Marine Corps Installations Command

FINAL

Range Environmental Vulnerability Assessment

5-Year Review Report
Marine Corps Air Station Miramar, California

June 2013
06285037.0000

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

Marine Corps Installations Command

MCICOM (GF-5) – 3000 Marine Corps Pentagon, Room 2D153 – Washington, DC 20350

FINAL

Range Environmental Vulnerability Assessment

5-Year Review

Marine Corps Air Station Miramar

June 2013

Report Prepared By:

701 Town Center Drive

Suite 600

Newport News, VA 23606

ARCADIS MALCOLM PIRNIE

Infrastructure · Water · Environment · Buildings

Table of Contents

List of Tables

List of Figures

Appendices

Acronym List

Acronym	Definition
°F	Degrees Fahrenheit
µg/kg	Micrograms per Kilogram
µg/L	Micrograms per Liter
3rd MAW	Third Marine Aircraft Wing
amsl	Above Mean Sea Level
bgs	Below Ground Surface
BRAC	Base Realignment and Closure
cal	Caliber
CPLO	Community Plans and Liaison Officer
CRWQCB	California Regional Water Quality Control Board
CSM	Conceptual Site Model
DoD	Department of Defense
DoDI	Department of Defense Instruction
DoDIC	Department of Defense Identification Code
EOD	Explosive Ordnance Disposal
EPCRA	Emergency Planning and Community Right-To-Know Act
ESQD	Explosive Safety Quantity-Distance Arc
FMD	Facilities Management Division
ft	Feet
GIS	Geographic Information System
HE	High Explosive

Acronym	Definition
HMX	Cyclotetramethylene Tetranitramine
IED	Improvised Explosive Device
INRMP	Integrated Natural Resource Management Plan
IR	Installation Restoration
kg/m^2	Kilograms per Square Meter
lb	Pound
lb/yd^2	Pounds per Square Yard
lb/yr	Pounds per Year
LOMAH	Location of Miss and Hit
m	Meters
m^2	Square Meters
Marine Corps	United States Marine Corps
MC	Munitions Constituents
MCAS	Marine Corps Air Station
MCB	Marine Corps Base
MCICOM	Marine Corps Installations Command
MIDAS	Munitions Items Disposition Action System
MMRP	Military Munitions Response Program
MTU	Marksmanship Training Unit
NAS	Naval Air Station
NEW	Net Explosive Weight
NRCS	Natural Resources Conservation Service

Acronym	Definition
O&T	Operations and Training
PCB	Polychlorinated Biphenyl
PMO	Provost Marshall Office
RDX	Cyclotrimethylene Trinitramine
REVA	Range Environmental Vulnerability Assessment
RFMSS	Range Facility Management Support System
RUSLE	Revised Universal Soil Loss Equation
SAR	Small Arms Range
SARAP	Small Arms Range Assessment Protocol
SDZ	Surface Danger Zone
TECOM	Training and Education Command
TNT	Trinitrotoluene
U.S.	United States
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
UXO	Unexploded Ordnance
WWI	World War I
WWII	World War II

Executive Summary

The United States Marine Corps (Marine Corps) Range Environmental Vulnerability Assessment (REVA) program meets the requirements of the Department of Defense (DoD) Directive 4715.11 *Environmental and Explosives Safety Management on Operational Ranges within the United States* and DoD Instruction 4715.14 *Operational Range Assessments*.

The purpose of the REVA program is to identify whether there is a release or substantial threat of a release of munitions constituents (MC) from the operational range or range complex areas to off-range areas. This is accomplished through a baseline assessment of operational range areas and periodic five-year review assessments, and, where applicable, the use of fate and transport modeling of the REVA indicator MC based upon site-specific environmental conditions at the operational ranges and training areas.

This report presents the five-year review assessment results for the operational ranges at the Marine Corps Air Station (MCAS) Miramar located in Southern California. This report serves as the first five-year review assessment documenting the period of munitions loading from 2008 through 2012. The baseline assessment examined and documented munitions use through 2007.

Military Munitions Training and Operations

MCAS Miramar is the Marine Corps' primary West Coast air station, comprising approximately 23,065 acres of land. The installation is located 13 miles north of downtown San Diego. The mission of MCAS Miramar is to maintain and operate facilities and provide services and material to support the Third Marine Aircraft Wing (3rd MAW) and other tenant organizations. The mission of the 3rd MAW, the station's primary tenant, is to provide combat-ready, expeditionary aviation forces capable of short-notice, worldwide deployment to Marine Air Ground Task Force, fleet, and unified commanders (MCAS Miramar, 2011a). All operational ranges at MCAS Miramar are located in East Miramar and consist of five training areas used for maneuver and land navigation training, nine small arms ranges (SARs) for weapon proficiency training, and one explosive ordnance disposal (EOD) training range used for training and emergency destruction of ordnance. There are no high explosive (HE) fixed training ranges or impact areas currently located at MCAS Miramar.

MC loading areas are where the majority of MC are deposited within an operational range area. During the baseline REVA assessment, completed in 2008, five MC loading areas were identified and evaluated within the installation boundary. Prior to assessing the current data, the results of the baseline assessment were considered (Table ES-1). The five-year review does not take into account historical use ranges, as no additional munitions use has occurred on these ranges since

Table ES-1: Summary of Baseline Assessment Results for MCAS Miramar

MC Loading Area	Screening-Level Modeling Results Predicted Exceedance of REVA Trigger Values		Samples Collected After Baseline Assessment	Assessing in Five-Year Review
	Surface Water	Groundwater		
EOD Training Range*	Yes	Not modeled	No	Yes
Former EOD Range / Defense Special Weapons Agency	Not modeled		No	No
South	Not modeled		No	No
Range C	Not modeled		No	No
Range G	Not modeled		No	No
SAR	**Surface Water Ranking**	**Groundwater Ranking**	**Samples Collected**	**Assessing in Five-Year Review**
Range 100	Minimal	Minimal	No	Yes
Range 101	Minimal	Minimal	No	Yes
Range 5	Moderate	Minimal	No	Yes
Range 6	Moderate	Minimal	No	Yes
Range 7	Moderate	Minimal	No	Yes
Range B	Moderate	Minimal	No	Yes
Range C	Moderate	Minimal	No	Yes
Range D	Moderate	Minimal	No	Yes

Note:

*The EOD Training Range was called the Current EOD Range in the baseline assessment

the baseline assessment. The term historical use refers to formerly used areas that lie within a designated operational range area. The EOD Training Range was identified as the only currently

operational range at which HE- and perchlorate-containing munitions are expended. Consequently, during the five-year review, the EOD Training Range MC loading area was identified as the only HE MC loading area at MCAS Miramar.

The REVA assessment team estimated MC loading rates for identified MC loading areas, in addition to lead loading rates for current SARs at MCAS Miramar. A conceptual site model was developed to qualitatively assess the potential for MC transport from the loading area to impact identified off-range human and ecological receptors.

Conceptual Site Model for MCAS Miramar

The undeveloped terrain in East Miramar, part of the Peninsular Range physiographic province, is characterized by steep, rugged hills separated by deep alluvial valleys that typically are dry throughout the majority of the year. There are no perennial water features within MCAS Miramar, although numerous ephemeral drainages may be found throughout the installation and, in particular, in East Miramar. The installation receives an average of approximately 10 inches of precipitation per year. During a significant rainfall event, water flows into the main drainage channels of a number of subwatersheds present within MCAS Miramar. Water eventually flows off the installation to the south and southwest. Ephemeral ponding may occur in hummocky areas underlain by a shallow hardpan that restricts infiltration. This may lead to the creation of vernal pools, which are ecological habitat areas that can support rare, threatened, and endangered flora and fauna.

Limited information is available regarding local and regional groundwater beneath MCAS Miramar. Groundwater in the alluvial units found in the canyon bottoms generally is close to the surface. It has been measured at depths between 2 and 10.5 feet. However, this shallow groundwater exists only intermittently after heavy rainfall or after a series of wet years. Previous studies at MCAS Miramar have shown that groundwater in the region generally is considered to be at a depth of 160 feet below ground surface, just above bedrock. Perched groundwater also may be found at shallow depths approximately 10 to 30 feet below ground surface where a well-cemented conglomerate layer underlies an unconsolidated layer.

The EOD Training Range, located in the northeast corner of the East Miramar Range Complex, is the only range at MCAS Miramar that handles munitions containing HEs. Therefore, the EOD Training Range is the only location where REVA indicator MC presently may be deposited. Additionally, nine SARs, located in two areas within the East Miramar Range Complex, are utilized by MCAS Miramar and other military, local law enforcement, and federal agencies for marksmanship/ proficiency training and qualification (MCAS Miramar, 2011a).

Erosion and subsequent transport of MC via surface water runoff through the West Sycamore Canyon subwatershed is the primary transport mechanism at MCAS Miramar, despite the limited

precipitation at the installation. Leaching to groundwater and subsequent groundwater flow beneath the range footprint is likely limited by relatively high evaporation rates, the presence of a shallow hardpan layer, and the deep depth to groundwater. Based on initial analysis, MC may be transported via surface water beyond the installation boundary and potentially can recharge the San Diego River Valley groundwater basin located south of the East Miramar installation boundary. This groundwater basin is a potential public water supply source; therefore, additional analysis was conducted. Results are detailed in the report.

Potential receptors for MC in surface water include users of the nearby Santee Recreational Lakes and ecological receptors with habitat within or near the West Sycamore Canyon subwatershed. In addition to potential threatened/endangered species located within vernal pools, sensitive species documented at MCAS Miramar include the threatened California gnatcatcher and the endangered least Bell's vireo, Del Mar manzanita, and willowy monardella. The San Diego Region Basin Plan identifies watersheds within East Miramar as having a number of existing beneficial uses, including industrial, agricultural, recreational, and ecological uses.

Groundwater resources near the MC loading areas are not used for potable, industrial, or agricultural purposes. No ecological groundwater receptors were identified, primarily due to the depth of regional groundwater and lack of defined groundwater discharge points to surface water bodies (CRWQCB, 1994). A potentially complete pathway exists for MC transport from the EOD Training Range MC loading area to receptors potentially using groundwater originating from San Diego Valley groundwater basin.

Surface Water and Sediment Analyses Summary

The screening-level analyses of MC fate and transport in surface water and sediment were conducted for the EOD Training Range MC loading area. The EOD Training Range MC loading area was selected for quantitative transport analysis based on its current use of munitions containing HE and surface drainages that lead to potential receptor location in West Sycamore Canyon at the southeastern installation boundary and in Santee Recreational Lakes.

The screening-level transport analyses indicated that average annual MC concentrations in surface water and sediment entering West Sycamore Canyon at the installation boundary were predicted to be negligible. Based on these results, no further evaluation (e.g., sampling of environmental media) of potential MC transport from the EOD Training Range MC loading area is required.

Groundwater Analysis Summary

A quantitative groundwater analysis was not conducted for the EOD Training Range MC loading area within the West Sycamore Canyon subwatershed. This is because 1) a direct groundwater pathway to potential receptors does not exist and 2) the only potential pathway to groundwater

receptors is through stream flow recharge in canyons draining from the EOD Training Range MC loading area to the San Diego River Valley groundwater basin. Results from the surface water screening-level analysis showed MC concentrations in West Sycamore Canyon reaching the installation boundary at negligible concentrations, indicating no potential impacts to possible groundwater receptors in the San Diego River Valley groundwater basin where drainage from West Sycamore Canyon recharges. As such, no further evaluation of potential MC transport in groundwater is required.

Small Arms Range Assessments

The primary MC of concern at SARs is lead because it is the most prevalent (by weight) potentially hazardous constituent associated with small arms ammunition. Modeling parameters for lead fate and transport are contingent upon site-specific geochemical data that generally are unavailable unless site-specific investigations are conducted. Therefore, SARs are qualitatively assessed under the REVA program to identify factors that influence the potential for lead migration. A total of nine SARs at MCAS Miramar were evaluated during this REVA five-year review.

Assessments completed to determine the potential for lead migration to surface water receptors resulted in all nine SARs receiving a minimal ranking for both surface water and groundwater. Similar assessments completed to determine the potential for lead migration to groundwater receptors rated all nine with a minimal ranking. Generally, the minimal rankings primarily are due to the low, intermittent precipitation rate; deep groundwater; and limited human and ecological receptors, all of which limit potential lead migration and impacts. Minimal rankings indicate little potential for off-range migration of lead to human or ecological receptors. As such, no further activities are required for these SARs at this time. The SARs will be re-evaluated during the next five-year review.

A summary of the results of the SARs assessed at MCAS Miramar in the REVA 5-year review are presented on **Table ES-2**.

Table ES-2: Summary of Five-Year Review Assessment Results for MCAS Miramar

SAR	Surface Water Ranking	Groundwater Ranking
Range 100	Minimal	Minimal
Range 101	Minimal	Minimal
Duffy Town Range	Minimal	Minimal
Range 5	Minimal	Minimal

SAR	Surface Water Ranking	Groundwater Ranking
Range 6	Minimal	Minimal
Range 7	Minimal	Minimal
Range B	Minimal	Minimal
Range C	Minimal	Minimal
Range D	Minimal	Minimal

1. Introduction

1.1. Purpose

The United States (U.S.) Marine Corps (Marine Corps) Range Environmental Vulnerability Assessment (REVA) program meets the requirements of the Department of Defense (DoD) Directive 4715.11 *Environmental and Explosives Safety Management on Operational Ranges within the United States* and DoD Instruction (DoDI) 4715.14 *Operational Range Assessments*.

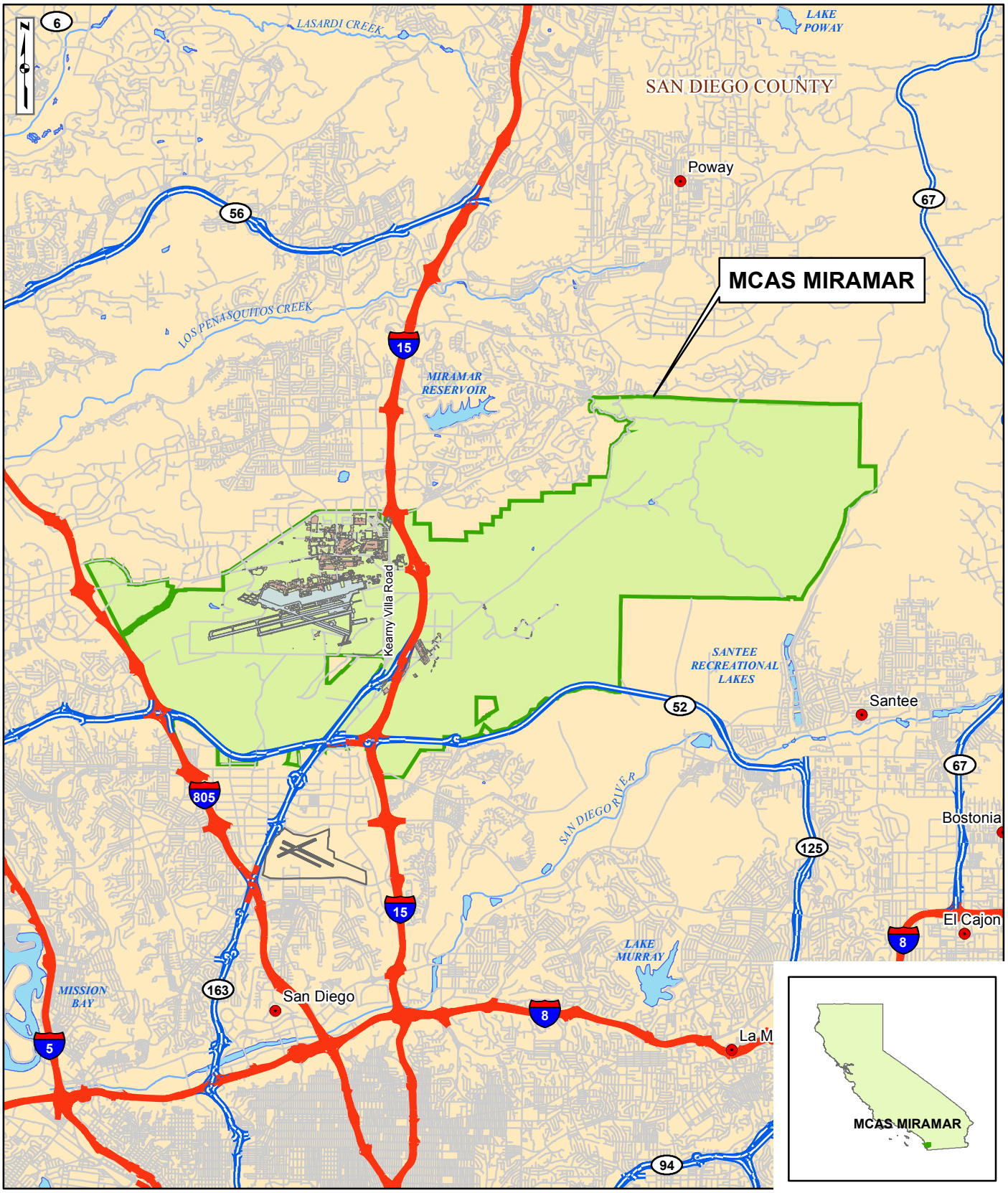
The REVA program is a proactive and comprehensive program designed to support the Marine Corps' Range Sustainment Program. Operational ranges across the Marine Corps are being assessed to identify areas and activities that are subject to possible impacts from external influences, as well as to determine whether a release or substantial threat of a release of munitions constituents (MC) from operational ranges to off-range areas creates an unacceptable risk to human health and/or the environment. This is accomplished through assessments of operational range areas and periodic five-year review assessments and, where applicable, the use of fate and transport modeling/analysis of the REVA indicator MC based upon site-specific environmental conditions at the operational ranges and training areas.

This report presents the five-year review assessment results for the operational ranges at the Marine Corps Air Station (MCAS) Miramar located in Southern California. This report serves as the first five-year review assessment documenting the period of munitions loading from 2008 through 2012. The baseline assessment completed in 2008 documented munitions use at MCAS Miramar through 2007.

MCAS Miramar consists of 23,065 acres in San Diego County, California, approximately 13 miles north of downtown San Diego, as shown in **Figure 1-1**. The mission of MCAS Miramar is to maintain and operate facilities and provide services and material to support the Third Marine Aircraft Wing (3rd MAW) and other tenant organizations. MCAS Miramar maintains a limited number of operational ranges and training areas within the eastern portion of the installation, known as East Miramar. A site location map is provided as **Figure 1-1**.

1.2. Scope and Applicability

The scope of the REVA program includes Marine Corps operational ranges located within the United States and overseas. Operational ranges (as defined in 10 United States Code 101 (e)(3)) include, but are not limited to, fixed ranges, live-fire maneuver areas, small arms ranges (SARs)



REVA
FIGURE 1-1
SITE LOCATION

MCAS MIRAMAR
MIRAMAR, CA

ARCADIS MALCOLM PIRNIE
Infrastructure. Water. Environment. Buildings.

LEGEND

- INSTALLATION BOUNDARY
- AIRFIELD
- LAKE
- CITY

ROAD

- INTERSTATE
- STATE HIGHWAY
- MINOR ROAD

0 0.375 0.75 1.5 2.25 MILES

DATE: FEBRUARY 2013

SOURCE: MCAS EMD GIS 2007
HQMC GEOFIDELIS 2007
SANGIS 2007 & CASIL 2007

Map Document: (G:\06285037 - REVA FY11\MCAS Miramar\GIS\Project MXD\5Yr REVA Report\Figure1-1.mxd)
09/14/2012 -- 03:44:23 PM

buffer areas, and training areas where military munitions are known or suspected currently to be or historically to have been used. Operational ranges used exclusively for small arms training are evaluated qualitatively under REVA. The Marine Corps (specifically the Training and Education Command [TECOM]) purposely separates operational ranges and training areas. For ease of understanding, in this document, the term "operational range" includes both operational ranges and training areas.

A number of range types are specifically excluded from DoDI 4715.14 and are not assessed as part of the REVA program. Operational ranges that have a Resource Conservation and Recovery Act Subpart X permit are excluded since these ranges are monitored under a specific regulatory program. Military Munitions Response Program (MMRP) sites are excluded, as they are nonoperational ranges; therefore, they no longer are used for their intended purpose. Additionally, the management and funding of MMRP sites are conducted under a separate DoD program. Skeet/trap ranges used solely for recreation are excluded; these recreational facilities are not deemed operational ranges as defined under Title 10. Any ranges located wholly indoors also are not included, as any MC associated with these ranges are assumed to be contained and not available to the environment.

Site-specific environmental conditions and MC loading rates are used in fate and transport models to assess whether the potential exists for a release or substantial threat of a release of MC from an operational range or range complex area to an off-range area. Modeling is conducted for MC loading areas, which are delineated based on the area in which the majority of MC is deposited within an operational range. Fate and transport modeling in REVA uses screening-level transport analyses that conservatively estimate the concentrations of MC potentially migrating to off-range exposure points. Receptor groups considered in the REVA process include human as well as ecological receptors (defined in the REVA analysis as any threatened or endangered species or species of concern). Human exposure pathways considered include consumption of surface water and groundwater for off-range human receptors, as described in the *REVA Five-year Review Manual* (HQMC, 2010). Exposure pathways for off-range ecological receptors include direct consumption of surface water and direct exposure to surface water and sediment. Other off-range exposure scenarios (e.g., soil ingestion, incidental dermal contact, bioaccumulation, food chain exposure) currently are not considered in the REVA process unless site-specific considerations warrant an evaluation. Environmental sampling and analysis (i.e., field data collection) is conducted if the results of the screening-level fate and transport modeling suggest an off-range release of MC where receptors may be present. Field data collection activities are conducted to determine whether an off-range release has occurred and whether such a release constitutes an unacceptable risk to human health and the environment.

The MC evaluated in the REVA program include trinitrotoluene (TNT), cyclotetramethylene tetranitramine (HMX), cyclotrimethylene trinitramine (RDX), perchlorate, and lead. TNT, HMX, and RDX are considered indicator MC. Studies have shown that they are detected in a high

percentage of samples containing MC because they are common high explosives (HEs) used in a wide variety of military munitions and because of their chemical stability within the environment. Perchlorate is a component of the solid propellants used in some military munitions. Perchlorate also is considered an indicator MC because its high solubility, low sorption potential, and low natural degradation rate make the compound highly mobile in the environment. Additional information pertaining to the physical and chemical characteristics of the REVA indicator compounds is provided in the *REVA Reference Manual* (HQMC, 2009).

The primary MC of concern at SARs is lead because it is the most prevalent (by weight) potentially hazardous constituent associated with small arms ammunition. Lead is geochemically specific regarding its mobility in the environment; thus, fate and transport modeling of lead requires site-specific geochemical data that usually are unavailable during a REVA assessment. Therefore, instead of modeling lead transport, operational SARs at the installation are qualitatively reviewed and assessed to identify factors that influence the potential for lead migration. These factors include a range's design and layout, the physical and environmental conditions of the area, current and past operation and maintenance practices, and the amount of lead that has been loaded to the operational range.

Lead loading associated with small arms and munitions components at HE ranges was estimated as part of the five-year review process. Lead is present primarily in expenditures at the point of impact as an inert compound and, consequently, does not undergo low order or high order detonations. As such, lead loading was estimated based on the total amount of lead content based on the munition DoD Identification Code (DoDIC) multiplied by the total number of items of each DoDIC fired into the range or MC loading area. The total lead loaded at the site aids in determining if additional actions, such as sampling, are necessary.

The process and assumptions used in estimating the amount of MC deposited onto operational ranges, defined in REVA as MC loading, are discussed in **Section 3**. The screening-level fate and transport modeling and analysis methods and assumptions for surface water and groundwater are discussed in **Section 5**.

This report presents the analysis of the data collected during site visits and the results of screening-level fate and transport modeling for MC loading areas. Additional details of the REVA assessment methods are outlined in the *REVA Reference Manual,* which includes a detailed description of the fate and transport models selected for the REVA assessments, the data needed to run those models, and recommended sources for data. In addition, the *REVA Reference Manual* provides a detailed description of the REVA MC Loading Rate Calculator tool used to estimate MC deposition on operational ranges (HQMC, 2009).

This five-year review REVA report presents the conditions of the operational ranges at the time the assessment was conducted. The assessment was performed using available data and

personnel interviews and is supplemented with information from external sources, including reports and documentation.

1.3. Data Collection Effort

A thorough review of data collected during the baseline assessment was conducted prior to collecting data from the installation. Data required for the operational range assessments were obtained from the installation during a site visit by the REVA assessment team, from Marine Corps Installations Command (MCICOM), and from external data sources. Data collected include various documents and reports prepared for the installation (e.g., expenditure data, range operating procedures, natural and cultural resource surveys), weather records, and spatial data (GIS).

The REVA assessment team conducted a site visit to MCAS Miramar from 19 to 21 March 2012. MCICOM and TECOM personnel accompanied the team during the site visit. The installation site visit involved a review of various data repositories and interviews with installation personnel from the following offices:

- Assistant Chief of Staff, Operations and Training (O&T)
- Assistant Chief of Staff, Environmental Management Department
- Facilities Management Division (FMD)
- Geographic Information Systems

The Community Plans and Liaison Officer (CPLO) and subject matter experts within each of these offices were interviewed to identify areas of interest and specific concerns pertaining to each office. Specific issues relating to operational range use and potential impacts to training were the focus of these discussions.

During the five-year review installation visit, site visits were performed at 10 operational ranges. The REVA assessment team surveyed the physical condition of each range, noting firing points, impact areas, engineered controls, and other environmental factors (e.g., areas of erosion, potential migration routes).

1.4. Report Organization

This REVA five-year review environmental range assessment report for MCAS Miramar is organized into the following sections:

Section 1 – Introduction

Section 2 – Baseline Results and Installation Changes

Section 3 – Munitions Constituents Loading Rate and Assumptions

Section 4 – Conceptual Site Model (CSM)

Section 5 – Modeling Assumptions and Parameters

Section 6 – Screening-Level Assessment Results

Section 7 – Small Arms Range Assessments

Section 8 – References

2. Baseline Results and Installation Changes

2.1. Baseline Results

The baseline assessment for MCAS Miramar was completed in September 2008. At the time of the baseline assessment, all identified operational range areas and historical data were used to assess the impact of munitions loading on operational range lands. The results of the baseline assessment are documented in the *Range Environmental Vulnerability Assessment Marine Corps Air Station Miramar* (Malcolm Pirnie, 2009). Specific details of the methodology implemented in calculating MC loading and determining surface water and groundwater pathways and receptors in the baseline assessment are identified in the report. The following sections provide a brief summary of the baseline assessment results that provide a framework for the structure and areas of focus for the five-year review.

The baseline review of MCAS Miramar included current operational range areas as well as historic use areas that lie within the operation training areas. Five operational training areas, the Explosive Ordnance Disposal (EOD) Training Range, and eight SARs were identified as current operational ranges / training areas during the baseline evaluation. In addition, 48 historical live-fire ranges associated with former training operations in World War I (WWI) and World War II (WWII) were identified. The term historical use refers to formerly used areas that lie within a designated operational range area. These historical training activities were evaluated in the REVA baseline assessment. The historical use ranges were located within East Miramar, which is considered an operational range.

Five MC loading areas were identified based upon an analysis of training activities at the identified operational ranges. The MC loading areas included one operationally active MC loading area (the Current EOD Range) and four MC loading areas based on historical use (Former EOD Range, South, Range C, and Range G). Of the five MC loading areas, screening-level transport analysis of MC concentrations in surface water was conducted for only the Current EOD Range MC loading area. Based on the results of the qualitative analysis of the groundwater information, which indicated deep groundwater and minimal loading, groundwater screening-level analysis was not warranted. Table 2-1 lists the areas that were evaluated using screening-level modeling and the SARAP in the baseline assessment and a summary of results. The baseline assessment concluded that the impact from the historical use training was considered minimal as a result of expected degradation of MC over the length of time since training was conducted at those locations. The baseline assessment concluded that the range use at the Current EOD Range MC loading area would not impact human health or the environment as a result of the low usage and the environmental characteristics of the range area.

Table 2-1: Summary of the Baseline Assessment at MCAS Miramar

MC Loading Area	Screening-Level Modeling Results Predicted Exceedance of REVA Trigger Values		Samples Collected After Baseline Assessment	Assessing in Five-Year Review
	Surface Water	Groundwater		
EOD Training Range*	Yes	Not modeled	No	Yes
Former EOD Range / Defense Special Weapons Agency	Not modeled		No	No
South	Not modeled		No	No
Range C	Not modeled		No	No
Range G	Not modeled		No	No
SAR	**Surface Water Ranking**	**Groundwater Ranking**	**Samples Collected**	**Assessing in Five-Year Review**
Range 100	Minimal	Minimal	No	Yes
Range 101	Minimal	Minimal	No	Yes
Range 5	Moderate	Minimal	No	Yes
Range 6	Moderate	Minimal	No	Yes
Range 7	Moderate	Minimal	No	Yes
Range B	Moderate	Minimal	No	Yes
Range C	Moderate	Minimal	No	Yes
Range D	Moderate	Minimal	No	Yes

Note:

*The EOD Training Range was called the Current EOD Range in the baseline assessment.

The baseline assessment of the eight SARs at the installation resulted in minimal surface water rankings for Ranges 100 and 101 and moderate surface water rankings for Ranges 5, 6, 7, B, C, and D. Minimal groundwater rankings were found for all eight SARs. The minimal and

moderate rankings for surface water and groundwater primarily are a result of the low, intermittent precipitation rate; deep groundwater; and limited human and ecological receptors. Minimal and moderate rankings indicate that existing conditions limit potential lead migration and impacts; therefore, no further action was required at the time of the baseline assessment and the sites would be reevaluated in future REVA efforts.

Based on the results of the REVA analysis, no further actions were deemed necessary during the baseline assessment to further evaluate MC transport to off-range areas.

2.2. Installation Changes

2.2.1. Changes at MCAS Miramar

Since the 2008 baseline assessment, the EOD Training Range (referred to as the Current EOD Range in the baseline assessment) has reopened. The range was not used from 2006 until 2010 due to chemical contamination concerns associated with the adjacent Installation Restoration (IR) Site 10. In 2010, the EOD Training Range was returned to an active status following the remediation of IR Site 10 and range modifications. These modifications include the addition of improvised explosive device (IED) training lanes to the range and an increase in the net explosive weight (NEW) for the "shotholes" at the range.

Several biological surveys were conducted at MCAS Miramar since the baseline assessment for special status species and their associated suitable or critical habitats. Biological surveys were conducted primarily for the following species: Riverside fairy shrimp, southwestern willow flycatcher, coastal California gnatcatcher, least Bell's vireo, willowy monardella, Del Mar manzanita, Quino checkerspot butterfly, and Hermes copper butterfly. Vernal pool surveys were conducted in 2009 and 2010 as part of an ongoing effort to precisely map vernal pool habitat basins, estimate watersheds, and determine species presence.

Since the baseline assessment, lead recovery operations were conducted on Ranges C and D. Additional lead recovery operations are in the planning stages for Ranges B, 100, and 101. The lease agreement between the Marine Corps and the San Diego County Sheriff's Department for use of Ranges 5, 6, and 7 and Duffy Town Range was renewed. As a part of the new lease agreement, the San Diego County Sheriff's Department is responsible for the maintenance of these ranges. Part of the maintenance agreement includes lead recovery operations on all four of their ranges, completed in April 2011.

The CPLO for MCAS Miramar noted that a new residential development called Castle Rock is being planned for construction near the Santee Recreational Lakes, west of the West Sycamore Canyon drainage and south of the East Miramar range complex boundary. In addition, the landfill located south of Training Area 2 is planned to quadruple its size in the coming years. While these planned changes have not occurred within the installation boundary, their close

proximity to the ranges and training areas may increase potential receptor interactions. These areas were taken into account during the five-year review for future potential MC exposure and will be evaluated again during future periodic reviews to ensure long-term protection of human health and the environment.

2.2.2. Changes in REVA Assessment

During the baseline assessment, the Duffy Town Range was not included in the assessment. At the time, the Duffy Town Range was thought to be an indoor range (indoor ranges are not assessed under REVA). Based on information collected during the site visit and a more complete understanding of the range layout and usage, the Duffy Town Range was determined to be an outdoor SAR. The range is included in the five-year REVA assessment for MCAS Miramar, and a Small Arms Range Assessment Protocol (SARAP) was completed.

Lead loading on operational ranges was considered only for SARs in the REVA baseline assessment. However, to provide an initial understanding of the amount of lead deposition on HE ranges and training areas, lead loading was estimated for all Marine Corps ranges, including non-SARs, in the five-year review. The total lead deposition on the EOD Training Range was estimated based on installation expenditure records. However, similar to SAR evaluations, the potential for lead migration was not quantitatively assessed because fate and transport parameters for lead are dependent on site-specific geochemical properties.

2.3. Summary of Areas Addressed

The baseline assessment report identified 5 MC loading areas and 8 SARs. Based on the results of the baseline assessment as detailed above and additional data collected for the five-year review effort, the following MC loading area is evaluated for the MCAS Miramar five-year review:

- EOD Training Range

During the five-year review, nine SARs were identified. The Duffy Town Range was not evaluated as part of the baseline assessment, as discussed in **Section 2.2.2**. The following SARs were evaluated through the SARAP in the five-year review:

- Range 100 (Location of Miss and Hit [LOMAH] Rifle Range)
- Range 101 (Pistol Range)
- Range B
- Range C
- Range D
- Range 5
- Range 6
- Range 7
- Duffy Town Range

3. Munitions Constituents Loading Rates and Assumptions

The qualitative and screening-level analyses conducted under REVA require estimation of the amount of indicator MC deposited on operational ranges over time in order to determine if there is a release or substantial threat of a release of MC. The deposition of indicator MC that is estimated under the REVA program is referred to as MC loading.

Operational range usage, boundaries, and other characteristics typically change over time. The objective of the five-year review is to determine the impact of MC loading since the baseline assessment. For this review of training at MCAS Miramar, MC loading estimates include the period from 2007 to 2011; no further review of historical loading prior to 2007 is required since it was addressed in the baseline assessment.

The MC loading process for a baseline assessment is outlined in the *REVA Reference Manual* (HQMC, 2009), while specifics pertaining to MCAS Miramar are discussed in its baseline REVA Report (Malcolm Pirnie, 2009). This five-year review utilizes and builds upon this process, developing MC loading estimates expressed as the average areal loading rate (kilograms per square meter [kg/m^2]) deposited annually in the defined area(s) of interest for the most recent time period (from baseline assessment to present). Assumptions were made throughout this MC loading analysis process pertaining to the spatial distribution of the MC on the MC loading areas, as summarized in **Section 3.1** through **Section 3.4**. **Section 3.5** provides a description of the training areas and ranges at MCAS Miramar and defines the specific MC loading areas identified for the installation as well as the overall assumptions for MC loading on the operational ranges. The range-specific assumptions used in the process and the results of the MC loading screening level assessment are provided in **Section 6**.

3.1. Munitions Constituents Loading Process

The MC loading was estimated based on mass-loading principles. One key consideration for MC loading estimates is the MC content of each type or specific item(s) used at a given MC loading area. Information on the types and amounts of energetic fillers associated with military munitions was developed primarily through the use of Internet-based sources, such as the Defense Ammunition Center's Munitions Items Disposition Action System (MIDAS) Web site and the ORDATA database (2012).

Additional key considerations for MC loading estimates are dud, low order, and high order detonation rates. Studies have shown that MC are deposited on operational ranges through low and high order detonations, as well as the leaching of corroded unexploded ordnance (UXO). MC loading estimates are based upon the sum of the MC deposition associated with each

outcome (i.e., high order, low order, and UXO) for a given MC loading area. Details on this process are included in the MCAS Miramar baseline report (Malcolm Pirnie, 2009) and the *REVA Reference Manual* (HQMC, 2009).

When calculating MC loading for a range/training area that is determined to be regularly and intensely managed for explosive hazards (e.g., the MCAS Miramar EOD Training Range), dud and low order rates were set to zero. Dud/UXO rates associated with DoDICs that were reported in the expenditure data were not used in place of the standard dud assumptions used in the REVA MC Loading Rate Calculator because these data were not reported for a long enough period to develop meaningful dud rates, and the data may not have been reported consistently. As such, the standard REVA methodology and dud rate assumptions were used in order to maintain a higher level of conservatism in the estimates.

Deposition of metals, specifically lead, was further considered during this review. Small arms are presumed to be the most significant contributor to lead deposition at operational ranges and training areas, although the metal may also be part of other HE munitions components to varying degrees. Using a similar MC loading methodology, the annual areal deposition of lead for any given MC loading area was estimated; the results are included in **Section 6**.

Deposition rates may provide an initial measure of potential impact from lead on training ranges; however, it is important to note such rates differ from other MC loading rates. Given the nature of metals, lead deposition estimates assume no consumption from impact (e.g., no loss due to detonation of the munition) and that all of the lead contained within the munition is deposited in the MC loading area. However, the amount of lead that is deposited in a form that is exposed to the environment and available for transport (e.g., small particles and dust separated from the munition body upon impact) cannot be estimated without site-specific measurements. This is further complicated at demolition or other ranges where management practices may involve collection of scrap metals, which would reduce the overall lead presence at that location. In such instances, unless information indicates otherwise, it is conservatively assumed that lead deposition is 5% of the munitions' lead content. Fate and transport parameters for lead are dependent on site-specific geochemical properties, which may vary across small areas in a designated MC loading area and cannot be determined solely by physical observation. For these reasons, the lead loading estimates developed for this assessment are intended to serve as a general indicator of the total lead deposited rather than an estimate of the fraction of lead that is environmentally available for transport and exposure to receptors. In the case of a SAR, range design typically concentrates the impact point to a small, restricted area, and the SARAP may be used to qualitatively assess the potential for off-site impacts, as covered in **Section 7**.

Additional specifics regarding how these data were incorporated are explored in the aforementioned *REVA Reference Manual* and baseline *Range Environmental Vulnerability Assessment Report for MCAS Miramar*.

3.2. Expenditure Data

O&T is responsible for the administration and oversight of the training operations conducted at MCAS Miramar. O&T coordinates primary recordkeeping for munitions expenditures at the operational ranges of the installation through use of the Range Facility Management Support System (RFMSS). These data were provided in electronic format.

The use of documented expenditure data is preferred in the REVA program. A quality review of the expenditure data provided by the installation resulted in a series of assumptions applicable across operational training areas at MCAS Miramar:

- The expenditure data provided by the installation came from two sources. Range Operations provided RFMSS data for the period of January 2007 through March 2012; this represents the primary source of expenditure data used in the MC loading estimation process. In addition, the Environmental Department provided expenditure data gathered to support annual Emergency Planning and Community Right-To-Know Act Section 313 (EPCRA) reports for 2008 to 2010.

- The data associated with the EPCRA reports do not include expenditure counts from the ranges operated by the Sheriff's Department (Ranges 5, 6, and 7 and Duffy Town Range). The expenditure data included in the EPCRA reports for the ranges operated by the Marine Corps (Ranges 100, 101, B, C, and D) matched the expenditure data provided by RFMSS. Therefore, the RFMSS data were utilized as the primary source for small arms expenditures for this five-year review.

- The RFMSS expenditure data for the Sheriff's Department ranges (Ranges 5, 6, and 7 and the Duffy Town Range) were listed as yearly expenditure totals per DoDIC under the single heading of "Duffy Town" and were not broken down by range. According to the Range Management Officer for the Sheriff's Department, the usage breakdown of the Sheriff's Department ranges is as follows: Range 7 – 70%; Range 6 – 20%; Range 5 – 9%; and Duffy Town Range – 1%. These usage percentages were applied to the yearly total expenditure counts listed for the Sheriff's Department ranges.

- Reliable expenditure data for 2008 were not available due to complications with the RFMSS during the site visit and, therefore, were not factored into the MC loading calculations. Expenditure data provided for 2007, 2009, 2010, and 2011 were determined to be sufficient to generate accurate annual expenditure averages for the MC loading calculations.

- The 2007 expenditure data recorded in RFMSS for Ranges 100 and 101 only captured 7 months of expenditures. The expenditure counts for these two ranges in 2007 were increased proportionately by 42% to estimate total expenditures for the entire 2007 year.

- Expenditure data for the SARs and the EOD Training Range were provided through March 2012. The 2012 expenditure data were not used for the five-year review MC loading calculations due to the inability to accurately predict the training tempo and seasonal variations in training through the remainder of 2012 based on only three months of expenditure data.

- The expenditure summaries contain some DoDICs for which data regarding MC content were not available in MIDAS or other inventories. In these instances, the general descriptions of the munitions associated with these DoDICs provided by the installation data were reviewed. Along with available information regarding the associated range, its design, and its regulations, professional judgment was used to select surrogate MC loading factors from available data for similar munitions for use in MC loading calculations.

EOD personnel provided a record of commitment sheets and associated expenditure reports used to account for EOD-related expenditures that may not be captured in the RFMSS data. The sheets cover the period of January 2007 to March 2012 and contain detailed information about what UXO was found, where it was found, and what remedy was applied, including a record of any transport or demolition materials used. These data were used to develop expenditure averages, which supplemented information extracted from the RFMSS data, using the following assumption:

> Only EOD expenditure data from 2010 and 2011 were used to calculate average yearly expenditures because the EOD Training Range was not in use from 2006 until 2010 except for incidental emergency situations when the UXO in need of disposal could not be transported safely to MCB Camp Pendleton.

Expenditure data recorded for the EOD Training Range in 2011 in RFMSS listed only one DoDIC, and the count was significantly higher than those found in the commitment sheets and expenditure reports provided by MCAS Miramar EOD personnel. To ensure conservative calculations, the expenditure counts in the RFMSS data for 2011 were used and all counts of disposed items associated with EOD operations were taken from expenditure reports and commitment sheets provided by MCAS Miramar EOD personnel.

3.3. REVA Munitions Constituents Loading Rate Calculator

The REVA MC Loading Rate Calculator is used to provide an automated method to calculate the overall loading of the operational range area in the units needed for the fate and transport analysis (kg/m^2). It utilizes information regarding the size of MC loading areas, the military munitions expenditure data obtained from the installation, and information and assumptions related to duds, low order, and high order detonations. Additionally, it utilizes training factors to account for fluctuations in training during periods of use where no expenditure data are available.

Further explanation regarding the REVA MC Loading Rate Calculator may be found in the *REVA Reference Manual* (HQMC, 2009). All known data and assumptions input into the MC Loading Rate Calculator for each operational range area assessed are documented elsewhere in **Section 3** and in **Section 6**.

3.4. Munitions Constituents Loading at MCAS Miramar

MCAS Miramar is located approximately 13 miles north of downtown San Diego and 4 miles east of the Pacific Ocean and occupies approximately 23,065 acres (MCAS Miramar, 2011b). Interstate 15, State Route 163, and Kearny Villa Road bisect the station into east and west sections. The area west of Kearny Villa Road contains the Main Station and South/West Miramar and supports the military need for commercial, administrative, operational, and residential facilities. Training activities are conducted within the rugged terrain in East Miramar, which consists of approximately 15,585 acres of land, defined as all of the installation area east of Kearny Villa Road and U.S. Highway 163.

