 2.30E-03 | 1.40E-02 | 0.014 | 8.75 | 1.0 | 1.0 | 0.70 | 2,327 |
| | Red-tailed hawk | 0.96 | 0.084 | 1 | =EXP(-1.328+0.561*LN(Cs)) | USEPA, 2007a | 2.5E-02 | =EXP(-0.218+0.807*LN(Cs)) | 0.73 | USEPA, 2007a | 2.7E-02 | =EXP(0.0761+0.4422*LN(Cs)) | USEPA, 2007a | 1.7E-01 | -- | -- | -- | -- | 1.0 | 1.40E-02 | 0.024 | 2.94E-05 | 1.40E-02 | 0.014 | 8.75 | 1.0 | 1.0 | 0.015 | 2,835 |
| Mercury | American badger | 4 | 0.033 | 1 | =EXP(-0.966+0.544*LN(Cs)) | Bechtel, 1998 | 3.9E+00 | 1.7 | 0.62 | Sample et al., 1998a | 1.2E+02 | 0.0543 | Sample et al., 1998b | 3.9E+00 | -- | -- | -- | -- | 1.0 | 1.28E-01 | 0.052 | 1.22E-01 | 2.50E-01 | 0.25 | 4 | 1.0 | 1.0 | 71.2 | 1,140 |
| | Deer mouse | 0.0193 | 0.170 | 1 | =EXP(-0.966+0.544*LN(Cs)) | Bechtel, 1998 | 4.3E-01 | 1.7 | 0.62 | Sample et al., 1998a | 2.1E+00 | 0.0543 | Sample et al., 1998b | 6.8E-02 | 0.4 | 2.93E-02 | 0.6 | 2.16E-01 | -- | -- | 0.02 | 4.26E-03 | 2.50E-01 | 0.25 | 4 | 1.0 | 1.0 | 1.25 | 22 |
| | Ground squirrel | 0.16 | 0.034 | 1 | =EXP(-0.966+0.544*LN(Cs)) | Bechtel, 1998 | 3.8E+00 | 1.7 | 0.62 | Sample et al., 1998a | 1.2E+02 | 0.0543 | Sample et al., 1998b | 3.8E+00 | 1.0 | 1.28E-01 | -- | -- | -- | -- | 0.052 | 1.22E-01 | 2.50E-01 | 0.25 | 4 | 1.0 | 1.0 | 69.8 | 1,856 |
| | California gnatcatcher | 0.006 | 0.318 | 1 | =EXP(-0.966+0.544*LN(Cs)) | Bechtel, 1998 | 9.1E-02 | 1.7 | 0.62 | Sample et al., 1998a | 1.2E-01 | 0.0543 | Sample et al., 1998b | 3.9E-03 | -- | -- | 1.0 | 3.85E-02 | -- | -- | 0.020 | 4.55E-04 | 3.90E-02 | 0.039 | 0 | 1.0 | 1.0 | 0.072 | 0.33 |
| | Mourning dove | 0.091 | 0.054 | 1 | =EXP(-0.966+0.544*LN(Cs)) | Bechtel, 1998 | 5.9E-01 | 1.7 | 0.62 | Sample et al., 1998a | 3.8E+00 | 0.0543 | Sample et al., 1998b | 1.2E-01 | 1.0 | 3.17E-02 | -- | -- | -- | -- | 0.061 | 7.32E-03 | 3.90E-02 | 0.039 | 0 | 1.0 | 1.0 | 2.23 | 21.6 |
| | Red-tailed hawk | 0.96 | 0.084 | 1 | =EXP(-0.966+0.544*LN(Cs)) | Bechtel, 1998 | 1.0E+00 | 1.7 | 0.62 | Sample et al., 1998a | 1.0E+01 | 0.0543 | Sample et al., 1998b | 3.2E-01 | -- | -- | -- | -- | 1.0 | 2.70E-02 | 0.024 | 1.20E-02 | 3.90E-02 | 0.039 | 0 | 1.0 | 1.0 | 5.93 | 27.4 |
| Molybdenum | American badger | 4 | 0.033 | 1 | 0.25 | Baes et al., 1984 | 1.9E+00 | 0.95 | 0.23 | Sample et al., 1998a | 7.1E+00 | 1.0 | Default | 7.5E+00 | -- | -- | -- | -- | 1.0 | 2.47E-01 | 0.052 | 1.29E-02 | 2.60E-01 | 0.26 | 2.6 | 1.0 | 1.0 | 7.49 | 74.9 |
| | Deer mouse | 0.0193 | 0.170 | 1 | 0.25 | Baes et al., 1984 | 5.5E-01 | 0.95 | 0.23 | Sample et al., 1998a | 2.1E+00 | 1.0 | Default | 2.2E+00 | 0.4 | 3.77E-02 | 0.6 | 2.15E-01 | -- | -- | 0.02 | 7.54E-03 | 2.60E-01 | 0.26 | 2.6 | 1.0 | 1.0 | 2.22 | 22.2 |
| | Ground squirrel | 0.16 | 0.034 | 1 | 0.25 | Baes et al., 1984 | 6.4E+00 | 0.95 | 0.23 | Sample et al., 1998a | 2.4E+01 | 1.0 | Default | 2.6E+01 | 1.0 | 2.15E-01 | -- | -- | -- | -- | 0.052 | 4.48E-02 | 2.60E-01 | 0.26 | 2.6 | 1.0 | 1.0 | 25.7 | 257 |