All of East Miramar has been designated as operational range lands (as defined by 10 United States Code 101(e)(3)), with the exception of several noncontiguous tracts of land that are considered to be unavailable for training (incompatible use areas), as shown in **Figure 3-1**. These areas have been or will be put to a new use that is incompatible with range activities. These areas include warehouses, the Navy / Marine Corps and Army Reserve centers, public transportation corridors, local school district land, an area known as Camp Elliott (a former WWII era camp), the future site of Military Housing Site 8, and various small tracts of land. The combined area of these incompatible use areas within East Miramar is 1,274 acres. Consequently, the remaining area within East Miramar that is available for military range training activities is approximately 14,311 acres (Richie, 2009). For the purposes of this document, the operational range lands at which training can occur are referred to as the East Miramar Range Complex. This range complex contains all of the specific range / training areas evaluated under REVA (MCAS Miramar, 2011b).

The East Miramar Range Complex can be divided into areas containing (1) training areas / fixed ranges and (2) other areas that are considered operational range lands but currently are not being used for training purposes. The first group consists of five training areas used for maneuver and land navigation training, nine SARs used for weapon proficiency training, and an EOD Training Range used for training and emergency destruction of ordnance. These fixed operational ranges are described in **Table 3-1** and are identified in **Figure 3-1**. The latter group represents all of the other remaining areas within the East Miramar Range Complex. These areas, while not currently being used for a specific training purpose, may be used or activated at any time for range/training activities.

Training within the East Miramar Range Complex includes land navigation training, troop maneuvers, bivouacking / overnight camping, aircraft / personnel support exercises, tactical vehicle driver training, and weapons instruction training (MCAS Miramar, 2011b). The primary range users at MCAS Miramar are elements of the 3rd MAW, the primary tenant at the installation. The mission of the 3rd MAW is to provide combat-ready expeditionary aviation forces capable of short-notice worldwide deployment to Marine Air Ground Task Force fleet and

unified commanders (3rd MAW, 2011). General training categories at MCAS Miramar include the following (MCAS Miramar, 2011b):

- Marine Corps common combat skills training
- Vehicle operations
- Marine Wing service support
- Air operations training

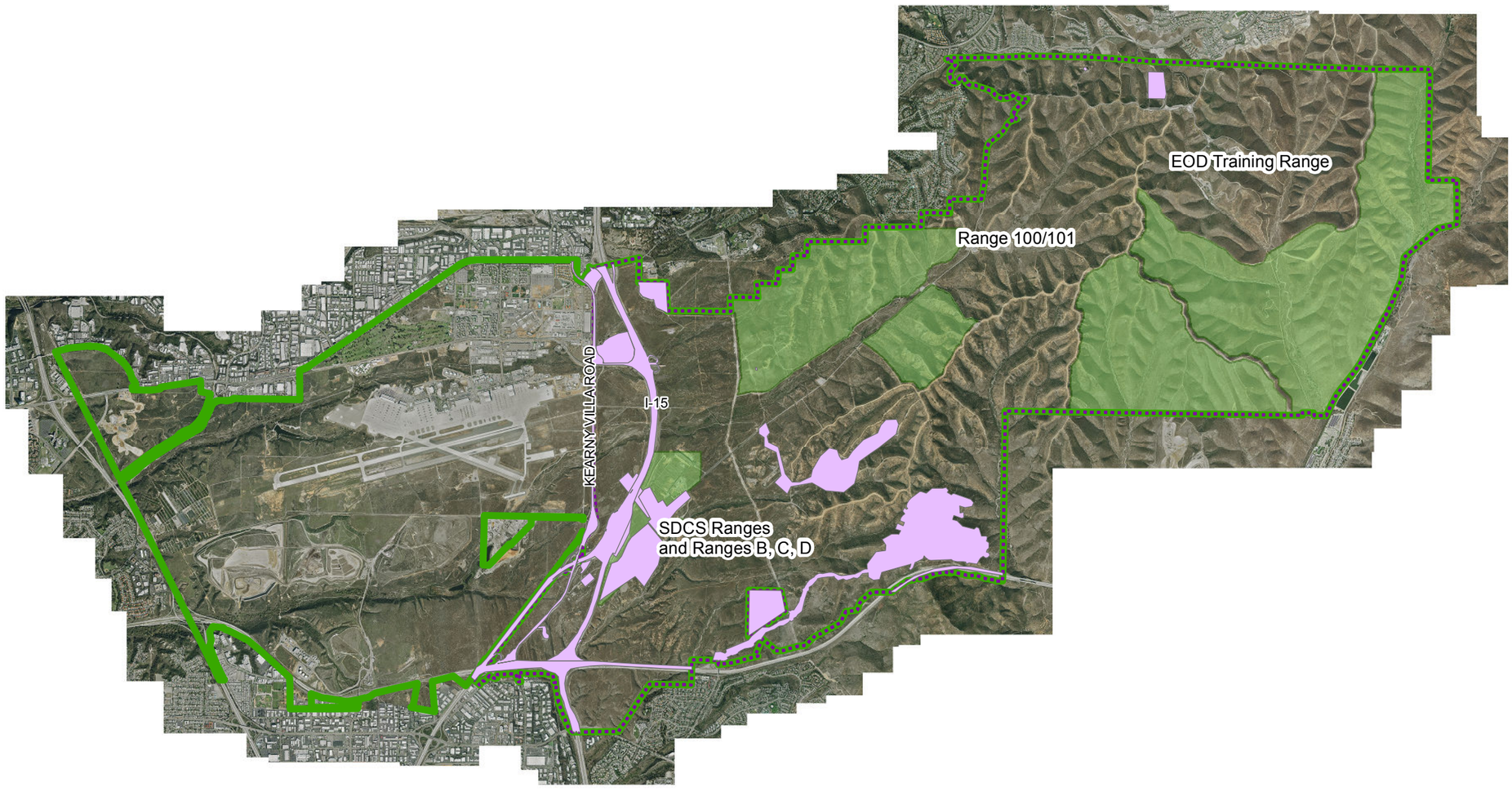
There are no training ranges to support aerial munitions use at MCAS Miramar. Fixed wing turboprop, jet, and rotary wing aircraft from the installation utilize ranges at Marine Corps Base (MCB) Camp Pendleton, Marine Corps Air Ground Combat Center Twentynine Palms, MCAS Yuma, and San Clemente Island for training involving aerial munitions. The various landing areas located across MCAS Miramar are utilized by rotary wing aircraft for other training operations not including the use of aerial munitions, such as external loading or confined area landings (TECOM, 2004; Ward, 2012).

3.4.1. Training Areas

Prior to the 1995 Base Realignment and Closure (BRAC) Act process, the Navy established five training areas within East Miramar to support ground training operations for Naval Air Station (NAS) Miramar. As part of the BRAC conversion of NAS Miramar to MCAS Miramar, the Marine Corps agreed to use training areas in a manner consistent with guidelines and procedures established by NAS Miramar Instruction 7050.2D (MCAS Miramar, 2011b). The Marine Corps developed MCAS Miramar Station Order P3500.2, which includes specific instructions for use of these training areas. As new mission requirements are identified, ground training areas may be modified (MCAS Miramar, 2011b).

The five training areas located within the East Miramar Range Complex are depicted in **Figure 3-1**. Training Areas 1 through 5 are field training areas for which the following tactical exercises / field training activities are approved (MCAS Miramar, 2012a):

- Land navigation
- Troop maneuvers
- Vehicle driver training
- Convoy operations
- Tactical operations
- Bivouac
- Aircraft/personnel exercises



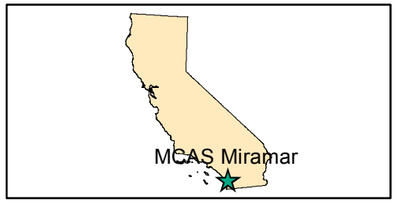
REVA
Figure 3-1
Operational Ranges and Training Areas

MCAS Miramar
Miramar, CA

Legend

- Installation Boundary
- East Miramar Range Complex
- Training Area
- Incompatible Use Areas

Note:
SDCS - San Diego County Sheriff



0 0.25 0.5 1 1.5
Miles

Date: February 2013

Source: MCAS/EMS GIS Office 2012
GEOFIDELIS 2011

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

Page left intentionally blank

TABLE 3-1
Summary of Operational Ranges and Training Areas, MCAS Miramar

Range Name	Period of Use	Size (acres)[a]	Small Arms Range	Authorized Military Munitions	Primary Use	Notes / Action Items
East Miramar Range Complex	**1995 - present**	**14,311[b]**	**--**	**Small arms only within the confines of designated ranges**	**Land navigation training, troop maneuvers, bivouacking/overnight camping, aircraft/personnel support excercises, tactical vehicle driver training, and weapons training**	**East Miramar Range Complex boundary not included in GIS data; acreage modified to remove area encompassed by magazine Public Transportation Route Explosive Safety Quantity Distance arc, which is incompatbile with operational range use. Pyrotechnics not authorized in training areas or ranges.**
Training Area 1 (TA-1)[c]	1995 - present	2,143	--	Blanks	Tactical excercises and field training	
Training Area 2 (TA-2)[c]	1995 - present	1,023	--	Blanks	Tactical excercises and field training	
Training Area 3 (TA-3)[c]	1995 - present	305	--	Blanks	Tactical excercises and field training	
Training Area 4 (TA-4)[c]	1995 - present	929	--	Blanks	Tactical excercises and field training	Pyrotechnics use is permitted with an approved waiver.
Training Area 5 (TA-5)[c]	1995 - present	300	--	Blanks	Tactical excercises and field training	
EOD Training Range	1997 - present	88[d]	--	Explosives	EOD personnel training and emergency destruction of hazardous explosive items	Range not used from 2006-2010. Lower shot hole is primary training location. IED lanes include any part of the asphalt or dirt roads circling the canyons and leading to the lower shot holes with the EOD compound. Navy EOD also uses range periodically.
LOMAH Rifle Range (Range 100)	2004 - present	3,509	X	Small Arms	Marksmanship training for service rifles	
Pistol Range (Range 101)	2007 - present	346	X	Small Arms	Marksmanship training for service pistol	
Duffy Town Range	1953 - present	519	X	Small Arms	Marksmanship training for pistol, shotgun, and rifle	Utilized by San Diego Sherriff's Department, MCRD PMO, local law enforcement agencies, and Special Operations personnel.
Sheriff's Range 5	1953 - present		X	Small Arms	Marksmanship training for pistol, shotgun, and rifle	Utilized by San Diego Sherriff's Department, MCRD PMO, local law enforcement agencies, and Special Operations personnel.
Sheriff's Range 6	1953 - present		X	Small Arms	Marksmanship training for pistol, shotgun, and rifle	Utilized by San Diego Sherriff's Department, MCRD PMO, local law enforcement agencies, and Special Operations personnel.
Sheriff's Range 7	1953 - present		X	Small Arms	Marksmanship training for pistol, shotgun, and rifle	Utilized by San Diego Sherriff's Department, MCRD PMO, local law enforcement agencies, and Special Operations personnel.
Small Arms Range B	1953 - present		X	Small Arms	Marksmanship training for pistol, shotgun, and rifle	Utilized by MCAS Miramar PMO, MCRD PMO, and the Marine Corps Police Academy West, Navy, and Federal Agencies for marksmanship training.
Small Arms Range C	1953 - present		X	Small Arms	Marksmanship training for pistol, shotgun, and rifle	Utilized by MCAS Miramar PMO, MCRD PMO, and the Marine Corps Police Academy West, Navy, and Federal Agencies for marksmanship training.
Small Arms Range D	1953 - present		X	Small Arms	Marksmanship training for pistol, shotgun, and rifle	Utilized by MCAS Miramar PMO, MCRD PMO, and the Marine Corps Police Academy West, Navy, and Federal Agencies for marksmanship training.

Notes:
[a] All operational range acreages, with the exception of the East Miramar Range Complex and the EOD Range, are based on area analyses on GIS data obtained from USMC GeoFidelis.
[b] USMC GeoFidelis GIS data did not provide boundaries of the East Miramar Range Complex. The acreage provided in this table is based on the results of the range definition process from the Baseline REVA Report (15,585 acres of East Miramar less 1,274 acres of incompatible use areas).
[c] Training Areas 1 through 5 were originally established by the Navy, date unknown. The 1995 start date reflects the transfer date to the USMC.
[d] EOD Training Range acreage was not listed in the installation GIS. Therefore the REVA team estimated the boundary and acreage based on Range SOP and information provided by Range Control.

There are two bivouac sites at MCAS Miramar (Site #1 and Site #2) which are not located within any training area boundaries (between TA-3 and TA-4). They are not listed in the table because no live-fire training is conducted at either site.
Total acreage of small arms ranges based on the extent of the Surface Danger Zone (SDZ) and range footprint from installation GIS data.
EOD - Explosive Ordnance Disposal
IED - Improvised Explosive Device
LOMAH - Location Of Miss And Hit
MCRD - Marine Corps Recruit Depot
PMO - Provost Marshall's Office
SDZ - Surface Danger Zone

Page left intentionally blank

Range Control personnel indicated that Training Area 4 receives approximately 90% of the total training activity (Ward, 2012).

Vehicle traffic is restricted to existing roads and creek crossings in order to prevent erosion and damage to wetlands and vernal pool habitats found within the training areas, which may contain sensitive species. Similarly, troop movements are restricted to existing road and trails, and access to creek crossings is restricted to certain seasons to reduce impacts to natural resources. Creek beds within Rose Canyon and San Clemente Canyon, which overlap with portions of Training Areas 3 and 4, are considered restricted areas as well. These and other restrictions within the East Miramar Range Complex protect sensitive ecological and cultural resources; they are described in detail in the MCAS Miramar Station Order 3500.2A (MCAS Miramar, 2012b). None of these training restrictions impact the reported total operational range acreage.

Due to the risk of generating wild fires in the dry and rugged areas of East Miramar, pyrotechnics, incendiary devices, HEs, and blank ammunition are restricted from use on Training Areas 1–3 and 5. Pyrotechnics are permitted on Training Area 4 if a special waiver is granted by the Training Area Management Officer. Interviews with Range Control personnel indicate that these types of waivers rarely are granted (approximately once a month). Since live fire is not authorized, surface danger zones (SDZs) have not been established for the training areas. Given the restrictions on munitions use, MC loading is not anticipated to be occurring on the training areas. A summary of the training areas is provided in **Table 3-1**.

3.4.2. EOD Training Range

The EOD Training Range, located in the northeast corner of the East Miramar Range Complex, is the only range at MCAS Miramar that allows the detonation of munitions containing HE. The range is located at the former Sycamore Canyon Missile Test Site, which tested Atlas missiles and was operated by the Air Force and the National Aeronautics and Space Administration between 1960 and 1969 (MCAS Miramar, 2011a). EOD operations, originally conducted at the Green's Farm research facility (where Ranges 100 and 101 are now located), were transferred to the current location in October 1997.

The range consists of two "shotholes" for EOD training and emergency destruction of UXO found on MCAS Miramar and surrounding areas due to past training activities associated with WWI and WWII. The upper shothole is present on a small clearing on the hillside and adjacent to the access road. This shothole receives less than 5% of all EOD expenditures and permits a NEW of 5 pounds (lb). The lower shothole, which receives approximately 95% of all EOD expenditures, is located in a canyon bottom adjacent to West Sycamore Creek. The NEW permitted for this shothole is 100 lb.

In addition to the two shotholes, all roads present within the fenced-in EOD area can be utilized as IED training lanes. Car hulks are placed sporadically along these roads to help simulate

current Marine combat conditions. According to MCAS Miramar EOD personnel, the IED lanes were established recently and, so far, rarely used. The NEW permitted for the IED training lanes is limited to 1.25 lb of nonfragmentary explosives.

The EOD Training Range was inactive from 2006 to 2010 due to concerns about polychlorinated biphenyl (PCB) concentrations in soil at IR Site 10 immediately adjacent to the range (NAVFAC, 2011). According to Range Operations personnel, an additional contributing factor to the inactivity of the EOD Training Range was the 2007 Cedar Fire. The fire department, which previously supported all EOD activities, was concerned that the fires had increased the exposure potential to the PCB concentrations (Ward, 2012). A temporary proposed location for the EOD Training Range was identified between the two former test facilities in an area not known to be contaminated; however, due to the higher elevation of the proposed location, the Federal Aviation Administration requested that the range be relocated to avoid interference with operations in Class B airspace (NAVFAC, 2011). Therefore, these plans were abandoned and the range remained in its current location and was used only under emergency conditions—when munitions requiring destruction could not be transported safely to MCB Camp Pendleton for disposal. MCAS Miramar resumed use of the EOD Training Range in mid-2010 upon completion of the non-time-critical removal action at IR Site 10.

3.4.3. Small Arms Ranges

Nine SARs, located in two separate areas within the East Miramar Range Complex (**Figure 3-1**), are utilized by MCAS Miramar and other military, local law enforcement, and federal agencies for marksmanship/proficiency training and qualification (MCAS Miramar, 2011a). SARs are qualitatively assessed using the REVA SARAP, provided in **Appendix A**. The SARs are described briefly in the following sections.

3.4.3.1. Range 100 (LOMAH Rifle Range)

Range 100, also known as the LOMAH Rifle Range, is a 500-yard rifle range located in the north-central section of East Miramar and, along with Range 101, comprises the Carlos Hathcock Range Complex. Range 100 is operated by the Marksmanship Training Unit (MTU). The range, constructed in 2004, is oriented for firing from west to east; its SDZ partially overlaps Training Areas 1 and 2. The range contains 40 firing lanes of multiple known distance targets, as well as eight lanes for unknown distance targets. Targets are located at distances of 100, 200, 300, and 500 yards from the firing line. The targets used in the LOMAH system electronically gauge the location of hits and misses on the target and report scores in real time. The range is used approximately 3 weeks per month. In addition, Table 2 rifle training has been initiated with Marines firing into the front of the earthen berm at the 100-yard target line; however, the majority of the rounds from this range are deposited on the backstop berm. Various types of small arms ammunition are used at this range.

3.4.3.2. Range 101 (Pistol Range)

Range 101 is located immediately south of and adjacent to the Range 100 firing line and is also part of the Carlos Hathcock Range Complex and MTU operations. This pistol range opened in January 2007 and contains 25 firing lanes at 7-, 15-, 25-, and 50-yard distances. Shotgun training also is conducted at this range. Firing is directed to the southeast, where a natural hillside serves as the rear impact berm for bullet containment. Various types of small arms ammunition are expended at this range. Range 101 has a similar rate of lead deposition per year as Range 100; however, where lead is dispersed across two impact berms at Range 100, it is directed into a smaller, single berm at Range 101.

3.4.3.3. Ranges B, C, and D (Marine Corps SARs)

Ranges B, C, and D are located in the southwestern section of East Miramar, adjacent to Training Area 5. The ranges, located in parallel along a north-south trending hillside, are oriented for firing to the east-southeast. The ranges are separated by earthen side berms, and the natural hillside serves as the rear impact berm for all three ranges. In addition, Range B contains wood baffling above the rear firing line to reduce the vertical trajectory of bullets fired during training.

These ranges historically were utilized by the Navy and remain in operation today. The primary users of these ranges are MCAS Miramar Provost Marshall Office (PMO), Marine Corps Recruit Depot San Diego PMO, Marine Corps Police Academy West, and Navy units, which schedule range usage with the MCAS Miramar Range Management/Control office. Various types of small arms ammunition are expended at these ranges. A combined SDZ has been established for the three Marine Corps ranges and the four San Diego County Sheriff's Department's ranges, which are located along the hillside to the north and described in detail below. The SDZ extends to a maximum distance of 5,906 feet (ft) downrange and overlaps a section of land owned by the San Diego County School District that is located within the boundaries of MCAS Miramar.

3.4.3.4. Ranges 5, 6, and 7 and Duffy Town Range (San Diego County Sheriff's Department Ranges)

The San Diego County Sheriff's Department, under a lease agreement with MCAS Miramar, operates a 43-acre training facility adjacent to Training Area 5. County, state, federal, and local law enforcement agencies and military personnel use the facility for role-play scenarios and live-fire training exercises and to practice rescue training techniques. The facility is composed of a dog training facility, an urban disaster training facility, an obstacle course, a mock town used for tactical training (known as Duffy Town), and administrative buildings (MCAS Miramar, 2011b).

Ranges 5, 6, and 7 and the Duffy Town Range share the same hillside impact berm as Ranges B, C, and D. In the baseline assessment, only three ranges were identified (Ranges 5, 6, and 7) among the Sheriff's Department ranges. Range Operations personnel indicated that the Duffy Town Range is the least used live-fire range of the ranges operated by the Sheriff's Department but confirmed it is used for small arms training. As such, it has been identified as a separate

range for the five-year review. The Sheriff's Department ranges are used heavily (daily training activities are conducted), resulting in significant lead deposition in the impact berm. The ranges are separated by concrete sidewalls. Various types of small arms ammunition are expended at these ranges.

3.4.4. Range Maintenance / Clearance Program

There is no current operational range clearance program in place at MCAS Miramar because there are no live-fire ranges that utilize HE rounds. Training and emergency disposal activities at the EOD Training Range are not expected to result in the deposition of munitions and explosives of concern.

According to Range Operations personnel, there is no standardized scheduling of range maintenance activities at MCAS Miramar. Activities such as excavation, lead recovery, and berm reconstruction are conducted on an as-needed basis depending on variables such as changes in ammunition expenditures, training tempo, seasonal effects, safety issues, and requirements to improve drainage. Since the baseline assessment, lead recovery operations were conducted on Ranges C and D (May 2011).

Lead recovery has not been conducted at Range 100 and Range 101 since their construction. In particular, "splash back" (a condition in which fired rounds ricochet off lead from previously deposited rounds or other hard objects located in the berm and sending fragments back at the shooter) has been noted at Range 101 due to erosion and the heavy amounts of lead deposition occurring there since training commenced. In addition, lead recovery has not been conducted at Range B. Range maintenance activities involving lead recovery and berm reconstruction are in the planning stages for all three ranges; according to Range Operations personnel, the funds are in place and the work likely will start in the near future.

As part of the range lease renewal with the Marine Corps, the Sheriff's Department also has conducted lead recovery operations on all four of their ranges (Ranges 5, 6, and 7 and the Duffy Town Range) since the baseline assessment; the lead recovery began in November 2010 and was completed in April 2011. The surface of the shared berm was excavated to a depth of approximately 2 ft, and the base of the berm was straightened to be parallel with the firing lines. The excavated soil was sifted and returned to the berm, and the lead cobbles and gravel extracted were removed from the area. As a result of these activities, a total of 78,088 lb of lead was recovered and recycled (BSE, 2011). In addition, a small trench was added at the base of the berm by the San Diego Sheriff's Department to improve the drainage.

3.5. Munitions Constituents Loading Assumptions

3.5.1. Selection of Munitions Constituents Loading Areas

The REVA team reviewed existing operational ranges and training areas to determine the locations of MC loading that required analysis in the five-year review. These areas represent the locations where significant MC loading is occurring or suspected to have occurred as a result of training with munitions containing HE (TNT, RDX, and HMX), illumination rounds and other munitions containing solid propellants (perchlorate), and metals (lead). Lead deposition was evaluated for all operational ranges during this review. One MC loading area, the EOD Training Range, was delineated (**Figure 3-2**). Five MC loading areas were identified during the baseline REVA assessment, including the EOD Training Range (previously referred to as the Current EOD Range in the baseline report). The remaining four MC loading areas included in the baseline assessment, as discussed in **Section 2**, were based on historical use ranges at MCAS Miramar.

Only the EOD Training Range MC loading area contains a currently operational range at which HE- and perchlorate-containing munitions are expended and, therefore, is the only MC loading area identified for this review. The MC loading assessment for this range includes only the ongoing activities performed at the EOD Training Range, and no loading from historical operations of the missile test site was conducted as part of the five-year review. Expenditure data obtained from the EOD Office combined with the available EOD expenditures listed in the RFMSS were used to conduct MC loading for this range. The EOD Training Range MC loading area, which encompasses the current EOD activities identified during the five-year review, is significantly smaller than the area of the entire EOD Training Area incorporated into the baseline assessment calculations. This was done to more accurately reflect the specific location of munitions utilization based upon improved information from the installation. In order to ensure conservative calculations, all expenditures at the EOD Training Range were assumed to occur in the lower shothole. This assumption is based upon knowledge of EOD operations provided by O&T. The area of the lower shothole (6,313 m^2) was calculated based on a 147 ft buffer noted in the Range Standard Operating Procedure.

MC loading areas were not established for the five training areas because HE munitions and illumination rounds are not authorized for use on East Miramar, with the exception of Training Area 4 with the approved waiver (which is not frequently granted). The training areas are used only for non-live-fire tactical exercises and/or field training activities. Lead loading at the nine SARs is addressed in the SARAP (**Appendix A**).

3.5.2. Overarching Assumptions

To estimate MC loading for operational ranges, assumptions were developed to apply to data collected during the five-year review. Complete details and background of these assumptions and data are available in the *REVA Reference Manual for Baseline Assessments* (HQMC, 2009). The following bullets represent the primary assumptions used in the MC loading assessment.

- Only the main fillers and perchlorate components (REVA indicator MC) are included in the estimates. The amount of MC in fuzes, boosters, and other components is not considered significant enough, by comparison, to impact the MC loading amounts.
- All REVA indicator MC are considered 100% pure and, therefore, more readily transported in the environment.
- Dud and low order detonation rate estimates are from the *Report of Findings for: Study of Ammunition Dud and Low Order Detonation Rates, United States Army Defense Ammunition Center* (DAC, 2000). In the event rate estimates are not available, the default values listed in the referenced report of 3.45% (dud rate) and 0.028% (low order detonation rate) are used.
- One hundred percent of the MC within a munition remains when a UXO event occurs. Following deposition of UXO, 1% of the total MC mass within the UXO is considered exposed and available for transport.
- For high order detonations, it is assumed 99.9% of the total MC per item is consumed, resulting in deposition of 0.1% of the MC mass on the loading area, as detailed in the *REVA Reference Manual* (HQMC, 2009).
- Calculations incorporating expenditures at EOD and demolition ranges are adjusted to reflect an assumed 100% high order detonation.
- In the event that data are unavailable for the entire training period identified, other methods or assumptions for estimating MC loading are implemented.
- Dud/UXO rates associated with DoDICs reported in the RFMSS data were not applicable and not used in place of the standard dud assumptions used in the REVA MC Loading Rate Calculator; these data were not reported for a long enough period to develop meaningful dud rates, and the data may not have been reported consistently. As such, the REVA standard dud rate assumptions are used in order to maintain a higher level of conservatism in the estimate.

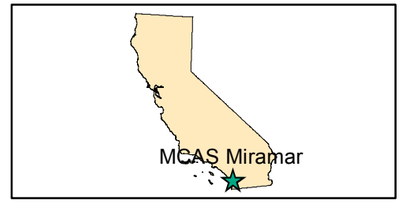
HE and perchlorate were evaluated at EOD Training Range MC loading area; lead was evaluated at the EOD Training Range MC loading area and all nine SARs. Calculation of representative annual expenditure estimates at the ranges was performed to help characterize MC loading. The recorded totals by DoDIC for applicable years were averaged together, with all fractional values conservatively rounded up to the next whole number. The specific methodologies and assumptions used to conduct the MC loading at each loading area are detailed in **Section 6**, as applicable.

REVA
Figure 3-2
MC Loading Areas

MCAS Miramar
Miramar, CA

Legend

- Installation Boundary
- East Miramar Range Complex
- MC Loading Area



0 400 800 1,600 2,400
Feet

Date: February 2013

Source: MCAS/EMS GIS Office 2012
GEOFIDELIS 2011

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

4. Conceptual Site Model

Predicting off-range migration of MC requires the evaluation of potential transport pathways, such as surface water and groundwater flow systems, and potential receptors (human and ecological) that could be affected. To this end, the REVA team developed a CSM of MC transport at MCAS Miramar. The primary components of this CSM include:

- delineation of the MC loading area,
- identification of which REVA indicator MC have been used at the MC loading area, and
- a synthesis and interpretation of various environmental data to identify potential MC migration pathways and receptors.

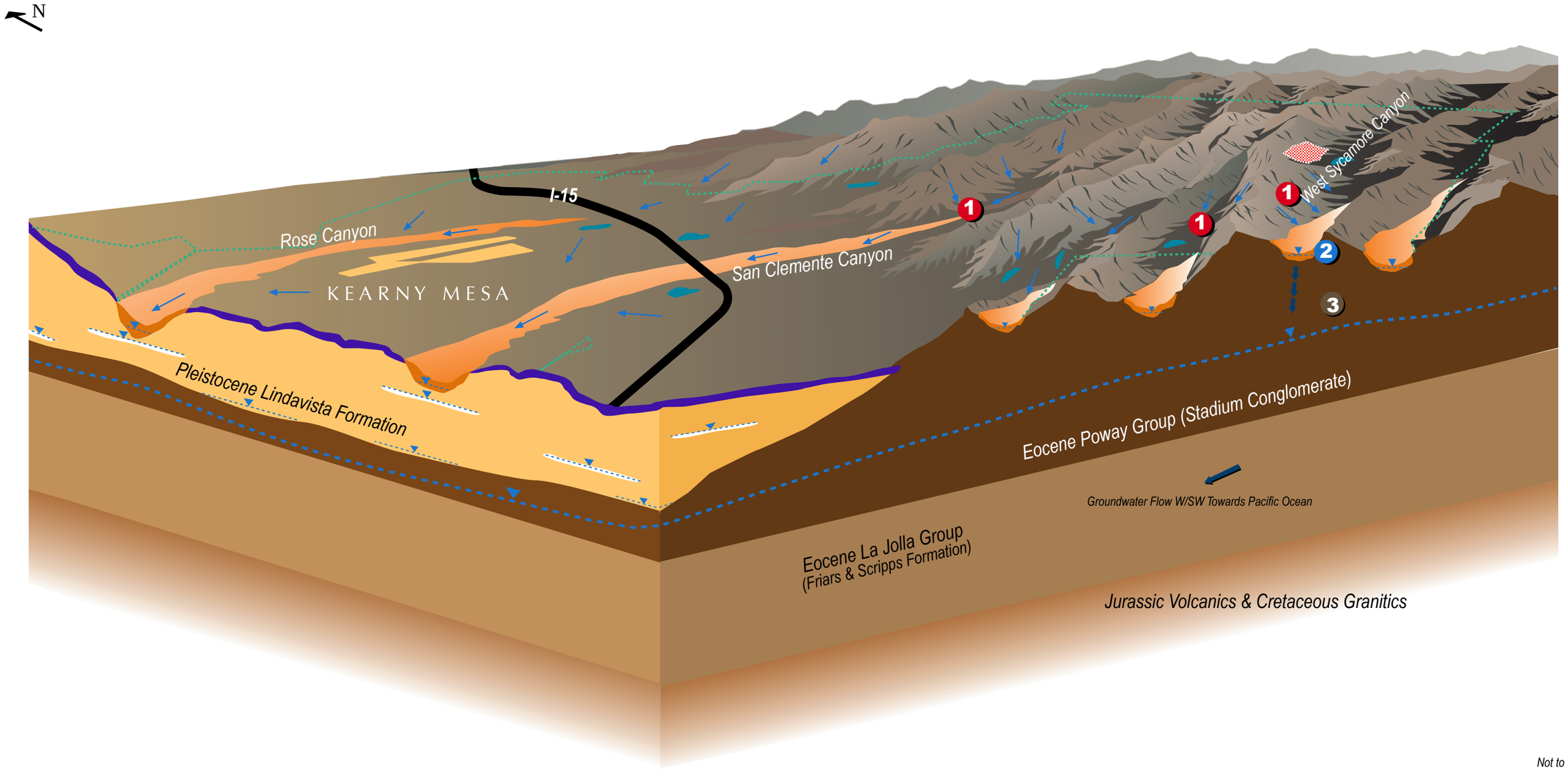
The CSM was developed using information obtained during the site visit, environmental reports obtained from MCAS Miramar, and local geologic field studies. Where information on site-specific characteristics was limited, regional information was used to estimate site-specific characteristics. Documents obtained from the Environmental Management Department, O&T, and the installation EOD unit include information on the site geology and hydrology, the water supply system, cultural resource studies, natural resource studies, range operating procedures, EOD commitments, and operational range clearances. In addition, the REVA team used various types of spatial data provided by the Environmental Management Department to map site characteristics.

A schematic diagram depicting the site conditions addressed in the CSM is presented in **Figure 4-1**. The geomorphology is shown relative to generalized MC loading areas, the installation boundary, and potential receptors (e.g., drinking water wells, ecological receptors).

The site-specific CSM for the MC loading area is provided in **Section 6**.

4.1. Installation Profile

CSM Information Profiles – Installation Profile	
Information Needs	**Information**
Installation location	The installation is located in San Diego County, California, approximately 13 miles north of downtown San Diego.
Date of installation establishment	The U.S. military has used the area in which the installation is located since 1917. The Marine Corps has been an occupant at various times; its current occupation of the installation began in October 1997 (Anteon, 2004).
Installation area and layout	MCAS Miramar encompasses 23,065 acres; there are also over 400 acres of aviation easements (USACE, 2001a; TECOM, 2004). The air station is comprised of three general geographic and functional sectors: Main Station, South/West Miramar, and East Miramar (TECOM, 2004). Kearny Villa Road divides the installation into two sections: the South/West Miramar and Main Station area (with the airfield, administration, maintenance, supply, housing, and recreation functions) and East Miramar (training, warehousing, and storage). East Miramar, which contains the training areas and operational ranges, comprises approximately 15,585 acres and is largely undeveloped since it lies beneath the flight path (Anteon, 2004).
Installation mission	The mission of MCAS Miramar is to maintain and operate facilities and provide services and material to support the 3rd MAW and other tenant organizations. The mission of the 3rd MAW, the station's primary tenant, is to provide combat-ready, expeditionary aviation forces capable of short-notice, worldwide deployment to Marine Air Ground Task Force, fleet, and unified commanders (MCAS Miramar, 2011a).



Not to Scale

Legend

- Alluvium & Slopewash
- Beach Deposits
- Pleistocene Lindavista Formation
- Eocene Poway Group *(Stadium Conglomerate)*
- Eocene La Jolla Group *(Friars & Scripps Formation)*
- Jurassic Volcanic & Cretaceous Granitics
- Vernal Pools
- Water Table
- Groundwater Flow
- Surface Water Flow
- Installation Boundary
- MC Loading Area

NOTE:
This cross-section is based on a basic understanding of the distribution of the geologic units and features and only represents the general conceptual model for the surface and groundwater flow at MCAS Miramar. This figure is not to be considered a geologic cross-section with accurate subsurface contacts or outcrops.

Possible MC Migration Pathways:

1. *Overland runoff down canyons.*
   a. *Dissolution of MCs in the runoff water.*
   b. *Erosion of particulate with adsorbed MCs in soil.*
2. *Canyons can recharge underlying alluvium deposits. Water is likely only found in the alluvium after heavy storms or several wet years; however, there is potential migration to shallow groundwater at designated groundwater basins outside the installation from stream flow recharge.*
3. *Possible infiltration to deep water table.*

Figure 4-1
Graphical Conceptual Site Model (CSM) at MCAS Miramar
Miramar, CA

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

Page intentionally blank

4.2. Operational Range Profile

CSM Information Profiles – Operational Range Profile	
Information Needs	**Information**
Range complex location	The East Miramar Range Complex is located on the eastern half of the installation, bounded on the west by Kearny Villa Road and U.S. Highway 163; its remaining boundaries follow the installation boundaries on the south, east, and north sides. The complex is approximately 14,311 acres. Approximately 1,274 acres of land located within East Miramar have been removed from the range complex due to incompatible uses.
MC loading areas	The REVA team delineated one MC loading area within the East Miramar Range Complex: EOD Training Range MC loading area. The MC loading area was selected based upon a review of existing operational ranges. Contributions from historical use areas located within the East Miramar Range Complex were considered in the baseline assessment. Historical use areas were not considered in this five-year assessment as no new loading has occurred in these areas. The EOD Training Range MC loading area is the only area that utilizes HE munitions.
Range names	The installation has administratively designated five training areas within East Miramar for various training purposes. In addition, there are nine operational SARs located within East Miramar. They include: ■ a rifle range and a pistol range utilized by the Marines (Range 100 and Range 101, respectively); ■ three ranges, utilized by MCAS Miramar and other military, local law enforcement, and federal agencies for marksmanship/proficiency training and qualification (designated Ranges B, C, and D); and ■ four ranges primarily utilized by the San Diego County Sheriff's Department (designated Ranges 5, 6, and 7 and Duffy Town Range). The EOD Training Range also is located within the complex, which was inactivated in 2006 and reopened in 2010. The ranges are summarized in **Table 3-1**.
Date of range	Historically, East Miramar has been used for training in various

CSM Information Profiles – Operational Range Profile	
Information Needs	**Information**
establishment	configurations, with different exercises and munitions. Training activities date to the beginning of WWI.
Range design and use	*Training Areas*: Five training areas are established to support ground training operations. Training Areas 1 through 5 are field training areas for which land navigation, troop maneuvers, vehicle driver training, convoy operations, tactical operations, bivouac, and aircraft/personnel exercises are approved (MCAS Miramar, 2012b). Due to the risk of generating wild fires in the dry, rugged areas of East Miramar, pyrotechnics, incendiary devices, HEs, and blank ammunition are prohibited on Training Areas 1–3 and 5. Pyrotechnics are permitted on Training Area 4 if a special waiver is granted by the Training Area Management Officer. These types of waivers rarely are granted (approximately once a month). Since live fire is not authorized, SDZs have not been established for the training areas. *EOD Training Range*: The EOD Training Range, located in the northeast corner of the East Miramar Range Complex, is the only range at MCAS Miramar that handles the detonation of munitions containing HEs. The range consists of two shotholes (upper and lower) for EOD training and emergency destruction of UXO. The upper shothole receives less than 5% of all EOD expenditures and permits a NEW of 5 lb. The lower shothole receives approximately 95% of all EOD expenditures and permits a NEW of 100 lb. Additionally, all roads present within the fenced-in EOD area can be utilized as IED training lanes. The EOD Training Range was inactivated in 2006 but reopened in 2010. *SARs*: MCAS Miramar and other military, local law enforcement, and federal agencies use nine SARs, located in two areas within the East Miramar Range Complex, for marksmanship/proficiency training and qualification (MCAS Miramar, 2011a). The SARs include Range 100 (LOMAH Rifle Range); Range 101 (Pistol Range); Ranges B, C, and D (Marine Corps SARs); and Ranges 5, 6, and 7 and Duffy Town Range (San Diego County Sheriff's Department ranges).
Range security	The main entry point into East Miramar is the Camp Elliot Gate off of Kearny Villa Road. The perimeters of the installation and range complex are fenced, with the exception of the eastern side. Trespassers have been

CSM Information Profiles – Operational Range Profile	
Information Needs	**Information**
Range security (cont)	documented in the eastern portions of East Miramar, specifically on the EOD Training Range and within the Range 100 SDZ. Trespassers also enter from the Mission Trails Regional Park located south of East Miramar. Trespassers typically consist of bikers and joggers who enter the installation without permission. Security patrols, sometimes concurrent with maneuver exercises, were conducted infrequently in past years within the range complex; however, the installation's PMO has increased patrols in the range complex to deter trespassing in the area.
Military munitions usage	Initial military use of the area during WWI supported infantry training and maneuvering activities (MCAS Miramar, 2011b). Many of the ranges were SARs, including pistol, rifle, and machine gun ranges. An artillery range also was present, accommodating use of a variety of HE and shrapnel shells (USACE, 2001a; USACE, 2001b). Through WWII, military munitions use varied to accommodate a wider range of training activities. Other types of ranges included anti-aircraft ranges, a bore sight range, a scout and sniper course, a grenade range, mortar ranges, a tank range, bombing targets, and an anti-tank range with electrical moving targets. By the mid-1950s, the types of munitions used at the installation generally were similar to those used today, as most ranges were SARs and maneuver areas; EOD activities also were conducted and were associated primarily with the historical use of the installation. Missile and weapon testing facilities also were present at East Miramar for significant portions of this time period but no longer exist at the installation. All historical munitions types were evaluated in the baseline review. Those training activities evaluated further in the five-year review include a review of the chemical, biological, radiological, and nuclear training that currently occurs within Training Area 5, the EOD training activities, and small arms training activities.
Munitions constituents	The presence of all five REVA indicator MC (TNT, HMX, RDX, perchlorate, and lead) are evaluated on the EOD Training Range. The REVA indicator MC evaluated at the SARs is lead.
Maintenance	According to Range Operations personnel, there is no standardized scheduling of range maintenance activities at MCAS Miramar. Activities such as excavation, lead recovery, and berm reconstruction are conducted on

CSM Information Profiles – Operational Range Profile	
Information Needs	**Information**
Maintenance (cont)	an as-needed basis depending on variables such as changes in ammunition expenditures, training tempo, seasonal effects, safety issues, or needs to improve drainage. In May 2011, lead recovery operations were conducted on Ranges C and D. Additional lead recovery operations are in the planning stages for Ranges B, 100, and 101. Since the baseline assessment, the lease agreement for the San Diego County Sheriff's Department ranges expired and was renewed. In the new lease agreement, the San Diego County Sheriff's Department is responsible for maintenance of the ranges. From November 2010 through April 2011, the Sheriff's Department conducted lead recovery operations on all four of their ranges (Ranges 5, 6, and 7 and the Duffy Town Range). Additionally, a trench was added by the San Diego Sheriff's Department at the base of the berm at all four ranges to improve the drainage.
Engineered controls	Drainage from the 500-yard berm of Range 100 is collected in an unlined area at the foot of the berm and directed toward a drain that flows a short distance to a vegetated ditch that runs the length of the range. The top of the 500-yard berm is sloped back to direct drainage away from the berm face. Drainage from the 100-yard berm is collected in an unlined area in the northwestern corner of the range. The top of the 100-yard berm is sloped toward the firing line, which directs drainage toward the drain in the northwestern corner. Drainage from the berm of Range 101 is collected at a drain that runs beneath the firing lines, ultimately discharging into a short length of thickly layered riprap before reaching the fence of the range complex. Additionally, a concrete-lined channel runs high above the visible bullet pickets in the berm, redirecting upland flow away from the berm. There are several layers of silt fence installed in the face of the berm above the bullet pockets to prevent sediment from flowing down the face of the berm. Storm drains and other surface water control measures are present at Ranges 5, 6, and 7 and the Duffy Town Range, including an unlined trench at the foot of the berm to channel water south toward the gravel parking lot between Range 7 and Range B. The ground surface immediately behind the top of the berm is sloped away from the ranges to further limit drainage from reaching the face of the berm. Additionally, Range 5 has baffling to help

CSM Information Profiles – Operational Range Profile	
Information Needs	**Information**
Engineered controls (cont)	limit expenditures into the ranges' SDZ. A concrete-lined channel runs above Ranges B, C, and D to redirect upland drainage away from the berm. An unlined lip below this channel is sloped away from the range to further limit drainage from reaching the berm. Drain lines in the side berms direct drainage down gradient toward the Murphy Canyon ephemeral stream. Additionally, Range B has wooden baffling to help limit expenditure into the ranges' SDZ.
Other features	A substation operated by San Diego Gas & Electric is located on the northern end of East Miramar; a number of electric and gas lines also traverse the area. The San Diego Community College Fire Academy has a facility near Training Area 5. A weather station operated by the National Weather Service is located along the northern edge of East Miramar. The San Diego County Water Authority has a series of pipelines within a 78-acre easement that runs south and north through the western portion of East Miramar. The San Diego Unified School District has a small, undeveloped parcel of land within the southern portion of East Miramar. A 978.3-acre Research Natural Area is present between Training Areas 2 and 3. Designated in 1987, it is used to provide education and research opportunities for scientists. The Marine Corps does not consider this to be a permanent preserve; a small portion of it recently was redesignated for future development for a military family housing site (see Human Land Use and Exposure Profile; MCAS Miramar, 2011b).

4.3. Physical Profile

CSM Information Profiles – Physical Profile	
Information Needs	**Information**
Climate	MCAS Miramar has a semi-arid Mediterranean climate, with warm, dry summers and mild, wet winters. The average annual temperature is 63 degrees Fahrenheit (°F); the average daily high is 71°F, and the average

CSM Information Profiles – Physical Profile	
Information Needs	**Information**
Climate (cont)	daily low is 53°F (Anteon, 2004). Daily high temperatures in the summer can exceed 90ºF, while lows in the winter can approach 40ºF. Most sources list the annual precipitation as approximately 10 inches (MCAS Miramar, 2011b; NAVFACSW, 2001; USACE, 2001a); however, Izbicki (1985) indicates that the average annual rainfall over the period 1897–1947 was between 13 and 15 inches. The total rainfall recorded at MCAS Miramar for the 2010/2011 wet season is 15.68 inches (MACTEC, 2011). Most of the precipitation occurs in the winter months, between November and April (URS, 2005). Infrequent thunderstorms may occur during the year (SCS, 1984; BEI, 2005a), resulting in a large amount of precipitation in a short period of time. Because of the hot, arid climate, evaporation is high. One report indicates the net pan evaporation south of Miramar Reservoir is 70.2 inches per year (SCS, 1984). Strong winds are not frequent. Prevailing winds average approximately 6 miles per hour and are from the west-northwest (SCS, 1984; MCAS Miramar, 2007).
Elevation	Elevations at the installation range from 224 to 1,110 ft above mean sea level (amsl) (MCAS Miramar, 2012a). Main Station and South/West Miramar area is set on Kearny Mesa. This broad, sloping land mass has an elevation of about 400–450 ft amsl. The mesa is cut by several canyon valleys, with valley bottoms as much as 100 ft below the mesa elevation. The two main canyons are Rose Canyon and San Clemente Canyon. The canyons slope gently toward the coast at a gradient of about 0.009 ft/ft in Rose Canyon and around 0.01 ft/ft in San Clemente Canyon (BEI, 2005b; SCS, 1984). The terrain in East Miramar is quite different, characterized by steep, rugged hills and valleys. Ground surface elevations near Interstate 15 are about 450 ft amsl, but the mountain peaks climb as high as 1,000 ft amsl in the northeastern portion of MCAS Miramar (BEI, 2005b; SCS, 1984).
Topography and geologic features	The developed portion of MCAS Miramar is located mostly on the eastern edge of Kearny Mesa (part of the Pacific Coastal Plain), a relatively flat,

CSM Information Profiles – Physical Profile	
Information Needs	**Information**
Topography and geologic features (cont)	gently sloping marine terrace of the Lindavista Formation (NAVFACSW, 2001; MCAS Miramar, 2011b). The mesa is cut by a few canyon valleys, including Rose Canyon and San Clemente Canyon (Izbicki, 1985; SCS, 1984). East Miramar is part of the Peninsular Range physiographic province and largely consists of steep, eroded, gravelly, or cobbly terraces dissected with numerous divides and ephemeral drainages. The rugged hills are separated by deep alluvial valleys, which are normally dry, filling with water only occasionally after heavy rain (Izbicki, 1985; SCS, 1984). Notable canyons in East Miramar include the southwesterly draining San Clemente Canyon and the southerly draining West Sycamore Canyon (MCAS Miramar, 2011b). Several other smaller drainages—including Murphy, Oak, and Spring Canyons—are located in the southern portion of East Miramar. Although this region is considered to be seismically active, there are no known faults within the boundaries of MCAS Miramar. Faulting, landslides, and liquefaction have the potential to occur in varying degrees throughout the installation (NAVFACSW, 2001). The Rose Canyon fault zone is located about 4 miles southwest of the installation and consists of several northwest-trending faults parallel to Interstate 5 (URS, 2005). The Torrey Pines fault is located near the northwest corner of MCAS Miramar and trends northeast to east (SCS, 1984).
Stratigraphy	The information on stratigraphy was obtained from a variety of sources, including SulTech (2005), Environmental Associates (1995), Evenson (1989), SCS Engineers (1984), Woodward-Clyde (1991), Foster Wheeler (2000), and URS (2005). *Bedrock:* The basement bedrock units at MCAS Miramar include Santiago Peak Volcanics of Jurassic age and granitic rocks of Cretaceous age. The Santiago Peak Volcanics are metamorphosed lava flows and breccias. The depth to these basement rocks is approximately 1,000 ft at MCAS Miramar. *La Jolla Group:* The bedrock units are overlain by two formations of the La Jolla Group of Eocene age: the Friars Formation, found mostly in the southern regions of MCAS Miramar but also found in other areas of the installation, and the Scripps Formation found in the western sections. The

CSM Information Profiles – Physical Profile	
Information Needs	**Information**
Stratigraphy (cont)	Friars Formation is approximately 300 ft thick and made up of olive-gray, well-consolidated, marine and lagoonal claystone and sandstone with localized cobble layers. The Scripps Formation is a yellow-brown, medium-grain sandstone with occasional cobble conglomerate interbeds. *Poway Group:* The La Jolla Group is overlain by the Stadium Conglomerate unit of the Poway Group of Eocene age. The thickness of this unit is estimated at 800–1000 ft. The unit consists of a well-consolidated cobble conglomerate with dark yellow-brown, coarse-grained sandstone with interbeds of well-indurated, dark greenish-gray claystone. The Stadium Conglomerate unit of the Poway Group is exposed at the surface throughout most of East Miramar. *Lindavista Formation:* In West Miramar, Kearny Mesa is capped with the Lindavista (or Linda Vista) Formation of Pleistocene age. This formation overlies the Stadium Conglomerate in West Miramar and is largely not present in East Miramar. The Lindavista formation is an interbedded sandstone, siltstone, and cobble conglomerate with a reddish-brown color caused by the cementation with iron oxides. The formation is about 100 ft thick and resistant to erosion. The essentially flat-lying orientation of the formation and its resistance to erosion are responsible for broad exposures forming most of the mesa tops and marine terraces around the main portion of the air station. *Undifferentiated Alluvium and Beach Deposits:* Unconsolidated to poorly consolidated sand, silt, and gravel alluvium and slope wash cover the bottoms of the canyons to varying thicknesses. The tops of the mesas are covered with beach deposits of similar composition.
Soil and vadose zone characteristics	More than three-quarters of the area of MCAS Miramar is covered by soils of the Redding Group, composed of shallow, well-drained, cobbly, or gravelly loams. Soils of this group normally are underlain by hardpan, resulting in slow infiltration and low permeability (MCAS Miramar, 2011b; NAVFACSW, 2001; SulTech, 2005; Evenson, 1989). The far west section of MCAS Miramar is covered by small areas of different soil types, including the Chesterton, Carlsbad, and Altamount groups. The Chesterton Group consists of fine sandy loam or loamy sand

CSM Information Profiles – Physical Profile	
Information Needs	**Information**
Soil and vadose zone characteristics (cont)	with 10%–30% iron content; the Carlsbad Group is a gravelly loamy sand; and the Altamount Group is clay. Unlike the Redding Group, these soil types are appropriate for growing irrigated crops (MCAS Miramar, 2011b). The canyon bottoms in both East and South/West Miramar are covered with alluvium or river wash sediments. These stream deposits consist of silt, sand, and cobble. Their thicknesses vary. Alluvial thickness in Soledad Canyon (northwest of MCAS Miramar) has been measured at 100 ft. Thicknesses within the boundaries of MCAS Miramar are not expected to be as high (Evenson, 1989). This alluvium is very permeable and allows for rapid infiltration (SCS, 1984). Because of the high erodibility of both the Redding Group and the alluvial sediments, the underlying rock often is exposed on the sides of the canyons, where the slopes are steepest (MCAS Miramar, 2011b).
Erosion potential	According to the Natural Resources Conservation Service (NRCS), most of the soil types at MCAS Miramar are severely erodible. This is because the soils are located on a steep topographic slope, have shallow depth to rock, have shallow depth to a hardpan, or have excessive silt in surface texture composition. Loss of plant cover in some parts of MCAS Miramar has resulted in severe erosion, causing a loss of topsoil and potential streambed siltation (MCAS Miramar, 2011b). A survey assessed by URS (2005) identified and prioritized 98 active erosion sites in parts of the undeveloped areas of MCAS Miramar. The soils assessed in this survey were rated to have moderately severe to severe erosion hazard. There are smaller areas of clay-texture type soils within MCAS Miramar that have a low erodibility. In addition, the numerous soil cobbles found in many areas reduce erodibility by self-sealing gullies or channels (MCAS Miramar, 2011b). Rainfall affects soil erosion most significantly at range areas in East Miramar, where there is a steeper topographic slope, sparse vegetation, and general land disturbance due to military activity. Stream bank erosion problems along the San Clemente and Rose Canyons have been identified. These stream banks are a height of typically 10–12 ft, though they may be as tall as 200 ft (Woodward-Clyde, 1986). Loose colluvial sand that generally makes up channel sides and bottoms is common in canyons (Lloyd-Reilly, 1987; Woodward-Clyde, 1986).

CSM Information Profiles – Physical Profile	
Information Needs	**Information**
Potential MC release mechanisms	The primary mechanism for potential release of MC at ranges at MCAS Miramar is erosion of soil where MC were deposited and subsequent downstream transport in surface runoff. Although rainstorms are infrequent, the surface water runoff may be high during significant storm events. The predominant surface water drainage direction is to the southwest; however, the surface water drainage direction for the EOD Training Range is to the south. Slopes range from gently sloping at eroded plateaus or mesas to steep at the dissected hills or canyons (MCAS Miramar, 2011b). Limited infiltration of MC may occur, but substantial releases to groundwater are not expected.

4.4. Surface Water Profile

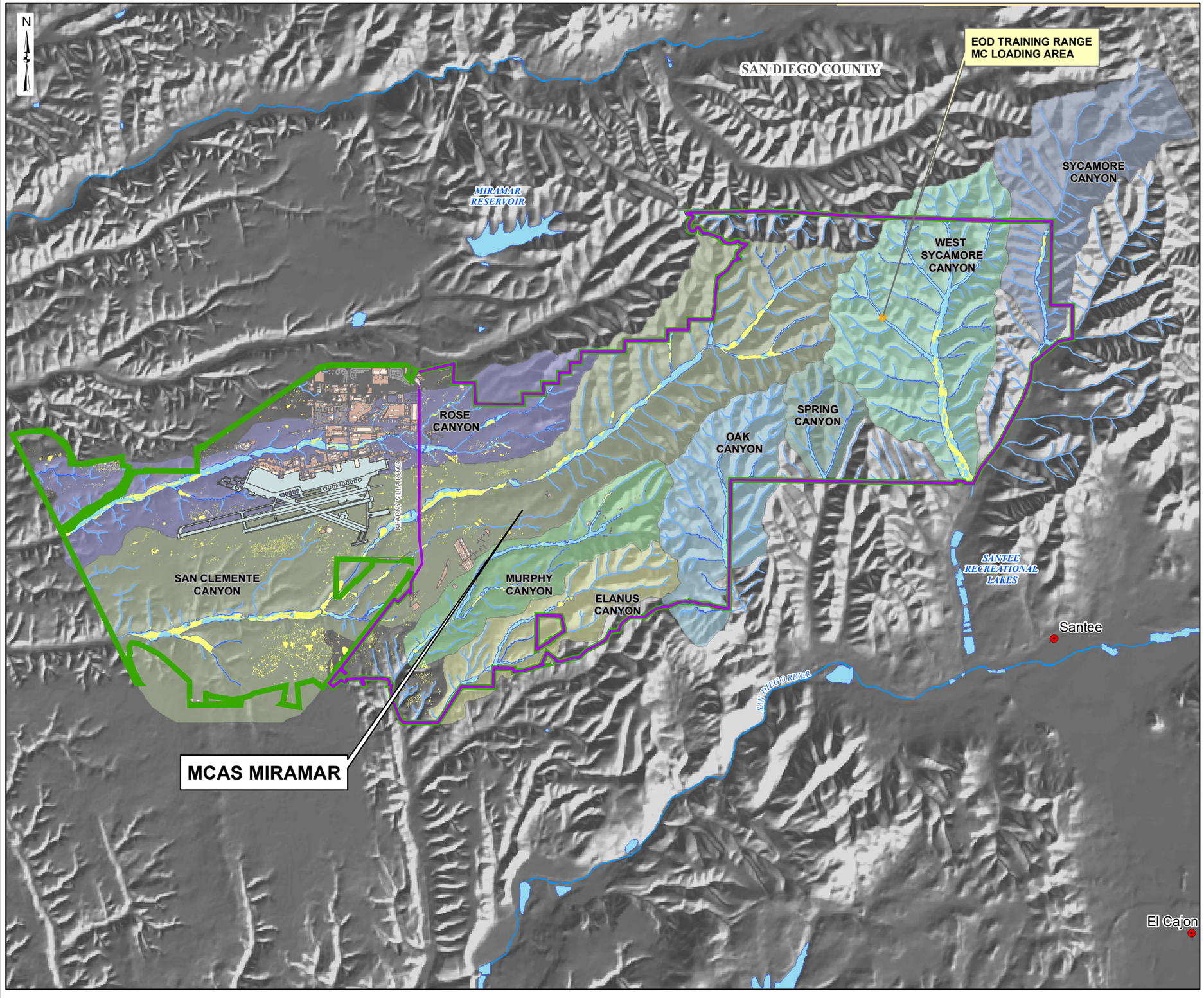
CSM Information Profiles – Surface Water Profile	
Information Needs	**Information**
Surface water drainage	Drainage in canyons and tributaries at MCAS Miramar is ephemeral or intermittent in nature. There are no natural perennial surface water bodies within the installation; however, during rainy periods, ephemeral ponding may occur in hummocky areas underlain by a shallow hardpan that restricts infiltration, creating vernal pools (BEI, 2002). Vernal pools are ecological habitat areas that support rare, threatened, or endangered plant and animal species. The pools are hydrologically isolated wetlands that only receive water from direct precipitation or runoff from their immediate surrounding area. However, vernal pools that are located adjacent to streams possibly can exhibit hydrological connectivity with streams. Water remains in the pools for several weeks to months, depending on the size of the pool, rainfall, and temperature (BEI, 2007). In addition, man-made water bodies exist at MCAS Miramar, including a golf course pond and several ephemeral ponds that are remnants from pre-military homesteading. Rose and San Clemente Canyons drain a large portion of the base. These canyons are as large as 100 ft deep and 300 ft wide (BEI, 2007). In

CSM Information Profiles – Surface Water Profile	
Information Needs	**Information**
Surface water drainage (cont)	accordance with a 100-year return period floodplain, areas of potential flooding are narrow because of canyon topography, but the potential for high water flooding at the narrow canyons does exist (MCAS Miramar, 2011b). The 2-year, 24-hour peak flows for Rose Canyon were calculated to range from 165 to 268 cubic ft per second (Woodward-Clyde, 1986). More than 14,000 cubic yards per year of sediment were estimated to be deposited into the canyon channels (MCAS Miramar, 2011b).
Hydrological unit & watershed areas	The installation is located within the Penasquitos (Unit 6) and San Diego (Unit 7) hydrologic units; both units are within the San Diego hydrological region. According to GIS data obtained from MCAS Miramar personnel, there are eight subwatersheds located within MCAS Miramar (MCAS Miramar, 2012a). The subwatershed delineations obtained from the installation include drainage areas of canyons upstream of the installation boundary but do not include drainage areas of canyons downstream of the installation boundary. Of these eight subwatersheds, only three are located completely within the installation boundary. The other five subwatersheds extend beyond the installation boundary and consist of ephemeral stream systems that drain to the south or southwest and ultimately discharge into the Pacific Ocean. The subwatersheds within MCAS Miramar boundary range in size from 582 to 9,680 acres (**Figure 4-2**). The EOD Training Range MC loading area and the SARs are located within three of the subwatershed areas in MCAS Miramar: San Clemente Canyon, West Sycamore Canyon, and Murphy Canyon. Existing training areas that are used for infantry maneuver and bivouac are located in six of the subwatershed areas: San Clemente Canyon, Sycamore Canyon, Rose Canyon, West Sycamore Canyon, Murphy Canyon, and Spring Canyon. Locations of watersheds, streams, and the EOD Training Range MC loading area are shown in **Figure 4-2**.

CSM Information Profiles – Surface Water Profile	
Information Needs	**Information**
San Clemente Canyon subwatershed area	The San Clemente Canyon subwatershed is the largest drainage area within MCAS Miramar. This 9,680-acre subbasin contains the longest stream network within MCAS Miramar. San Clemente Canyon has a dendritic drainage pattern and drains southwesterly from the north-central section of East Miramar through all of South/West Miramar and Main Station. Flow through the canyon comes to a confluence with flow from Rose Canyon approximately 3 miles west of the installation boundary. Rose Canyon flow continues from the confluence and discharges into Mission Bay. Wetlands exist along the main drainage of San Clemente Canyon and some of its tributaries. Wetlands also exist in areas set away from streams throughout the western portion of the watershed. Vernal pool habitats are found in the western portion of the watershed. Range 100 and Range 101 are within the San Clemente Canyon subwatershed.
Sycamore Canyon subwatershed area	The 3,932-acre Sycamore Canyon subwatershed is located on the northeastern corner of MCAS Miramar. A large portion of this subwatershed lies outside of the MCAS Miramar installation boundary. Sycamore Canyon originates outside of the installation, northeast from the installation boundary, and drains south within MCAS Miramar. After leaving the installation boundary, the drainage flows past the Padre Dam Municipal Water District water recycling facility and the Santee Recreational Lakes. It drains into the San Diego River approximately 4 miles south of the installation boundary and then westward to the Pacific Ocean. Wetlands exist along a short segment of the main drainage of Sycamore Canyon. No SARs or MC loading areas are located within the subwatershed.
Rose Canyon subwatershed area	The Rose Canyon subwatershed is located in the northern section of MCAS Miramar. Most of the watershed area is located within MCAS Miramar, but some northeastern and northwestern portions lie outside of the installation boundary. This 3,863-acre subwatershed consists of the second largest stream network within MCAS Miramar. Rose Canyon has a dendritic drainage pattern and drains southwesterly across the entire length of West Miramar. It originates about a mile east of Interstate 15 in the northwest corner of East Miramar and drains southwest through South/West Miramar and Main Station then flows off the installation boundary to discharge into Mission Bay. Wetlands are located throughout the main drainage of Rose Canyon and its

CSM Information Profiles – Surface Water Profile	
Information Needs	**Information**
Rose Canyon subwatershed area (cont)	tributaries. Vernal pools are scattered throughout the subwatershed but are more common in the northwestern and southern parts of the watershed. No SARs or MC loading areas are located within the subwatershed.
West Sycamore Canyon subwatershed area	The West Sycamore Canyon subwatershed is located on the eastern portion of MCAS Miramar. This 3,323-acre subwatershed is located almost entirely within the MCAS Miramar boundary. The predominant feature is West Sycamore Canyon, which drains south within the eastern section of East Miramar. It continues draining south off the installation and joins with Sycamore Canyon, which ultimately flows into San Diego River and later the Pacific Ocean. Wetlands exist along the main drainage of West Sycamore Canyon. The EOD Training Range MC loading area is located within this subwatershed.
Murphy Canyon subwatershed area	The Murphy Canyon subwatershed is located on the southern portion of MCAS Miramar. This 1,546-acre subwatershed is located entirely within the installation boundary. Murphy Canyon originates on MCAS Miramar and drains southwesterly within the installation. It drains south off the installation and discharges into the San Diego River south of the installation boundary. Wetlands exist throughout the subwatershed but are located predominantly along the main drainage of Murphy Canyon and its tributaries. Vernal pools also exist along the main drainage of Murphy Canyon and some of its tributaries. Duffy Town Range, Sheriff's Range 5, Sherriff's Range 6, Sherriff's Range 7, Small Arms Range B, Small Arms Range C, and Small Arms Range D are located within this subwatershed.
Spring Canyon subwatershed area	The Spring Canyon subwatershed is located on the eastern portion of MCAS Miramar. This 582-acre subwatershed is the smallest drainage area within MCAS Miramar and is located entirely within the installation. Spring Canyon is the shortest ephemeral stream system within MCAS Miramar. Spring Canyon originates on MCAS Miramar and drains southward within the installation. It discharges into San Diego River approximately 2 miles south of the installation boundary.
Designated beneficial uses	Most surface waters at MCAS Miramar (including major canyons) have been designated by the California Regional Water Quality Control Board's

CSM Information Profiles – Surface Water Profile	
Information Needs	**Information**
Designated beneficial uses (cont)	(CRWQCB's) San Diego Region Basin Plan (1994) to have existing and potential beneficial uses for agricultural supply, industrial service supply, contact and noncontact water recreation, warm freshwater habitat, cold freshwater habitat, wildlife habitat, and preservation of rare, threatened, or endangered species. In accordance with the Basin Plan, all waters at MCAS Miramar have been exempted from municipal use. Drinking water at MCAS Miramar is supplied by the City of San Diego. The City of San Diego gets its water from the Colorado River, the State Water Projects California Aqueduct, and other distant sources (MCAS Miramar, 2011b).
Supported habitats/ ecosystems	A variety of wildlife species, including amphibians, reptiles, mammals, and birds, inhabit MCAS Miramar (MCAS Miramar, 2011b). A wide range of vegetation types also is found within MCAS Miramar. The intermittently flowing canyons within MCAS Miramar support the majority of the wildlife and vegetation species. Federally listed threatened and endangered species are described in the Natural Resources Profile. Seasonal wetlands exist within MCAS Miramar. These include vernal marsh wetlands, freshwater marshes, and vernal pools. Vernal marshes typically occur in main drainages, including Rose Canyon, San Clemente Canyon, Murphy Canyon, Elanus Canyon, West Sycamore Canyon, and Sycamore Canyon. There are approximately 89 acres of this type of wetland on base, which is slightly reduced from the 2006 estimate of 90 acres. Approximately 31 acres of freshwater marsh wetland exist on base, of which 10 acres are disturbed (MCAS Miramar, 2011b). Vernal pools exist throughout MCAS Miramar but are found predominantly in western and central Miramar.
Gaining or losing streams	Surface water flow through canyons and other main drainages resulting from seasonal and long-term direct precipitation is recharged to the underlying alluvium, which is relatively coarse grained and permeable. This recharge may contribute to shallow, ephemeral groundwater. Some soil types along San Clemente Canyon are estimated to have a permeability value that ranges from 2 to 6.3 inches/hour at a depth of 3 ft (SCS, 1984). Streams at MCAS Miramar are generally losing.



REVA
Figure 4-2
Surface Water Features

MCAS Miramar
Miramar, CA

LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- MC LOADING AREAS
- AIRFIELD SURFACE
- BUILDINGS
- CITY
- WETLANDS
- SURFACE WATER COURSE AREA
- SURFACE WATER (INTERMITTENT)

SUB-WATERSHEDS

- ELANUS CANYON
- MURPHY CANYON
- OAK CANYON
- ROSE CANYON
- SAN CELEMENTE CANYON
- SPRING CANYON
- SYCAMORE CANYON
- SYCAMORE WEST CANYON

0 0.25 0.5 1 1.5 MILES

Date: February 2013

Source: MCAS EMD GIS 2012
HQMC GEOFIDELIS 2007
LIDAR, SANGIS 2007,
CASIL 2007

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

Map Document: (P:\62850241\MCAS Miramar\GIS\Projects\FinalReport\Figure6.4-1.mxd)
9/17/2008 – 1:10:23 PM

Page intentionally blank

CSM Information Profiles – Surface Water Profile	
Information Needs	**Information**
Surface water collection points	There are no actively used potable water storage reservoirs within MCAS Miramar. The Miramar Reservoir, located approximately 2 miles north of MCAS Miramar, is a major water storage facility for the City of San Diego and is one of the primary water supply sources for the installation. The reservoir contains imported water from the Colorado River, and it does not receive drainage from the installation.
San Clemente Canyon subwatershed area	The San Clemente Canyon subwatershed is the largest drainage area within MCAS Miramar. This 9,680-acre subbasin contains the longest stream network within MCAS Miramar. San Clemente Canyon has a dendritic drainage pattern and drains southwesterly from the north-central section of East Miramar through all of South/West Miramar and Main Station. Flow through the canyon comes to a confluence with flow from Rose Canyon approximately 3 miles west of the installation boundary. Rose Canyon flow continues from the confluence and discharges into Mission Bay. Wetlands exist along the main drainage of San Clemente Canyon and some of its tributaries. Wetlands also exist in areas set away from streams throughout the western portion of the watershed. Vernal pool habitats are found in the western portion of the watershed. Range 100 and Range 101 are within the San Clemente Canyon subwatershed.
Sycamore Canyon subwatershed area	The 3,932-acre Sycamore Canyon subwatershed is located on the northeastern corner of MCAS Miramar. A large portion of this subwatershed lies outside of the MCAS Miramar installation boundary. Sycamore Canyon originates outside of the installation, northeast from the installation boundary, and drains south within MCAS Miramar. After leaving the installation boundary, the drainage flows past the Padre Dam Municipal Water District water recycling facility and the Santee Recreational Lakes. It drains into the San Diego River approximately 4 miles south of the installation boundary and then westward to the Pacific Ocean. Wetlands exist along a short segment of the main drainage of Sycamore Canyon. No SARs or MC loading areas are located within the subwatershed.
Rose Canyon subwatershed	The Rose Canyon subwatershed is located in the northern section of MCAS Miramar. Most of the watershed area is located within MCAS Miramar, but

CSM Information Profiles – Surface Water Profile	
Information Needs	**Information**
Rose Canyon subwatershed (cont)	some northeastern and northwestern portions lie outside of the installation boundary. This 3,863-acre subwatershed consists of the second largest stream network within MCAS Miramar. Rose Canyon has a dendritic drainage pattern and drains southwesterly across the entire length of West Miramar. It originates about a mile east of Interstate 15 in the northwest corner of East Miramar and drains southwest through South/West Miramar and Main Station then flows off the installation boundary to discharge into Mission Bay. Wetlands are located throughout the main drainage of Rose Canyon and its tributaries. Vernal pools are scattered throughout the subwatershed but are more common in the northwestern and southern parts of the watershed. No SARs or MC loading areas are located within the subwatershed.
West Sycamore Canyon subwatershed area	The West Sycamore Canyon subwatershed is located on the eastern portion of MCAS Miramar. This 3,323-acre subwatershed is located almost entirely within the MCAS Miramar boundary. The predominant feature is West Sycamore Canyon, which drains south within the eastern section of East Miramar. It continues draining south off the installation and joins with Sycamore Canyon, which ultimately flows into San Diego River and later the Pacific Ocean. Wetlands exist along the main drainage of West Sycamore Canyon. The EOD Training Range MC loading area is located within this subwatershed.
Murphy Canyon subwatershed area	The Murphy Canyon subwatershed is located on the southern portion of MCAS Miramar. This 1,546-acre subwatershed is located entirely within the installation boundary. Murphy Canyon originates on MCAS Miramar and drains southwesterly within the installation. It drains south off the installation and discharges into the San Diego River south of the installation boundary. Wetlands exist throughout the subwatershed but are located predominantly along the main drainage of Murphy Canyon and its tributaries. Vernal pools also exist along the main drainage of Murphy Canyon and some of its tributaries. Duffy Town Range, Sheriff's Range 5, Sherriff's Range 6, Sherriff's Range 7, Small Arms Range B, Small Arms Range C, and Small Arms Range D are located within this subwatershed.
Spring Canyon subwatershed	The Spring Canyon subwatershed is located on the eastern portion of MCAS Miramar. This 582-acre subwatershed is the smallest drainage area within

CSM Information Profiles – Surface Water Profile	
Information Needs	**Information**
	MCAS Miramar and is located entirely within the installation. Spring Canyon is the shortest ephemeral stream system within MCAS Miramar. Spring Canyon originates on MCAS Miramar and drains southward within the installation. It discharges into San Diego River approximately 2 miles south of the installation boundary.
Designated beneficial uses	Most surface waters at MCAS Miramar (including major canyons) have been designated by the California Regional Water Quality Control Board's (CRWQCB's) San Diego Region Basin Plan (1994) to have existing and potential beneficial uses for agricultural supply, industrial service supply, contact and noncontact water recreation, warm freshwater habitat, cold freshwater habitat, wildlife habitat, and preservation of rare, threatened, or endangered species. In accordance with the Basin Plan, all waters at MCAS Miramar have been exempted from municipal use. Drinking water at MCAS Miramar is supplied by the City of San Diego. The City of San Diego gets its water from the Colorado River, the State Water Projects California Aqueduct, and other distant sources (MCAS Miramar, 2011b).
Supported habitats/ ecosystems	A variety of wildlife species, including amphibians, reptiles, mammals, and birds, inhabit MCAS Miramar (MCAS Miramar, 2011b). A wide range of vegetation types also is found within MCAS Miramar. The intermittently flowing canyons within MCAS Miramar support the majority of the wildlife and vegetation species. Federally listed threatened and endangered species are described in the Natural Resources Profile. Seasonal wetlands exist within MCAS Miramar. These include vernal marsh wetlands, freshwater marshes, and vernal pools. Vernal marshes typically occur in main drainages, including Rose Canyon, San Clemente Canyon, Murphy Canyon, Elanus Canyon, West Sycamore Canyon, and Sycamore Canyon. There are approximately 89 acres of this type of wetland on base, which is slightly reduced from the 2006 estimate of 90 acres. Approximately 31 acres of freshwater marsh wetland exist on base, of which 10 acres are disturbed (MCAS Miramar, 2011b). Vernal pools exist throughout MCAS Miramar but are found predominantly in western and central Miramar.
Gaining or losing streams	Surface water flow through canyons and other main drainages resulting from seasonal and long-term direct precipitation is recharged to the underlying

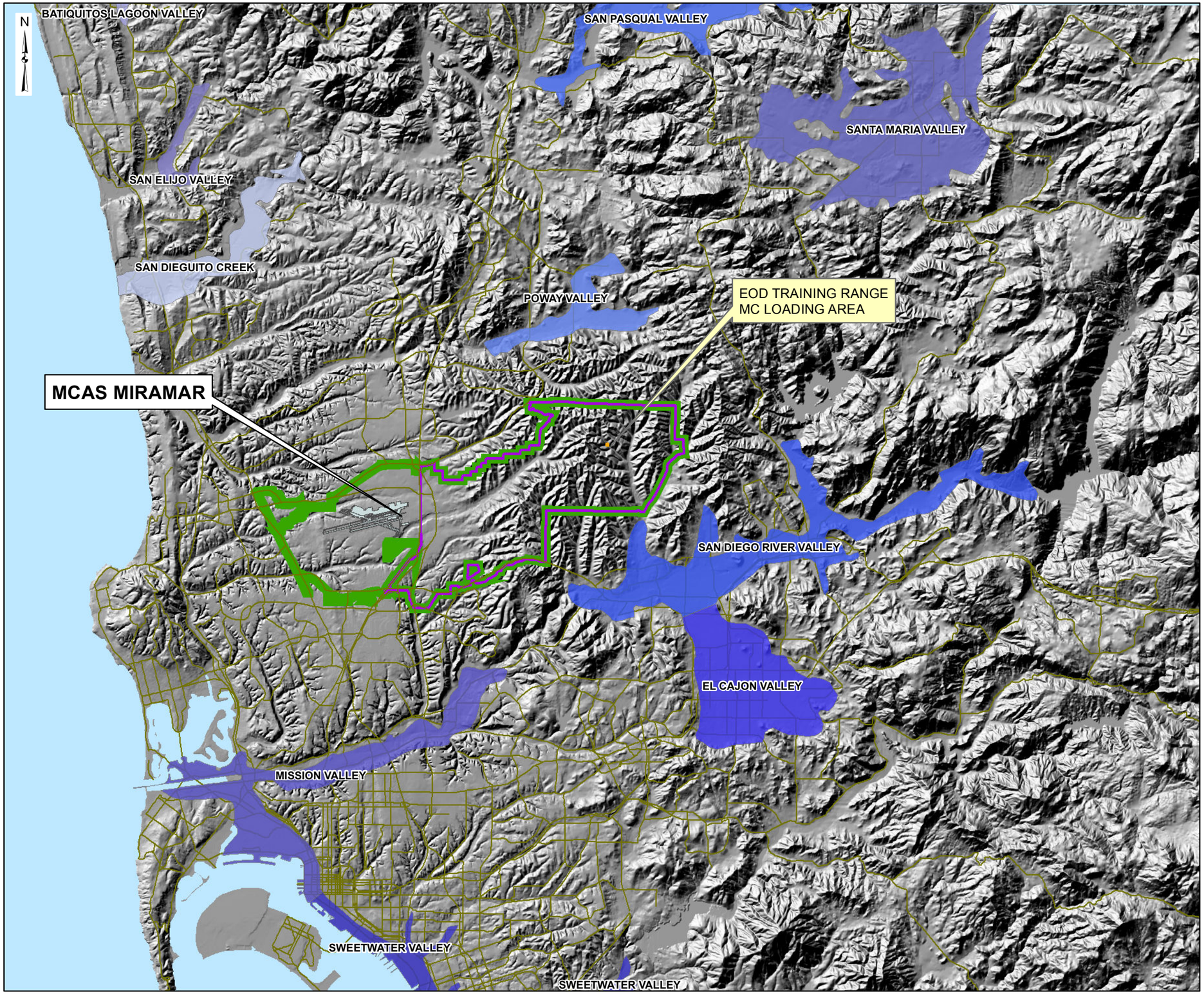
CSM Information Profiles – Surface Water Profile	
Information Needs	**Information**
	alluvium, which is relatively coarse grained and permeable. This recharge may contribute to shallow, ephemeral groundwater. Some soil types along San Clemente Canyon are estimated to have a permeability value that ranges from 2 to 6.3 inches/hour at a depth of 3 ft (SCS, 1984). Streams at MCAS Miramar are generally losing.
Surface water collection points	There are no actively used potable water storage reservoirs within MCAS Miramar. The Miramar Reservoir, located approximately 2 miles north of MCAS Miramar, is a major water storage facility for the City of San Diego and is one of the primary water supply sources for the installation. The reservoir contains imported water from the Colorado River, and it does not receive drainage from the installation.

4.5. Groundwater Profile

CSM Information Profiles – Groundwater Profile	
Information Needs	**Information**
Groundwater basins	The California Department of Water Resources (2003) does not designate a groundwater basin underlying MCAS Miramar. This is because the existing water-bearing units within MCAS Miramar do not constitute a groundwater basin, which is defined as a hydrogeologic unit containing one large aquifer or several connected and interconnected aquifers that can transmit and yield appreciable quantity of groundwater. Instead, in order to define beneficial uses for groundwater at MCAS Miramar, the San Diego Region Basin Plan has designated the groundwater at MCAS Miramar into hydrologic subareas. According to this designation, there are three hydrologic subareas within MCAS Miramar: Mission San Diego (in the south-central part of East Miramar), Santee (in the far eastern part

CSM Information Profiles – Groundwater Profile	
Information Needs	**Information**
Groundwater basins (cont)	of MCAS Miramar), and Miramar (in West Miramar and part of north and central parts of East Miramar) (CRWQRB, 1994). However, there are designated groundwater basins in the San Diego region, outside of MCAS Miramar. These designated groundwater basins are shown in **Figure 4-3**. The potential water-bearing units in the MCAS Miramar region include the alluvium and beach deposits, the Lindavista Formation, and parts of the Poway and La Jolla groups. *Alluvium and Beach Deposits*: The alluvium and beach deposits are unconsolidated or poorly consolidated mixtures of gravel, sand, silt, and varying amounts of clay. The beach deposits are thin units located on top of the mesas and are not likely to be saturated. The alluvium, which lies along the canyon bottoms, may transmit groundwater under unconfined conditions when saturated. The lower portions of the alluvium probably are only saturated after winter rains or a series of wet years. Runoff in the canyons can rapidly recharge the fill materials in the valley. Annual recharge may cause rapid downstream migration of any contaminants in the alluvium (SCS, 1984). *The Lindavista Formation*: The Lindavista Formation potentially can transmit groundwater, but its permeability is low because of consolidation and cementation. Like the beach deposits, it is located mainly on the mesa tops, so it has little potential for saturation except seasonally or after several wet years. Groundwater in this formation generally would be unconfined (SCS, 1984). *Stadium Conglomerate (Poway Group)*: In West Miramar, the well-cemented Stadium Conglomerate, which underlies the Lindavista Formation, is relatively impermeable and can restrict infiltration, resulting in vernal pools when surface water runoff collects in topographic depressions (OHM, 1997). When water is able to infiltrate the Lindavista Formation, perched conditions may form when it reaches the more impermeable conglomerate layer. Perched groundwater conditions have been observed within the upper portions of the Lindavista Formations at various sites across MCAS Miramar (SES-TECH, 2011). Perched groundwater collects at the interface of the unconsolidated reddish-brown silty sand and the well-cemented cobble conglomerate layer (hardpan).

CSM Information Profiles – Groundwater Profile	
Information Needs	**Information**
	The hardpan retards groundwater infiltration and forms a thin-perched zone. These perched zones tend to occur between 10 and 30 ft below ground surface (bgs); however, discontinuous perched zones have been observed at depths greater than 100 ft bgs (SES-TECH, 2011). In East Miramar, the Stadium Conglomerate may hold groundwater in its coarser-grained conglomerate units. Where this formation is exposed on the surface or overlain by only a thin layer, it has a high recharge potential,



REVA
Figure 4-3
Groundwater Features

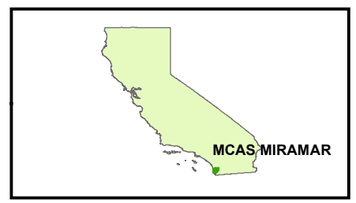
MCAS Miramar
Miramar, CA

LEGEND

- INSTALLATION BOUNDARY
- EAST MIRAMAR RANGE COMPLEX
- MC LOADING AREAS
- AIRFIELD SURFACE

GROUNDWATER BASINS

- BATIQUITOS LAGOON VALLEY
- EL CAJON VALLEY
- MISSION VALLEY
- POWAY VALLEY
- SAN DIEGO RIVER VALLEY
- SAN DIEGUITO CREEK
- SAN ELIJO VALLEY
- SAN PASQUAL VALLEY
- SANTA MARIA VALLEY
- SWEETWATER VALLEY



0 0.5 1 2 3
MILES

Date: February 2013

Source: MCAS EMD GIS 2012
HQMC GEOFIDELIS 2007
CDWR, 2003
USGS, 2007

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

Map Document: (P:\6285024\MCAS Miramar\GIS\Projects\FinalReport\Figure6.5-1.mxd)
9/17/2008 -- 1:21:49 PM

Page intentionally blank

CSM Information Profiles – Groundwater Profile	
Information Needs	**Information**
Groundwater basins (cont)	and sand lenses may store and yield significant water volumes (SCS, 1984). The water table generally is considered to occur within this layer in East Miramar (Woodward-Clyde, 1991). *The La Jolla Group*: The La Jolla Group is expected to have more limited water-bearing capacity, but very few data on the hydrologic characteristics of this unit are available (SCS, 1984). If present, the water table probably occurs in the Friars Formation of the La Jolla Group (Woodward-Clyde, 1991).
Designated beneficial uses	As discussed in the groundwater basins section above, the San Diego Region Basin Plan identifies the beneficial use designations for MCAS Miramar as three hydrologic subareas: the Mission San Diego, the Santee, and the Miramar hydrologic subareas. The *Mission San Diego subarea* is designated as beneficial for agriculture, industrial process, and industrial service. The groundwater also is designated with a potential beneficial use for municipal and domestic supply. The *Santee subarea* is designated as beneficial for municipal and domestic supply, agricultural supply, industrial service supply, and industrial process supply (CRWQRB, 1994). The *Miramar subarea* has no existing beneficial uses for groundwater; however, this area is listed as having a potential industrial service supply use (CRWQRB, 1994). The Miramar hydrographic subarea is exempt from municipal beneficial use. The shallow groundwater is known to be of low quality and is unsuitable for domestic use (Woodward-Clyde, 1991; Environmental Associates, 1995; SCS, 1984).
Groundwater supply wells	Based on a study conducted by Woodward-Clyde (1991), at least 19 wells used for domestic, industrial, and irrigation supply were identified to exist within MCAS Miramar. These wells are currently not active, and they have most likely been abandoned, as installation personnel from interviews conducted in March 2012 indicate that there are no wells present within and around the installation. There are potential active off-installation water

CSM Information Profiles – Groundwater Profile	
Information Needs	**Information**
Groundwater supply wells (cont)	supply wells existing in nearby groundwater basins, including Poway Valley on the northeast, San Diego River Valley on the southeast, and Mission Valley on the southwest (**Figure 4-3**). However, these groundwater basins are bounded by impermeable and semipermeable contacts of rocks and formations (CDWR, 2004); potential groundwater flow from the installation likely will not migrate to these groundwater basins. According to installation personnel, none of the water used at MCAS Miramar comes from wells on the installation. Potable water is provided by the City of San Diego (SCS, 1984). Installation personnel did indicate that water is brought into the installation from Miramar Reservoir through aqueducts (MCAS Miramar, 2012a).
Recharge source(s)	Historically, the primary sources of groundwater recharge near MCAS Miramar were the stream flow in the San Diego River and San Vicente Creek. With the construction of the El Capitan Dam in 1935 and the San Vicente Dam in 1943, these recharge sources were removed. Today, direct precipitation and municipal wastewater treatment discharges are more important recharge sources (Izbicki, 1985). A study in the Escondido area approximately 17 miles north of MCAS Miramar indicates that only 7% of precipitation recharges groundwater (Heaton and Giesick, 2002). Recharge in alluvium at canyon bottoms can occur from ephemeral stream flow in canyons. It is unlikely that the alluvium remains saturated long after a precipitation event because of the high potential for evaporation caused by high temperatures and low humidity. The possibility that some of this water may be able to infiltrate to deeper geologic units cannot be eliminated based on the available information, but the infiltrating volume would be small due to some areas of lower permeability separating the alluvium from the deeper groundwater (Izbicki, 1985).
Porous or fracture flow	Groundwater flow through the alluvium and other water-bearing units at MCAS Miramar, including the Lindavista Formation and parts of the Poway and La Jolla groups, is generally porous-media flow. None of the geologic reports indicate significant fracture flow in the area of MCAS Miramar, and most make no mention of it.