| | California gnatcatcher | 0.006 | 0.318 | 1 | 0.25 | Baes et al., 1984 | 2.9E+00 | 0.95 | 0.23 | Sample et al., 1998a | 1.1E+01 | 1.0 | Default | 1.1E+01 | -- | -- | 1.0 | 3.46E+00 | -- | -- | 0.020 | 7.28E-02 | 3.53E+00 | 3.53 | 35.33 | 1.0 | 1.0 | 11.4 | 114 |
| | Mourning dove | 0.091 | 0.054 | 1 | 0.25 | Baes et al., 1984 | 5.3E+01 | 0.95 | 0.23 | Sample et al., 1998a | 2.0E+02 | 1.0 | Default | 2.1E+02 | 1.0 | 2.84E+00 | -- | -- | -- | -- | 0.061 | 6.92E-01 | 3.53E+00 | 3.53 | 35.33 | 1.0 | 1.0 | 211 | 2,111 |
| | Red-tailed hawk | 0.96 | 0.084 | 1 | 0.25 | Baes et al., 1984 | 1.0E+01 | 0.95 | 0.23 | Sample et al., 1998a | 3.9E+01 | 1.0 | Default | 4.1E+01 | -- | -- | -- | -- | 1.0 | 3.45E+00 | 0.024 | 8.27E-02 | 3.53E+00 | 3.53 | 35.33 | 1.0 | 1.0 | 41.1 | 411 |
| Zinc | American badger | 4 | 0.033 | 1 | =EXP(1.575+0.554*LN(Cs)) | USEPA, 2007a | 4.0E+02 | =EXP(4.449+0.328*LN(Cs)) | -0.47 | USEPA, 2007a | 1.2E+03 | =EXP(4.3632+0.0706*LN(Cs)) | USEPA, 2007a | 1.4E+02 | -- | -- | -- | -- | 1.0 | 4.55E+00 | 0.052 | 5.05E+00 | 9.60E+00 | 9.6 | 411.4 | 1.0 | 1.0 | 2,939 | 236,012 |
| | Deer mouse | 0.0193 | 0.170 | 1 | =EXP(1.575+0.554*LN(Cs)) | USEPA, 2007a | 5.3E+00 | =EXP(4.449+0.328*LN(Cs)) | -0.47 | USEPA, 2007a | 9.0E+01 | =EXP(4.3632+0.0706*LN(Cs)) | USEPA, 2007a | 7.9E+01 | 0.4 | 3.61E-01 | 0.6 | 9.23E+00 | -- | -- | 0.02 | 4.04E-03 | 9.60E+00 | 9.6 | 411.4 | 1.0 | 1.0 | 1.19 | 24,375 |
| | Ground squirrel | 0.16 | 0.034 | 1 | =EXP(1.575+0.554*LN(Cs)) | USEPA, 2007a | 2.3E+02 | =EXP(4.449+0.328*LN(Cs)) | -0.47 | USEPA, 2007a | 8.4E+02 | =EXP(4.3632+0.0706*LN(Cs)) | USEPA, 2007a | 1.3E+02 | 1.0 | 7.73E+00 | -- | -- | -- | -- | 0.052 | 1.87E+00 | 9.60E+00 | 9.6 | 411.4 | 1.0 | 1.0 | 1,073 | 164,013 |
| | California gnatcatcher | 0.006 | 0.318 | 1 | =EXP(1.575+0.554*LN(Cs)) | USEPA, 2007a | 2.2E+00 | =EXP(4.449+0.328*LN(Cs)) | -0.47 | USEPA, 2007a | 5.4E+01 | =EXP(4.3632+0.0706*LN(Cs)) | USEPA, 2007a | 7.1E+01 | -- | -- | 1.0 | 1.72E+01 | -- | -- | 0.020 | 1.57E-03 | 1.72E+01 | 17.20 | 172.0 | 1.0 | 1.0 | 0.25 | 267 |
| | Mourning dove | 0.091 | 0.054 | 1 | =EXP(1.575+0.554*LN(Cs)) | USEPA, 2007a | 2.5E+02 | =EXP(4.449+0.328*LN(Cs)) | -0.47 | USEPA, 2007a | 8.8E+02 | =EXP(4.3632+0.0706*LN(Cs)) | USEPA, 2007a | 1.3E+02 | 1.0 | 1.32E+01 | -- | -- | -- | -- | 0.061 | 3.96E+00 | 1.72E+01 | 17.20 | 172.0 | 1.0 | 1.0 | 1,205 | 28,919 |
| | Red-tailed hawk | 0.96 | 0.084 | 1 | =EXP(1.575+0.554*LN(Cs)) | USEPA, 2007a | 3.9E+02 | =EXP(4.449+0.328*LN(Cs)) | -0.47 | USEPA, 2007a | 1.2E+03 | =EXP(4.3632+0.0706*LN(Cs)) | USEPA, 2007a | 1.4E+02 | -- | -- | -- | -- | 1.0 | 1.15E+01 | 0.024 | 5.66E+00 | 1.72E+01 | 17.20 | 172.0 | 1.0 | 1.0 | 2,810 | 78,149 |