CSM Information Profiles – Groundwater Profile	
Information Needs	**Information**
Depth to groundwater	Groundwater, when present in the alluvial units found in the canyon bottoms, generally is close to the surface. It has been measured at depths between 2 and 10.5 ft. However, this groundwater exists only intermittently after heavy rainfall or after a series of wet years (BEI, 2005b; SCS, 1984; Evenson, 1989; URS, 2005). Past subsurface investigations at MCAS Miramar have identified regional groundwater to be encountered at a depth of approximately 160 ft bgs in the portion of the air station west of Interstate 15 (BEI, 2007). Investigations of groundwater in the older units indicate a depth to groundwater of approximately 200 ft (URS, 2005; BEI, 2005a; Foster Wheeler, 2000). Perched groundwater often is found at shallower depths of 10 to 30 ft bgs (SulTech, 2005; Foster Wheeler, 2000; URS, 2005). This normally occurs in the Lindavista or Stadium Conglomerate formations. Discontinuous perched zones also have been observed at depths greater than 100 ft bgs (SES-TECH, 2011).
Gradient and flow velocity	According to monitoring well data, the shallow groundwater gradient in the southern and western portions of MCAS Miramar is to the west and southwest, parallel to Rose and San Clemente Canyons (BEI, 2007). In the northeast portion of MCAS Miramar, the groundwater gradient is to the northwest. The Rose Canyon fault zone near Interstate 5 is a potential groundwater barrier, but few data exist to analyze the effect of this barrier on flow or water quality (SCS, 1984). Deeper groundwater flow directions have not been determined, but one report indicates that the gradient should conform roughly to the westerly dip of the bedding in the Poway and La Jolla Formations (SCS, 1984; URS, 2005; Foster Wheeler, 2000; SulTech, 2005; BEI, 2005a). Average groundwater flow velocities are estimated between 0.006 and 0.27 ft/day (SCS, 1984; Foster Wheeler, 2000; BEI, 2002). The hydraulic gradients in the alluvium are probably similar to the ground surface gradients, which are 0.009 ft/ft in Rose Canyon and 0.01 ft/ft in San Clemente Canyon. In the Poway and La Jolla groups, the bedding dips to the west at 3 to 4 degrees, corresponding to a hydraulic gradient of 0.05 ft/ft (SCS, 1984).

CSM Information Profiles – Groundwater Profile	
Information Needs	**Information**
Known water quality characteristics	The quality of groundwater near MCAS Miramar is described as poor or marginal by most sources. It has high total dissolved solids concentration of 1,000 milligrams per liter or more and has high levels of calcium sulfite and sodium chloride. There are no known active water supply wells near MCAS Miramar, and the groundwater would require treatment before domestic use (Woodward-Clyde, 1991; Environmental Associates, 1995; SCS, 1984). Available groundwater pH measurements in various wells (e.g., monitoring, exploratory) near MCAS Miramar ranged from 6.5 to 7.6 (Woodward-Clyde, 1991; Evenson, 1989; CDWR, 1967).
Discharge location(s)	There are no known groundwater discharge locations near MCAS Miramar. It is not believed that groundwater significantly contributes to surface water on the installation; all surface water, including vernal pools and wetlands, is believed to originate primarily as runoff from precipitation events.

4.6. Human Land Use and Exposure Profile

CSM Information Profiles – Human Land Use and Exposure Profile	
Information Needs	**Information**
Land use	East Miramar is used primarily for small arms, infantry, and maneuver training exercises. Specific activities include navigation training, troop maneuvers, bivouacking / overnight camping, aircraft/personnel support exercises, tactical vehicle driver training, and weapons instruction training (MCAS Miramar, 2011b). Much of East Miramar is undeveloped because it serves as the approach corridor for military aircraft. Portions of the undeveloped areas also are designated as SDZs for operational ranges. Warehouses and a storage area are also present within East Miramar. Much of East Miramar has been surveyed for cultural resources, with the exception of the area encompassed by the Range 100 and 101 SDZs; a number of prehistoric and historic cultural resources have been identified.

CSM Information Profiles – Human Land Use and Exposure Profile	
Information Needs	**Information**
Land use (cont)	Sycamore Canyon, running north-south on the eastern edge of the installation, is utilized by the public for recreation. Previously, the installation had a tentative plan to formally transfer a portion of the canyon to the local government for recreational use; however, the CPLO confirmed that the plan is no longer being discussed (Thornton, 2012). Because no fencing exists along the eastern edge of the installation, unauthorized recreational use within East Miramar occasionally occurs. An area on the southern boundary of East Miramar is the proposed future location of a military family housing development (Military Family Housing Site 8). The land immediately surrounding MCAS Miramar represents a mix of residential, commercial, industrial, and recreational uses. A major transportation corridor, Interstate 15, runs north-south and cuts through the center of the installation. The north and south sides of East Miramar are bordered by residential homes and undeveloped areas; the eastern side is bordered by artificial lakes serving as a public recreation area (Santee Recreational Lakes) and the Padre Dam Municipal Water District water recycling facility. A residential development known as Castle Rock is planned for construction on the west side of Sycamore Canyon, west of the recreational lakes. In addition, a landfill is present on the southeast side of the installation; the CPLO indicates there are plans in place to quadruple the size of the landfill (Thornton, 2012).
Current human receptors	Potential human receptors may include installation personnel and contractors, primarily located in nonoperational areas to the west of Kearny Villa Road, and users of the Santee Recreational Lakes recreational area southeast of the installation. Future residents of the planned Castle Rock development could be considered receptors given the proximity to Sycamore Canyon. The CRWQCB San Diego Region Basin Plan (1994) has designated major canyons within MCAS Miramar to have existing beneficial uses for contact and noncontact water recreation. The water recycling facility is not considered to be impacted by MC migration because it is located north of the West Sycamore Canyon subwatershed discharge point and there are no other MC loading areas defined within the West Sycamore Canyon subwatershed, which discharges near the facility. Potential exposure of any MC from operational ranges to these receptors is

CSM Information Profiles – Human Land Use and Exposure Profile	
Information Needs	**Information**
Current human receptors (cont)	anticipated to be limited. There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar, 2011b). Installation personnel are not aware of any production wells within a 1-mile radius of the installation. Active munitions use is limited to the EOD Training Range and nine SARs at East Miramar. MC potentially deposited on historical use HE ranges are expected to have degraded over the approximately 60 years since the ranges were last used. Although soils tend to be erodible, precipitation is limited, thereby limiting opportunities for transport of MC.
Land use restrictions	Much of the installation's perimeter is fenced, with the exception of its easternmost reaches. Use of certain maneuver and field training areas is limited by season. Vehicles are restricted to paved and unpaved roads (no off-road travel). Construction of fighting holes is limited to previously disturbed areas. The use of explosive devices is approved within the EOD Training Range for disposal and training purposes; however, the use of pyrotechnics, flares, smoke grenades, and similar heat-producing devices in the training areas is restricted and severely limited due to fire dangers (MCAS Miramar, 2012b). The Record of Decision selecting Site 8 for military family housing effectively closed that area of the East Miramar Range Complex, and munitions response planning is underway for that area. The ESQDs surrounding ordnance magazines, a San Diego Gas & Electric substation, and warehousing represent other areas within East Miramar that restrict or are closed to training activities. Other land use constraints in East Miramar include aircraft accident potential zones, noise zones, and areas of electromagnetic interference (MCAS Miramar, 2011b). Some actions, such as construction and maintenance activities, may require special regulatory review. The ephemeral drainages at MCAS Miramar meet the federal classification of "waters of the United States" and, therefore, are subject to U.S. Army Corps of Engineers wetland regulations. The CRWQCB also may have regulatory jurisdiction when wetlands may be involved. The presence of threatened and endangered species and their critical habitat may create a need for consultation with the U.S. Fish and Wildlife Service (USFWS). Presence of cultural resources may also

CSM Information Profiles – Human Land Use and Exposure Profile	
Information Needs	**Information**
Land use restrictions (cont)	necessitate consultation with the State Historic Preservation Officer.

4.7. Natural Resources Profile

CSM Information Profiles – Natural Resources Profile	
Information Needs	**Information**
Ecosystems	MCAS Miramar is located within an arid, Mediterranean-type ecosystem. The land varies from marine terrace on the coastal plain (West Miramar) to coastal foothills and canyons with moderate to steep slopes (East Miramar).
Vegetation	Three major plant communities have been identified at MCAS Miramar: ■ Chaparral (9,258 acres) – community subtypes, including chamise, southern mixed chaparral, Nuttal's scrub oak (Quercus dumosa), and ceanothus (Ceanothus tomentosus and C. verrucosus) with mixed and disturbed versions of each ■ Coastal sage scrub (3,770 acres) – drought-hardy deciduous shrubs typically associated with southern facing slopes and ridges ■ Grasslands (1,907 acres) – native needlegrasses and/or nonnative species dominant ground cover associated with disturbed or undisturbed areas
Fauna	MCAS Miramar supports 7 species of amphibians, 30 species of reptiles, and 39 species of mammals that are adapted for chaparral / coastal sage scrub habitat. Additionally, over 200 species of birds have been observed on the station. Habitat linkages and wildlife corridors are important natural areas that

CSM Information Profiles – Natural Resources Profile	
Information Needs	**Information**
Fauna (cont)	provide essential connectivity for fauna to habitat patches among developed areas. The entire eastern portion of MCAS Miramar functions as an important habitat linkage with adjacent off-installation open spaces. The construction of State Route 52 south of MCAS Miramar fragmented the open habitat linkage with the Mission Trails Regional Park located to the south. Two large bridges of State Route 52, spanning Oak and Spring Canyons, now provide connectivity between MCAS Miramar and Mission Trails Regional Park. Wildlife corridors generally follow major drainages and open ridgelines. Primary east-west corridors on MCAS Miramar are Rose and San Clemente Canyons. North-south wildlife movement in East Miramar oriented with Oak, Spring, West Sycamore, and Sycamore Canyons is relatively unconstrained, where the area functions more like a large habitat linkage than narrower corridors (MCAS Miramar, 2011b).
Special status species	Federally listed species found on MCAS Miramar include the following (MCAS Miramar, 2011b): ■ Coastal California gnatcatcher (*Polioptila californica*) – threatened; obligate resident of coastal sage scrub communities ■ Least Bell's vireo (*Vireo bellii pusillus*) – endangered; rare sightings in the southeast portion of installation ■ Golden eagle (*Aquila chrysaetos*) – fully protected; requires large, undeveloped open areas for foraging and nesting ■ Quino checkerspot butterfly (*Euphydryas editha quino*) – endangered; restricted to open grassland and openings in chaparral and coastal sage scrub ■ Hermes copper butterfly (*Hermelycaena [Lycaena] hermes*) – candidate; occurs in coastal sage scrub and southern mixed chaparral containing its host plant, spiny redberry ■ Southwestern willow flycatcher (*Empidonax traillii extimus*) – endangered; preferred habitat includes riparian habitats along rivers, streams, ponds, lakes, or other wetlands with dense growth of willows ■ Del Mar manzanita (*Arctostaphylos glandulosa ssp. crassifolia*) –

CSM Information Profiles – Natural Resources Profile	
Information Needs	**Information**
Special status species (cont)	endangered; occurs in chaparral communities with eroding sandstone substrate ■ Willowy monardella (*Monardella linoides ssp. viminea; Monardella viminea*) – endangered; occurs in riverwash cobbly loams of ephemeral drainages and floodplains ■ Orcutt's spineflower (*Chorizanthe orcuttiana*) – endangered; can be found in coastal chamise chaparral, coastal sage scrub, and close-coned coniferous forest openings with a distinctive loose sandy substrate ■ San Diego thornmint (*Acanthomintha ilicifolia*) – threatened; occurs in grassy openings in chaparral or coastal sage scrub with loose clay loam soils ■ Encinitas baccharis (*Baccharis vanessae*) – threatened; occurs in low-growing chaparral ■ Seven species are associated with vernal pool habitat: o San Diego mesa mint (*Pogogyne abramsii*) – endangered; occurs in vernal pool habitat in chaparral, coastal sage scrub and grassland habitats o San Diego fairy shrimp (*Branchinecta sandiegonensis*) – endangered; spread easily into puddle depressions and vehicle tracks o San Diego button-celery (*Eryngium aristulatum* var. *parishii*) – endangered; prefers gravelly loam soils o California Orcutt grass (*Orcuttia californica*) – endangered; usually in wetter portions as pools are drying o Riverside fairy shrimp (*Streptocephalus woottoni*) – endangered; found in deep vernal pool and wetland habitat o Spreading navarretia (*Navarretia fossalis*) – threatened; occurs in shallow pool habitat o San Diego ambrosia (*Ambrosia pumila*) – endangered; occurs in chaparral, coastal sage scrub, grassland, and vernal pool habitat,

CSM Information Profiles – Natural Resources Profile	
Information Needs	**Information**
Special status species (cont)	often in disturbed areas Vernal pool habitats (147.1 acres) at MCAS Miramar are the largest and most contiguous in Southern California. These habitats represent the most important and least disturbed examples of vernal pool habitat in the region and support various endangered and sensitive species that are dependent on these environs. The USFWS considered but determined not to designate or propose to designate critical habitat at MCAS Miramar for the San Diego fairy shrimp, Riverside fairy shrimp, coastal California gnatcatcher, spreading navarretia, and willowy monardella. The USFWS made this determination because the installation's Integrated Natural Resources Management Plan (INRMP), as implemented, is a legally operative plan that "provides a benefit to the species for which critical habitat [was] proposed for designation," per section 218 of the 2004 National Defense Authorization Act.

4.8. Potential Pathways and Receptors

MC accumulated in the MC loading area potentially can migrate to potential receptors via the following exposure pathways:

- Surface water runoff, including sediment transport
- Leaching to groundwater and subsequent groundwater flow

Exposure pathways considered in the REVA process include consumption of surface water and groundwater by off-range human receptors, as described in the *REVA Reference Manual* (HQMC, 2009). Other off-range exposure scenarios (e.g., soil ingestion, incidental dermal contact, bioaccumulation and food chain exposure) are not considered in the REVA process. In summary, the potential points of exposure for receptors of MC at MCAS Miramar include the following:

- Water bodies used in association with recreational activities, including the Santee Recreational Lakes
- Intermittent water bodies / drainages that leave the installation/range boundary and may contain special status ecological receptors
- An off-installation groundwater basin (the San Diego River Valley basin) that is a potential public water supply source

4.8.1. Surface Water and Sediment Pathway

Surface water runoff is the primary MC transport mechanism at the East Miramar Range Complex. Although rainstorms are infrequent, the surface water runoff may be high during significant storm events. The predominant surface water drainage direction is to the southwest; this includes subwatersheds where SARs are located. The surface water drainage direction for the EOD Training Range is to the south. Slopes range from gently sloping at eroded plateaus or mesas to steep at the dissected hills or canyons (MCAS Miramar, 2011b).

Most soils at the range complex are severely erodible with a few exceptions, such as the clayey types of soils found in hummocky areas underlain by bedrock or hardpan. Following rainstorm events, surface drainage and potential MC migration occurs by way of natural topographic gradients and drainage directly into canyons. Such drainage systems can transport MC to canyons from soil through dissolution in runoff water and erosion of soil and sediments. Dissolved MC transported through canyons can be recharged to the underlying alluvium, as the alluvium in these canyons is comprised of shallow, well-drained sandy or gravelly soils (SCS, 1984). Dissolved and soil-associated MC potentially can be transported through surface drainage to habitats containing ecological receptors (e.g., vernal pools) located outside of the MCAS Miramar operational range or installation. While vernal pools typically only receive water from direct precipitation or runoff from their immediate surrounding area, vernal pools adjacent to streams potentially can receive water from streams, typically during high water flows, and also can discharge water to streams. Overall, the hydrology of vernal pools is highly site specific. In addition, MC can be transported to potential human receptors in canyons (through contact recreational use) within and outside MCAS Miramar and to human receptors in other areas outside the installation, such as the Santee Recreational Lakes.

As discussed in **Section 4.4**, the identified MC loading area (EOD Training Range MC loading area) and SARs are located in three of the eight subwatershed areas within MCAS Miramar, specifically San Clemente Canyon, West Sycamore Canyon, and Murphy Canyon. All of the canyons within these three subwatershed areas flow off range to areas that have been documented to be associated with potential threatened and endangered ecological species. San Clemente, West Sycamore, and Murphy Canyons have existing beneficial uses of contact and noncontact recreation and, therefore, have potential human receptors (CRWQCB, 1994). However, the canyons and associated streams are intermittent and generally do not have surface water that would come into contact with recreational users. West Sycamore Canyon drains from the installation into areas with current human receptors (Santee Recreational Lakes) and potential future receptors (Castle Rock residential area). These lakes are perennial man-made water bodies used for recreational purposes.

None of the surface waters within MCAS Miramar are used as a source of drinking water. The West Sycamore Canyon subwatershed contains the only operational range utilizing HE and

munitions (the EOD Training Range MC loading area). Locations of the watershed, stream, and impact areas that may potentially receive MC are shown in **Figure 4-2**.

4.8.2. Groundwater Pathway

The EOD Training Range MC loading area and the SARs within MCAS Miramar are located within canyons. MC and lead potentially transported down canyons from these areas potentially recharge the underlying alluvium and slope wash. Groundwater in the alluvium at canyon bottoms has been measured at depths of 2 to 10.5 ft bgs but is expected to be present only after heavy rainfall or after a series of wet years. However, subsurface flow in the alluvium may be rapid after rainfall. Shallow groundwater flow in the alluvium and slope wash likely migrates to the northwest from the EOD Training Range MC loading area and to the south and southwest from the SARs. MC from the EOD Training Range MC loading area potentially transported off the installation boundary through the West Sycamore Canyon also potentially can migrate to shallow groundwater in areas south of the installation boundary. Impacts to deep groundwater are highly unlikely because of the great depths to groundwater and the presence of hardpan below most surficial soil layers.

There are no known human receptors of the shallow groundwater in and around MCAS Miramar. The shallow groundwater is known to be of low quality and is unsuitable for domestic use (SCS, 1984; Woodward-Clyde, 1991; Environmental Associates, 1995). Ecological receptors may use the water if it discharges to the surface. However, there are no known points of groundwater discharge except for interflow following precipitation events.

There are potential off-installation water supply wells in designated groundwater basins northeast and south of the installation (**Figure 4-3**); however, the groundwater basins are bounded by impermeable and semipermeable contacts of rocks and formations (CDWR, 2004). Shallow groundwater from the EOD Training Range MC loading area and the SARs likely would not flow into these groundwater basins. Also, these ranges are located more than 2.6 miles up gradient of the groundwater basins, and given that the alluvium does not remain saturated long after a precipitation event, there is minimal potential for MC migration in groundwater.

MC that may be transported in surface water within the West Sycamore Canyon from the EOD Training Range MC loading area potentially can recharge the San Diego River Valley groundwater basin located south of the East Miramar installation boundary (**Figure 4-3**). The principal water-bearing unit within this groundwater basin is quaternary alluvial deposits (CDWR, 2004). This groundwater basin is a potential public water supply source. Therefore, a potentially complete pathway exists for MC transport from the EOD Training Range MC loading area to receptors potentially using groundwater originating from this basin.

5. Modeling Assumptions and Parameters

As part of the REVA five-year review effort, fate and transport screening-level modeling analyses were conducted for the EOD Training Range MC loading area at MCAS Miramar. The EOD Training Range MC loading area was the only identified area that currently uses munitions containing MC. Other identified potential loading areas either are historical use areas that were assessed in the MCAS Miramar REVA baseline analysis or are associated with small arms ammunition that are assessed qualitatively through the SARAP (**Section 7**).

The purpose of the fate and transport screening-level analyses is to determine the potential for release of MC in surface water, groundwater, and sediment from the identified MC loading area. If the results of the screening-level analyses indicate a potential release of MC, additional assessments (such as sampling) are conducted. Otherwise, no further assessment is conducted, and the identified MC loading area will be reassessed in the next five-year review to ensure that continued loading at the site is not impacting surface water, sediment, and groundwater. The surface water, sediment, and groundwater screening-level modeling analyses methods and assumptions are presented in the following sections.

5.1. Surface Water and Sediment Modeling Assumptions

The analyses of potential surface water and sediment impacts for MCAS Miramar were conducted following the REVA process described in the *REVA Reference Manual* and the *REVA 5-Year Review Manual* (HQMC, 2009; HQMC, 2010). The initial step is a qualitative analysis of the surface water and sediment conditions based on the CSM, described in detail in **Section 4**, including the identification of potential exposure pathways, migration routes, and potential receptors (human and ecological). When these qualitative analyses indicate a potential for MC migration from MC loading areas to surface water receptors, screening-level MC transport analyses are performed to quantitatively estimate potential concentrations of indicator MC (RDX, HMX, TNT, and perchlorate) that can migrate in surface water and sediment.

Under REVA, screening-level transport analyses are used first to estimate the MC concentrations in surface water runoff and sediment at the edge of the identified MC loading area. If these analyses predict potential impacts at the edge of the loading area, then additional calculations are performed to estimate the potential MC concentrations at a downstream receptor location. Average annual surface water and sediment concentrations of the indicator MC are estimated based on the average annual MC loading of each indicator MC to each MC loading area.

All parameters used in the screening-level analyses are provided in **Appendix B**.

The mass loading of the indicator MC on the operational ranges was estimated as described in **Section 3**. In accordance with the REVA Part I surface water and sediment screening-level methodology, the entire annual MC load was converted to an average daily loading rate. This average daily loading rate was assumed to be loaded to the ground surface soil. The screening-level analyses were conducted for 2010–2011.

A conservative, screening-level modeling approach was taken to estimate the annual average concentrations of MC in surface water runoff and sediment from the identified MC loading area.

Results of the surface water and sediment screening-level analyses were compared to the REVA trigger values (**Table 5-1**) to evaluate the potential for MC releases to off-range receptors. The screening-level analyses methods are described briefly in the following sections. Additional details on the methods are provided in the *REVA Reference Manual* and the *REVA 5-Year Review Manual* (HQMC, 2009; HQMC, 2010).

Table 5-1: REVA Trigger Values for MC

MC	Trigger Value for Water (µg/L)	Trigger Value for Sediment (µg/kg)
RDX	0.110	32.5
TNT	0.113	25
HMX	0.114	51
Perchlorate	0.021	0.18

Note:
µg/L – micrograms per liter
µg/kg – micrograms per kilogram

5.1.1. Surface Water Screening-Level Approach at the EOD Training Range MC Loading Area

This subsection discusses the methods used in estimating MC entering surface water through (1) erosion of particulate or adsorbed MC in soil and transported in surface water runoff and (2) direct dissolution of MC in surface water runoff.

MC at the loading area was assumed to be loaded to the ground surface soil.

5.1.1.1. Estimation of the Annual Average MC Concentrations Leaving MC Loading Areas

The following three calculations were carried out in order to estimate average annual MC concentrations in surface water runoff leaving the EOD Training Range MC loading area.

Estimation of Soil Erosion

An estimate of total soil erosion over the EOD Training Range MC loading area was required for subsequent calculation of the mass of MC transported away from MC loading area. Estimation of the soil erosion to calculate transported MC mass is especially important for MC that strongly adsorb to soil (e.g., TNT). An annual soil erosion rate was estimated using the Revised Universal Soil Loss Equation (RUSLE), which incorporates the major factors affecting erosion to predict the rate of soil loss in mass per area per year. The RUSLE is expressed as follows:

A = RKLSCP

Where: A = Predicted soil loss
R = Rainfall energy factor
K = Soil erodibility factor
LS = Topographic factor (factor influenced by length and steepness of slope)
C = Cover and management factor
P = Erosion control practice factor

These factors were estimated for the EOD Training Range MC loading areas at MCAS Miramar using available information, such as soil types, land use / land cover, and digital elevation data (MCAS Miramar, 2012a). **Appendix B** lists parameter values used for estimating soil erosion for the MC loading area.

Estimation of Surface Water Runoff Rate

The annual surface water runoff rate for the EOD Training Range MC loading area was estimated simply as the product of the average annual precipitation, the loading area, and a runoff coefficient. The average annual precipitation of 12.4 inches per year was evaluated from annual precipitation data obtained from MCAS Miramar weather data (2007) (for the year 2007) and Izbicki (1985) (for the period 1897–1947). Runoff coefficient was estimated from Caltrans highway design manual (Caltrans, 2006) based on soil hydrologic group, slope, and land cover of the EOD Training Range MC loading area being analyzed (**Appendix B**).

Estimation of MC Mass and Concentration in Surface Water Runoff

A multimedia partitioning model, CalTOX, was used to estimate the mass of MC transported from surface soil to surface water runoff. This model has the capability of simulating the major transport mechanisms that are likely to affect MC from their point of origin in surface soils to

their release into surface water runoff. CalTOX was used to simulate the partitioning of MC loaded into various media (soil, air, and water) over time. The rate at which MC will partition among these media is dependent on both the chemical properties of the MC and the physical/hydrological properties of the site. CalTOX requires the input of landscape properties of the MC loading areas and chemical properties of the MC (**Appendix B**). Values of landscape and chemical properties were selected based on local reports, soil surveys, mapping information, and the scientific literature. Estimates of soil erosion and surface water runoff were calculated as described above and entered into CalTOX. An estimated groundwater recharge rate was also entered into CalTOX as one of the input parameters.

The chemical parameter values used in the model were selected as the most recent available at the time the modeling was carried out. It was noted that some of the parameter values have variability in the literature, such as MC decay rate and MC organic carbon partition coefficient (K_{oc}). In general, variability of many of the chemical parameters in the literature is not wide enough to cause significant variations in model results.

The CalTOX output of interest for the surface water analysis was the MC mass transferred from surface soil to surface water, which CalTOX expresses as an average daily load in grams per day. This daily mass transfer rate was divided by the daily runoff volume to estimate the MC concentration in surface water runoff at the edge of the MC loading area, prior to down gradient mixing/dilution in streams.

Temporal and spatial resolution of the analysis is limited by the basic input parameter, the loading rate, which is defined on an annual basis and to a fixed area. Therefore, the screening analysis inherently results in annual average concentrations.

5.1.1.2. Estimation of Munitions Constituents Concentrations Entering West Sycamore Canyon at the Southeastern Boundary of the Installation

The EOD Training Range MC loading area drains to an ephemeral stream that flows to West Sycamore Canyon. This canyon drains southeast to the installation boundary where it meets up with Sycamore Canyon, which flows toward the Santee Recreational Lakes outside of the installation boundary (a potential human receptor point). West Sycamore Canyon itself is a potential habitat for a California special species plant (willowy monardella).

Where the MC concentrations in surface water runoff at the edge of the MC loading area were estimated to be above the REVA trigger value, a simple approach was taken to estimate the order-of-magnitude reduction in the concentrations that could be expected to be caused by down gradient mixing with runoff from non-MC loading areas at the point of a potential downstream receptor location, assumed to be at the installation boundary. The total drainage area to the potential downstream receptor location in West Sycamore Canyon upstream of the point where

the canyon crosses the installation boundary was estimated (**Figure 4-2**) (MCAS Miramar, 2012a).

The down gradient mixed MC concentrations entering the receptor location in West Sycamore Canyon at the point where the canyon crosses the installation boundary were estimated by multiplying the estimated concentrations in surface water runoff at the edge of the EOD Training Range MC loading area by the ratio of the loading area to the total drainage area of the canyon upstream of the point where it crosses the installation boundary:

$$C_{mixed} = (C_{runoff} \times A_{LA}) / A_{DA}$$

Where: C_{mixed} = Post-mixed concentrations entering West Sycamore Canyon at the southeastern installation boundary (µg/L)

C_{runoff} = Concentration in runoff from loading area (µg/L)

A_{LA} = Area receiving MC loading (m^2)

A_{DA} = Total drainage area of West Sycamore Canyon (m^2)

All of the EOD Training Range MC loading area drains to the downstream surface water receptor locations. An inherent assumption of this analysis is that all areas other than the MC loading area contribute runoff that has negligible MC concentrations. This provides a simple estimate of the potential for estimated concentrations to be reduced by mixing with other runoff prior to entry into the down gradient end of West Sycamore Canyon. This approach conservatively assumes no reduction of MC through MC decay in surface water.

5.1.2. Sediment Screening-Level Approach at MC Loading Areas

The CalTOX partitioning model was used to estimate MC concentrations in sediment leaving MC loading areas. The input variables used are similar to the input variables used for the surface water analysis, as described in **Section 5.1.1.1**. CalTOX was used to estimate the MC mass transferred to surface water through partitioning into the soil/sediment eroding from the site and transported in surface water runoff. The MC concentrations in eroded soil/sediment leaving the MC loading area then was estimated by dividing the MC mass in eroded soil (obtained from CalTOX) by the estimated total soil erosion (obtained from RUSLE).

If the MC concentrations in sediment at the edge of the EOD Training Range MC loading area were estimated to be above the REVA trigger value, additional screening analysis was carried out to estimate MC concentration in sediment at the downstream receptor location in West Sycamore Canyon at the point where the canyon crosses the installation boundary. This involved using RUSLE to estimate the total annual mass of sediment transported to the downstream receptor location from areas upstream of the receptor location (the total mass of sediment eroded within

the drainage area of the receptor location). The sediment MC concentration at the downstream receptor location in West Sycamore Canyon was estimated to be equivalent to the MC mass in sediment leaving the MC loading area divided by the total sediment mass from the drainage area transported to the downstream receptor location as follows:

$$C_{sed,mixed} = M_{MC,LA} / M_{sed,DA}$$

Where: $C_{sed,mixed}$ = Post-mixed MC concentration in sediment entering receptor location in West Sycamore Canyon at the point where the canyon crosses the installation boundary (µg/kg)

$M_{MC,LA}$ = MC mass in sediment leaving the EOD Training Range MC loading area (micrograms per day [µg/day])

$M_{sed,DA}$ = Sediment mass eroded within the drainage area to the receptor location in West Sycamore Canyon at the point where the canyon crosses the installation boundary (kilograms per day [kg/day])

This method conservatively assumes that 100% of the sediment generated over the loading area is deposited into downstream surface water (downstream receptor locations). This is a conservative approach because typical sediment yields in surface water range from 30% to 50%.

5.2. Groundwater Modeling Assumptions

The purpose of the groundwater analysis in the REVA program is to make best use of the available information to infer whether indicator MC (RDX, HMX, TNT, and perchlorate) can be transported in groundwater from loading areas to receptors. Both conceptual and quantitative methods are used. The initial step is a qualitative analysis of the groundwater conditions based on the CSM, described in detail in **Section 4**, including the identification of potential exposure pathways, migration routes, and potential receptors (human and ecological). When this qualitative analysis indicates there is potential for MC migration from loading areas to groundwater receptors, a screening-level MC transport analysis is performed to quantitatively estimate potential concentrations of indicator MC in groundwater migrating to a receptor or beyond the installation boundaries.

5.2.1. Qualitative Analysis

The qualitative groundwater analysis looked at multiple data sources, which are detailed in the CSM. The following key information sources were used in the qualitative assessment:

- Military munitions expenditure data
- GIS data (MCAS Miramar FMD)
- IR Program site data

- INRMP
- U.S. Geological Survey topographic maps and regional groundwater resource reports
- U.S. Department of Agriculture (USDA) NRCS soil survey
- Precipitation data

The groundwater conditions, the potential for MC migration in vadose zone and saturated zones, and the presence of potential groundwater receptors at off-range locations are described in more detail in **Section 4.5**, **Section 4.3**, and **Section 4.8.2**, respectively.

5.2.2. Groundwater Analysis

Based on the qualitative assessment of the groundwater at MCAS Miramar and the surface water screening-level analysis results presented in **Section 6.1.2**, a quantitative groundwater screening-level analysis was not conducted at MCAS Miramar.

Based on the qualitative assessment of the groundwater:

- There are no known groundwater receptors within MCAS Miramar.
- There are potential off-installation receptors within designated groundwater basins; however, minimal potential exists for MC migration in groundwater from the EOD Training Range MC loading area to potential off-installation receptors within designated groundwater basins. This is because:
  - the groundwater basins where potential receptors exist are bounded by impermeable and semi-permeable contacts of rock and formations,
  - there is significant distance between the loading area and the groundwater basins (minimum of 2.6 miles), and
  - the alluvium underlying canyons where groundwater potentially can move off range does not remain saturated long after a precipitation event.
- There is little possibility of shallow groundwater in the alluvium infiltrating to deeper groundwater, which is located about 160 to 200 ft bgs and is separated from the alluvium by several low-conductivity zones.

MC transported in surface water within West Sycamore Canyon from the EOD Training Range MC loading area potentially can recharge into the San Diego River Valley groundwater basin located just south of the east MCAS Miramar installation boundary (**Figure 4-3**). This groundwater basin is a potential public water supply source and potentially contains public supply wells. Based on the surface water screening-level analysis conducted (**Section 5.1.1**), MC in surface water were not estimated to reach the San Diego River Valley groundwater basin at concentrations above REVA trigger values. As a result, the only potential pathway to a groundwater receptor was eliminated. Thus, a quantitative groundwater screening analysis was not deemed necessary at MCAS Miramar.

6. Screening-Level Assessment Results

The EOD Training Range MC loading area was assessed qualitatively through the development of a site-specific CSM and quantitatively through screening-level transport assessments. The assessment results for the MC loading area are presented within this section under the heading West Sycamore Canyon Subwatershed (**Section 6.1**), which is the hydrologic subwatershed area within which it is located. The section contains discussions on the operational range areas identified, the site-specific CSM, MC deposition estimates, screening-level modeling results, and additional range information.

6.1. West Sycamore Canyon Subwatershed

The West Sycamore Canyon subwatershed is located on the eastern portion of MCAS Miramar; it is approximately 3,323 acres, with of the majority of the area (approximately 89%) located inside the MCAS Miramar installation boundary (**Figure 6-1**). The subwatershed area encompasses a stream network that is ephemeral. Part of Training Area 1 (2,143 acres) and all of the EOD Training Range (88 acres) are located within the subwatershed.

All MC deposition in the subwatershed is anticipated to occur at the EOD Training Range MC loading area, as identified in **Figure 6-1**.

Military Munitions

Military munitions authorized for use within the EOD Training Range MC loading area are listed in **Table 3-1**.

6.1.1. Conceptual Site Model

6.1.1.1. Estimated Munitions Constituents Loading

The boundaries of the EOD Training Range MC loading area were selected based on training-specific information (e.g., operational range boundaries, target locations, other GIS data). As mentioned in **Section 3.5.1**, the area of the EOD Training Range MC loading area has been decreased significantly since the baseline assessment based on improved available information.

The MC Loading Rate Calculator was used to estimate the amount of MC deposited annually within this MC loading area (**Table 6-1**); the assumptions used to guide the estimates are detailed in **Section 3**. The MC with the highest MC loading rate and most significant loading observed at the EOD Training Range loading area during the five-year review period was RDX, followed by

Table 6-1: Estimated MC Loading for the West Sycamore Canyon Subwatershed

Assessment (years)	MC Loading Area	Assumed Loading Area (m^2)	Estimated Annual Loading Rate ($kg/m^2/yr$)			
			HMX	RDX	TNT	Perchlorate
Baseline* (1989–2006)	Current EOD Range	162,559	0.00E+00	2.22E-07	5.32E-08	1.05E-07
Five-Year Review (2007–2011)	EOD Training Range	6,313	0.00E+00	1.42E-05	6.41E-08	7.11E-12

* Estimated baseline MC loading rates are based on Period E values of the baseline report, which incorporate a +50% training factor to conservatively account for potential/actual inconsistent expenditure recordkeeping.

TNT. Compared to the baseline assessment, overall MC loading for this review is estimated to have decreased at the single MC loading area within the subwatershed. As observed during the baseline assessment, the estimated HMX loading remained zero; the estimated TNT loading remained approximately the same as the predicted loading calculated during the baseline assessment. The estimated RDX loading rate increased by approximately two orders of magnitude compared to the baseline assessment; this most likely was due to the reduction in the loading area acreage since the range was used on a limited basis (i.e., only 2 years). Lastly, the estimated perchlorate loading rate decreased by approximately five orders of magnitude compared to the baseline estimates.

Annual lead deposition for the EOD Training Range MC loading area was estimated during this five-year review (**Table 6-2**). As noted in **Section 3.1**, the lead deposition rate is not comparable to an MC loading rate; rather, it is an estimate of the total amount of lead deposited in a given MC loading area. The baseline assessment did not include such lead loading estimates for MC loading areas. Calculations indicate the EOD Training Range MC loading area has a total lead deposition rate estimated at 2.02E-04 lb of lead annually.

N

MIRAMAR RESERVOIR

EOD TRAINING RANGE MC LOADING AREA

WEST SYCAMORE CANYON

SYCAMORE CANYON

SANTEE RECREATIONAL LAKES

SAN DIEGO RIVER

REVA
Figure 6-1
The EOD Training Range MC Loading Area within the West Sycamore Canyon Subwatershed

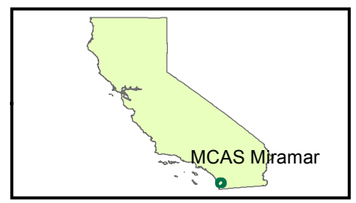
MCAS Miramar
Miramar, CA

LEGEND

- INSTALLATION BOUNDARY
- MC LOADING AREA
- STREAM/RIVER
- SURFACE WATER COURSE AREA
- WETLANDS

SUB-WATERSHEDS

- WEST SYCAMORE CANYON
- SANTEE RECREATIONAL LAKES



0 0.275 0.55 1.1
Miles

Date: February 2013

Source: MCAS EMD GIS 2012
USGS, 2007

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

Page intentionally blank

Table 6-2: Estimated Annual Lead Deposition for the West Sycamore Canyon Subwatershed

MC Loading Area	Size (m^2)	Lead Deposition Rate		
		$kg/m^2/yr$	$lb/yd^2/yr$	Total lb/yr
EOD Training Range	6,313	1.45E-08	2.68E-08	2.02E-04

Note:
$kg/m^2/yr$ – kilograms per square meter per year
$lb/yd^2/yr$ – pounds per square yard per year
lb/yr – pounds per year

6.1.1.2. Geography and Topography

The West Sycamore Canyon subwatershed is characterized by gently sloping, eroded plateaus or mesas that are cut by the southeasterly draining West Sycamore Canyon. These give rise to a series of marine wave-cut terraces, which, in turn, grade to the steep and dissected hills of Sycamore Canyon. The terrain generally slopes toward the center of the subwatershed to West Sycamore Canyon, the major ephemeral stream that ultimately flows southeast toward Sycamore Canyon. Available contour data indicate the elevation of the subwatershed area within the installation boundary ranges from approximately 422 ft amsl at the southeastern end of West Sycamore Canyon to approximately 1,112 ft amsl at the western boundary of the subwatershed (MCAS Miramar, 2012a). Based on available spatial data, the slope within the installation boundary of the subwatershed area can range from approximately 2% to over 90% in the hills. The average estimated slope within the subwatershed area is 37% (MCAS Miramar, 2012a).

6.1.1.3. Surface Water Features

The West Sycamore Canyon subwatershed contains an ephemeral stream network with a parallel drainage pattern. The major stream, West Sycamore Canyon, originates approximately one-half mile up gradient of the installation boundary, flows southeasterly through the installation, and meets with Sycamore Canyon at the southern end of the installation boundary. Sycamore Canyon continues to flow off the installation boundary toward the Santee Recreational Lakes (located approximately 0.6 miles south of the installation boundary) and ultimately joins with the San Diego River. Tributaries of West Sycamore Canyon flow southeast and southwest into the canyon. All of the EOD Training Range MC loading area drains within the West Sycamore Canyon subwatershed.

A tributary stream of West Sycamore Canyon flows southeasterly through the EOD Training Range MC loading area into West Sycamore Canyon. West Sycamore Canyon is approximately 0.6 miles down gradient of the loading area.

6.1.1.4. Soil Characteristics and Land Cover

The predominant soil map symbol of the West Sycamore Canyon subwatershed within the installation boundary is RfF (Redding cobbly loam). This soil consists of cobbly loam, cobbly clay, and cobbly clay loam. The soil is well drained and has an acidic pH range (4.5 to 6) (USDA NRCS, 2007). The organic content ranges from 0% to 2%. The inherent soil erodibility for the soil is moderate, with an estimated soil erodibility factor of 0.32. The soil has a high runoff potential (hydrologic group D).

The West Sycamore Canyon subwatershed is sparsely vegetated. The sparse vegetation includes disturbed non-native grass, disturbed Diegan coastal sage scrub, and chemise chaparral.

6.1.1.5. Erosion Potential

Both the EOD Training Range MC loading area and the larger West Sycamore Canyon subwatershed area were estimated to have high soil erosion potential (RUSLE predicted soil loss value of 6.91E-03 kilograms per square meters per day [$kg/m^2/d$]). This estimated high soil erosion potential is a result of the steep topography and poor vegetation cover.

6.1.1.6. Groundwater Characteristics

The principal water-bearing unit within the West Sycamore Canyon subwatershed is the alluvium and beach deposits. These consist of unconsolidated or poorly consolidated mixtures of gravel, sand, silt, and varying amounts of clay. The beach deposits are thin units located on top of the mesas and the alluvium lying along the canyon bottoms. Groundwater that is found in alluvial units generally exists intermittently following heavy rainfall or a series of wet years. The Eocene Poway Group (the Stadium Conglomerate) underlying the West Sycamore Canyon subwatershed area also can hold groundwater in its coarser-grained conglomerate units. This can happen where the formation is exposed on the surface or overlain by a thin alluvium layer, where it has high recharge potential and sand lenses may store and yield significant water volumes (SCS, 1984). Groundwater, when present in alluvial units, is close to the ground surface (ranging from 2 to 10.5 ft bgs).

There are no designated groundwater basins within the West Sycamore Canyon subwatershed; however, a designated groundwater basin (the San Diego River Valley groundwater basin) exists approximately 0.2 miles south of the subwatershed and the installation boundary (**Figure 4-3**). This groundwater basin is surrounded by contacts with semipermeable rocks of the Eocene Poway Group, impermeable Cretaceous crystalline rock, and impermeable Jurassic to Cretaceous Santiago Peak volcanic rocks (CDWR, 2004). The principal water-bearing unit within the basin is quaternary alluvial deposits. The most productive portions of the alluvium are well-sorted sands that are located in buried river channels, along with a layer of coarse gravel near the base of the aquifer (CDWR, 2004). Thickness of the alluvium can exceed 200 ft but typically is about 70 ft thick.

6.1.1.7. Potential Surface Water and Groundwater Pathways

Surface Water and Sediment Pathways

The runoff coefficient at the EOD Training Range MC loading area within the West Sycamore Canyon subwatershed was estimated to be 0.64. This relatively high runoff potential is largely attributable to the infrequent torrential storms that occur (often resulting in flash floods), the soil type at the loading area with high runoff potential (hydrologic group D), the sparse vegetation cover at the loading area, and the steep topographic slope at the MC loading area within the subwatershed.

The high soil erosion potential that may occur at the MC loading area makes soil erosion an important mechanism for MC mobilization into surface water runoff. MC migration from the MC loading area to surface water runoff would drain southwest into West Sycamore Canyon, ultimately reaching Sycamore Canyon and the Santee Recreational Lakes outside of the installation boundary.