Notes:

Parameters presented in terms of dry weight

[a] Source: Allometric relationship for receptor group (Nagy, 2001) normalized to body weight and adjusted to units of kg/kg-bw/d. Nagy (2001) regression equation for food ingestion rate (grams dry matter ingested/day/gram body weight = (a x $BW^b$)/BW

| *Where:* | *Group* | *a* | *b* | *Receptor* |
|---|---|---|---|---|
| | carnivorous birds | 0.849 | 0.663 | hawk |
| | insectivorous birds | 0.54 | 0.705 | gnatcatcher |
| | herbivorous birds | 0.088 | 0.891 | dove |
| | rodentia | 0.332 | 0.774 | mouse |
| | carnivorous mammals | 0.102 | 0.864 | badger |
| | granivorous mammals | 0.659 | 0.413 | squirrel |

Soil to plant: BAF for organics with log Kows between 3 and 8 derived using log BAF = -0.229*(logKow)+1.0237 (unrinsed plants, USEPA, 2007a)

Soil to invertebrate: Concentration in worm calculated for organics with LogKows (2 to 8) using model from USEPA (2007a), where Koc is estimated from Kow using general chemical model from Gerstl (1990) and Foc = 0.01. Cworm=10^((0.87*logKow)-2)*(Csoil/(foc*10^((0.679*logKow)+0.663)).

| | Soil ingestion % | |
|---|---|---|
| Badger | 5.2% | Data regarding soil ingestion of badgers are unavailable. Because the badger is a burrowing mammal, soil ingestion may be similar to that of the prairie dog. It was assumed that the median soil ingestion of the two prairie dog species with available data (2.7 and 7.7 percent) would be representative of the badger. |
| Deer mouse | 2.0% | Value for white-footed mouse from Beyer et al., 1994 |
| Ground squir | 5.2% | Data regarding soil ingestion of ground squirrels are unavailable. Because the squirrel is a burrowing mammal, soil ingestion may be similar to that of the prairie dog. It was assumed that the median soil ingestion of the two prairie dog species with available data (2.7 and 7.7 percent) would be representative of the ground squirrel |
| Gnatcatcher | 2.0% | Assumed due to feeding habits. Adapted from Beyer et al., 1994 |
| Mourning do | 6.1% | Median soil ingestion rate estimated for mourning dove in Table 3 of the Eco-SSL guidance. The median was selected as the best measure of central tendency that is unbiased by outliners. |
| Redtailed ha | 2.4% | Median soil ingestion rate estimated for red-tailed hawk in Table 3 of the Eco-SSL guidance. The median was selected as the best measure of central tendency that is unbiased by outliners. |

-- not available, could not be located, or not applicable
BAF = bioaccumulation factor
Cs = concentration in soi
ESV = ecological screening value
HQ = hazard quotient
kg = kilogram

mg/kg-d = milligrams per kilogram body weight per day
MRP = Munitions Response Program
NAVWPNSTA = Naval Weapons Station
TRV = wildlife toxicity reference value
UXO = unexploded ordnance
Sources:

Baes, C.F. III, R.D. Sharp, A.L. Sjoreen, and R.W. Shor. 1984. A review and analysis of parameters for assessing transport of environmentally released radionuclides through agriculture. Oak Ridge National Laboratory. ORNL-5786. 148 pp.
Bechtel Jacobs. 1998. Empirical models for the uptake of inorganic chemicals from soil by plants. Prepared for U.S. Department of Energy. BJC/OR-133. September 1998.
Beyer, W.N., E.E. Connor, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. Journal of Wildlife Management. 58:375-382.
Gerstl, Z. 1990. Estimation of organic chemical sorption by soils. J. Contam. Hydrology 6:357-375.
Nagy, K. A. 2001. Food requirements of wild animals: predictive equations for free-living mammals, reptiles, and birds. Nutrition Abstracts and Reviews. Series B. 71:21R-31R.
Sample, B.E., J.J. Beauchamp, R.A. Efroymson, G.W. Suter II, and T.L. Ashwood. 1998a. Development and validation of bioaccumulation models for earthworms. Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-220.
Sample, B.E., J.J. Beauchamp, R.A. Efroymson, and G.W. Suter II. 1998b. Development and validation of bioaccumulation models for small mammals. Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-219.
United States Environmental Protection Agency (USEPA). 2005a. Ecological Soil Screening Levels for Antimony. Interim Final. OSWER Directive 92857-61, Revised. Office of Solid Waste and Emergency Response. February.
United States Environmental Protection Agency (USEPA). 2007a. Guidance for Developing Ecological Soil Screening Levels, OSWER Directive 9285.7-55, Office of Solid Waste and Emergency Response, United States Environmental Protection Agency, Washington, D.C. Issued November 2003, revised April 2007.

TABLE N-6

Summary of Ecological Screening Results for Soil

*RI for MRP Site UXO5, NAVWPNSTA Seal Beach, Detachment Fallbrook, Fallbrook, California*