Groundwater Pathways

MC deposited on the EOD Training Range MC loading area has the potential to migrate down to the underlying alluvium and slope wash. Groundwater in the alluvium is only expected to be present intermittently, only after heavy rainfall or after a series of wet years. However, subsurface flow in the alluvium may be rapid after rainfall. Shallow groundwater flow in the alluvium and slope wash likely migrates to the northwest from the EOD Training Range MC loading area. The closest human receptors of the shallow groundwater potentially are located within the San Diego River Valley groundwater basin, which is approximately 2.7 miles from the EOD Training Range MC loading area outside the installation boundary. This groundwater basin is bounded by semipermeable and impermeable contacts of rocks and formations. Given this bounding of the basin, the significant distance from the loading area, and the short period of time that the alluvium remains saturated, there is minimal potential for shallow groundwater migration from the EOD Training Range MC loading area to the potential human receptors within the San Diego River Valley groundwater basin. MC migration to deep groundwater is highly unlikely because of the great depths to groundwater and the presence of hardpan below surficial soil layers.

MC transported off the southern installation boundary in surface water with West Sycamore Canyon potentially can reach the San Diego River Valley groundwater basin where MC in the canyon can be recharged to the underlying quaternary alluvial deposits. These quaternary alluvial deposits are the principal water-bearing unit of the San Diego River Valley groundwater basin. They could contain water supply wells, thus indicating a potentially complete pathway for MC migration to possible groundwater receptors within the San Diego River Valley groundwater basin.

6.1.1.8. Potential Surface Water and Groundwater Receptors

Surface Water and Sediment Receptors

West Sycamore Canyon and the Santee Recreational Lakes are potential human receptor locations through recreational use. The recreational use of West Sycamore Canyon is limited due to its ephemeral nature; however, the Santee Recreational Lakes are permanent features that are used for recreational purposes. Some populations of the special species willowy monardella plant are located downstream of the MC loading area within the subwatershed. Also, nonvernal pool wetlands are located along the drainages within the subwatershed.

Groundwater Receptors

There are no groundwater receptors within MCAS Miramar. The closest groundwater basin (the San Diego River Valley basin), which is located approximately 2.7 miles southeast of the EOD Training Range MC loading area outside the installation boundary, potentially contains public supply wells.

6.1.2. Surface Water and Sediment Analysis Results

A screening-level analysis was used to obtain conservative estimates of MC concentrations in surface water and sediment from the EOD Training Range MC loading area that drain to West Sycamore Canyon and, ultimately, toward the Santee Recreational Lakes. As discussed in **Section 6.1.1.8**, West Sycamore Canyon has limited recreational use but potentially contains the special status species willowy monardella plant. The canyon also flows into Sycamore Canyon, which flows toward the Santee Recreational Lakes.

The screening-level analyses for surface water and sediment were conducted as described in **Section 5.1.1** and **Section 5.1.2,** respectively. The screening-level transport analysis at the EOD Training Range MC loading area was conducted for RDX, TNT, and perchlorate. HMX was not included in the analysis; based on the types of munitions used at the range, it was estimated to have a negligible loading rate.

The surface water and sediment screening-level analyses were carried out for the time period matching the estimated MC loading period (2010–2011). All of the EOD Training Range MC loading area drains within the West Sycamore Canyon subwatershed (**Figure 6-1**).

Table 6-3 presents the estimated annual average edge-of-loading-area concentrations in surface water runoff from the EOD Training Range MC loading area draining within the West Sycamore Canyon subwatershed. Based on the screening-level calculations, the concentration of RDX was predicted to exceed the REVA trigger value at the edge of the EOD Training Range MC loading area modeled within the West Sycamore Canyon subwatershed. The concentrations of other MC

modeled (TNT and perchlorate) were predicted to be below REVA trigger values at the edge of the EOD Training Range MC loading area (**Table 6-3**).

Table 6-3: Screening-Level Estimates of Annual Average Edge-of-Loading-Area MC Concentrations in Surface Water Runoff within the West Sycamore Canyon Subwatershed

MC Loading Area	Estimated MC Concentration (µg/L)			
	HMX	RDX	TNT	Perchlorate
EOD Training Range	N/A	**19.4**	0.066	~0
REVA Trigger Value for Water	0.114	0.110	0.113	0.021

Note:

N/A – not modeled because the MC loading rate was estimated to be negligible
Shading and bold indicate concentration exceeds the REVA trigger value

.

Additional analyses were conducted to estimate the annual average MC concentrations in surface water entering the downstream point of West Sycamore Canyon at the installation boundary. The estimated drainage area of West Sycamore Canyon upstream of the point where the canyon crosses the installation boundary is equivalent to 3,325 acres. The average annual concentration of RDX in surface water entering West Sycamore Canyon at the MCAS Miramar installation boundary was predicted to be below the REVA trigger value (**Table 6-4**). Concentrations of TNT and perchlorate that were predicted to be below REVA trigger values at the edge of the EOD Training Range MC loading area (**Table 6-3**) were predicted to be negligible farther downstream in West Sycamore Canyon at the installation boundary (**Table 6-4**). Additional analysis was not conducted to estimate concentrations in surface water potentially entering the Santee Recreation Lakes, which are located farther downstream off the installation boundary, because MC concentrations reaching the Santee Recreational Lakes are expected to be even lower due to additional dilution and mixing.

Table 6-4: Screening-Level Estimates of Annual Average MC Concentrations in Surface Water Entering West Sycamore Canyon at the Southeastern Installation Boundary

MC Loading Area	Estimated MC Concentration (µg/L)			
	HMX	RDX	TNT	Perchlorate
EOD Training Range	N/A	0.009	~0	~0
REVA Trigger Value for Water	0.114	0.110	0.113	0.021

Table 6-5 presents the estimated annual average edge-of-loading-area concentrations in sediment from the EOD Training Range MC loading area draining within the West Sycamore Canyon subwatershed. Based on the screening-level calculations, the average annual concentrations of MC in sediment at the edge of the EOD Training Range MC loading area were predicted to be below REVA trigger values (**Table 6-5**).

Table 6-5: Screening-Level Estimates of Annual Average Edge-of-Loading-Area MC Concentrations in Sediment within the West Sycamore Canyon Subwatershed

MC Loading Area	MC Concentration (µg/kg)			
	HMX	RDX	TNT	Perchlorate
EOD Training Range	N/A	0.559	0.121	~0
REVA Trigger Value for Sediment	51	32.5	25	0.18

Note:

N/A – not modeled because the MC loading rate was estimated to be negligible

Based on the surface water and sediment screening-level analyses results, no additional assessment is required at this time for the EOD Training Range MC loading area.

6.1.3. Groundwater Analysis Results

A quantitative groundwater analysis was not conducted for the EOD Training Range MC loading area within the West Sycamore Canyon subwatershed. This is because 1) the direct groundwater pathway to potential receptors was eliminated (**Section 6.1.1.7**) and 2) the only potential pathway to groundwater receptors is through stream flow recharge in canyons draining from the EOD Training Range MC loading area to the San Diego River Valley groundwater basin where there are potential supply wells. However, results from the surface water screening-level analysis (**Section 6.1.2**) showed MC concentrations in West Sycamore Canyon at the installation boundary to be below REVA trigger values, indicating no potential impacts to possible groundwater receptors in the San Diego River Valley groundwater basin where drainage from West Sycamore Canyon recharges. As a result, additional groundwater screening-level analysis is not required at this time.

7. Small Arms Range Assessments

The REVA indicator MC for SARs is lead because it is the most prevalent (by weight) potentially hazardous constituent associated with small arms ammunition. As described in previous sections, fate and transport parameters for lead at SARs are dependent on site-specific geochemical properties, which cannot be determined solely by physical observation. Training areas and ranges that use only small arms ammunition that are .50 caliber or smaller are qualitatively assessed. Ranges that perform joint small arms and live-fire training with HE munitions are not assessed through this process; rather, they are assessed through the MC loading estimation and modeling processes previously described. Only operational SARs are addressed in this protocol; historical use SARs that are no longer used are not assessed due to lack of information to adequately perform an assessment.

The SARAP was developed as a qualitative approach to identify and assess factors that influence the potential for lead to migrate from an operational range. These factors include the following:

- Range design and layout, including any best management practices
- Physical and chemical characteristics of the area
- Past and present operation and maintenance practices

In addition, potential receptors and pathways are identified relative to the SAR being assessed. The potential for an identified receptor to be impacted by MC migration through an identified pathway is evaluated.

7.1. Summary of the Small Arms Range Assessment Protocol

The SARAP produces two scores: the sum of surface water elements and the sum of groundwater elements. These determine the overall rankings for surface water and groundwater conditions. The scoring system assigns minimal, moderate, and high values for each category:

- Minimal (0 to 29 points) – The SAR has minimal or no potential for lead migration to a receptor, but actions may be necessary to ensure that continuing training activity at the range does not pose a future threat to human health and the environment.
- Moderate (30 to 49 points) – The SAR may have the potential for lead migration to a receptor, most likely indicating no immediate threat to human health and the environment, but actions may be necessary to prevent a greater or future concern.
- High (50 to 65 points) – The SAR most likely has the potential for lead migration to an identified receptor and requires additional action(s).

Additional documentation describing the purpose, requirements, and supporting drivers for the performance of the SAR assessment is provided with the range-specific assessments in **Appendix A**, which contains the assessments of the operational SARs at MCAS Miramar. While each range was evaluated separately using the SARAP, several of the ranges had similar periods of use, types of ammunition, and physical/environmental characteristics, which resulted in similar scoring results. Therefore, the discussions of the Marine Corps Ranges B, C, and D have been grouped together in **Section 7.2.3**; likewise, the discussions of the San Diego County Sheriff's Department's ranges (Ranges 5, 6, and 7 and Duffy Town Range) have been consolidated in **Section 7.2.4**. Nine SARs were identified at MCAS Miramar during the five-year review as opposed to the eight identified during the baseline. The Duffy Town Range was identified as an operational range during the five-year review; during the baseline assessment, it was thought to be considered an indoor range and was not evaluated during the assessment). All other SARs evaluated in the five-year review also were evaluated during the baseline. As discussed in **Section 3.2**, estimation of average annual lead loading at each SAR was based upon approximately 4 years of expenditure data (2009 to 2012).

7.2. Small Arms Ranges

Nine SARs, located in two separate areas within the East Miramar Range Complex, are utilized by MCAS Miramar and other military, local law enforcement, and federal agencies for marksmanship/proficiency training and qualification (MCAS Miramar, 2011a). For many of the SARs, the general information used to document soil characteristics, groundwater characteristics, fate and transport pathways, potential receptors, and threatened and endangered species are the same. Information applicable across the installation is further detailed in **Section 4**. Site-specific information, if available, was used to complete the SARAPs for each SAR and is provided in **Appendix A**. The SARs are described briefly in the following sections.

7.2.1. Range 100 (Location of Miss and Hit Rifle Range)

7.2.1.1. Site Background

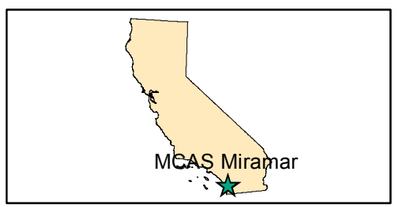
Range 100, also known as the LOMAH Rifle Range, is a 500-yard rifle range located in the north-central section of East Miramar and, along with Range 101, comprises the Carlos Hathcock Range Complex. The location of Range 100 is shown in **Figure 7-1**. The range is operated as part of the MTU and was constructed in 2004. It is oriented for firing from east to west. Its SDZ partially overlaps Training Areas 1 and 2 and the EOD Training Range. The range contains 40 firing lanes of multiple known distance targets, as well as eight lanes for unknown distance targets. Targets are located at distances of 100, 200, 300, and 500 yards from the firing line. The targets used in the LOMAH system electronically gauge the location of hits and misses on the target and report scores in real time. The range is used approximately 3 weeks per month. In addition, Table 2 rifle training has been initiated, with Marines firing into the base of the earthen

REVA
Figure 7-1
Ranges 100 and 101

MCAS Miramar
Miramar, CA

Legend

San Clemente Creek Drainage



0 80 160 320 480 Feet

Date: February 2013

Source: MCAS/EMS GIS Office 2012
GEOFIDELIS 2011

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

Page intentionally blank

berm that comprises the 100-yard target line; however, the majority of the rounds from this range are deposited on the rear backstop berm.

Various types of small arms ammunition are used at this range. During the five-year review period, this range had an average lead loading rate of approximately 8,570 lb/yr based on the available expenditure data. Lead recovery activities never have been conducted at Range 100. Range maintenance activities involving lead recovery and berm reconstruction are in the planning stages for this range. According to Range Operations personnel, the funds are in place and the lead recovery is likely to start in the near future.

During the site visit, visual observations indicated gravelly and silty sand across much of the surface of Range 100. USDA NRCS data describe the soil beneath the firing lanes and berms as primarily Visalia gravelly sandy loam, which is associated with surface water drainages. The soil type is generally well drained with a slope less than 5%. The other soil type found in the more upland areas, with slopes between 15% and 50% in the Rifle Range SDZ, is Redding cobbly loam. Soils of this group typically are underlain by hardpan, resulting in slow infiltration and low permeability (MCAS Miramar, 2011b).

Range 100 is equipped with several measures to control surface water runoff and run-on. The surface water runoff in the area around the range ultimately discharges into the main drainage of San Clemente Canyon located north and west of the range. Prior to Range 100's construction in 2004, a tributary of the San Clemente Canyon was present on the footprint of the range flowing east to west, where it intersected with the main drainage of San Clemente Canyon. Runoff from the rear impact berm is directed toward a gently depressed drain at the base of the berm, which flows a short distance to a vegetated drainage channel that diverts runoff to the north-central portion of the range footprint. Runoff then is carried westward, where it intersects with the main channel of San Clemente Canyon, approximately 150 ft to the northwest. The top of the rear impact berm slopes gently back to direct drainage away from the face of the berm. The top of the 100-yard impact berm is sloped toward the firing line, which directs runoff toward the drain in the northwestern corner of the range adjacent to the end of the 500-yard firing line. In addition, a concrete-lined surface water diversion for run-on control is present along the southern boundary of Range 100. The surface water diversion continues west, across the top of the Pistol Range (Range 101); surface water collected in this channel flows to the west and ultimately is discharged into the main drainage of San Clemente Canyon.

Visual observations during the site visit indicated the rear impact berm is well vegetated with tall grasses, with the exception of the bullet pockets in the face of the berm. The vegetation on the range floor, also consisting of mostly tall grasses, is concentrated in and around the drainage channel that is located in the middle of the range floor between the 200-yard firing line and the rear impact berm. Vegetative cover is not as heavy on the face or base of the 100-yard impact berm. The range floor in front of the 100-yard impact berm is lightly vegetated with grass

primarily in the areas where runoff flows. Despite the significant vegetative coverage at Range 100, such coverage typically is dry or dead during the dry season.

Human receptors for surface water in off-range areas could include persons using the canyon for non-contact recreational purposes; however, as the drainage is typically dry and there are no specific activities within the drainage on MCAS Miramar, human receptors likely are limited. Vernal pools within or immediately adjacent to the San Clemente Canyon are located 4 miles downstream of the range. Generally, the vernal pools are hydrologically isolated wetlands that only receive water from direct precipitation or runoff from their immediate surrounding area. The California gnatcatcher is not likely to consume significant quantities of water from the drainages near the range. In addition, the willowy monardella, Del Mar manzanita, and coastal sage scrub habitat have been observed near the range; however, these vegetative communities are unlikely to come in contact with water in the San Clemente Canyon drainages. Therefore, surface water exposure to ecological receptors is likely to be limited.

Previous studies at MCAS Miramar have shown that groundwater in the region generally is considered to be at a depth of 160 ft bgs, with several locations having perched groundwater at depths between 10 and 30 ft bgs. Groundwater, when present in the alluvial units found in the canyon bottoms, generally is close to the surface. It has been measured at depths between 2 and 10.5 ft. However, this groundwater exists only intermittently after heavy rainfall or after a series of wet years (BEI, 2005b; SCS, 1984; Evenson, 1989; URS, 2005). It is possible that shallow groundwater may be present near the ranges following precipitation events and may discharge via base flow to the drainages. Groundwater is not used as water supply in the MCAS Miramar region. As such, there are no groundwater receptors for potable water use at Range 100.

7.2.1.2. Assessment Results

The evaluation of Range 100 resulted in a minimal ranking for both surface water and groundwater. Range 100 was evaluated in the baseline assessment, which also resulted in minimal rankings for both surface water and groundwater. Despite the high lead loading at Range 100 during the five-year review period, there is a low potential for the off-range migration of lead due to low precipitation levels and effective storm water controls in place at the range. There is also limited to no presence of ecological or human receptors within or close to this range, further contributing to the minimal surface water ranking. The minimal groundwater ranking was based on site conditions, such as deep groundwater, low precipitation, limited soil permeability, and groundwater with neutral pH, which result in limited potential for groundwater transport of lead. There are also no receptor exposure points, such as groundwater wells, present at or near this range. As a result of the minimal surface water and groundwater rankings, no further action is required for this range at this time. This range will be re-evaluated in the next five-year review.

7.2.2. Range 101

7.2.2.1. Site Background

Range 101 is located immediately southwest of and adjacent to Range 100 in the north-central section of the East Miramar Range Complex, as shown in **Figure 7-1**. It is also part of the Carlos Hathcock Range Complex and MTU operations. This pistol range opened in January 2007 and contains 25 firing lanes at 7, 15, 25, and 50 yard distances. Shotgun training also is conducted at this range. Firing is directed to the southeast, where a natural hillside serves as the rear impact berm for bullet containment. The slope of the hillside berm is steep, and significant erosion or the impact berm face was evident. Various types of small arms ammunition are expended at this range. Range 101 had a similar rate of lead deposition per year during the five-year review period as Range 100 (approximately 8,620 lb/yr); however, where lead is dispersed across two impact berms at Range 100, it is directed into a smaller, single berm at Range 101. Lead recovery activities never have been conducted at Range 101. Range maintenance activities involving lead recovery and berm reconstruction are in the planning stages for this range. According to Range Operations personnel, the funds are in place and the lead recovery is likely to start in the near future.

The soil within the impact area consists of Redding cobbly loam and Visalia gravelly sandy loam. Soils of these groups typically are underlain by hardpan, resulting in slow infiltration and low permeability (MCAS Miramar, 2011b). Very limited vegetation in the form of grass is present on the top of the impact berm or on the range floor, which is mostly covered with gravel. Eroded bullet pockets are present across the face of the impact berm.

Surface water runoff at Range 101 is directed from the face of the impact berm to the floor. A small grated drain at the foot of the berm collects surface water drainage and directs the flow under the gravel-covered firing lines to a point west of the range, where it discharges to a short but thick layer of riprap. Based on its design, the discharge point is anticipated to act as a sediment trap, reducing soil and lead particles from being carried downstream. Discharge ultimately runs into the main drainage channel of San Clemente Canyon, which runs from northeast to southwest and is approximately 450 ft west of the Pistol Range. At the time of the REVA site visit, significant erosion was observed, as the culvert for the point of discharge was silted in and the grated drain was blocked, flooding the area between the target stands and rear impact berm. A concrete-lined diversion at the top of the berm directs surface water drainage from upland reaches around the range. The diversion and several layers of silt fence are installed in the face of the impact berm above the projectile impact area in an effort to reduce the erosion of the impact berm. However, significant erosion continues on the range with these measures in place. Human and ecological receptors for surface water at Range 101 are the same as those described in **Section 7.2.1.1**. Groundwater conditions at Range 101 are similar to those previously described for Range 100. As such, there are no groundwater receptors for Range 101.

7.2.2.2. Assessment Results

The evaluation of Range 101 resulted in minimal rankings for surface water and groundwater. Range 101 was evaluated in the baseline assessment, which also resulted in minimal rankings for both surface water and groundwater. The evaluation indicated a low potential for the off-range migration of lead despite the high lead loading at the range. Low precipitation in the region and limited or no presence of receptors in the area contributed to the minimal surface water ranking. While active erosional processes were observed at the range, it is anticipated that the storm water controls minimize the amount of runoff that is exposed to embedded expenditures in the impact berm and creates opportunities for suspended lead particles to settle out. Thus, the storm water controls are considered effective and contribute to mitigation of lead migration from the range.

The minimal groundwater ranking was a result of site conditions, such as deep groundwater, low precipitation, limited soil permeability, and neutral groundwater pH, which reduce the potential for groundwater transport of lead. There are also no receptor exposure points, such as groundwater wells, present at or near this range. As a result of the minimal surface water and groundwater rankings, no further action is required for this range at this time. This range will be re-evaluated in the next five-year review.

7.2.3. Ranges B, C, and D

7.2.3.1. Site Background

Ranges B, C, and D are located in the southwestern section of East Miramar adjacent to Training Area 5, as shown in **Figure 7-2**. The ranges, located in parallel along a north-south trending hillside, are oriented for firing to the east-southeast. The ranges are separated by earthen side berms, and the natural hillside serves as the rear impact berm for all three ranges. In addition, Range B contains wood baffling above the rear firing line to reduce the vertical trajectory of bullets fired during training. All three ranges are used frequently.

These ranges historically were utilized by the Navy and remain in operation today. The primary users of these ranges are the MCAS Miramar PMO, Marine Corps Recruit Depot San Diego PMO, Marine Corps Police Academy West, and Navy units, which schedule range usage with the MCAS Miramar Range Management/Control office. Various types of small arms ammunition are expended at these ranges.

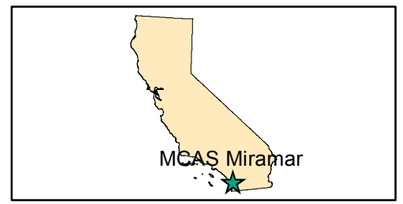
Range B is approximately 300 ft wide and contains 22 firing positions at distances of 35, 40, and 50 yards. Range B has wooden baffling above the rear of the firing line to reduce the vertical trajectory of small arms projectiles fired during training. Range C, approximately 200 ft wide, contains 26 firing positions at distances of 9, 15, 25, and 35 yards. Range D, approximately 100 ft in width, contains 20 firing positions at 7, 11, and 25 yards. All targets are comprised of paper set on wooden frames in front of the impact berm. A combined SDZ has been established for the three Marine Corps ranges and the four San Diego County Sheriff's Department's ranges, which

REVA
Figure 7-2
Ranges B, C, and D

MCAS Miramar
Miramar, CA

Legend

Murphy Canyon Drainage



0 45 90 180 270
Feet

Date: February 2013

Source: MCAS/EMS GIS Office 2012
GEOFIDELIS 2011

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

Page intentionally blank

are located along the hillside to the north. The SDZ extends to a maximum distance of 5,906 ft downrange and overlaps a section of land owned by the San Diego County School District that is located within the boundaries of MCAS Miramar. During the five-year review period, these ranges had a combined estimated lead loading rate of approximately 6,635 lb/yr (3,540 lb/yr – Range B; 2,025 lb/yr – Range C; 1,070 lb/yr – Range D). According to Range Operations personnel, activities such as excavation, lead recovery, and berm reconstruction are conducted at these ranges on an as-needed basis depending on variables such as changes in ammunition expenditures, training tempo, seasonal effects, safety issues, and requirements to improve drainage. Since the baseline assessment, lead recovery operations were conducted on Ranges C and D in May 2011. Similar maintenance activities are in the planning stages for Range B. According to Range Operations personnel, the funds are in place and the lead recovery is likely to start in the near future.

The hillside, which acts as the rear impact berm for the ranges, and the range floor contain soils characterized as Redding cobbly loam. Visual observations of the exposed impact area noted gravelly and silty sands. As previously mentioned, soils of this group typically are underlain by hardpan, resulting in slow infiltration and low permeability (MCAS Miramar, 2011b). During the site visit, significant vegetation in the form of grass was present on the face of the impact berm and range floor in areas that were not covered with concrete or gravel. Significant vegetation cover on top of and behind the berm also was present. A concrete-lined channel is located on top of the hillside and runs the length of all three ranges. It redirects upland flow away from the face of the berms toward the Murphy Canyon drainage channel located approximately 100 ft west of the firing lines at Ranges B, C, and D. During the site visit, a sediment blockage was observed in the northern-most section of the concrete-lined channel that is allowing some drainage to flow toward the northeastern corner of Range B. An unlined lip sits below this concrete channel; it is gently sloped away from the berm face to further reduce the drainage flowing over the impact berm during precipitation events. Drainage lines also are located within the side berms of these ranges, allowing runoff to flow from Range B to Range C to Range D and then finally to the Murphy Canyon drainage channel. The canyon drains to the southwest and ultimately discharges to the San Diego River, located approximately 3.6 miles south of the installation boundary.

Human receptors for surface water in off-range areas could include persons using Murphy Canyon for noncontact recreational purposes; however, as the drainage typically is dry and there are no specific activities conducted within the drainage on MCAS Miramar, human receptors are likely to be limited. Vernal pools are located near the end of the Murphy Canyon drainage as it approaches the intersection of Interstate 15 and State Route 52. However, these pools are located approximately 400 ft southeast of the drainage, are approximately 80 ft higher in elevation, and are located within the operational footprint of the East Miramar Range Complex. Therefore, there is no potential for off-range exposure to ecological receptors present in these pools. Breeding sites for the California gnatcatcher previously have been noted to the north and west of the range. However, based on its foraging behavior, it is unlikely to consume significant

quantities of water from the drainages near the range. Therefore, exposure to ecological receptors is not anticipated.

Previous studies at MCAS Miramar have shown that groundwater in the region generally is considered to be at a depth of 160 ft bgs, with several locations having perched groundwater at depths between 10 and 30 ft bgs. Groundwater, when present in the alluvial units found in the canyon bottoms, generally is close to the surface. It has been measured at depths between 2 and 10.5 ft. However, this groundwater exists only intermittently after heavy rainfall or after a series of wet years (BEI, 2005b; SCS, 1984; Evenson, 1989; URS, 2005). While the soil types present at the ranges generally are acidic, enhancing the potential for subsurface transport of dissolved lead, a shallow hardpan has been noted in the area of East Miramar, which would restrict significant subsurface migration. In addition, groundwater is not used as water supply in the MCAS Miramar region. Groundwater is not known or suspected to discharge to surface water locations within MCAS Miramar. Therefore, groundwater receptors are not anticipated for these ranges.

7.2.3.2. Assessment Results

Separate SARAP evaluations were completed for each of these ranges (Ranges B, C, and D) for potential off-range release of lead. The evaluations of Ranges B, C, and D all resulted in minimal surface water rankings and minimal groundwater rankings. The baseline evaluations of these ranges all resulted in moderate surface water rankings and minimal groundwater rankings. Despite high lead loading and long periods of use at these ranges, the presence of the partial storm water controls and low precipitation in the region decrease the potential for lead migration from the ranges via surface water. Additionally, human and ecological receptors are unlikely to interact with surface water in off-range areas, further limiting the potential for exposure to lead.

The minimal groundwater rankings for these ranges were based on site conditions, such as low precipitation in the region, depth to groundwater, limited permeability of the soils, and groundwater with neutral pH, which all reduce the potential for groundwater transport of lead. Additionally, there are no receptor exposure points (groundwater wells) identified within these ranges or the surrounding area. As a result of the minimal surface water and groundwater rankings, no further action is required for these ranges at this time. These ranges will be re-evaluated in the next five-year review.

7.2.4. Ranges 5, 6, and 7 and Duffy Town Range (San Diego County Sheriff's Department Ranges)

7.2.4.1. Site Background

The San Diego County Sheriff's Department, under a lease agreement with MCAS Miramar, operates a 43-acre training facility adjacent to Training Area 5. County, state, federal, and local law enforcement agencies and military personnel use the facility for role-play scenarios, for live-

fire training exercises, and to practice rescue training techniques. The four SARs (Ranges 5, 6, 7, and Duffy Town) are located within this facility, directly north of Ranges B, C, and D (**Figure 7-3**). The facility is composed of a dog training facility, an urban disaster training facility, an obstacle course, a mock town (known as Duffy Town) used for tactical training, and administrative buildings (MCAS Miramar, 2011b).

The Sheriff's Department ranges are used heavily (daily training activities are conducted), resulting in significant lead deposition in the impact berm. The ranges are separated by concrete sidewalls. Range 5 is a long, narrow range with 10 firing positions and contains wooden baffling to reduce the allowable angle of fire and to reduce expenditure into the ranges' SDZ. The range floor comprises concrete from the rear firing line to the target area, where it transitions to a gravel base between the target area and impact zone. Range 6 contains 30 firing positions with a gravel floor. Range 7 contains 28 firing positions at distances of 3, 10, 15, 20, and 25 yards. The southern side wall for Range 7 is composed of earthen material. All targets utilized on Ranges 5, 6, and 7 are composed of paper set on wooden frames. The Duffy Town Range is a SAR that facilitates role-play scenario training. It is significantly smaller than the other Sherriff's Department ranges with only approximately 5 to 8 firing positions and features a structural façade on the firing line for role-play simulations. Bullet-capturing targets (steel) were observed at the Duffy Town Range by the REVA team during the site visit. Various types of small arms ammunition are expended at these ranges. During the five-year review period, these ranges had a combined lead loading rate of approximately 9,099 lb/yr (819 lb/yr – Range 5; 1,820 lb/yr – Range 6; 6,370 lb/yr – Range 7; 90 lb/yr – Duffy Town Range).

Ranges 5, 6, and 7 and Duffy Town Range share the same hillside impact berm as Ranges B, C, and D. The hillside contains soils characterized as Redding cobbly loam. Visual observations of the exposed impact area noted gravelly and silty sands. The shallow hardpan also is anticipated to be present at these ranges, which significantly restricts infiltration. The impact area of the hillside berm was heavily saturated with unweathered small arms projectiles; however, no bullet pockets were visible. This is likely due to the lead recovery and berm reconstruction activities that occurred on the Sherriff's Department ranges between November 2010 and April 2011. There is no vegetation on the impact area; grassy vegetation is present on the upper portions of the face of the berm and beyond, within the range SDZ.

Since the baseline assessment, an unlined trench was installed at the foot of the berm that connects across all the Sherriff's Department ranges. It channels runoff from the face of the berm south toward a gravel parking area between Range 7 and Range B, which ultimately drains toward the Murphy Canyon drainage channel. Additionally, the top of the berm is gently sloped away from the range to further reduce the drainage flowing over the impact berm during precipitation events. Floor drains also are present on Ranges 5, 6, and 7, which collect and direct runoff from the range floor toward the Murphy Canyon drainage channel.

Human and ecological receptors for surface water at Ranges 5, 6, and 7 and Duffy Town Range are the same as those described in **Section 7.2.3.1** for Ranges B, C, and D (no significant exposure to human or ecological receptors to lead associated with these ranges is anticipated).

Groundwater characteristics for Ranges 5, 6, and 7 and Duffy Town Range are similar to those previously described for adjacent Ranges B, C, and D. As such, groundwater receptors are not anticipated to be present for these ranges.

7.2.4.2. Assessment Results

Each of the ranges (Ranges 5, 6, 7, and Duffy Town Range) was evaluated separately for potential off-range release of lead. The evaluations of the four ranges all resulted in minimal surface water rankings and minimal groundwater rankings. The baseline evaluations of these ranges all resulted in moderate surface water rankings and minimal groundwater rankings. Reductions in the surface water rankings were due to lead mining activities in the impact berm and installation of improved storm water control measures since the baseline assessment (drainage trench at base of impact berm). These factors, along with low precipitation in the region and a lack of human or ecological receptors in the area, reduce the potential for lead transport through the surface water and contribute to the minimal surface water rankings for these ranges.

The minimal groundwater rankings for these ranges were based on site conditions, such as low precipitation in the region, depth to groundwater, limited permeability of the soils, and groundwater with neutral pH, which all reduce the potential for lead migration through groundwater. Additionally, there are no receptor exposure points identified in the area around these ranges. As a result of the minimal surface water and groundwater rankings, no further action is required for these ranges at this time. These ranges will be re-evaluated in the next five-year review.

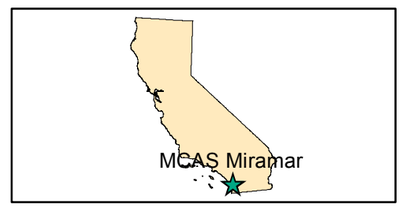
A summary of all the qualitative SAR assessment results for MCAS Miramar is provided in **Table 7-1.**

REVA
Figure 7-3
Ranges 5, 6, 7, and the Duffy Town Range

MCAS Miramar
Miramar, CA

Legend

Murphy Canyon Drainage



0 30 60 120 180
Feet

Date: February 2013

Source: MCAS/EMS GIS Office 2012
GEOFIDELIS 2011

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

Page intentionally blank

Table 7-1: Summary of SAR Assessment Results

Range Name	Annual Lead Use (lb)	Total Surface Water Score	Surface Water Ranking	Total Groundwater Score	Groundwater Ranking
Range 100	8,570	25	Minimal	27	Minimal
Range 101	8,620	24	Minimal	27	Minimal
Range B	3,540	27	Minimal	29	Minimal
Range C	2,025	25	Minimal	27	Minimal
Range D	1,070	25	Minimal	27	Minimal
Range 5	819	20	Minimal	25	Minimal
Range 6	1,820	22	Minimal	27	Minimal
Range 7	6,370	22	Minimal	27	Minimal
Duffy Town Range	90	16	Minimal	23	Minimal

8. References

10 U.S.C. § 101(e) (3). 2006.

Anteon Corporation. 2004. *Integrated Cultural Resources Management Plan for Marine Corps Air Station Miramar, San Diego, California.*

Bechtel Environmental, Incorporated. (BEI). 2002. *Final Site Closure Report Release H80004-021 Tank E-131 Marine Corps Air Station Miramar San Diego California.*

------. 2005a. *Final Site Inspection Report IR Site 18, NEX Gas Station Marine Corps Air Station Miramar San Diego, California.*

------. 2005b. *Letter to San Diego County Re: CTO-056 Soil Boring and Temporary Monitoring Well Installation Submittal IRP Site 10.*

------. 2007. *Final Site Inspection Report IR site 10, Former Sycamore Canyon Atlas Missile Test Facility Marine Corps Air Station Miramar San Diego, California, CTO-005610073-1.*

Bering Sea Eccotech, Inc. (BSE). 2011. *Final Report San Diego Sheriff's Department Small Arms Range Berm Maintenance Project San Diego, California.*

California Department of Transportation (Caltrans). 2006. *Stormwater Pollution Prevention Plan and Water Pollution Control Program Preparation Manual.*

California Department of Water Resources (CDWR). 1967. *Ground Water Occurrence and Quality: San Diego Region.* Volume I: Text. Bulletin No. 106-2.

------. 2004. *California's Groundwater Bulletin 118; Hydrologic Region South Coast*.

California Office of Scientific Affairs, Department of Toxic Substances Control. 1994. *CalTOX™, A Multimedia Total Exposure Model For Hazardous Waste Sites: User's Guide, Prepared by The University of California, Davis in Cooperation with Lawrence Livermore National Laboratory*.

California Regional Water Quality Control Board (CRWQCB) San Diego Region. 1994 (with amendments effective on or before April 4, 2011). *Water Quality Control Plan for the San Diego Basin (9)*.

Defense Ammunition Center (DAC). 2000. Munitions Items Disposition Action System (MIDAS). *Report of Findings for: Study of Ammunition Dud and Low Order Detonation Rates, United States Army Defense Ammunition Center.*

------. 2012 https://midas.dac.army.mil/.

Department of Defense (DoD). 2004. Department of Defense Directive 4715.11. *Environmental and Explosives Safety Management on Operational Ranges within the United States.*

------. 2005. Department of Defense Instruction 4715.14, *Operational Range Assessments*.

Environmental Associates. See The Environmental Associates.

Evenson, Kristin D. 1989. *Water Resources of Soledad, Poway, and Moosa Basins, San Diego County, California*. U.S. Geological Survey. Water Resources Investigations Report 88-4030.

Foster Wheeler Environmental Corporation. 2000. *Final Tank Removal and Corrective Action Report*.

Headquarters Marine Corps (HQMC). 2009. *REVA Reference Manual*.

------. 2010. *Range Environmental Vulnerability Assessment 5-year Review Manual.*

Heaton, Kevin and Bob Giesick. 2002. *Limited Hydrological Study of the Citrus Avenue Watershed, Escondido, California*.

Izbicki, John A. 1985. *Evaluation of the Mission, Santee, and Tijuana hydrologic Subareas for Reclaimed-Water Use, San Diego County, California.* U.S. Geological Survey. Water Resources Investigations Report 85-4032.

Lloyd-Reilly. 1987. *Natural Resource Management Plan for Naval Air Station Miramar.* Western Division, Naval Facility Engineering Command, Dan Bruno, CA.

Mactec Engineering and Consulting Incorporated (MACTEC). 2011. *Storm Water Monitoring Report for Marine Corps Air Station Miramar, San Diego California.*

Malcolm Pirnie, Inc. 2009. *Range Environmental Vulnerability Assessment Marine Corps Air Station Miramar.*

Marine Corps Air Station (MCAS) Miramar. 2007. Presentation on Monthly Average Weather Data.

------. 2011a. *Integrated Cultural Resources Management Plan Update for Marine Corps Air Station Miramar.*

------. 2011b. *Integrated Natural Resources Management Plan for Marine Corps Air Station Miramar, California 2011-2015.*

------. 2012a. Geographic Information System Data.

------. 2012b. *Station Order 3500.2, Range and Training Area Regulations.*

Naval Facilities Engineering Command, Southwest Division (NAVFACSW). 2001. *Environmental Assessment for Proposed Rifle/Pistol Range at Marine Corps Air Station Miramar*.

------. 2011. *Removal Action Closure Report for Installation Restoration Site 10 Former Sycamore Canyon Atlas Missile Test Facility Marine Corps Air Station Miramar San Diego, California.*

OHM Remediation Services Corp. 1997. *Site 75 – Site Specific Report (DEH Release No. H80004-075) Remedial Investigation/Removal Action at Various Underground Storage Tank Sites Naval Air Station Miramar San Diego, California.*

Richie, Col. F.A. Marine Corps Air Station Miramar Range Inventory Correction. Letter. Deputy Commandant of the Marine Corps, Installations and Logistics. 31 Aug. 2009.

SCS Engineers, Inc (SCS). 1984. *Initial Assessment Study Naval Air Station Miramar, San Diego, California*.

SES-TECH. 2011. *Removal Action Closure Report. Interim Non-Time-Critical Removal Action for Installation Restoration Site 10 Former Sycamore Canyon Atlas Missile Test Facility Marine Corps Air Station Miramar San Diego, California*.

SulTech, a Joint Venture of Sullivan Consulting Group and Tetra Tech EM Inc. 2005. *UST Closure Report for Release Site H80004-106, Building 21091 – Marine Corps Air Station Miramar San Diego, California*.

TECOM. See United States Marine Corps Training and Education Command.

The Environmental Associates. 1995. *Environmental Site Assessment "Phase II" Workplan*.

Thornton, C.L. 20 March 2012. Community Plans and Liaison Officer, MCAS Miramar. Personal communication to ARCADIS-Malcolm Pirnie, Incorporated. Subject: Range encroachment.

United States Army Corps of Engineers, St. Louis District (USACE). 2001a. *Archives Search Report for Marine Corps Air Station Miramar, San Diego, California.*

------. 2001b. *Range Identification and Preliminary Range Assessment, Marine Corps Air Station Miramar, San Diego, California.*

United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS). 2007. Soil Survey Geographic (SSURGO) Database for San Diego County, California. http://soildatamart.nrcs.usda.gov. (Accessed 18 December 2011).

United States Marines Corps Training and Education Command (TECOM). 2004. *Section 366 Report Update*.

URS. 2005. *Soil Erosion Inventory, Evaluation, and Erosion Site Mapping for Marine Corps Air Station Miramar, San Diego, California*. Prepared for Environmental Management Department, MCAS Miramar, San Diego, CA. URS Project No. 27654134.00200, San Diego, CA

Ward, A.J. 19 March 2012. Range Management/Control, MCAS Miramar. Personal communication to ARCADIS-Malcolm Pirnie, Incorporated. Subject: range utilization.

Woodward-Clyde Consultants. 1986. *Watershed Erosion and Sedimentation Study, Rose and San Clemente Canyons, City of San Diego, CA.*

------. 1991. *Groundwater Availability Study Naval Air Station Miramar San Diego, California.*

Appendix A

Small Arms Range Assessment Protocol Tables

SMALL ARMS RANGE ASSESSMENT

Appendix Table of Contents

Introduction

The purpose of the Range Environmental Vulnerability Assessment (REVA) is to identify whether there has been a release or there is a substantial threat of a release of munitions constituents (MC) of concern from the operational range or range complex areas to off-range areas. This is accomplished through the use of fate and transport modeling and analysis of the REVA indicator MC based upon site-specific environmental conditions at the operational ranges and training areas at an installation.

Lead is the primary REVA indicator MC for small arms ranges. The fate and transport parameters for lead are based entirely on site-specific geochemical properties, which cannot be determined solely by physical observation. Therefore, small arms ranges associated with the installation are qualitatively reviewed and assessed to identify factors that influence the potential for lead migration at the operational range, including:

- design and layout,
- the physical and chemical characteristics of the area, and
- current and past operation and maintenance practices.

In addition, potential receptors and pathways must be identified relative to the small arms range being assessed. The potential for an identified receptor to be impacted by MC migration through an identified pathway is evaluated.

MC associated with small arms ammunition commonly used at operational ranges include lead, antimony, copper, and zinc. REVA focuses on lead as the MC indicator for small arms ranges because lead is the most prevalent (by weight) potentially hazardous constituent associated with small arms ammunition. No specific quantitative conclusions can be made regarding the fate and transport of lead since it is unlike any other MC. Lead is geochemically specific regarding its mobility in the environment. Site-specific conditions (i.e., geochemical properties) must be known in order to quantitatively assess lead migration. Site-specific geochemical properties are only identified via sampling and cannot be observed physically. Without site-specific physical and chemical characterization, lead cannot effectively be modeled using fate and transport modeling like the other indicator MC in REVA. The scientific community has established that metallic lead (such as recently fired, unweathered bullets and shot) generally has low chemical reactivity and low solubility in water and is relatively inactive in the environment under most ambient or everyday conditions. However, a portion of lead deposited on a range may become environmentally active if the right combination of conditions exists.

This Small Arms Range Assessment Protocol was developed in lieu of collecting site-specific information for every small arms range. The protocol helps to determine which ranges necessitate data collection of site-specific geochemical properties or further assessment based the range's overall prioritization regarding the potential for an identified receptor to be impacted by potential lead migration through an identified pathway.

Purpose

This protocol is to be used for:

1) identifying the small arms ranges within the Marine Corps that have the greatest potential for lead migration and impact to identified receptors, and
2) assessing the need for implementing further actions. Recommended further actions may include, but are not limited to, the following:
    - Sampling surface water, groundwater, and/or soil
    - Conducting additional studies
    - Implementing best management practices (BMPs)

Data Collection and Documentation

The qualitative assessment process for a small arms range involves first defining and documenting its physical and environmental conditions, as well as how the range is utilized and maintained (including dates of use and types and amounts of small arms ammunition expended). The small arms range data collection form within Section 3 of the REVA Reference Manual is a guide to collecting and documenting the necessary information in order to complete the evaluation forms presented later in this protocol (Tables 1 through 6). It includes a comprehensive list of data elements that are useful in establishing the historical and current physical and environmental conditions, as well as capturing the types of information on conditions that influence lead's potential to migrate from the range. The data collection form is organized by major topics or information areas associated with the operational range, including the following:

- Basic range information
- Current range layout
- Current range operations
- Historical range operations
- Amount of lead potentially deposited
- Environmental characteristics
- Potential receptors
- Surrounding land use
- Environmental activities conducted on the range
- Summary

The data collection form in the REVA Reference Manual can be modified, where needed, to fully capture the major factors that potentially can influence lead's ability to migrate from each specific small arms range.