| Analyte | Receptor | Receptor-specific ESVs (mg/kg) | | 0 to 0.5 foot bgs | | 0 to 6 feet bgs | | Weight of Evidence |
|---|---|---|---|---|---|---|---|---|
| | | Low ESV | High ESV | Site Maximum | Site 95UCL | Site Maximum | Site 95UCL | |
| Antimony | American badger | 33.7 | 1,020 | **5.94** | **0.82** | **5.94** | 0.55 | -- |
| | ***Deer mouse*** | ***0.55*** | 26.0 | | | | | |
| | Ground squirrel | 20.8 | 1,076 | | | | | |
| | California gnatcatcher | -- | -- | | | | | |
| | Mourning dove | -- | -- | | | | | |
| | Red-tailed hawk | -- | -- | | | | | |
| Cadmium | ***American badger*** | ***15.2*** | 1,372 | **13.0** | **1.95** | **27.8** | **2.68** | 95UCL for 0 to 0.5-foot bgs exceeds Low ESV for gnatcatcher. 95UCLs do not exceed High ESVs for other receptors. |
| | ***Deer mouse*** | ***0.031*** | ***3.99*** | | | | | |
| | ***Ground squirrel*** | ***5.15*** | 997 | | | | | |
| | ***California gnatcatcher*** | ***0.19*** | ***5.60*** | | | | | |
| | Mourning dove | 92.5 | 2,445 | | | | | |
| | Red-tailed hawk | 202 | 4,531 | | | | | |
| Cobalt | American badger | 306 | 3,207 | 19.6 | 11.1 | 19.6 | 10.5 | -- |
| | Deer mouse | 73.4 | 1,223 | | | | | |
| | Ground squirrel | 602 | 10,033 | | | | | |
| | California gnatcatcher | 168 | 398 | | | | | |
| | Mourning dove | 2,064 | 4,882 | | | | | |
| | Red-tailed hawk | 800 | 1,595 | | | | | |
| Copper | American badger | 1,146 | 366,935 | **108** | **28.1** | **108** | **24.2** | 95UCL for 0 to 0.5-foot bgs exceeds Low ESV for gnatcatcher; but background 95UCL (22.4 mg/kg) results in incremental concentration below Low ESV. 95UCLs do not exceed High ESVs for other receptors. |
| | ***Deer mouse*** | ***37.8*** | 11,195 | | | | | |
| | Ground squirrel | 969 | 356,693 | | | | | |
| | ***California gnatcatcher*** | ***13.5*** | 307 | | | | | |
| | Mourning dove | 371 | 14,516 | | | | | |
| | Red-tailed hawk | 383 | 24,564 | | | | | |
| Lead | ***American badger*** | 317 | 136,498 | **227 J** | **32.5** | **227 J** | **22.1** | 95UCL for 0 to 0.5-foot bgs exceeds Low ESV for gnatcatcher. 95UCLs do not exceed High ESVs for other receptors. |
| | ***Deer mouse*** | ***18.0*** | 14,540 | | | | | |
| | Ground squirrel | 423 | 134,451 | | | | | |
| | ***California gnatcatcher*** | ***0.027*** | ***74.3*** | | | | | |
| | ***Mourning dove*** | ***0.70*** | 2,327 | | | | | |
| | ***Red-tailed hawk*** | ***0.015*** | 2,835 | | | | | |
| Mercury | American badger | 71.2 | 1,140 | **0.11** | 0.019 | **0.11** | 0.017 | -- |
| | Deer mouse | 1.25 | 21.9 | | | | | |
| | Ground squirrel | 69.8 | 1,856 | | | | | |
| | ***California gnatcatcher*** | ***0.072*** | 0.33 | | | | | |
| | Mourning dove | 2.23 | 21.6 | | | | | |
| | Red-tailed hawk | 5.93 | 27.4 | | | | | |
| Molybdenum | American badger | 7.49 | 74.9 | 1.40 J | 0.37 | 1.40 J | 0.40 | -- |
| | Deer mouse | 2.22 | 22.2 | | | | | |
| | Ground squirrel | 25.7 | 257 | | | | | |
| | California gnatcatcher | 11.4 | 114 | | | | | |
| | Mourning dove | 211 | 2,111 | | | | | |
| | Red-tailed hawk | 41.1 | 411 | | | | | |
| Zinc | American badger | 2,939 | 236,012 | **1,200** | **190** | **1,200** | **135** | 95UCL for 0 to 0.5-foot bgs exceeds Low ESV for gnatcatcher. 95UCLs do not exceed High ESVs for other receptors. |
| | ***Deer mouse*** | ***1.19*** | 24,375 | | | | | |
| | ***Ground squirrel*** | ***1,073*** | 164,013 | | | | | |
| | ***California gnatcatcher*** | ***0.25*** | 267 | | | | | |
| | Mourning dove | 1,205 | 28,919 | | | | | |
| | Red-tailed hawk | 2,810 | 78,149 | | | | | |

Notes:

***Bold and italics*** = ESV for this receptor is exceeded by MRP Site UXO5 soil concentration.

**Bold only** = Soil concentration exceeds Low ESV for at least one receptor.

= Soil concentration exceeds High ESV for at least one receptor.

-- not available, could not be located, or not applicable

95UCL = 95% upper confidence limit on the mean concentration

bgs = below ground surface

ESV = ecological screening value

mg/kg = milligram per kilogram

MRP = Munitions Response Program

NAVWPNSTA = Naval Weapons Station

UXO = unexploded ordnance

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