Qualitative Assessment

The small arms range can be qualitatively assessed once the conditions of the range have been fully understood and documented. The assessment process involves a discussion of possible factors that can influence the potential for lead to migrate off range. Several of these factors are listed below, followed by a detailed discussion:

- Range use and range management (source)
- Surface water conditions
- Groundwater and soil conditions
- Pathways
- Receptors

Range Use and Range Management (Source)

The amount of lead and other MC deposited on a range is a combination of the following factors:

- Duration of use
- Current and historical frequency of range usage
- Amount and types of small arms ammunition expended on the range
- Scope and frequency of any range maintenance activities involving the removal of lead from the range
- Presence and duration of bullet-capturing technologies

Surface Water Conditions

Under specific pH conditions, lead from shot or bullets can slowly dissolve in water. Runoff and groundwater recharge could transport this dissolved lead off range. In addition, lead adsorbed onto sediment can be transported off range in surface runoff. The

primary factors influencing the potential for lead to migrate via surface water include, but are not limited to, the following:

- pH of the water
- Duration of water contact with the lead
- Intensity and frequency of rainfall
- Steepness of the slope containing lead
- Amount and type of vegetation on the slope
- Infiltration rate of surface soils
- Presence of engineering controls or BMPs to modify or control surface water runoff

Groundwater and Soil Conditions

The amount of lead that dissolves in water primarily is influenced by the pH of the water and the duration of water contact with the lead. Once lead is dissolved in water, the amount of lead that attaches to the soil and/or enters the groundwater is determined by several factors, including the following:

- Organic carbon content of the soil
- pH of the soil
- Properties of the soil, including porosity, irreducible water content, and hydraulic conductivity
- Amount of recharge percolating through the vadose zone
- Clay content of the soil (lead attaches to clay minerals more than other soil fractions)
- Depth to groundwater

Pathways

The REVA Small Arms Range Assessment Protocol involves developing a conceptual site model (CSM) for the range to identify the range's physical and environmental conditions. The CSM's purpose is to identify if a potential for source-receptor-pathway interaction may exist. Factors that influence the potential for a source-receptor-pathway interaction (e.g., heavy range use, potable water supply wells in proximity to the range),

as well as factors that decrease the potential for such interactions, should be discussed in the assessment.

Potential pathways include:

- groundwater used as a source of potable or agricultural water,
- the use of surface water downstream of a range as a source of potable or agricultural water, and
- the use of the soil, surface water, or groundwater by sensitive species.

Receptors

Receptors in REVA can include on-range and off-range personnel and sensitive species and ecosystem areas. Factors considered when assessing the potentially complete exposure pathways for receptors include, but are not limited to, the following:

- The number and proximity of water supply wells relative to the range
- The characteristics of nearby water supply wells (e.g., depth to groundwater, well construction details)
- The uses of the surface water or groundwater (e.g., agriculture, drinking water)
- The locations of nearby sensitive species areas, such as endangered species habitats (i.e., within proximity to the range)

Small Arms Range Assessment Protocol

This Small Arms Range Assessment Protocol is based on evaluating the potential for exposure to receptors by MC. Evaluation rankings for surface water and groundwater conditions are established for each small arms range. The rankings range between high (indicating the highest potential for lead to migrate toward identified receptors) and minimal (indicating the lowest potential for lead to migrate toward identified receptors). Possible recommended actions are based on the relative evaluation rankings assigned by the protocol. High rankings necessitate further actions. Further actions may included sampling, additional site-specific studies, and/or BMPs. These actions will be evaluated based on site conditions for each range.

Protocol Instructions

1. For Tables 1 through 5, Enter the appropriate score for each criteria in the site score column. Use the highest (i.e., most conservative) value if no information is known to complete the score. A designated score may be overridden if it is determined that the value does not adequately represent the site based on site characteristics and constituent loading estimates. Mark the score column appropriately (*) and fill in the notes section at the bottom of the table with text detailing why the score was adjusted. Sum the site scores in the last row.
2. Transfer the scores from Tables 1 through 5 onto Table 6 in the appropriate rows.
3. Use the scores in Table 6 to determine the surface water and groundwater evaluation rankings.

Evaluation Ranking Designation

Once Table 6 is complete, the protocol finishes with two scores: the sum of surface water elements and the sum of groundwater elements. These scores are used to identify the appropriate evaluation ranking (High, Moderate, Minimal) for surface water and groundwater (as mentioned in step 3 of the protocol instructions).

The surface water evaluation ranking and the groundwater evaluation ranking identify the potential impact for lead migration for each of those pathways at the small arms range. The ranking designations and their descriptions follow:

- High = Small arms range most likely has the potential for lead migration to an identified receptor and requires additional action(s).
- Moderate = Small arms range may have the potential for lead migration to a receptor, most likely indicating that there is no immediate threat to human health and the environment, but actions may be necessary to mitigate future concerns..
- Minimal = Small arms range has minimal or no potential for lead migration, but actions may be necessary to ensure that continuing training activity at the range does not pose a future threat to human health and the environment.

These rankings are used to determine whether additional actions are appropriate. The evaluation ranking (surface water or groundwater), as determined in Table 6, is used to evaluate if further actions are suggested, based on the guidelines for recommended actions (Guidelines for Recommended Actions table, Page C-9).

The overall range evaluation rankings should be compared to each range within the installation and to the overall rankings of all ranges across the Marine Corps. These rankings will assist in determining how funding should best be allocated across the Marine Corps to prevent environmental concerns due to small arms ranges.

Assessment Report

Once the Small Arms Range Assessment Protocol has been completed and appropriate actions have been designated and implemented, the assessment should be written into a report that describes the process taken, details the information used to score Tables 1 through 5, outlines the scores and evaluation rankings, and identifies the additional actions taken. The report should detail whether an identified receptor is or is not impacted by lead migration through the identified pathway(s). The completed protocol tables should be included as an appendix to the report.

Best Management Practices for Small Arms Ranges

BMPs are important for all ranges and should be used appropriately to maintain the sustainability of operational ranges. However, this protocol prioritizes which small arms ranges may need BMPs to address specific possibilities of lead migration.

Following the Small Arms Range Assessment Protocol, BMPs may be recommended based on the evaluation ranking. Prior to selecting and implementing BMPs, the management objectives must be established. Depending on the range-specific site conditions and the management objectives, the following BMPs should be considered:

- Bullet and shot containment techniques (e.g., berms, backstops, traps)
- Prevention of soil erosion from berms, aprons, and other range areas
- Soil amendments
- Recovery and/or recycling of lead

Negative impacts of implementation also should be considered when selecting a BMP. For example, using soil amendments may affect water quality of nearby water bodies or modifying surface water runoff may impact nearby habitats.

The prevention of soil erosion can be achieved by implementing one or several of the following practices:

- Maintaining vegetation on berms and drainageways
- Reducing runoff rates by adjusting site drainage patterns
- Providing sediment traps such as a vegetated detention basin or infiltration area
- Preventing the creation of a "point source"

Soil amendments may be an effective BMP by implementing one or both of the following practices:

- Increasing the retentive capacity of soil by adding organic matter, fertilizer, and/or lime
- Maintaining a pH range between 6 and 8 by adding triple superphosphate, bone meal, or other applicable additives

The recovery and recycling of lead from operational ranges should be considered as a way to control the migration of lead. The following should be considered when implementing recovery and recycling practices:

- Focus on safety as the primary concern of the proposed activities.
- Avoid practices that appear as treatment activities (e.g. acid leaching, fixation, etc.).
- Dispose of lead by using a lead recycler or smelter.
- Use residual soil for the original purpose (e.g. berm/target area soil) following lead recovery practices.

Guidelines for Recommended Actions	
Evaluation Ranking	**Recommended Action**
High	Action required. 1) Consider sampling appropriate media (groundwater, surface water, and/or soil). 2) Identify and implement BMPs, if necessary.
Moderate	1) Consider identifying and implementing BMPs, if necessary. 2) Consider sampling appropriate media (groundwater, surface water, and/or soil).
Minimal	1) No further action is needed at this time. 2) Consider identifying and implementing BMPs, if necessary.

INSTALLATION: MARINE CORPS AIR STATION MIRAMAR
LOCATION: MIRAMAR, CALIFORNIA
RANGE: RANGE 100

ASSESSMENT RESULTS:

The Surface Water Ranking is Minimal. Range conditions presented in the following tables were evaluated using public databases, historical documentation, installation personnel interviews, and field observations made during the site visit. Lead loading is high at Range 100; however, the evaluation indicates a low potential for the off-range migration of lead (low precipitation and presence of storm water controls) and limited or no presence of receptors (no human receptors; limited potential exposure to ecological receptors).

The Groundwater Ranking is Minimal. Site conditions (deep groundwater, low precipitation, presence of hardpan layer, neutral pH) result in a limited potential for groundwater transport. In addition, there are no receptor exposure points (groundwater wells).

MCAS Miramar
Range 100 (Rifle Range)

Table 1: Range Use and Range Management (*Source)* Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Duration of Range Use	Range has been in use since 2004.	5 if usage > 30 years 3 if usage is 10 to 30 years 1 if usage < 10 years	1
Bullet-Capturing Technology	No bullet-capturing technology is present.	-3 if range usage duration = bullet capture duration -1 if range usage duration – bullet capture duration = 10 to 30 years 0 if range usage duration – bullet capture duration > 30 years	0
MC Loading Rates	The lead loading average between 2007 and 2011 was 8,570 pounds/year.	5 if MC loading > 1000 pounds/year 3 if MC loading = 100 to 1000 pounds/year 1 if MC loading < 100 pounds/year	5
Range Maintenance	No lead removal activities have been performed in the last 5 years.	5 if lead is removed less than every 3 years 3 if lead is removed more than every 3 years but less than annually 1 if lead is removed at least annually	5
Source Element Score			11

Note:

Installation personnel interviews, field observations, and expenditure records strongly support the identified scores for this table. This range was constructed 8 years ago; it serves as a primary small arms range for live-fire training for the installation's Marines.

Table 2: Surface Water Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
pH of Water	Measurements at outfalls, performed as part of industrial storm water monitoring at the main base, indicate pH is typically between 6.5 and 8.5, with occasional detections outside of that range.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
Precipitation	Typical precipitation averages approximately 10 inches/year.	5 if precipitation > 40 inches/year 3 if precipitation = 20–40 inches/year 1 if precipitation < 20 inches/year	1
Slope of Range	Two backstop berms are present; both have slope >10%.	5 if slope > 10% 3 if slope = 5% to 10% 1 if slope < 5%	5
Vegetation	The rear impact berm on the range is well vegetated with tall grasses, with the exception of the bullet pockets in the face of the berm; however, this vegetation dries up during the dry season. Little vegetation was observed on the impact berm at the base of the 100-yard firing line, although some grass was present at the foot of the berm. The drainage swale running through the center of the range is densely vegetated with tall grass.	5 if vegetation cover < 20% 3 if vegetation cover = 20% to 50% 1 if vegetation cover > 50%	3
Soil Type / Runoff Conditions	Visual observations indicated gravelly and silty sand across much of the surface of the range. NRCS data describe the soil beneath the firing lanes and berm as primarily Visalia gravelly sandy loam. A shallow hardpan is present across much of MCAS Miramar.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	1
Runoff/ Erosion Engineering Controls	Drainage from the rear impact berm is collected in an unlined area at the foot of the berm and directed toward a drain that flows a short distance to a vegetated ditch that runs the length of the range. Drainage from the 100-yard berm is collected in an unlined area in the northwestern corner of the range. The two impact berms are sloped back to direct drainage away from the berm face.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	-5

Table 2: Surface Water Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)	
Surface Water Pathway Score	6

Note:

According to most sources (MCAS Miramar, 2011; NAVFACSW, 2011), the annual precipitation at MCAS Miramar is approximately 10 inches. Storm water monitoring associated with industrial-linked outfalls at the main (developed) portion of the installation typically has shown pH levels in a neutral range over the last 5 reporting years, with limited, incidental exceptions (NAVFACSW, 2011). No information pertaining to the pH of storm water in East Miramar was identified.

Observed slope of both berms at Range 100 is greater than 10%; the remainder of the range itself is relatively flat. The range is buffered by a taller hillside and berms along its sides, thereby keeping drainage from flowing immediately off the range. Vegetation consisting of grass and weeds is present on both of the berms. Vegetation also is present in a channel that directs surface drainage away from the berm, down the middle of the range.

Visual observations indicated gravelly and silty sand to be present across much of the surface of the range. Varying pieces of rock and cobble were strewn across the range, typically 1 to 2 inches in diameter; a partial gravel cover also was identified on the south side of the range. The MCAS Miramar INRMP report (MCAS Miramar, 2011) indicates the presence of shallow hardpan in the subsurface across much of East Miramar, given it is situated on conglomerated sandstone and cobble formations of Kearny Mesa.

Drainage from the rear impact berm collects in a gently depressed, unlined access road that runs along the foot of the berm. Water that does not infiltrate into the soil flows toward a small drain located at the midpoint of the access road. It subsequently flows down a pipe that runs a short distance west beneath the target line and empties out into a vegetated dry swale that gently slopes to the west end of the range. Additionally, the top of the berm is gently angled so minimal precipitation can drain from the top over the berm face. There is also a concrete-lined diversion along the southern boundary of the range that catches drainage from upland reaches, redirects it west across the top of the Pistol Range (Range 101), and discharges into the main drainage of San Clemente Canyon. Along with the vegetative cover on and along the lower portion of the berm, these controls minimize the amount of runoff and run-on that is exposed to embedded expenditures and creates opportunities for any suspended lead particles to settle;therefore, they are considered effective engineering controls.

Drainage from the 100-yard berm face flows down the face of the berm toward the target line. Water that does not infiltrate into the soil flows northwest to a drain located at the northwestern corner of the range adjacent to the end of the 500-yard firing line. Additionally, the face and the foot of the 100-yard berm has little vegetative cover.

The vegetation was rated a 3 for this range as it is not consistent throughout the year. During certain months, the vegetative cover decreases significantly as it dries up.

Note:
INRMP =
NRCS =

Table 3: Groundwater Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Depth to Groundwater	Previous studies at the installation suggest regional groundwater is approximately 160 feet below ground surface. Shallow perched water is known to exist at some locations; an assessment for this range indicated groundwater may be found approximately 10 feet below the surface.	5 if depth to groundwater < 20 feet 3 if depth to groundwater = 20–99 feet 1 if depth to groundwater = 100–300 feet 0 if depth to groundwater > 300 feet	1
Precipitation	Typical precipitation averages approximately 10 inches/year.	5 if precipitation > 40 inches/year 3 if precipitation = 20–40 inches/year 1 if precipitation < 20 inches/year	1
pH of Water	The average pH in groundwater monitoring wells at the installation is between 7.2 and 7.6.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
pH of Soil	Visalia gravelly sandy loam is described as "slightly acidic," from 6.3 to 6.5 pH, in NRCS soil descriptions.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
Soil Type / Infiltration Conditions	While observations and NRCS data suggest surface soil may be somewhat permeable, a shallow hardpan is present across much of MCAS Miramar; it is expected to greatly restrict infiltration to deep soil.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Clay Content in Soil	Visual observations indicated gravelly and silty sand across much of the surface of the range. Visalia soils contain little, if any, clay to which lead can adsorb.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	5
Groundwater Pathway Score			10

Table 3: Groundwater Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Note:

Recent investigations found regional groundwater to be approximately 160 feet below ground surface (BEI, 2007); perched groundwater has been encountered at several locations approximately 10 to 30 feet below ground surface. The environmental assessment prepared for this range suggests that groundwater may be found approximately 10 feet below ground surface (NAVFACSW, 2001).

Several reports document pH levels in all wells sampled ranged from 6.5 to 7.6 (Woodward Clyde, 1991; Evenson, 1989; CDWR, 1967). Only one well from 52 sampled near MCAS Miramar reported a pH of 6.5. The average pH in these wells is between 7.2 and 7.6.

The NRCS soil series description of the Visalia gravelly sandy loam describes several soil layers that are "slightly acidic" (NRCS, 1973). pH range was listed between 6.3 and 6.5. No other data sources were found describing soil pH. The soil series description does not indicate clay is a component of these soils.

Table 4: Surface Water Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Drinking Water Usage	The range is immediately adjacent to San Clemente Canyon, an ephemeral stream drainage. These waters are not used as a drinking water source on or off the installation.	10 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has a reasonable potential to move toward a surface water body used as a potable water supply or if a designation as a potable water source is unknown 5 if contamination in the media has moved or is expected to move only slightly beyond the source (tens of feet) or could move, but is not moving appreciably, toward surface water body used as a potable water supply or if a designation as a potable water source is unknown 2 if low possibility for contamination in the media to be present at or migrate to a point of exposure	2
Agricultural or Other Beneficial Usage	No agricultural activities are noted within the immediate vicinity of East Miramar. Agricultural operations may border the westernmost side of the installation.	5 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has moved to a point of exposure or if a designation as agricultural or other beneficial usage is unknown 3 if contamination in the media has moved only slightly beyond the source (tens of feet) or could move but is not moving appreciably 1 if low possibility for contamination in the media to be present at or migrate to a point of exposure	1
Sensitive Species Habitat and Threatened or Endangered Species	Vernal pools and associated species are 4 miles from the range and isolated from drainage areas. Coastal sage scrub habitat has been noted near the range, as well as the California gnatcatcher, willowy monardella, and Del Mar manzanita. However, exposure to dissolved lead in runoff is likely to be limited.	10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary 5 if potential for receptors to have access to possibly contaminated media 1 if little or no potential for receptors to have access to possible contaminated media	5
Surface Water Receptor Score			8

Table 4: Surface Water Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)
Note: All water is supplied by the City of San Diego (MCAS Miramar, 2011). None of the ephemeral streams are utilized as a potable water source. Agricultural activities are not evident in the areas immediately surrounding East Miramar. Vernal pools within or immediately adjacent to the San Clemente Canyon are located 4 miles downstream of the range; these vernal pools are hydrologically isolated wetlands that only receive water from direct precipitation or runoff from their immediate surrounding area. No contact with runoff potentially containing lead is anticipated. Del Mar manzanita, willowy monardella, and coastal sage scrub habitat have been observed near the range. These vegetative communities are unlikely to come into contact with water in the San Clemente Canyon drainages. A California gnatcatcher breeding site previously had been noted approximately 1,000 feet to the west (MCAS Miramar, 2011). However, the primary source of water for the gnatcatcher is its diet (e.g., insects, fruit), and it is not likely to consume significant quantities of water from the drainages near the range.

Table 5: Groundwater Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Wells Identified as Potable Water Sources	No groundwater wells exist at the installation. There are no known production wells within 1 mile of East Miramar.	10 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure or if a designation as a potable water source is unknown 5 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably 2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure	2
Wells Identified for Agricultural or Other Beneficial Usage	There are no known production wells within 1 mile of East Miramar.	5 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure or if a designation as agricultural or other beneficial usage is unknown 3 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably 1 if low possibility for MC to be present at or migrate to within a reasonable radius of influence of a well or point of exposure	1
Sensitive Species Habitat and Threatened and Endangered Species	Sensitive habitat and species have been noted near the range; however, there are no known springs in the area.	5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources 3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources 1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources	3
Groundwater Receptor Score			6

Table 5: Groundwater Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)
Note: There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar, 2011). Installation personnel are not aware of any production wells within 1 mile of the installation. Vernal pools may be found in East Miramar, notably within its westernmost regions. Del Mar manzanita, willowy monardella, and coastal sage scrub habitat has been observed near the range; a California gnatcatcher breeding site previously had been noted approximately 2,500 feet to the west (MCAS Miramar, 2011). The environmental assessment prepared for this range suggests that groundwater may be found approximately 10 feet below ground surface (NAVFACSW, 2001). However, there are no known groundwater discharge locations near the range.

Table 6: Evaluation Results
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Surface Water		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	11
Surface Water Pathways	2	6
Surface Water Receptors	4	8
Sum of Surface Water Element Scores		**25**

Groundwater		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	11
Groundwater Pathways	3	10
Groundwater Receptors	5	6
Sum of Groundwater Element Scores		**27**

The evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media:

Evaluation Ranking*	Score Range
High	50-65
Moderate	30-49
Minimal	0-29

*Use the Evaluation Ranking to determine if further actions are warranted based on the guidelines for recommended actions, as defined in Table 7.

Surface Water Evaluation Ranking	**MINIMAL**
Groundwater Evaluation Ranking	**MINIMAL**

Note:

INSTALLATION: MARINE CORPS AIR STATION MIRAMAR
LOCATION: MIRAMAR, CALIFORNIA
RANGE: RANGE 101

ASSESSMENT RESULTS:

The Surface Water Ranking is Minimal. Range conditions presented in the following tables were evaluated using public databases, historical documentation, installation personnel interviews, and field observations made during the site visit. Lead loading is high at Range 101; however, the evaluation indicates a low potential for the off-range migration of lead (low precipitation and presence of storm water controls) and limited or no presence of receptors (no human receptors; limited potential exposure to ecological receptors).

The Groundwater Ranking is Minimal. Site conditions (deep groundwater, low precipitation, presence of hardpan layer, neutral pH) result in a limited potential for groundwater transport. In addition, there are no receptor exposure points (groundwater wells).

MCAS Miramar
Range 101 (Pistol Range)

Table 1: Range Use and Range Management (*Source)* Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Duration of Range Use	Use has been from January 2007 to present.	5 if usage > 30 years 3 if usage is 10 to 30 years 1 if usage < 10 years	1
Bullet-Capturing Technology	Other than a soil berm, no bullet-capturing technology was noted by installation personnel or observed by REVA team.	-3 if range usage duration = bullet capture duration -1 if range usage duration – bullet capture duration = 10 to 30 years 0 if range usage duration – bullet capture duration > 30 years	0
MC Loading Rates	The lead loading average between 2007 and 2011 was 8,620 pounds/year.	5 if MC loading > 1000 pounds/year 3 if MC loading = 100 to 1000 pounds/year 1 if MC loading < 100 pounds/year	5
Range Maintenance	No lead removal activities were performed in the last 5 years.	5 if lead is removed less than every three years 3 if lead is removed more than every three years but less than annually 1 if lead is removed at least annually	5
Source Element Score			11

Notes:

Installation personnel interviews, field observations, and expenditure records strongly support the identified scores for this table. This range was constructed in 2006 and was activated in January of 2007. It serves as a primary small arms range for live-fire training for the installation's Marines.

Table 2: Surface Water Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
pH of Water	Measurements at outfalls, performed as part of industrial storm water monitoring at the main base, indicate pH is typically between 6.5 and 8.5, with occasional detections outside of that range.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
Precipitation	Typical precipitation averages approximately 10 inches/year.	5 if precipitation > 40 inches/year 3 if precipitation = 20-40 inches/year 1 if precipitation < 20 inches/year	1
Slope of Range	Berm is cut from a hillside; its slope is greater than 10%. The interior of the range itself is relatively flat.	5 if slope > 10% 3 if slope = 5% to 10% 1 if slope < 5%	5
Vegetation	Very little vegetation was present across the berm or range; there is no vegetated area on the range itself receiving drainage. Some light vegetation exists in drainage outfall to the west.	5 if vegetation cover < 20% 3 if vegetation cover = 20% to 50% 1 if vegetation cover > 50%	5
Soil Type/Runoff Conditions	Visual observations noted silty sand across the surface of the berm. Much of the range floor is covered with a thick layer of gravel fill to facilitate drainage. NRCS data describe the soil beneath the firing lines and berm as Redding cobbly loam with some Visalia gravelly sandy loam. A shallow hardpan is believed to exist across much of MCAS Miramar.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	3
Runoff/ Erosion Engineering Controls	Drainage from the berm is collected at a drain that runs beneath the firing lines, ultimately discharging into a short yet thick layer of riprap before reaching the fence of the range complex. During the site visit, this control was observed to be blocked by eroded sediment, causing water to pool between the berm and target stand. Additionally, a concrete-lined channel runs high above the visible bullet pickets in the berm, redirecting upland flow away from the berm. There are several layers of silt fence installed in the face of the berm above the bullet pockets to reduce erosion at the top of the berm.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	-10

Table 2: Surface Water Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Surface Water Pathway Score			5

Notes:

Most sources list the annual precipitation as approximately 10 inches per year (MCAS Miramar, 2011; NAVFACSW, 2011). Storm water monitoring associated with industrial-linked outfalls at the main (developed) portion of the installation typically have shown pH levels in a neutral range over the last 5 reporting years, with limited, incidental exceptions (NAVFACSW, 2011). No information pertaining to the pH of storm water in East Miramar was identified.

Observed slope of the berm is greater than 10%; the remainder of the range itself is relatively flat. The berm and range are cut into a natural hillside. Sparse vegetation was noted on the range.

Visual observation noted silty sand across much of the surface of the berm; the surface of the firing lines is largely covered with gravel to facilitate drainage. The MCAS Mirmar INRMP indicates the presence of shallow hardpan in the subsurface across much of East Miramar, given it is situated on conglomerated sandstone and cobble formations of Kearny Mesa (MCAS Miramar, 2011).

A small, grated drain at the foot of the impact area collects drainage from the berm. This drain runs beneath the gravel-covered firing lines to a discharge on the western side of the range; this discharge is intercepted by a short but thick run of cobble-sized riprap prior to flowing beyond the fence and the adjacent road. Range personnel note that this drain at the foot of the berm usually works as designed, though it occasionally backs up with excessive sedimentation, a condition that was observed during the REVA site visit. There is also a concrete-lined diversion along the top of the berm that catches drainage from upland reaches and redirects it around the range, thereby preventing additional flow and erosion of bullet pockets. Together, it is anticipated that these controls minimize the amount of runoff that is exposed to embedded expenditures and create opportunities for any suspended lead particles to settle; therefore, they are considered effective engineering controls.

Table 3: Groundwater Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Depth to Groundwater	Previous studies at the installation suggest regional groundwater is approximately 160 feet below ground surface. However, shallow perched water is known to exist at some locations; an assessment for this range indicated groundwater may be found approximately 10 feet below the surface.	5 if depth to groundwater < 20 feet 3 if depth to groundwater = 20-99 feet 1 if depth to groundwater = 100-300 feet 0 if depth to groundwater >300 feet	1
Precipitation	Typical precipitation averages approximately 10 inches/year.	5 if precipitation > 40 inches/year 3 if precipitation = 20-40 inches/year 1 if precipitation < 20 inches/year	1
pH of Water	The average pH in groundwater monitoring wells at the installation is between 7.2 and 7.6.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
pH of Soil	The Redding series soil ranges from extremely (pH 4.2) to medium acidic (pH 5.8). Visalia gravelly sandy loam is described as slightly acidic, from 6.3 to 6.5 pH.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	5
Soil Type/Infiltration Conditions	While observations and NRCS data suggest surface soil may be somewhat permeable, a shallow hardpan (30 inches) generally is present in Redding series soils; it is expected to greatly restrict infiltration to deep soil.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Clay Content in Soil	Visual observations indicated gravelly and silty sand across much of the surface of the range. The Redding series, the dominant soil type at this range, contains a large amount of clay.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Groundwater Pathway Score			10

Notes:

Recent investigations found regional groundwater to be approximately 160 feet below ground surface (BEI, 2007); perched groundwater has been encountered at several locations approximately 10 to 30 feet below ground surface. The environmental assessment prepared for the adjacent range 100 suggests that groundwater may be found approximately 10 feet below ground surface (NAVFACSW, 2001).

Several reports document that pH levels in all wells sampled ranged from 6.5 to 7.6 (Woodward Clyde, 1991; Evenson, 1989; CDWR, 1967). Only one well from 52 sampled near MCAS Miramar reported a pH of 6.5. The average pH in these wells is between 7.2 and 7.6.

The rear impact berm, set in a steep hillside, mostly consists of Redding cobbly loam (15%–50% slopes). This soil series is very acidic, ranging from 4.2 to 5.8. The soil series contains gravelly heavy clay loam and gravelly clay from 15 to 30 inches, with an iron-silica cemented hardpan beneath (NRCS, 1973).

Table 4: Surface Water Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Drinking Water Usage	A number of ephemeral streams are present in the canyons that traverse the installation; this range is immediately adjacent to San Clemente Canyon. These waters are not used as a drinking water source on or off the installation.	10 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has a reasonable potential to move toward a surface water body used as a potable water supply or if a designation as a potable water source is unknown 5 if contamination in the media has moved or is expected to move only slightly beyond the source (tens of feet) or could move, but is not moving appreciably, toward surface water body used as a potable water supply or if a designation as a potable water source is unknown 2 if low possibility for contamination in the media to be present at or migrate to a point of exposure	2
Agricultural or Other Beneficial Usage	No agricultural activities are noted near East Miramar. Agricultural operations may abut the westernmost side of the installation.	5 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has moved to a point of exposure or if a designation as agricultural or other beneficial usage is unknown 3 if contamination in the media has moved only slightly beyond the source (tens of feet) or could move but is not moving appreciably. 1 if low possibility for contamination in the media to be present at or migrate to a point of exposure	1
Sensitive Species Habitat and Threatened or Endangered Species	Vernal pools and associated species are 4 miles from range and isolated from drainage areas. Coastal sage scrub habitat has been noted near the range as well as the California gnatcatcher, willowy monardella, and Del Mar manzanita. However, exposure to dissolved lead in runoff is likely to be limited.	10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary 5 if potential for receptors to have access to possibly contaminated media 1 if little or no potential for receptors to have access to possible contaminated media	5

Table 4: Surface Water Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)	
Surface Water Receptor Score	8

Notes:

All water is supplied by the City of San Diego (MCAS Miramar, 2011). None of the ephemeral streams are utilized as a potable water source.

Agricultural activities are not evident in the areas immediately surrounding East Miramar.

Vernal pools within or immediately adjacent to the San Clemente Canyon are located 4 miles downstream of the range; these vernal pools are hydrologically isolated wetlands that only receive water from direct precipitation or runoff from their immediate surrounding area. No contact with runoff potentially containing lead is anticipated. Del Mar manzanita, willowy monardella, and coastal sage scrub habitat have been observed near the range. These vegetative communities are unlikely to come into contact with water in the San Clemente Canyon drainages. A California gnatcatcher breeding site previously had been noted approximately 1,000 feet to the west (MCAS Miramar, 2011). However, the primary source of water for the gnatcatcher is its diet (e.g., insects, fruit) and is not likely to consume significant quantities of water from the drainages near the range.

Table 5: Groundwater Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Wells Identified as Potable Water Sources	No groundwater wells exist at the installation. There are no known production wells within 1 mile of East Miramar.	10 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure or if a designation as a potable water source is unknown 5 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably 2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure	2
Wells Identified for Agricultural or Other Beneficial Usage	There are no known production wells within 1 mile of East Miramar.	5 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure or if a designation as agricultural or other beneficial usage is unknown 3 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably 1 if low possibility for MC to be present at or migrate to within a reasonable radius of influence of a well or point of exposure	1
Sensitive Species Habitat and Threatened and Endangered Species	Sensitive habitat and species have been noted near the range; however, there are no known springs in the area.	5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources 3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources 1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources	3
Groundwater Receptor Score			6

Table 5: Groundwater Receptors Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar, 2011). Installation personnel are not aware of any production wells within 1 mile of the installation.

Vernal pools may be found in East Miramar, notably within its westernmost regions. Del Mar manzanita, willowy monardella, and coastal sage scrub habitat has been observed near the range; a California gnatcatcher breeding site previously has been noted approximately 2,500 feet to the west (MCAS Miramar, 2011).

The environmental assessment prepared for this range suggests that groundwater may be found approximately 10 feet below ground surface (NAVFACSW, 2001). However, there are no known groundwater discharge locations near the range.

Table 6: Evaluation Results
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Surface Water		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	11
Surface Water Pathways	2	5
Surface Water Receptors	4	8
Sum of Surface Water Element Scores		**24**

Groundwater		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	11
Groundwater Pathways	3	10
Groundwater Receptors	5	6
Sum of Groundwater Element Scores		**27**

The evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media:

Evaluation Ranking*	Score Range
High	50-65
Moderate	30-49
Minimal	0-29

*Use the Evaluation Ranking to determine if further actions are warranted based on the guidelines for recommended actions, as defined in Table 7.

Surface Water Evaluation Ranking	**MINIMAL**
Groundwater Evaluation Ranking	**MINIMAL**

Notes:

INSTALLATION: **MARINE CORPS AIR STATION MIRAMAR**
LOCATION: **MIRAMAR, CALIFORNIA**
RANGE: **Small Arms Range B**

ASSESSMENT RESULTS:

The Surface Water Ranking is Minimal. Range conditions presented in the following tables were evaluated using public databases, historical documentation, installation personnel interviews, and field observations made during the site visit. Lead loading is high at this range and, based on the evaluation, only partial engineering controls exist for surface water. However, site characteristics indicate low potential for the off-range migration of lead (low precipitation and partial storm water controls) and limited or no presence of receptors (no human receptors; limited potential exposure to ecological receptors).

The Groundwater Ranking is Minimal. Site conditions (deep groundwater, low precipitation, presence of hardpan layer, neutral pH) result in a limited potential for groundwater transport. In addition, there are no receptor exposure points (groundwater wells).

MCAS Miramar
Small Arms Range B

Table 1: Range Use and Range Management (*Source)* Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Duration of Range Use	Unknown; initial use occurred some time during Navy administration of the installation (from 1952 to 1997).	5 if usage > 30 years 3 if usage is 10 to 30 years 1 if usage < 10 years	5
Bullet-Capturing Technology	Other than the soil berm, no bullet-capturing technology was noted by installation personnel or observed by REVA team.	-3 if range usage duration = bullet capture duration -1 if range usage duration – bullet capture duration = 10 to 30 years 0 if range usage duration – bullet capture duration > 30 years	0
MC Loading Rates	The lead loading average between 2007 and 2011 was 3,540 pounds/year.	5 if MC loading > 1000 pounds/year 3 if MC loading = 100 to 1000 pounds/year 1 if MC loading < 100 pounds/year	5
Range Maintenance	No lead removal activities have occurred. Plans to conduct lead removal activities in the near future are in place.	5 if lead is removed less than every three years 3 if lead is removed more than every three years but less than annually 1 if lead is removed at least annually	5
Source Element Score			15

Notes:

The ranges originally were installed during Navy administration of the installation (1952 to 1997), but an exact date is not known. It is unknown if bullet-capturing technology has ever been used at this range; none was observed during the REVA five-year review site visit.

Range-specific yearly expenditure counts were provided by MCAS Miramar Range Operations personnel for January 2007 to March 2012. Since January of 2007, Range B is estimated to have received 3,540 pounds of lead per year. Visual observations during the REVA site visit noted small arms projectiles throughout the berm. Information regarding historical lead removal activities was not available; installation personnel are in the planning stages for lead removal activities for Range B in the near future.

Table 2: Surface Water Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Table 2: Surface Water Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
pH of Water	Measurements at outfalls, performed as part of industrial storm water monitoring at the main base, indicate pH is typically between 6.5 and 8.5, with occasional detections outside of that range.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
Precipitation	Typical precipitation averages approximately 10 inches/year.	5 if precipitation > 40 inches/year 3 if precipitation = 20-40 inches/year 1 if precipitation < 20 inches/year	1
Slope of Range	Berm is cut from a hillside; its slope is greater than 10%. The interior of the range itself is relatively flat.	5 if slope > 10% 3 if slope = 5% to 10% 1 if slope < 5%	5
Vegetation	Grass was observed across the face of the berm and range floor where not covered with concrete or gravel. Vegetative cover on top of and behind the berm was significant. This vegetation typically is dry or dead during the dry season; thus, vegetation coverage is not consistent year-round.	5 if vegetation cover < 20% 3 if vegetation cover = 20% to 50% 1 if vegetation cover > 50%	3
Soil Type/Runoff Conditions	Visual observations noted gravelly and silty sand across the range. NRCS data describe the soil comprising the rear impact berms as Redding cobbly loam. A shallow hardpan is believed to exist across much of MCAS Miramar.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	3
Runoff/ Erosion Engineering Controls	A concrete-lined channel runs above the range to redirect upland drainage away from the berm. An unlined lip below this channel is sloped away from the range to further limit drainage from reaching the berm. Range B has wooden baffling to help limit expenditure into the ranges' surface danger zone (SDZ). There are also drain lines in the side berms that allow drainage to flow from Range B to Range C, from Range C to Range D, and from Range D to the Murphy Canyon ephemeral stream.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	-5
Surface Water Pathway Score			8

Table 2: Surface Water Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

According to most sources, the annual precipitation at MCAS Miramar is approximately 10 inches (MCAS Miramar, 2011; NAVFACSW, 2011). Storm water monitoring associated with industrial-linked outfalls at the main (developed) portion of the installation typically have shown pH levels in a neutral range over the last 5 reporting years, with limited, incidental exceptions (NAVFACSW, 2011). No information pertaining to the pH of storm water in East Miramar was identified.

Observed slope of the berm is greater than 10%; the remainder of the range is relatively flat. The berm and range are cut into a natural hillside. A natural ephemeral drainage runs on the opposite (west) side of the access road behind the range firing line; this drainage generally follows surface topography as it drains to the south-southeast. Grassy vegetation was present across this range during the REVA team site visit as it was conducted during the wet season. The actual overall vegetation coverage is judged to be moderate on this range considering that it gets severely dried out and, in some cases, dies during the dry season.

Visual observations noted gravelly and silty sand across much of the range. Shallow borings at a former underground storage tank (UST) site just under 0.25 miles northwest of the range indicate the presence of sandy silts with gravel, underlain by well-cemented conglomerate (OHM, 1997). The presence of shallow hardpan in the subsurface has been recorded across much of East Miramar, given it is situated on conglomerated sandstone and cobble formations of Kearny Mesa (MCAS Miramar, 2011).

There is a continuous, concrete-lined channel that runs along the top of the berm; it is situated to capture upland drainage and direct it away from the impact area on the berm. During the REVA team site visit, a sediment blockage was observed in the northernmost section of the concrete-lined channel that was allowing some drainage to flow toward the northeastern corner of Range B. An unlined lip rests just below this concrete channel; it slopes away from the range to further prevent drainage from reaching the berm. There are also drain lines located in the side berms shared by Ranges B, C, and D that direct drainage down gradient toward the Murphy Canyon ephemeral stream. Additionally, Range B has wooden overhead baffling to reduce expenditure into the ranges' SDZ. Together, these controls may offer partial control of lead migration from this range.

Table 3: Groundwater Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Depth to Groundwater	Previous studies at the installation suggest regional groundwater is approximately 160 feet below ground surface. Shallow perched water is known to exist in some locations.	5 if depth to groundwater < 20 feet 3 if depth to groundwater = 20-99 feet 1 if depth to groundwater = 100-300 feet 0 if depth to groundwater >300 feet	1
Precipitation	Typical precipitation averages approximately 10 inches/year.	5 if precipitation > 40 inches/year 3 if precipitation = 20-40 inches/year 1 if precipitation < 20 inches/year	1
pH of Water	The average pH in groundwater monitoring wells at the installation is between 7.2 and 7.6.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
pH of Soil	The Redding series soil ranges from extremely (pH 4.2) to medium acidic (pH 5.8).	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	5
Soil Type/Infiltration Conditions	While observations and NRCS data suggest surface soil may be somewhat permeable, a shallow hardpan generally is believed to exist across much of MCAS Miramar; it is expected to greatly restrict infiltration to deep soil	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Clay Content in Soil	Visual observations indicated gravelly and silty sand across much of the surface of the range. The Redding series, the dominant soil type at this range, contains a large amount of clay.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Groundwater Pathway Score			10

Table 3: Groundwater Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

Recent investigations found regional groundwater to be approximately 160 feet below ground surface (BEI, 2007); perched groundwater has been encountered at several locations approximately 10 to 30 feet below ground surface.

Several reports report that pH levels in all wells sampled ranged from 6.5 to 7.6 (Woodward Clyde, 1991; Evenson, 1989; CDWR, 1967). Only one well from 52 sampled near MCAS Miramar reported a pH of 6.5. The average pH in these wells is between 7.2 and 7.6.

The rear impact berm, set in a hillside, mostly consists of Redding cobbly loam (9%–30% slopes). This soil series is very acidic, ranging in pH from 4.2 to 5.8. The soil series contains gravelly heavy clay loam and gravelly clay from 15 to 30 inches, with an iron-silica cemented hardpan beneath (NRCS, 1973).

Table 4: Surface Water Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Drinking Water Usage	A number of ephemeral streams are present in the canyons that traverse the installation; this range is located in Murphy Canyon. These waters are not used as a drinking water source on or off the installation.	10 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has a reasonable potential to move toward a surface water body used as a potable water supply or if a designation as a potable water source is unknown 5 if contamination in the media has moved or is expected to move only slightly beyond the source (tens of feet) or could move, but is not moving appreciably, toward surface water body used as a potable water supply or if a designation as a potable water source is unknown 2 if low possibility for contamination in the media to be present at or migrate to a point of exposure	2
Agricultural or Other Beneficial Usage	No agricultural activities are noted near East Miramar. Agricultural operations may abut the westernmost side of the installation.	5 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has moved to a point of exposure or if a designation as agricultural or other beneficial usage is unknown 3 if contamination in the media has moved only slightly beyond the source (tens of feet) or could move but is not moving appreciably. 1 if low possibility for contamination in the media to be present at or migrate to a point of exposure	1
Sensitive Species Habitat and Threatened or Endangered Species	Vernal pools and associated species are present in drainage leading from range areas, but are isolated. Coastal sage scrub habitat and California gnatcatcher also have been noted. These habitats and species have been identified to the north and west of the range. However, exposure to lead in runoff is likely to be limited.	10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary 5 if potential for receptors to have access to possibly contaminated media 1 if little or no potential for receptors to have access to possible contaminated media	1
Surface Water Receptor Score			4

Table 4: Surface Water Receptors Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

All water is supplied by the City of San Diego (MCAS Miramar, 2011). None of the ephemeral streams are utilized as a potable water source.

Agricultural activities are not evident in the areas immediately surrounding East Miramar.

Vernal pools are located near the end of the Murphy Canyon drainage as it approaches the intersection of Interstate 15 and State Route 52. However, these pools are located approximately 400 feet southeast of the drainage, are approximately 80 feet higher in elevation, and are located within the operational footprint of the East Miramar Range Complex. Therefore, there is no potential for off-range exposure to ecological receptors present in these pools. Breeding sites for the California gnatcatcher previously have been noted to the north and west of the range (MCAS Miramar, 2011). However, the primary source of water for the gnatcatcher is its diet (e.g., insects, fruit), and it is not likely to consume significant quantities of water from the drainages near the range. Therefore, exposures to ecological receptors are likely to be limited.

Table 5: Groundwater Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Wells Identified as Potable Water Sources	No groundwater wells exist at the installation. There are no known production wells within 1 mile of East Miramar.	10 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure or if a designation as a potable water source is unknown 5 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably 2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure	2
Wells Identified for Agricultural or Other Beneficial Usage	There are no known production wells within 1 mile of East Miramar.	5 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure or if a designation as agricultural or other beneficial usage is unknown 3 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably 1 if low possibility for MC to be present at or migrate to within a reasonable radius of influence of a well or point of exposure	1
Sensitive Species Habitat and Threatened and Endangered Species	Vernal pools, coastal sage scrub, and associated species (including the California gnatcatcher) have been noted to the north and west of this range. However, there are no known springs in the area.	5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources 3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources 1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources	1
Groundwater Receptor Score			4

Table 5: Groundwater Receptors Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar, 2011). Installation personnel are not aware of any production wells within 1 mile of the installation.

Vernal pools may be found in East Miramar, notably within its westernmost regions. They previously have been identified near this range, approximately 0.2 miles to the west and 0.4 miles to the northeast. Vernal marsh and coastal sage scrub habitats have been observed near the range; California gnatcatcher breeding sites have also been noted to the north and west of this range (MCAS Miramar, 2011).

There are no known groundwater discharge locations near the range.

Table 6: Evaluation Results
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Surface Water		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	15
Surface Water Pathways	2	8
Surface Water Receptors	4	4
Sum of Surface Water Element Scores		**27**

Groundwater		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	15
Groundwater Pathways	3	10
Groundwater Receptors	5	4
Sum of Groundwater Element Scores		**29**

The evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media:

Evaluation Ranking*	Score Range
High	50-65
Moderate	30-49
Minimal	0-29

*Use the Evaluation Ranking to determine if further actions are warranted based on the guidelines for recommended actions, as defined in Table 7.

Surface Water Evaluation Ranking	**MINIMAL**
Groundwater Evaluation Ranking	**MINIMAL**

Notes:

INSTALLATION: MARINE CORPS AIR STATION MIRAMAR
LOCATION: MIRAMAR, CALIFORNIA
RANGE: Small Arms Range C

ASSESSMENT RESULTS:

The Surface Water Ranking is Minimal. Range conditions presented in the following tables were evaluated using public databases, historical documentation, installation personnel interviews, and field observations made during the site visit. Lead loading is high at this range and, based on the evaluation, only partial engineering controls exist for surface water. However, site characteristic indicate low potential for the off-range migration of lead (low precipitation and partial storm water controls) and limited or no presence of receptors (no human receptors; limited potential exposure to ecological receptors).

The Groundwater Ranking is Minimal. Site conditions (deep groundwater, low precipitation, presence of hardpan layer, neutral pH) result in a limited potential for groundwater transport. In addition, there are no receptor exposure points (groundwater wells).

MCAS Miramar
Small Arms Range C

Table 1: Range Use and Range Management (*Source)* Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Duration of Range Use	Unknown; initial use occurred some time during Navy administration of the installation (from 1952 to 1997).	5 if usage > 30 years 3 if usage is 10 to 30 years 1 if usage < 10 years	5
Bullet-Capturing Technology	Other than the soil bern, no bullet-capturing technology noted by installation personnel or observed by REVA team.	-3 if range usage duration = bullet capture duration -1 if range usage duration – bullet capture duration = 10 to 30 years 0 if range usage duration – bullet capture duration > 30 years	0
MC Loading Rates	The lead loading average between 2007 and 2011 was 2,025 pounds/year.	5 if MC loading > 1000 pounds/year 3 if MC loading = 100 to 1000 pounds/year 1 if MC loading < 100 pounds/year	5
Range Maintenance	Lead removal activities occurred in May 2011. These activities are conducted on an as-needed basis.	5 if lead is removed less than every three years 3 if lead is removed more than every three years but less than annually 1 if lead is removed at least annually	3*
Source Element Score			13

Notes:

The ranges originally were installed during Navy administration of the installation (1952 to 1997), but an exact date is not known. It is unknown if bullet-capturing technology has ever been used at this range; none was observed during the REVA five-year review site visit.

Range-specific yearly expenditure counts were provided by MCAS Miramar Range Operations personnel for January 2007 to March 2012. Since January of 2007, Range C is estimated to have received 2,025 pounds of lead per year. Lead removal activities were conducted at Range C in May 2011 and will be conducted in the future on an as-needed basis.

*The Range Maintenance factor of the Range Use and Range Management (Source) Element in the SARAP evaluation typically is evaluated on the basis of frequency. Despite the lack of a formal scheduling of lead removal activities for this range, due to the recent lead removal conducted there, it is appropriate to score the range as a 3 during this review period. This score will be reevaluated during the next five-year review period.

Table 2: Surface Water Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
pH of Water	Measurements at outfalls, performed as part of industrial storm water monitoring at the main base, indicate pH is typically between 6.5 and 8.5, with occasional detections outside of that range.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
Precipitation	Typical precipitation averages approximately 10 inches/year.	5 if precipitation > 40 inches/year 3 if precipitation = 20-40 inches/year 1 if precipitation < 20 inches/year	1
Slope of Range	Berm is cut from a hillside; its slope is greater than 10%. The interior of the range itself is relatively flat.	5 if slope > 10% 3 if slope = 5% to 10% 1 if slope < 5%	5
Vegetation	Sparse grass was observed across the face of the berm and range floor. Vegetative cover on top of and behind the berm was significant. This vegetation typically is dry or dead during the dry season; thus, the vegetation coverage is not consistent year round.	5 if vegetation cover < 20% 3 if vegetation cover = 20% to 50% 1 if vegetation cover > 50%	3
Soil Type/Runoff Conditions	Visual observations noted gravelly and silty sand across the range. NRCS data describe the soil comprising the rear impact berms as Redding cobbly loam. A shallow hardpan is believed to exist across much of MCAS Miramar.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	3
Runoff/ Erosion Engineering Controls	A concrete-lined channel runs above the range to redirect upland drainage away from the berm. An unlined lip below this channel is sloped away from the range to further limit drainage from reaching the berm. There are also drain lines located in the side berms shared by Ranges B, C, and D that direct drainage down gradient toward the Murphy Canyon ephemeral stream.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	-5
Surface Water Pathway Score			8

Table 2: Surface Water Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

According to most sources, the annual precipitation at MCAS Miramar is approximately 10 inches (MCAS Miramar, 2011; NAVFACSW, 2011). Storm water monitoring associated with industrial-linked outfalls at the main (developed) portion of the installation typically have shown pH levels in a neutral range over the last 5 reporting years, with limited, incidental exceptions (NAVFACSW, 2011). No information pertaining to the pH of storm water in East Miramar was identified.

Observed slope of the berm is greater than 10%; the remainder of the range is relatively flat. The berm and range are cut into a natural hillside. A natural ephemeral drainage runs on the opposite (west) side of the access road behind the range firing line; this drainage generally follows surface topography as it drains to the south-southeast. Sparse grassy vegetation was present across this range during the REVA team site visit, as it was conducted during the wet season. The actual overall vegetation coverage is judged to be moderate on this range considering that it gets severely dried out and, in some cases, dies during the dry season.

Visual observations noted gravelly and silty sand across much of the range. Shallow borings at a former UST site just under 0.25 miles northwest of the range indicate the presence of sandy silts with gravel, underlain by well-cemented conglomerate (OHM, 1997). The presence of shallow hardpan in the subsurface has been observed across much of East Miramar, given it is situated on conglomerated sandstone and cobble formations of Kearny Mesa (MCAS Miramar, 2011).

There is a continuous, concrete-lined channel that runs along the top of the berm; it is situated to capture upland drainage and direct it away from the impact area on the berm. An unlined lip rests just below this concrete channel; it slopes away from the range to further prevent drainage from reaching the berm. Additionally, there also are drain lines located in the side berms shared by Ranges B, C, and D that direct drainage down gradient toward the Murphy Canyon ephemeral stream. Together, these controls offer partial control of lead migration from this range.

Table 3: Groundwater Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Depth to Groundwater	Previous studies at the installation suggest regional groundwater is approximately 160 feet below ground surface. Shallow perched water is known to exist in some locations.	5 if depth to groundwater < 20 feet 3 if depth to groundwater = 20-99 feet 1 if depth to groundwater = 100-300 feet 0 if depth to groundwater >300 feet	1
Precipitation	Typical precipitation averages approximately 10 inches/year.	5 if precipitation > 40 inches/year 3 if precipitation = 20-40 inches/year 1 if precipitation < 20 inches/year	1
pH of Water	The average pH in groundwater monitoring wells at the installation is between 7.2 and 7.6.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
pH of Soil	The Redding series soil ranges from extremely (pH 4.2) to medium acidic (pH 5.8).	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	5
Soil Type/Infiltration Conditions	While observations and NRCS data suggest surface soil may be somewhat permeable, a shallow hardpan generally is believed to exist across much of MCAS Miramar; it is expected to greatly restrict infiltration to deep soil.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Clay Content in Soil	Visual observations indicated gravelly and silty sand across much of the surface of the range. The Redding series, the dominant soil type at this range, contains a large amount of clay.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Groundwater Pathway Score			10

Table 3: Groundwater Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

Recent investigations found regional groundwater to be approximately 160 feet below ground surface (BEI, 2007); perched groundwater has been encountered at several locations approximately 10 to 30 feet below ground surface.

Several reports document that pH levels in all wells sampled ranged from 6.5 to 7.6 (Woodward Clyde, 1991; Evenson, 1989; CDWR, 1967). Only one well from 52 sampled near MCAS Miramar reported a pH of 6.5. The average pH in these wells is between 7.2 and 7.6.

The rear impact berm, set in a hillside, mostly consists of Redding cobbly loam (9%–30% slopes). This soil series is very acidic, ranging in pH from 4.2 to 5.8. The soil series contains gravelly heavy clay loam and gravelly clay from 15 to 30 inches, with an iron-silica cemented hardpan beneath (NRCS, 1973).

Table 4: Surface Water Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Drinking Water Usage	A number of ephemeral streams are present in the canyons that traverse the installation; this range is located in Murphy Canyon. These waters are not used as a drinking water source on or off the installation.	10 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has a reasonable potential to move toward a surface water body used as a potable water supply or if a designation as a potable water source is unknown 5 if contamination in the media has moved or is expected to move only slightly beyond the source (tens of feet) or could move, but is not moving appreciably, toward surface water body used as a potable water supply or if a designation as a potable water source is unknown 2 if low possibility for contamination in the media to be present at or migrate to a point of exposure	2
Agricultural or Other Beneficial Usage	No agricultural activities are noted near East Miramar. Agricultural operations may abut the westernmost side of the installation.	5 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has moved to a point of exposure or if a designation as agricultural or other beneficial usage is unknown 3 if contamination in the media has moved only slightly beyond the source (tens of feet) or could move but is not moving appreciably. 1 if low possibility for contamination in the media to be present at or migrate to a point of exposure	1
Sensitive Species Habitat and Threatened or Endangered Species	Vernal pools and associated species are present in drainage leading from range areas but are isolated. Coastal sage scrub habitat and California gnatcatcher also have been noted. These habitats and species have been identified to the north and west of the range. However, exposure to dissolved lead in runoff is likely to be limited.	10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary 5 if potential for receptors to have access to possibly contaminated media 1 if little or no potential for receptors to have access to possible contaminated media	1
Surface Water Receptor Score			4

Table 4: Surface Water Receptors Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

All water is supplied by the City of San Diego (MCAS Miramar, 2011). None of the ephemeral streams are utilized as a potable water source.

Agricultural activities are not evident in the areas immediately surrounding East Miramar.

Vernal pools are located near the end of the Murphy Canyon drainage as it approaches the intersection of Interstate 15 and State Route 52. However, these pools are located approximately 400 feet southeast of the drainage, are approximately 80 feet higher in elevation, and are located within the operational footprint of the East Miramar Range Complex. Therefore, there is no potential for off-range exposure to ecological receptors present in these pools. Breeding sites for the California gnatcatcher previously have been noted to the north and west of the range (MCAS Miramar, 2011). However, the primary source of water for the gnatcatcher is its diet (e.g., insects, fruit), and it is not likely to consume significant quantities of water from the drainages near the range. Therefore, exposures to ecological receptors are likely to be limited.

Table 5: Groundwater Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Wells Identified as Potable Water Sources	No groundwater wells exist at the installation. There are no known production wells within 1 mile of East Miramar.	10 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure or if a designation as a potable water source is unknown 5 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably 2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure	2
Wells Identified for Agricultural or Other Beneficial Usage	There are no known production wells within 1 mile of East Miramar.	5 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure or if a designation as agricultural or other beneficial usage is unknown 3 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably 1 if low possibility for MC to be present at or migrate to within a reasonable radius of influence of a well or point of exposure	1
Sensitive Species Habitat and Threatened and Endangered Species	Vernal pools, coastal sage scrub, and associated species (including the California gnatcatcher) have been noted to the north and west of this range. However, there are no known springs in the area.	5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources 3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources 1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources	1
Groundwater Receptor Score			4

Table 5: Groundwater Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)
Notes: There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar, 2011). Installation personnel are not aware of any production wells within 1 mile of the installation. Vernal pools may be found in East Miramar, notably within its westernmost regions. They previously have been identified near this range, approximately 0.2 miles to the west and 0.4 miles to the northeast. Vernal marsh and coastal sage scrub habitats have been observed near the range; California gnatcatcher breeding sites also have been noted to the north and west of this range (MCAS Miramar, 2011). There are no known groundwater discharge locations near the range.

Table 6: Evaluation Results
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Surface Water		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	13
Surface Water Pathways	2	8
Surface Water Receptors	4	4
Sum of Surface Water Element Scores		**25**

Groundwater		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	13
Groundwater Pathways	3	10
Groundwater Receptors	5	4
Sum of Groundwater Element Scores		**27**

The evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media:

Evaluation Ranking*	Score Range
High	50-65
Moderate	30-49
Minimal	0-29

*Use the Evaluation Ranking to determine if further actions are warranted based on the guidelines for recommended actions, as defined in Table 7.

Surface Water Evaluation Ranking	**MINIMAL**
Groundwater Evaluation Ranking	**MINIMAL**

Notes:

INSTALLATION: MARINE CORPS AIR STATION MIRAMAR
LOCATION: MIRAMAR, CALIFORNIA
RANGE: Small Arms Range D

ASSESSMENT RESULTS:

The Surface Water Ranking is Minimal. Range conditions presented in the following tables were evaluated using public databases, historical documentation, installation personnel interviews, and field observations made during the site visit. Lead loading is high at this range and, based on the evaluation, only partial engineering controls exist for surface water. However, site characteristic indicate low potential for the off-range migration of lead (low precipitation and partial storm water controls) and limited or no presence of receptors (no human receptors; limited potential exposure to ecological receptors).

The Groundwater Ranking is Minimal. Site conditions (deep groundwater, low precipitation, presence of hardpan layer, neutral pH) result in a limited potential for groundwater transport. In addition, there are no receptor exposure points (groundwater wells).

MCAS Miramar
Small Arms Range D

Table 1: Range Use and Range Management (*Source)* Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Duration of Range Use	Unknown; initial use occurred some time during Navy administration of the installation (from 1952 to 1997).	5 if usage > 30 years 3 if usage is 10 to 30 years 1 if usage < 10 years	5
Bullet-Capturing Technology	Other than the soil berm, no bullet-capturing technology noted by installation personnel or observed by REVA team.	-3 if range usage duration = bullet capture duration -1 if range usage duration – bullet capture duration = 10 to 30 years 0 if range usage duration – bullet capture duration > 30 years	0
MC Loading Rates	The lead loading average between 2007 and 2011 is 1,070 pounds/year.	5 if MC loading > 1000 pounds/year 3 if MC loading = 100 to 1000 pounds/year 1 if MC loading < 100 pounds/year	5
Range Maintenance	Lead removal activities occurred in May 2011. These activities are conducted on an as-needed basis.	5 if lead is removed less than every three years 3 if lead is removed more than every three years but less than annually 1 if lead is removed at least annually	3*
Source Element Score			13

Notes:

The ranges originally were installed during Navy administration of the installation (1952 to 1997), but an exact date is not known. It is unknown if any bullet-capturing technology has ever been used at this range; none was observed during the REVA five-year review site visit.

Range-specific yearly expenditure counts were provided by MCAS Miramar Range Operations personnel for January 2007 to March 2012. Since January of 2007, Range C is estimated to have received 1,070 pounds of lead per year.

Lead removal activities were conducted at Range D in May 2011 and will be conducted in the future on an as-needed basis.

*The Range Maintenance factor of the Range Use and Range Management (Source) Element in the SARAP evaluation typically is evaluated on the basis of frequency. Despite the lack of a formal scheduling of lead removal activities for this range, due to the recent lead removal conducted there, it is appropriate to score the range as a 3 during this review period. This score will be reevaluated during the next 5-year review period.

Table 2: Surface Water Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
pH of Water	Measurements at outfalls, performed as part of industrial storm water monitoring at the main base, indicate pH is typically between 6.5 and 8.5, with occasional detections outside of that range.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
Precipitation	Typical precipitation averages approximately 10 inches/year.	5 if precipitation > 40 inches/year 3 if precipitation = 20-40 inches/year 1 if precipitation < 20 inches/year	1
Slope of Range	Berm is cut from a hillside; its slope is greater than 10%. The interior of the range itself is relatively flat.	5 if slope > 10% 3 if slope = 5% to 10% 1 if slope < 5%	5
Vegetation	Grassy vegetation was observed across the face of the berm and range floor. Vegetative cover on top of and behind the berm was significant. This vegetation typically is dry or dead during the dry season; thus, the vegetation coverage is not consistent year round.	5 if vegetation cover < 20% 3 if vegetation cover = 20% to 50% 1 if vegetation cover > 50%	3
Soil Type/Runoff Conditions	Visual observations noted gravelly and silty sand across the range. NRCS data describes the soil comprising the rear impact berms as Redding cobbly loam. A shallow hardpan is believed to exist across much of MCAS Miramar.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	3
Runoff/ Erosion Engineering Controls	A concrete-lined channel runs above the range to redirect upland drainage away from the berm. An unlined lip below this channel is sloped away from the range to further limit drainage from reaching the berm. There are also drain lines located in the side berms shared by Ranges B, C, and D that direct drainage down gradient toward the Murphy Canyon ephemeral stream.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	-5
Surface Water Pathway Score			8

Table 2: Surface Water Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

According to most sources, the annual precipitation at MCAS Miramar is approximately 10 inches (MCAS Miramar, 2011; NAVFACSW, 2011). Storm water monitoring associated with industrial-linked outfalls at the main (developed) portion of the installation typically have shown pH levels in a neutral range over the last 5 reporting years, with limited, incidental exceptions (NAVFACSW, 2011). No information pertaining to the pH of storm water in East Miramar was identified.

Observed slope of the berm is greater than 10%; the remainder of the range is relatively flat. The berm and range are cut into a natural hillside. A natural ephemeral drainage runs on the opposite (west) side of the access road behind the range firing line; this drainage generally follows surface topography as it drains to the south-southeast. Sparse grassy vegetation was present across this range during the REVA team site visit as it was conducted during the wet season. The actual overall vegetation coverage is judged to be moderate on this range considering that it gets severely dried out and, in some cases, dies during the dry season.

Visual observations noted gravelly and silty sand across much of the range. Shallow borings at a former UST site just under 0.25 miles northwest of the range indicate the presence of sandy silts with gravel, underlain by well-cemented conglomerate (OHM, 1997). The presence of shallow hardpan in the subsurface has been observed across much of East Miramar, given it is situated on conglomerated sandstone and cobble formations of Kearny Mesa (MCAS Miramar, 2011).

There is a continuous, concrete-lined channel that runs along the top of the berm that is situated to capture upland drainage and direct it away from the impact area on the berm. An unlined lip rests just below this concrete channel; it slopes away from the range to further prevent drainage from reaching the berm. Additionally, there are also drain lines located in the side berms shared by Ranges B, C, and D that direct drainage down gradient toward the Murphy Canyon ephemeral stream. Together, these controls offer partial control of lead migration from this range.

Table 3: Groundwater Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Depth to Groundwater	Previous studies at the installation suggest regional groundwater is approximately 160 feet below ground surface. Shallow perched water is known to exist in some locations.	5 if depth to groundwater < 20 feet 3 if depth to groundwater = 20-99 feet 1 if depth to groundwater = 100-300 feet 0 if depth to groundwater >300 feet	1
Precipitation	Typical precipitation averages approximately 10 inches/year.	5 if precipitation > 40 inches/year 3 if precipitation = 20-40 inches/year 1 if precipitation < 20 inches/year	1
pH of Water	The average pH in groundwater monitoring wells at the installation is between 7.2 and 7.6.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
pH of Soil	The Redding series soil ranges from extremely (pH 4.2) to medium acidic (pH 5.8).	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	5
Soil Type/Infiltration Conditions	While observations and NRCS data suggest surface soil may be somewhat permeable, a shallow hardpan is generally believed to exist across much of MCAS Miramar; it is expected to greatly restrict infiltration to deep soil.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Clay Content in Soil	Visual observations indicated gravelly and silty sand across much of the surface of the range. The Redding series, the dominant soil type at this range, contains a large amount of clay.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Groundwater Pathway Score			10

Table 3: Groundwater Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

Recent investigations found regional groundwater to be approximately 160 feet below ground surface (BEI, 2007); perched groundwater has been encountered at several locations approximately 10 to 30 feet below ground surface.

Several reports report that pH levels in all wells sampled ranged from 6.5 to 7.6 (Woodward Clyde, 1991; Evenson, 1989; CDWR, 1967). Only one well from 52 sampled near MCAS Miramar reported a pH of 6.5. The average pH in these wells is between 7.2 and 7.6.

The rear impact berm, set in a hillside, mostly consists of Redding cobbly loam (9%–30% slopes). This soil series is very acidic, ranging in pH from 4.2 to 5.8. The soil series contains gravelly heavy clay loam and gravelly clay from 15 to 30 inches, with an iron-silica cemented hardpan beneath (NRCS, 1973).

Table 4: Surface Water Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Drinking Water Usage	A number of ephemeral streams are present in the canyons that traverse the installation; this range is located in Murphy Canyon. These waters are not used as a drinking water source on or off the installation.	10 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has a reasonable potential to move toward a surface water body used as a potable water supply or if a designation as a potable water source is unknown 5 if contamination in the media has moved or is expected to move only slightly beyond the source (tens of feet) or could move, but is not moving appreciably, toward surface water body used as a potable water supply or if a designation as a potable water source is unknown 2 if low possibility for contamination in the media to be present at or migrate to a point of exposure	2
Agricultural or Other Beneficial Usage	No agricultural activities are noted near East Miramar. Agricultural operations may abut the westernmost side of the installation.	5 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has moved to a point of exposure or if a designation as agricultural or other beneficial usage is unknown 3 if contamination in the media has moved only slightly beyond the source (tens of feet) or could move but is not moving appreciably. 1 if low possibility for contamination in the media to be present at or migrate to a point of exposure	1
Sensitive Species Habitat and Threatened or Endangered Species	Vernal pools and associated species are present in drainage leading from range areas but are isolated. Coastal sage scrub habitat and California gnatcatcher also have been noted. These habitats and species have been identified to the north and west of the range. However, exposure to dissolved lead in runoff is likely to be limited.	10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary 5 if potential for receptors to have access to possibly contaminated media 1 if little or no potential for receptors to have access to possible contaminated media	1
Surface Water Receptor Score			4

Table 4: Surface Water Receptors Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

All water is supplied by the City of San Diego (MCAS Miramar, 2011). None of the ephemeral streams are utilized as a potable water source.

Agricultural activities are not evident in the areas immediately surrounding East Miramar.

Vernal pools are located near the end of the Murphy Canyon drainage as it approaches the intersection of Interstate 15 and State Route 52. However, these pools are located approximately 400 feet southeast of the drainage, are approximately 80 feet higher in elevation, and are located within the operational footprint of the East Miramar Range Complex. Therefore, there is no potential for off-range exposure to ecological receptors present in these pools. Breeding sites for the California gnatcatcher previously have been noted to the north and west of the range (MCAS Miramar, 2011). However, the primary source of water for the gnatcatcher is its diet (e.g., insects, fruit), and it is not likely to consume significant quantities of water from the drainages near the range. Therefore, exposures to ecological receptors are likely to be limited.

Table 5: Groundwater Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Wells Identified as Potable Water Sources	No groundwater wells exist at the installation. There are no known production wells within 1 mile of East Miramar.	10 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure or if a designation as a potable water source is unknown 5 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably 2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure	2
Wells Identified for Agricultural or Other Beneficial Usage	There are no known production wells within 1 mile of East Miramar.	5 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure or if a designation as agricultural or other beneficial usage is unknown 3 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably 1 if low possibility for MC to be present at or migrate to within a reasonable radius of influence of a well or point of exposure	1
Sensitive Species Habitat and Threatened and Endangered Species	Vernal pools, coastal sage scrub, and associated species (including the California gnatcatcher) have been noted to the north and west of this range. However, there are no known springs in the area.	5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources 3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources 1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources	1
Groundwater Receptor Score			4

Table 5: Groundwater Receptors Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar, 2011). Installation personnel are not aware of any production wells within 1 mile of the installation.

Vernal pools may be found in East Miramar, notably within its westernmost regions. They previously have been identified near this range, approximately 0.2 miles to the west and 0.4 miles to the northeast. Vernal marsh and coastal sage scrub habitats have been observed within proximity of the range; California gnatcatcher breeding sites also have been noted to the north and west of this range (MCAS Miramar, 2011).

There are no known groundwater discharge locations near the range.

Table 6: Evaluation Results
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Surface Water		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	13
Surface Water Pathways	2	8
Surface Water Receptors	4	4
Sum of Surface Water Element Scores		**25**

Groundwater		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	13
Groundwater Pathways	3	10
Groundwater Receptors	5	4
Sum of Groundwater Element Scores		**27**

The evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media:

Evaluation Ranking*	Score Range
High	50-65
Moderate	30-49
Minimal	0-29

*Use the Evaluation Ranking to determine if further actions are warranted based on the guidelines for recommended actions, as defined in Table 7.

Surface Water Evaluation Ranking	**MINIMAL**
Groundwater Evaluation Ranking	**MINIMAL**

Notes:

INSTALLATION: MARINE CORPS AIR STATION MIRAMAR
LOCATION: MIRAMAR, CALIFORNIA
RANGE: Sheriff's Department Range 5

ASSESSMENT RESULTS:

The Surface Water Ranking is Minimal. Range conditions presented in the following tables were evaluated using public databases, historical documentation, installation personnel interviews, and field observations made during the site visit. Lead loading is moderate at Range 5; however, the evaluation indicates a low potential for the off-range migration of lead (low precipitation and presence of storm water controls) and limited or no presence of receptors (no human receptors; limited potential exposure to ecological receptors).

The Groundwater Ranking is Minimal. Site conditions (deep groundwater, low precipitation, presence of hardpan layer, neutral pH) result in a limited potential for groundwater transport. In addition, there are no receptor exposure points (groundwater wells).

MCAS Miramar
Sheriff's Department Range 5

Table 1: Range Use and Range Management (*Source)* Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Duration of Range Use	Unknown; initial use occurred some time during Navy administration of the installation (from 1952 to 1997).	5 if usage > 30 years 3 if usage is 10 to 30 years 1 if usage < 10 years	5
Bullet-Capturing Technology	Other than the soil berm, no bullet-capturing technology noted by installation personnel or observed by REVA team.	-3 if range usage duration = bullet capture duration -1 if range usage duration – bullet capture duration = 10 to 30 years 0 if range usage duration – bullet capture duration > 30 years	0
MC Loading Rates	The lead loading average between 2007 and 2011 is 819 pounds/year.	5 if MC loading > 1000 pounds/year 3 if MC loading = 100 to 1000 pounds/year 1 if MC loading < 100 pounds/year	3
Range Maintenance	Lead removal activities were conducted November 2010 – April 2011 and are conducted on an as-needed basis.	5 if lead is removed less than every three years 3 if lead is removed more than every three years but less than annually 1 if lead is removed at least annually	3*
Source Element Score			11

Table 1: Range Use and Range Management (*Source)* Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

The ranges originally were installed during Navy administration of the installation (1952 to 1997), but an exact date is not known. It is not known when the County Sheriff began leasing this range, though it is known they held a 2-year lease in 1995 on Ranges 5, 6, and 7. No bullet-capturing technology (e.g., bullet trap) was observed during the REVA five-year review site visit.

Yearly expenditure counts were provided by MCAS Miramar Range Operations personnel for January 2007 to March 2012. These data were presented as a total expenditure count from Ranges 5, 6, 7, and the Duffy Town Range. According to Sheriff's Department personnel, the distribution of range usage is as follows: 70% of expenditures at Range 7, 20% of expenditures at Range 6, 9% of expenditures at Range 5, and 1% of expenditures at the Duffy Town Range. Since January of 2007, Range 5 is estimated to have received 820 pounds of lead per year. Note that a single earthen berm is used for bullet containment on all four ranges.

Lead removal activities at this (and other Sheriff's Department ranges) were conducted between November 2010 and April 2011. There is no formal scheduling of these activities, as they are conducted on an as-needed basis.

*The Range Maintenance factor of the Range Use and Range Management (Source) Element in the SARAP evaluation typically is evaluated on the basis of frequency. Despite the lack of a formal scheduling of lead removal activities for this range, due to the recent lead removal conducted there, it is appropriate to score the range as a 3 during this review period. This score will be reevaluated during the next 5-year review period.

Table 2: Surface Water Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
pH of Water	Measurements at outfalls, performed as part of industrial storm water monitoring at the main base, indicate pH is typically between 6.5 and 8.5, with occasional detections outside of that range.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
Precipitation	Typical precipitation averages approximately 10 inches/year.	5 if precipitation > 40 inches/year 3 if precipitation = 20-40 inches/year 1 if precipitation < 20 inches/year	1
Slope of Range	Berm is cut from a hillside; its slope is greater than 10%. The interior of the range itself is relatively flat.	5 if slope > 10% 3 if slope = 5% to 10% 1 if slope < 5%	5
Vegetation	Some vegetation was noted on the face of the berm as well as on top of and behind it. This vegetation typically is dry or dead during the dry season; thus, the score for vegetation coverage is high.	5 if vegetation cover < 20% 3 if vegetation cover = 20% to 50% 1 if vegetation cover > 50%	5
Soil Type/Runoff Conditions	Visual observations noted gravelly and silty sand across the range. NRCS data describe the soil comprising the rear impact berms as Redding cobbly loam. A shallow hardpan is believed to exist across much of MCAS Miramar.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	3
Runoff/ Erosion Engineering Controls	Drains at the base of the sidewalls and other surface water control measures are present including an unlined trench at the foot of the berm to channel water south toward gravel parking lot between Range 7 and Range B. Range 5 has baffling to help limit expenditures into the ranges' SDZ. The ground surface immediately behind the top of the berm is sloped away from the range to further limit drainage from reaching the face of the berm.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	-10
Surface Water Pathway Score			5

Table 2: Surface Water Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

According to most sources, the annual precipitation at MCAS Miramar is approximately 10 inches (MCAS Miramar, 2011; NAVFACSW, 2011). Storm water monitoring associated with industrial-linked outfalls at the main (developed) portion of the installation typically shown pH levels in a neutral range over the last five reporting years, with limited, incidental exceptions (NAVFACSW, 2011). No information pertaining to the pH of storm water in East Miramar was identified.

Observed slope of the berm is greater than 10%; the remainder of the range is relatively flat. The berm and range are cut into the same natural hillside as Ranges B, C, and D. A natural ephemeral drainage runs on the opposite (west) side of the access road behind the range firing line; this drainage generally follows surface topography as it drains to the south-southeast. Some vegetation was noted on this range during the REVA five year review site visit, however, most of it is typically dry or dead during the dry season.

Visual observations noted gravelly and silty sand across much of the range. Shallow borings at a former UST site just under ¼ miles northwest of the range indicated the presence of sandy silts with gravel, underlain by well-cemented conglomerate (OHM, 1997). The MCAS Miramar INRMP indicates the presence of shallow hardpan in the subsurface across much of East Miramar, given it is situated on conglomerated sandstone and cobble formations of Kearny Mesa (MCAS Miramar, 2011). During the lead removal activities conducted at this range, soil composed primarily of sand was brought in to replace the volume extracted from the berm in the form of cobbles and projectiles. In this case, the soil type/runoff conditions were still given an intermediate score as there was no information indicating if the soil was mixed with the soil extracted from the berm prior to the reconstruction or simply applied as a layer to the berm's surface.

Drains are present at the corners of the range floor to collect and direct runoff to the drainage channel west of the firing points. Since the baseline assessment, the Sheriff's Department has installed an unlined drainage trench at the foot of the shared berm across the Duffy Town Range, Range 5, Range 6, and Range 7, which drains south toward the parking lot that separates Range 7 and Range B. Additionally, Range 5 has overhead baffling to reduce expenditure into the ranges' SDZ. Together, these controls offer effective control of lead migration from this range.

Table 3: Groundwater Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Depth to Groundwater	Previous studies at the installation suggest regional groundwater is approximately 160 feet below ground surface. Shallow perched water is known to exist in some locations.	5 if depth to groundwater < 20 feet 3 if depth to groundwater = 20-99 feet 1 if depth to groundwater = 100-300 feet 0 if depth to groundwater >300 feet	1
Precipitation	Typical precipitation averages approximately 10 inches/year.	5 if precipitation > 40 inches/year 3 if precipitation = 20-40 inches/year 1 if precipitation < 20 inches/year	1
pH of Water	The average pH in groundwater monitoring wells at the installation is between 7.2 and 7.6.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
pH of Soil	The Redding series soil ranges from extremely (pH 4.2) to medium acidic (pH 5.8).	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	5
Soil Type/Infiltration Conditions	While observations and NRCS data suggest surface soil may be somewhat permeable, a shallow hardpan generally is believed to exist across much of MCAS Miramar; it is expected to greatly restrict infiltration to deep soil.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Clay Content in Soil	Visual observations indicated gravelly and silty sand across much of the surface of the range. The Redding series, the dominant soil type at this range, contains a large amount of clay.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Groundwater Pathway Score			10

Table 3: Groundwater Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

Recent investigations found regional groundwater to be approximately 160 feet below ground surface (BEI, 2007); perched groundwater has been encountered at several locations approximately 10 to 30 feet below ground surface.

Several reports report that pH levels in all wells sampled ranged from 6.5 to 7.6 (Woodward Clyde, 1991; Evenson, 1989; CDWR, 1967). Only one well from 52 sampled near MCAS Miramar reported a pH of 6.5. The average pH in these wells is between 7.2 and 7.6.

The rear impact berm, set in a hillside, mostly consists of Redding cobbly loam (9%–30% slopes). This soil series is very acidic, ranging in pH from 4.2 to 5.8. The soil series contains gravelly heavy clay loam and gravelly clay from 15 to 30 inches, with an iron-silica cemented hardpan beneath (NRCS, 1973).

Table 4: Surface Water Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Drinking Water Usage	A number of ephemeral streams are present in the canyons that traverse the installation; this range is located in Murphy Canyon. These waters are not used as a drinking water source on or off the installation.	10 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has a reasonable potential to move toward a surface water body used as a potable water supply or if a designation as a potable water source is unknown 5 if contamination in the media has moved or is expected to move only slightly beyond the source (tens of feet) or could move, but is not moving appreciably, toward surface water body used as a potable water supply or if a designation as a potable water source is unknown 2 if low possibility for contamination in the media to be present at or migrate to a point of exposure	2
Agricultural or Other Beneficial Usage	No agricultural activities are noted near East Miramar. Agricultural operations may abut the westernmost side of the installation.	5 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has moved to a point of exposure or if a designation as agricultural or other beneficial usage is unknown 3 if contamination in the media has moved only slightly beyond the source (tens of feet) or could move but is not moving appreciably. 1 if low possibility for contamination in the media to be present at or migrate to a point of exposure	1
Sensitive Species Habitat and Threatened or Endangered Species	Vernal pools and associated species are present in drainage leading from range area, but are isolated. Coastal sage scrub habitat and California gnatcatcher also have been noted. These habitats and species have been identified to the north and west of the range. However, exposure to lead in runoff is likely to be limited.	10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary 5 if potential for receptors to have access to possibly contaminated media 1 if little or no potential for receptors to have access to possible contaminated media	1
Surface Water Receptor Score			4

Table 4: Surface Water Receptors Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

All water is supplied by the City of San Diego (MCAS Miramar, 2011). None of the ephemeral streams are utilized as a potable water source.

Agricultural activities are not evident in the areas immediately surrounding East Miramar.

Vernal pools are located near the end of the Murphy Canyon drainage as it approaches the intersection of Interstate 15 and State Route 52. However, these pools are located approximately 400 feet southeast of the drainage, are approximately 80 feet higher in elevation, and are located within the operational footprint of the East Miramar Range Complex. Therefore, there is no potential for off-range exposure to ecological receptors present in these pools. Breeding sites for the California gnatcatcher previously have been noted to the north and west of the range (MCAS Miramar, 2011). However, the primary source of water for the gnatcatcher is its diet (e.g., insects, fruit), and it is not likely to consume significant quantities of water from the drainages near the range. Therefore, exposures to ecological receptors are likely to be limited.

Table 5: Groundwater Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Wells Identified as Potable Water Sources	No groundwater wells exist at the installation. There are no known production wells within 1 mile of East Miramar.	10 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure or if a designation as a potable water source is unknown 5 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably 2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure	2
Wells Identified for Agricultural or Other Beneficial Usage	There are no known production wells within 1 mile of East Miramar.	5 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure or if a designation as agricultural or other beneficial usage is unknown 3 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably 1 if low possibility for MC to be present at or migrate to within a reasonable radius of influence of a well or point of exposure	1
Sensitive Species Habitat and Threatened and Endangered Species	Vernal pools, coastal sage scrub, and associated species (including the California gnatcatcher) have been noted to the north and west of this range. However, there are no known springs in the area.	5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources 3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources 1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources	1
Groundwater Receptor Score			4

Table 5: Groundwater Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)
Notes: There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar, 2011). Installation personnel are not aware of any production wells within 1 mile of the installation. Vernal pools may be found in East Miramar, notably within its westernmost regions. They have been previously identified near this range, approximately 0.2 miles to the west and 0.4 miles to the northeast. Vernal marsh and coastal sage scrub habitats have been observed near the range; California gnatcatcher breeding sites also have been noted to the north and west of this range (MCAS Miramar, 2011). There are no known groundwater discharge locations near the range.

Table 6: Evaluation Results
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Surface Water		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	11
Surface Water Pathways	2	5
Surface Water Receptors	4	4
Sum of Surface Water Element Scores		**20**

Groundwater		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	11
Groundwater Pathways	3	10
Groundwater Receptors	5	4
Sum of Groundwater Element Scores		**25**

The evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media:

Evaluation Ranking*	Score Range
High	50-65
Moderate	30-49
Minimal	0-29

*Use the Evaluation Ranking to determine if further actions are warranted based on the guidelines for recommended actions, as defined in Table 7.

Surface Water Evaluation Ranking	**MINIMAL**
Groundwater Evaluation Ranking	**MINIMAL**

Notes:

INSTALLATION: MARINE CORPS AIR STATION MIRAMAR
LOCATION: MIRAMAR, CALIFORNIA
RANGE: Sheriff's Department Range 6

ASSESSMENT RESULTS:

The Surface Water Ranking is Minimal. Range conditions presented in the following tables were evaluated using public databases, historical documentation, installation personnel interviews, and field observations made during the site visit. Lead loading is high at Range 6; however, the evaluation indicates a low potential for the off-range migration of lead (low precipitation and presence of storm water controls) and limited or no presence of receptors (no human receptors; limited potential exposure to ecological receptors).

The Groundwater Ranking is Minimal. Site conditions (deep groundwater, low precipitation, presence of hardpan layer, neutral pH) result in a limited potential for groundwater transport. In addition, there are no receptor exposure points (groundwater wells).

MCAS Miramar
Sheriff's Department Range 6

Table 1: Range Use and Range Management (*Source)* Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Duration of Range Use	Unknown; initial use occurred some time during Navy administration of the installation (from 1952 to 1997).	5 if usage > 30 years 3 if usage is 10 to 30 years 1 if usage < 10 years	5
Bullet-Capturing Technology	Other than the soil berm, no bullet-capturing technology noted by installation personnel or observed by REVA team.	-3 if range usage duration = bullet capture duration -1 if range usage duration – bullet capture duration = 10 to 30 years 0 if range usage duration – bullet capture duration > 30 years	0
MC Loading Rates	The lead loading average between 2007 and 2011 is 1,820 pounds /year.	5 if MC loading > 1000 pounds/year 3 if MC loading = 100 to 1000 pounds/year 1 if MC loading < 100 pounds/year	5
Range Maintenance	Lead removal activities were conducted November 2010 – April 2011 and are conducted on an as-needed basis.	5 if lead is removed less than every three years 3 if lead is removed more than every three years but less than annually 1 if lead is removed at least annually	3*
Source Element Score			13

Table 1: Range Use and Range Management (*Source)* Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

This range is primarily utilized by the San Diego County Sheriff's Department. The ranges originally were installed during Navy administration of the installation (1952 to 1997), but an exact date is not known. It is not known when the County Sheriff began leasing this range, though it is known they held a 2-year lease in 1995 on Ranges 5, 6, and 7. It is also unknown if any bullet-capturing technology has ever been used at this range; none was observed during the REVA five-year review site visit.

Yearly expenditure counts were provided by MCAS Miramar Range Operations personnel for January 2007 to March 2012. These data were presented as a total expenditure count from Ranges 5, 6, 7, and the Duffy Town Range. According to Sheriff's Department personnel, the distribution of range usage is as follows: 70% of expenditures at Range 7, 20% of expenditures at Range 6, 9% of expenditures at Range 5, and 1% of expenditures at the Duffy Town Range. Since January of 2007, Range 6 is estimated to have received 1,820 pounds of lead per year.

Lead removal activities commenced at Range 6 in November 2010 and were completed in April 2011. There is no formal scheduling of these activities as they are conducted on an as-needed basis.

*The Range Maintenance factor of the Range Use and Range Management (Source) Element in the SARAP evaluation typically is evaluated on the basis of frequency. Despite the lack of a formal scheduling of lead removal activities for this range, due to the recent lead removal conducted there, it is appropriate to score the range as a 3 during this review period. This score will be reevaluated during the next 5-year review period.

Table 2: Surface Water Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
pH of Water	Measurements at outfalls, performed as part of industrial storm water monitoring at the main base, indicate pH is typically between 6.5 and 8.5, with occasional detections outside of that range.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
Precipitation	Typical precipitation averages approximately 10 inches/year.	5 if precipitation > 40 inches/year 3 if precipitation = 20-40 inches/year 1 if precipitation < 20 inches/year	1
Slope of Range	Berm is cut from a hillside; its slope is greater than 10%. The interior of the range itself is relatively flat.	5 if slope > 10% 3 if slope = 5% to 10% 1 if slope < 5%	5
Vegetation	Some vegetation was noted on the face of the berm as well as on top of and behind it. This vegetation typically is dry or dead during the dry season; thus, the score for vegetation coverage is high.	5 if vegetation cover < 20% 3 if vegetation cover = 20% to 50% 1 if vegetation cover > 50%	5
Soil Type/Runoff Conditions	Visual observations noted gravelly and silty sand across the range. NRCS data describe the soil comprising the rear impact berms as Redding cobbly loam. A shallow hardpan is believed to exist across much of MCAS Miramar.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	3
Runoff/ Erosion Engineering Controls	Floor drains and other surface water control measures are present including an un-lined trench at the foot of the berm to channel water south toward gravel parking lot between Range 7 and Range B. The ground surface immediately behind the top of the berm is sloped away from the range to further limit drainage from reaching the face of the berm.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	-10
Surface Water Pathway Score			5

Table 2: Surface Water Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

According to most sources, the annual precipitation at MCAS Miramar is approximately 10 inches (MCAS Miramar, 2011; NAVFACSW, 2011). Storm water monitoring associated with industrial-linked outfalls at the main (developed) portion of the installation typically have shown pH levels in a neutral range over the last 5 reporting years, with limited, incidental exceptions (NAVFACSW, 2011). No information pertaining to the pH of storm water in East Miramar was identified.

Observed slope of the berm is greater than 10%; the remainder of the range is relatively flat. The berm and range are cut into the same natural hillside as Ranges B, C, and D. A natural ephemeral drainage runs on the opposite (west) side of the access road behind the range firing line; this drainage generally follows surface topography as it drains to the south-southeast. Some vegetation was noted on this range during the REVA five-year review site visit; however, most of it typically is dry or dead during the dry season.

Visual observations noted gravelly and silty sand across much of the range. Shallow borings at a former UST site just under 0.25 miles northwest of the range indicate the presence of sandy silts with gravel, underlain by well-cemented conglomerate (OHM, 1997). The MCAS Miramar INRMP report indicates the presence of shallow hardpan in the subsurface across much of East Miramar, given it is situated on conglomerated sandstone and cobble formations of Kearny Mesa (MCAS Miramar, 2011). During the lead removal activities conducted at this range, soil composed primarily of sand was brought in to replace the volume extracted from the berm in the form of cobbles and projectiles. In this case, the soil type / runoff conditions still were given an intermediate score, as there was no information indicating if the soil was mixed with the soil extracted from the berm prior to the reconstruction or simply applied as a layer to the berm's surface.

Drains are present in the floor at the base of the cinder block walls that separate Ranges 5 and 6 and Rnages 6 and 7 to collect and direct runoff to the drainage channel west of the firing points. Additionally, the Sheriff's Department has installed an unlined drainage trench at the foot of the shared berm across the Duffy Town Range, Range 5, Range 6, and Range 7, which drains south toward the parking lot that separates Range 7 and Range B. Together, these controls offer effective control of lead migration from this range.

Table 3: Groundwater Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Depth to Groundwater	Previous studies at the installation suggest regional groundwater is approximately 160 feet below ground surface. Shallow perched water is known to exist in some locations.	5 if depth to groundwater < 20 feet 3 if depth to groundwater = 20-99 feet 1 if depth to groundwater = 100-300 feet 0 if depth to groundwater >300 feet	1
Precipitation	Typical precipitation averages approximately 10 inches/year.	5 if precipitation > 40 inches/year 3 if precipitation = 20-40 inches/year 1 if precipitation < 20 inches/year	1
pH of Water	The average pH in groundwater monitoring wells at the installation is between 7.2 and 7.6.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
pH of Soil	The Redding series soil ranges from extremely (pH 4.2) to medium acidic (pH 5.8).	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	5
Soil Type/Infiltration Conditions	While observations and NRCS data suggest surface soil may be somewhat permeable, a shallow hardpan is generally believed to exist across much of MCAS Miramar; it is expected to greatly restrict infiltration to deep soil.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Clay Content in Soil	Visual observations indicated gravelly and silty sand across much of the surface of the range. The Redding series, the dominant soil type at this range, contains a large amount of clay.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Groundwater Pathway Score			10

Table 3: Groundwater Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

Recent investigations found regional groundwater to be approximately 160 feet below ground surface (BEI, 2007); perched groundwater has been encountered at several locations approximately 10 to 30 feet below ground surface.

Several reports report that pH levels in all wells sampled ranged from 6.5 to 7.6 (Woodward Clyde, 1991; Evenson, 1989; CDWR, 1967). Only one well from 52 sampled near MCAS Miramar reported a pH of 6.5. The average pH in these wells is between 7.2 and 7.6.

The rear impact berm, set in a hillside, mostly consists of Redding cobbly loam (9%–30% slopes). This soil series is very acidic, ranging in pH from 4.2 to 5.8. The soil series contains gravelly heavy clay loam and gravelly clay from 15 to 30 inches, with an iron-silica cemented hardpan beneath (NRCS, 1973).

Table 4: Surface Water Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Drinking Water Usage	A number of ephemeral streams are present in the canyons that traverse the installation; this range is located in Murphy Canyon. These waters are not used as a drinking water source on or off the installation.	10 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has a reasonable potential to move toward a surface water body used as a potable water supply or if a designation as a potable water source is unknown 5 if contamination in the media has moved or is expected to move only slightly beyond the source (tens of feet) or could move, but is not moving appreciably, toward surface water body used as a potable water supply or if a designation as a potable water source is unknown 2 if low possibility for contamination in the media to be present at or migrate to a point of exposure	2
Agricultural or Other Beneficial Usage	No agricultural activities are noted near East Miramar. Agricultural operations may abut the westernmost side of the installation.	5 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has moved to a point of exposure or if a designation as agricultural or other beneficial usage is unknown 3 if contamination in the media has moved only slightly beyond the source (tens of feet) or could move but is not moving appreciably. 1 if low possibility for contamination in the media to be present at or migrate to a point of exposure	1
Sensitive Species Habitat and Threatened or Endangered Species	Vernal pools and associated species are present in drainage leading from range areas but are isolated. Coastal sage scrub habitat and California gnatcatcher also have been noted. These habitats and species have been identified to the north and west of the range. However, exposure to dissolved lead in runoff is likely to be limited.	10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary 5 if potential for receptors to have access to possibly contaminated media 1 if little or no potential for receptors to have access to possible contaminated media	1
Surface Water Receptor Score			4

Table 4: Surface Water Receptors Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

All water is supplied by the City of San Diego (MCAS Miramar, 2011). None of the ephemeral streams are utilized as a potable water source.

Agricultural activities are not evident in the areas immediately surrounding East Miramar.

Vernal pools are located near the end of the Murphy Canyon drainage as it approaches the intersection of Interstate 15 and State Route 52. However, these pools are located approximately 400 feet southeast of the drainage, are approximately 80 feet higher in elevation, and are located within the operational footprint of the East Miramar Range Complex. Therefore, there is no potential for off-range exposure to ecological receptors present in these pools. Breeding sites for the California gnatcatcher previously have been noted to the north and west of the range (MCAS Miramar, 2011). However, the primary source of water for the gnatcatcher is its diet (e.g., insects, fruit), and it is not likely to consume significant quantities of water from the drainages near the range. Therefore, exposures to ecological receptors are likely to be limited.

Table 5: Groundwater Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Wells Identified as Potable Water Sources	No groundwater wells exist at the installation. There are no known production wells within 1 mile of East Miramar.	10 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure or if a designation as a potable water source is unknown 5 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably 2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure	2
Wells Identified for Agricultural or Other Beneficial Usage	There are no known production wells within 1 mile of East Miramar.	5 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure or if a designation as agricultural or other beneficial usage is unknown 3 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably 1 if low possibility for MC to be present at or migrate to within a reasonable radius of influence of a well or point of exposure	1
Sensitive Species Habitat and Threatened and Endangered Species	Vernal pools, coastal sage scrub, and associated species (including the California gnatcatcher) have been noted to the north and west of this range. However, there are no known springs in the area.	5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources 3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources 1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources	1
Groundwater Receptor Score			4

Table 5: Groundwater Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)
Notes: There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar, 2011). Installation personnel are not aware of any production wells within 1 mile of the installation. Vernal pools may be found in East Miramar, notably within its westernmost regions. They previously have been identified near this range, approximately 0.2 miles to the west and 0.4 miles to the northeast. Vernal marsh and coastal sage scrub habitats have been observed within proximity of the range; California gnatcatcher breeding sites also have been noted to the north and west of this range (MCAS Miramar, 2011). There are no known groundwater discharge locations near the range.

Table 6: Evaluation Results
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Surface Water		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	13
Surface Water Pathways	2	5
Surface Water Receptors	4	4
Sum of Surface Water Element Scores		**22**

Groundwater		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	13
Groundwater Pathways	3	10
Groundwater Receptors	5	4
Sum of Groundwater Element Scores		**27**

The evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media:

Evaluation Ranking*	Score Range
High	50-65
Moderate	30-49
Minimal	0-29

*Use the Evaluation Ranking to determine if further actions are warranted based on the guidelines for recommended actions, as defined in Table 7.

Surface Water Evaluation Ranking	**MINIMAL**
Groundwater Evaluation Ranking	**MINIMAL**

Notes:

INSTALLATION: MARINE CORPS AIR STATION MIRAMAR
LOCATION: MIRAMAR, CALIFORNIA
RANGE: Sheriff's Department Range 7

ASSESSMENT RESULTS:

The Surface Water Ranking is Minimal. Range conditions presented in the following tables were evaluated using public databases, historical documentation, installation personnel interviews, and field observations made during the site visit. Lead loading is high at Range 7; however, the evaluation indicates a low potential for the off-range migration of lead (low precipitation and presence of storm water controls) and limited or no presence of receptors (no human receptors; limited potential exposure to ecological receptors).

The Groundwater Ranking is Minimal. Site conditions (deep groundwater, low precipitation, presence of hardpan layer, neutral pH) result in a limited potential for groundwater transport. In addition, there are no receptor exposure points (groundwater wells).

MCAS Miramar
Sheriff's Department Range 7

Table 1: Range Use and Range Management (*Source)* Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Duration of Range Use	Unknown; initial use occurred some time during Navy administration of the installation (from 1952 to 1997).	5 if usage > 30 years 3 if usage is 10 to 30 years 1 if usage < 10 years	5
Bullet-Capturing Technology	Other than the soil berm, no bullet-capturing technology noted by installation personnel or observed by REVA team.	-3 if range usage duration = bullet capture duration -1 if range usage duration – bullet capture duration = 10 to 30 years 0 if range usage duration – bullet capture duration > 30 years	0
MC Loading Rates	The lead loading average between 2007 and 2011 is 6,370 pounds/year.	5 if MC loading > 1000 pounds/year 3 if MC loading = 100 to 1000 pounds/year 1 if MC loading < 100 pounds/year	5
Range Maintenance	Lead removal activities conducted November 2010 – April 2011 and are conducted on an as-needed basis.	5 if lead is removed less than every three years 3 if lead is removed more than every three years but less than annually 1 if lead is removed at least annually	3*
Source Element Score			13

Table 1: Range Use and Range Management (*Source)* Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

This range is primarily utilized by the San Diego County Sheriff's Department. The ranges originally were installed during Navy administration of the installation (1952 to 1997), but an exact date is not known. It is not known when the County Sheriff began leasing this range, though it is known they held a 2-year lease in 1995 on Ranges 5, 6, and 7. It is also unknown if any bullet-capturing technology has ever been used at this range; none was observed during the REVA five-year review site visit.

Yearly expenditure counts were provided by MCAS Miramar Range Operations personnel for January 2007 to March 2012. These data were presented as a total expenditure count from Ranges 5, 6, 7, and the Duffy Town Range. According to Sheriff's Department personnel, the distribution of range usage is as follows: 70% of expenditures at Range 7, 20% of expenditures at Range 6, 9% of expenditures at Range 5, and 1% of expenditures at the Duffy Town Range. Since January of 2007, Range 7 is estimated to receive 6,370 pounds of lead per year.

Lead removal activities commenced at Range 7 in November 2010 and were completed in April 2011. There is no formal scheduling of these activities as they are conducted on an as-needed basis.

*The Range Maintenance factor of the Range Use and Range Management (Source) Element in the SARAP evaluation typically is evaluated on the basis of frequency. Despite the lack of a formal scheduling of lead removal activities for this range, due to the recent lead removal conducted there, it is appropriate to score the range as a 3 during this review period. This score will be reevaluated during the next 5-year review period.

Table 2: Surface Water Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
pH of Water	Measurements at outfalls, performed as part of industrial storm water monitoring at the main base, indicate pH is typically between 6.5 and 8.5, with occasional detections outside of that range.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
Precipitation	Typical precipitation averages approximately 10 inches/year.	5 if precipitation > 40 inches/year 3 if precipitation = 20-40 inches/year 1 if precipitation < 20 inches/year	1
Slope of Range	Berm is cut from a hillside; its slope is greater than 10%. The interior of the range itself is relatively flat.	5 if slope > 10% 3 if slope = 5% to 10% 1 if slope < 5%	5
Vegetation	Some vegetation was noted on the face of the berm as well as on top of and behind it. This vegetation typically is dry or dead during the dry season; thus, the score for vegetation coverage is high.	5 if vegetation cover < 20% 3 if vegetation cover = 20% to 50% 1 if vegetation cover > 50%	5
Soil Type/Runoff Conditions	Visual observations noted gravelly and silty sand across the range. NRCS data describe the soil comprising the rear impact berms as Redding cobbly loam. A shallow hardpan is believed to exist across much of MCAS Miramar.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	3
Runoff/ Erosion Engineering Controls	Floor drains and other surface water control measures are present, including an unlined trench at the foot of the berm to channel water south toward gravel parking lot between Range 7 and Range B. The ground surface immediately behind the top of the berm is sloped away from the range to further limit drainage from reaching the face of the berm.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	-10
Surface Water Pathway Score			5

Table 2: Surface Water Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

According to most sources, the annual precipitation at MCAS Miramar is approximately 10 inches (MCAS Miramar, 2011; NAVFACSW, 2011). Storm water monitoring associated with industrial-linked outfalls at the main (developed) portion of the installation typically have shown pH levels in a neutral range over the last 5 reporting years, with limited, incidental exceptions (NAVFACSW, 2011). No information pertaining to the pH of storm water in East Miramar was identified.

Observed slope of the berm is greater than 10%; the remainder of the range is relatively flat. The berm and range are cut into the same natural hillside as Ranges B, C, and D. A natural ephemeral drainage runs on the opposite (west) side of the access road behind the range firing line; this drainage generally follows surface topography as it drains to the south-southeast. Some vegetation was noted on this range during the REVA five-year review site visit; however, most of it typically is dry or dead during the dry season.

Visual observations noted gravelly and silty sand across much of the range. Shallow borings at a former UST site just under 0.25 miles northwest of the range indicate the presence of sandy silts with gravel, underlain by well-cemented conglomerate (OHM, 1997). The MCAS Mirmar INRMP indicates the presence of shallow hardpan in the subsurface across much of East Miramar, given it is situated on conglomerated sandstone and cobble formations of Kearny Mesa (MCAS Miramar, 2011). During the lead removal activities conducted at this range, soil composed primarily of sand was brought in to replace the volume extracted from the berm in the form of cobbles and projectiles. In this case, the soil type / runoff conditions still were given an intermediate score, as there was no information indicating if the soil was mixed with the soil extracted from the berm prior to the reconstruction or simply applied as a layer to the berm's surface.

Drains are present in the floor at the base of the cinder block walls that separate Ranges 6 and 7 and in the southeastern corner of Range 7 to collect and direct runoff to the drainage channel west of the firing points. Additionally, the Sheriff's Department has installed an unlined drainage trench at the foot of the shared berm across the Duffy Town Range, Range 5, Range 6, and Range 7, which drains south toward the parking lot that separates Range 7 and Range B. Together, these controls offer effective control of lead migration from this range.

Table 3: Groundwater Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Depth to Groundwater	Previous studies at the installation suggest regional groundwater is approximately 160 feet below ground surface. Shallow perched water is known to exist in some locations.	5 if depth to groundwater < 20 feet 3 if depth to groundwater = 20-99 feet 1 if depth to groundwater = 100-300 feet 0 if depth to groundwater >300 feet	1
Precipitation	Typical precipitation averages approximately 10 inches/year.	5 if precipitation > 40 inches/year 3 if precipitation = 20-40 inches/year 1 if precipitation < 20 inches/year	1
pH of Water	The average pH in groundwater monitoring wells at the installation is between 7.2 and 7.6.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
pH of Soil	The Redding series soil ranges from extremely (pH 4.2) to medium acidic (pH 5.8).	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	5
Soil Type/Infiltration Conditions	While observations and NRCS data suggest surface soil may be somewhat permeable, a shallow hardpan is generally believed to exist across much of MCAS Miramar; it is expected to greatly restrict infiltration to deep soil.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Clay Content in Soil	Visual observations indicated gravelly and silty sand across much of the surface of the range. The Redding series, the dominant soil type at this range, contains a large amount of clay.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Groundwater Pathway Score			10

Table 3: Groundwater Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

Recent investigations found regional groundwater to be approximately 160 feet below ground surface (BEI, 2007); perched groundwater has been encountered at several locations approximately 10 to 30 feet below ground surface.

Several reports report that pH levels in all wells sampled ranged from 6.5 to 7.6 (Woodward Clyde, 1991; Evenson, 1989; CDWR, 1967). Only one well from 52 sampled near Miramar reported a pH of 6.5. The average pH in these wells is between 7.2 and 7.6.

The rear impact berm, set in a hillside, mostly consists of Redding cobbly loam (9%–30% slopes). This soil series is very acidic, ranging in pH from 4.2 to 5.8. The soil series contains gravelly heavy clay loam and gravelly clay from 15 to 30 inches, with an iron-silica cemented hardpan beneath (NRCS, 1973).

Table 4: Surface Water Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Drinking Water Usage	A number of ephemeral streams are present in the canyons that traverse the installation; this range is located in Murphy Canyon. These waters are not used as a drinking water source on or off the installation.	10 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has a reasonable potential to move toward a surface water body used as a potable water supply or if a designation as a potable water source is unknown 5 if contamination in the media has moved or is expected to move only slightly beyond the source (tens of feet) or could move, but is not moving appreciably, toward surface water body used as a potable water supply or if a designation as a potable water source is unknown 2 if low possibility for contamination in the media to be present at or migrate to a point of exposure	2
Agricultural or Other Beneficial Usage	No agricultural activities are noted near East Miramar. Agricultural operations may abut the westernmost side of the installation.	5 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has moved to a point of exposure or if a designation as agricultural or other beneficial usage is unknown 3 if contamination in the media has moved only slightly beyond the source (tens of feet) or could move but is not moving appreciably. 1 if low possibility for contamination in the media to be present at or migrate to a point of exposure	1
Sensitive Species Habitat and Threatened or Endangered Species	Vernal pools and associated species are present in drainage leading from range areas but are isolated. Coastal sage scrub habitat and California gnatcatcher also have been noted. These habitats and species have been identified to the north and west of the range. However, exposure to dissolved lead in runoff is likely to be limited.	10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary 5 if potential for receptors to have access to possibly contaminated media 1 if little or no potential for receptors to have access to possible contaminated media	1
Surface Water Receptor Score			4

Table 4: Surface Water Receptors Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

All water is supplied by the City of San Diego (MCAS Miramar, 2011). None of the ephemeral streams are utilized as a potable water source.

Agricultural activities are not evident in the areas immediately surrounding East Miramar.

Vernal pools are located near the end of the Murphy Canyon drainage as it approaches the intersection of Interstate 15 and State Route 52. However, these pools are located approximately 400 feet southeast of the drainage, are approximately 80 feet higher in elevation, and are located within the operational footprint of the East Miramar Range Complex. Therefore, there is no potential for off-range exposure to ecological receptors present in these pools. Breeding sites for the California gnatcatcher previously have been noted to the north and west of the range (MCAS Miramar, 2011). However, the primary source of water for the gnatcatcher is its diet (e.g., insects, fruit), and it is not likely to consume significant quantities of water from the drainages near the range. Therefore, exposures to ecological receptors are likely to be limited.

Table 5: Groundwater Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Wells Identified as Potable Water Sources	No groundwater wells exist at the installation. There are no known production wells within 1 mile of East Miramar.	10 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure or if a designation as a potable water source is unknown 5 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably 2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure	2
Wells Identified for Agricultural or Other Beneficial Usage	There are no known production wells within 1 mile of East Miramar.	5 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure or if a designation as agricultural or other beneficial usage is unknown 3 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably 1 if low possibility for MC to be present at or migrate to within a reasonable radius of influence of a well or point of exposure	1
Sensitive Species Habitat and Threatened and Endangered Species	Vernal pools, coastal sage scrub, and associated species (including the California gnatcatcher) have been noted to the north and west of this range. However, there are no known springs in the area.	5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources 3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources 1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources	1
Groundwater Receptor Score			4

Table 5: Groundwater Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)
Notes: There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar, 2011). Installation personnel are not aware of any production wells within 1 mile of the installation. Vernal pools may be found in East Miramar, notably within its westernmost regions. They previously have been identified near this range, approximately 0.2 miles to the west and 0.4 miles to the northeast. Vernal marsh and coastal sage scrub habitats have been observed near the range; California gnatcatcher breeding sites also have been noted to the north and west of this range (MCAS Miramar, 2011). There are no known groundwater discharge locations near the range.

Table 6: Evaluation Results
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Surface Water		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	13
Surface Water Pathways	2	5
Surface Water Receptors	4	4
Sum of Surface Water Element Scores		**22**

Groundwater		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	13
Groundwater Pathways	3	10
Groundwater Receptors	5	4
Sum of Groundwater Element Scores		**27**

The evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media:

Evaluation Ranking*	Score Range
High	50-65
Moderate	30-49
Minimal	0-29

*Use the Evaluation Ranking to determine if further actions are warranted based on the guidelines for recommended actions, as defined in Table 7.

Surface Water Evaluation Ranking	**MINIMAL**
Groundwater Evaluation Ranking	**MINIMAL**

Notes:

INSTALLATION: MARINE CORPS AIR STATION MIRAMAR
LOCATION: MIRAMAR, CALIFORNIA
RANGE: Sheriff's Department Duffy Town Range

ASSESSMENT RESULTS:

The Surface Water Ranking is Minimal. Range conditions presented in the following tables were evaluated using public databases, historical documentation, installation personnel interviews, and field observations made during the site visit. Lead loading is low at the Duffy Town Range. The evaluation also indicates a low potential for the off-range migration of lead (low precipitation and presence of storm water controls) and limited or no presence of receptors (no human receptors; limited potential exposure to ecological receptors).

The Groundwater Ranking is Minimal. Site conditions (deep groundwater, low precipitation, presence of hardpan layer, neutral pH) result in a limited potential for groundwater transport. In addition, there are no receptor exposure points (groundwater wells).

MCAS Miramar
Sheriff's Department Duffy Town Range

Table 1: Range Use and Range Management (*Source)* Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Duration of Range Use	Unknown; initial use occurred some time during Navy administration of the installation (from 1952 to 1997).	5 if usage > 30 years 3 if usage is 10 to 30 years 1 if usage < 10 years	5
Bullet-Capturing Technology	Bullet-capturing targets were observed by REVA team in addition to soil berm. The usage duration and consistency of these targets is not known.	-3 if range usage duration = bullet capture duration -1 if range usage duration – bullet capture duration = 10 to 30 years 0 if range usage duration – bullet capture duration > 30 years	0
MC Loading Rates	The lead loading average between 2007 and 2011 is 90 pounds/year.	5 if MC loading > 1000 pounds/year 3 if MC loading = 100 to 1000 pounds/year 1 if MC loading < 100 pounds/year	1
Range Maintenance	Lead removal activities conducted November 2010 – April 2011 and are conducted on an as-needed basis.	5 if lead is removed less than every three years 3 if lead is removed more than every three years but less than annually 1 if lead is removed at least annually	3*
Source Element Score			9

Table 1: Range Use and Range Management (*Source)* Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

This range is primarily utilized by the San Diego County Sheriff's Department. The ranges were originally installed during Navy administration of the installation (1952 to 1997), but an exact date is not known. It is not known when the County Sheriff began leasing this range, though it is known they held a 2-year lease in 1995 on Ranges 5, 6, and 7. No bullet-capturing technology (e.g., bullet trap) was observed during the REVA five-year review site visit.

Yearly expenditure counts were provided by MCAS Miramar Range Operations personnel for January 2007 to March 2012. These data were presented as a total expenditure count from Ranges 5, 6, 7, and the Duffy Town Range. According to Sheriff's Department personnel, the distribution of range usage is as follows: 70% of expenditures at Range 7, 20% of expenditures at Range 6, 9% of expenditures at Range 5, and 1% of expenditures at the Duffy Town Range. Since January of 2007, the Duffy Town Range is estimated to receive 91 pounds of lead per year. Note that a single earthen berm is used for bullet containment on all four ranges.

Lead removal activities at the Duffy Town Range (and other Sheriff's Department ranges) were conducted between November 2010 and April 2011. There is no formal scheduling of these activities as they are conducted on an as needed basis.

*The Range Maintenance factor of the Range Use and Range Management (Source) Element in the SARAP evaluation typically is evaluated on the basis of frequency. Despite the lack of a formal scheduling of lead removal activities for this range, due to the recent lead removal conducted there, it is appropriate to score the range as a 3 during this review period. This score will be reevaluated during the next 5-year review period.

Table 2: Surface Water Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
pH of Water	Measurements at outfalls, performed as part of industrial storm water monitoring at the main base, indicate pH is typically between 6.5 and 8.5, with occasional detections outside of that range.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
Precipitation	Typical precipitation averages approximately 10 inches/year.	5 if precipitation > 40 inches/year 3 if precipitation = 20-40 inches/year 1 if precipitation < 20 inches/year	1
Slope of Range	Berm is cut from a hillside; its slope is greater than 10%. The interior of the range itself is relatively flat.	5 if slope > 10% 3 if slope = 5% to 10% 1 if slope < 5%	5
Vegetation	Some vegetation was noted on the face and on top of the berm at this range. Vegetation coverage is significantly decreased during the nonrainy season.	5 if vegetation cover < 20% 3 if vegetation cover = 20% to 50% 1 if vegetation cover > 50%	3
Soil Type/Runoff Conditions	Visual observations noted gravelly and silty sand across the range. NRCS data describe the soil comprising the rear impact berms as Redding cobbly loam. A shallow hardpan is believed to exist across much of MCAS Miramar.	5 if soil type is clay / silty clay 3 if soil type is clayey sand / silt 1 if soil type is sand/gravel	3
Runoff/ Erosion Engineering Controls	An unlined trench was installed at the foot of the berm to channel water south towards gravel parking lot between Range 7 and Range B. Some vegetation was observed on face of the berm. The ground surface immediately behind the top of the berm is sloped away from the range to further limit drainage from reaching the face of the berm.	0 if no engineering controls -5 if partial engineering controls -10 if effective engineering controls	-10
Surface Water Pathway Score			3

Table 2: Surface Water Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

According to most sources, the annual precipitation at MCAS Miramar is approximately 12 inches (MCAS Miramar, 2011; NAVFACSW, 2011). Storm water monitoring associated with industrial-linked outfalls at the main (developed) portion of the installation typically have shown pH levels in a neutral range over the last 5 reporting years, with limited, incidental exceptions (NAVFACSW, 2011). No information pertaining to the pH of storm water in East Miramar was identified.

Observed slope of the berm is greater than 10%; the remainder of the range is relatively flat. The berm and range are cut into the same natural hillside as Ranges B, C, and D. A natural ephemeral drainage runs on the opposite (west) side of the access road behind the range; this drainage generally follows surface topography as it drains to the south-southeast. Vegetation was observed on this range by the REVA team during the five-year review site visit; however, during the dry season, vegetation is significantly decreased.

Visual observations noted gravelly and silty sand across much of the range. Shallow borings at a former UST site just under 0.25 miles northwest of the range indicate the presence of sandy silts with gravel, underlain by well-cemented conglomerate (OHM, 1997). The shallow hardpan in the subsurface has been observed across much of East Miramar, given it is situated on conglomerated sandstone and cobble formations of Kearny Mesa (MCAS Miramar, 2011). During the lead removal activities conducted at this range, soil composed primarily of sand was brought in to replace the volume extracted from the berm in the form of cobbles and projectiles. In this case, the soil type / runoff conditions still were given an intermediate score, as there was no information indicating if the soil was mixed with the soil extracted from the berm prior to the reconstruction or simply applied as a layer to the berm's surface.

The Sheriff's Department has installed an unlined drainage trench at the foot of the shared berm across the Duffy Town Range, Range 5, Range 6, and Range 7, which drains south toward the parking lot that separates Range 7 and Range B. This along with the light vegetation observed on the face of the berm and the slope of the ground surface behind the top of the berm offer effective control of lead migration from this range.

Table 3: Groundwater Pathways Characteristics Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Depth to Groundwater	Previous studies at the installation suggest regional groundwater is approximately 160 feet below ground surface. Shallow perched water is known to exist in some locations.	5 if depth to groundwater < 20 feet 3 if depth to groundwater = 20-99 feet 1 if depth to groundwater = 100-300 feet 0 if depth to groundwater >300 feet	1
Precipitation	Typical precipitation averages approximately 10 inches/year.	5 if precipitation > 40 inches/year 3 if precipitation = 20-40 inches/year 1 if precipitation < 20 inches/year	1
pH of Water	The average pH in groundwater monitoring wells at the installation is between 7.2 and 7.6.	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	1
pH of Soil	The Redding series soil ranges from extremely (pH 4.2) to medium acidic (pH 5.8).	5 if pH < 6.5 3 if pH > 8.5 1 if pH 6.5 ≤ pH ≤ 8.5	5
Soil Type/Infiltration Conditions	While observations and NRCS data suggest surface soil may be somewhat permeable, a shallow hardpan is generally believed to exist across much of MCAS Miramar; it is expected to greatly restrict infiltration to deep soil	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Clay Content in Soil	Visual observations indicated gravelly and silty sand across much of the surface of the range. The Redding series, the dominant soil type at this range, contains a large amount of clay.	5 if soil type is sand/gravel 3 if soil type is clayey sand / silt 1 if soil type is clay / silty clay	1
Groundwater Pathway Score			10

Table 3: Groundwater Pathways Characteristics Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

Recent investigations found regional groundwater to be approximately 160 feet below ground surface (BEI, 2007); perched groundwater has been encountered at several locations approximately 10 to 30 feet below ground surface.

Several reports report that pH levels in all wells sampled ranged from 6.5 to 7.6 (Woodward Clyde, 1991; Evenson, 1989; CDWR, 1967). Only one well from 52 sampled near MCAS Miramar reported a pH of 6.5. The average pH in these wells is between 7.2 and 7.6.

The rear impact berm, set in a hillside, mostly consists of Redding cobbly loam (9%–30% slopes). This soil series is very acidic, ranging in pH from 4.2 to 5.8. The soil series contains gravelly heavy clay loam and gravelly clay from 15 to 30 inches, with an iron-silica cemented hardpan beneath (NRCS, 1973).

Table 4: Surface Water Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Drinking Water Usage	A number of ephemeral streams are present in the canyons that traverse the installation; this range is located in Murphy Canyon. These waters are not used as a drinking water source on or off the installation.	10 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has a reasonable potential to move toward a surface water body used as a potable water supply or if a designation as a potable water source is unknown 5 if contamination in the media has moved or is expected to move only slightly beyond the source (tens of feet) or could move, but is not moving appreciably, toward surface water body used as a potable water supply or if a designation as a potable water source is unknown 2 if low possibility for contamination in the media to be present at or migrate to a point of exposure	2
Agricultural or Other Beneficial Usage	No agricultural activities are noted near East Miramar. Agricultural operations may abut the westernmost side of the installation.	5 if analytical data or observable evidence indicates that contamination in the media is present at, is moving toward, or has moved to a point of exposure or if a designation as agricultural or other beneficial usage is unknown 3 if contamination in the media has moved only slightly beyond the source (tens of feet) or could move but is not moving appreciably. 1 if low possibility for contamination in the media to be present at or migrate to a point of exposure	1
Sensitive Species Habitat and Threatened or Endangered Species	Vernal pools and associated species are present in drainage leading from range areas but are isolated. Coastal sage scrub habitat and California gnatcatcher also have been noted. These habitats and species have been identified to the north and west of the range. However, exposure to lead in runoff is likely to be limited.	10 if identified receptors have access to possibly contaminated media and/or are located adjacent to the range boundary 5 if potential for receptors to have access to possibly contaminated media 1 if little or no potential for receptors to have access to possible contaminated media	1
Surface Water Receptor Score			4

Table 4: Surface Water Receptors Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

All water is supplied by the City of San Diego (MCAS Miramar, 2011). None of the ephemeral streams are utilized as a potable water source.

Agricultural activities are not evident in the areas immediately surrounding East Miramar.

Vernal pools are located near the end of the Murphy Canyon drainage as it approaches the intersection of Interstate 15 and State Route 52. However, these pools are located approximately 400 feet southeast of the drainage, are approximately 80 feet higher in elevation, and are located within the operational footprint of the East Miramar Range Complex. Therefore, there is no potential for off-range exposure to ecological receptors present in these pools. Breeding sites for the California gnatcatcher previously have been noted to the north and west of the range (MCAS Miramar, 2011). However, the primary source of water for the gnatcatcher is its diet (e.g., insects, fruit), and it is not likely to consume significant quantities of water from the drainages near the range. Therefore, exposures to ecological receptors are likely to be limited.

Table 5: Groundwater Receptors Element (These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)			
Criteria	**Evaluation Characteristics**	**Score Criteria**	**Site Score**
Wells Identified as Potable Water Sources	No groundwater wells exist at the installation. There are no known production wells within 1 mile of East Miramar.	10 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure or if a designation as a potable water source is unknown 5 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably 2 if low possibility for MC to be present at or migrate to within a reasonable radius of influence or point of exposure	2
Wells Identified for Agricultural or Other Beneficial Usage	There are no known production wells within 1 mile of East Miramar.	5 if analytical data or observable evidence or site conditions indicate that MC may be within or moving toward a reasonable radius of influence of a well or other point of exposure or if a designation as agricultural or other beneficial usage is unknown 3 if analytical data or observable evidence or site conditions indicate that MC have moved only slightly beyond the source (tens of feet) or could move toward a reasonable radius of influence of a well or other point of exposure, but are not moving appreciably 1 if low possibility for MC to be present at or migrate to within a reasonable radius of influence of a well or point of exposure	1
Sensitive Species Habitat and Threatened and Endangered Species	Vernal pools, coastal sage scrub, and associated species (including the California gnatcatcher) have been noted to the north and west of this range. However, there are no known springs in the area.	5 if identified receptors exposed to potentially MC-impacted water from groundwater or groundwater sources 3 if potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources 1 if little or no potential for receptors exposed to potentially MC-impacted water from groundwater or groundwater sources	1
Groundwater Receptor Score			4

Table 5: Groundwater Receptors Element
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Notes:

There are no water supply wells present at the installation; all water is supplied by the City of San Diego (MCAS Miramar, 2011). Installation personnel are not aware of any production wells within 1 mile of the installation.

Vernal pools may be found in East Miramar, notably within its westernmost regions. They previously have been identified near this range, approximately 0.2 miles to the west and 0.4 miles to the northeast. Vernal marsh and coastal sage scrub habitats have been observed within proximity of the range; California gnatcatcher breeding sites also have been noted to the north and west of this range (MCAS Miramar, 2011).

There are no known groundwater discharge locations near the range.

Table 6: Evaluation Results
(These definitions only apply for the purposes of the Small Arms Range Assessment Protocol.)

Surface Water		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	9
Surface Water Pathways	2	3
Surface Water Receptors	4	4
Sum of Surface Water Element Scores		**16**

Groundwater		
Element	**Table**	**Score**
Range Use and Range Management (Source)	1	9
Groundwater Pathways	3	10
Groundwater Receptors	5	4
Sum of Groundwater Element Scores		**23**

The evaluation ranking for each media is determined by selecting the appropriate score based on the data elements for that media:

Evaluation Ranking*	Score Range
High	50-65
Moderate	30-49
Minimal	0-29

*Use the Evaluation Ranking to determine if further actions are warranted based on the guidelines for recommended actions, as defined in Table 7.

Surface Water Evaluation Ranking	**MINIMAL**
Groundwater Evaluation Ranking	**MINIMAL**

Notes:

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 100	San Diego, CA

Photo No.	Date:
1	3/20/2012

Direction Photo Taken:

East

Description:

View of Range 100, with its rear backstop berm in the distance. Bullet pockets are evident in the impact berm.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 100	San Diego, CA

Photo No.	Date:
2	3/20/2012

Direction Photo Taken:

South

Description:

View of the rear backstop berm of Range 100.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 100	San Diego, CA

Photo No.	Date:
3	3/20/2012

Direction Photo Taken:

South

Description:

View of drain inlet at foot of rear backstop berm of Range 100.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 100	San Diego, CA

Photo No.	Date:
4	3/20/2012

Direction Photo Taken:

North

Description:

View of top and behind the rear backstop berm of Range 100.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 100	San Diego, CA

Photo No.	Date:
5	3/20/2012

Direction Photo Taken:

South

Description:

View of lined drainage channel along the south side of Range 100.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 100	San Diego, CA

Photo No.	Date:
6	3/20/2012

Direction Photo Taken:

Northwest

Description:

View of drainage channel in middle of Range 100 with mechanical targets at base of rear backstop berm in foreground.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 100	San Diego, CA

Photo No.	Date:
7	3/20/2012

Direction Photo Taken:

Southeast

Description:

View of 100-yard target line and target frames with firing line markers in the foreground at range 100.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 100	San Diego, CA

Photo No.	Date:
8	3/20/2012

Direction Photo Taken:

West

Description:

View of drain located to the northwest of the 100-yard target line with the main firing line in the background.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 101	San Diego, CA

Photo No.	Date:
9	3/20/2012

Direction Photo Taken:

South

Description:

View of Range 101 from rear firing point. Concrete channel is visible across the top of the impact berm; bullet pockets are evident in the impact berm.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 101	San Diego, CA

Photo No.	Date:
10	3/20/2012

Direction Photo Taken:

Southwest

Description:
View of target frames, impact berm, and drainage at Range 101. Note the standing water behind the target frames. Inlet at foot of impact berm likely clogged with sediment from heavy rain event that occurred the day before the REVA team site visit.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 101	San Diego, CA

Photo No.	Date:
11	3/20/2012

Direction Photo Taken:

Southeast

Description:

View of northeastern portion of impact berm at Range 101. Bullet pockets are evident in impact berm.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 101	San Diego, CA

Photo No.	Date:
12	3/20/2012

Direction Photo Taken:

North

Description:

View of firing lines at Range 101. Note gravel on range floor for drainage purposes.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 101	San Diego, CA

Photo No.	Date:
13	3/20/2012

Direction Photo Taken:

East

Description:

View of outfall with Range 101 in the background.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 101	San Diego, CA

Photo No.	Date:
14	3/20/2012

Direction Photo Taken:

West

Description:

View of outfall as it directs drainage off the Carlos Hathcock Range Complex.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 101	San Diego, CA

Photo No.	Date:
15	3/20/2012

Direction Photo Taken:

South

Description:

Outfall of inlet at foot of impact berm at Range 101.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range B	San Diego, CA

Photo No.	Date:
16	3/20/2012

Direction Photo Taken:

Southeast

Description:

View of impact berm at Range B.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range B	San Diego, CA

Photo No.	Date:
17	3/20/2012

Direction Photo Taken:

Northeast

Description:

View of vegetation on top of impact berm at Range B.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range B	San Diego, CA

Photo No.	Date:
18	3/20/2012

Direction Photo Taken:

Northeast

Description:

View of concrete-lined channel running above Range B.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range B	San Diego, CA

Photo No.	Date:
19	3/20/2012

Direction Photo Taken:

South

Description:

View of sediment blockage observed in northernmost section of concrete-lined channel above Range B impact berm.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range B	San Diego, CA

Photo No.	Date:
20	3/20/2012

Direction Photo Taken:

Northeast

Description:

View of the overhead baffling at Range B.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range C	San Diego, CA

Photo No.	Date:
21	3/20/2012

Direction Photo Taken:

Southeast

Description:

View of target frames and impact berm at Range C.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range C	San Diego, CA

Photo No.	Date:
22	3/20/2012

Direction Photo Taken:

Southwest

Description:

View of top of impact berm at Range C.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range C	San Diego, CA

Photo No. 23	Date: 3/20/2012

Direction Photo Taken:

West

Description:

View of standing water after heavy precipitation event in southern side of Range C.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range C	San Diego, CA

Photo No. 24	Date: 3/20/2012

Direction Photo Taken:

South

Description:

View of drain which is located in the side berm separating Range C and Range D.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range D	San Diego, CA

Photo No.	Date:
25	3/20/2012

Direction Photo Taken:

Southeast

Description:

View of target area and impact berm at Range D.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range D	San Diego, CA

Photo No.	Date:
26	3/20/2012

Direction Photo Taken:

Southwest

Description:

View of firing lines at Range D and outfall from Ranges B, C, and D in the background.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range D	San Diego, CA

Photo No. 27	Date: 3/20/2012

Direction Photo Taken:

South

Description:

View of top of impact berm of Range D.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range D	San Diego, CA

Photo No. 28	Date: 3/20/2012

Direction Photo Taken:

South

Description:

View of concrete-lined channel that runs above Ranges B, C, and D.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range D	San Diego, CA

Photo No.	Date:
29	3/20/2012

Direction Photo Taken:

South

Description:

Outfall of concrete-lined channel that runs above Ranges B, C, and D into the Murphy Canyon ephemeral stream.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range D	San Diego, CA

Photo No.	Date:
30	3/20/2012

Direction Photo Taken:

South

Description:

View of outfall to Murphy Canyon ephemeral stream adjacent to Range D.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range D	San Diego, CA

Photo No. 31	Date: 3/20/2012

Direction Photo Taken:

North

Description:

View of outfall to Murphy Canyon ephemeral stream with Range D in the background.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Duffytown Range	San Diego, CA

Photo No. 32	Date: 3/20/2012

Direction Photo Taken:

Northeast

Description:

View of bullet-capturing targets set up at Duffytown Range.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Duffytown Range	San Diego, CA

Photo No. 33	Date: 3/20/2012

Direction Photo Taken:

East

Description:

View of impact berm at Duffytown Range.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Duffytown Range	San Diego, CA

Photo No. 34	Date: 3/20/2012

Direction Photo Taken:

Southwest

Description:

View of drainage trench at Duffytown Range installed by Sheriff's Department which drains towards parking lot between Range 7 and Range B.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Duffytown Range	San Diego, CA

Photo No. 35	Date: 3/20/2012

Direction Photo Taken:

Southwest

Description:
View of natural ephemeral drainage that runs behind the Duffytown Range impact berm as well as the impact berms on Ranges 5, 6, and 7. It drains into the Murphy Canyon ephemeral stream adjacent to the Duffytown Range seen in Photo No. 36.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Duffytown Range	San Diego, CA

Photo No. 36	Date: 3/20/2012

Direction Photo Taken:

Northwest

Description:

View of outfall for drainage from natural ephemeral stream that runs behind impact berms of Ranges 5, 6, 7, and the Duffytown Range.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 5	San Diego, CA

Photo No. 37	Date: 3/20/2012

Direction Photo Taken:

East

Description:

View of firing lines, overhead baffling, sidewall, target frames, and impact berm of Range 5.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 5	San Diego, CA

Photo No. 38	Date: 3/20/2012

Direction Photo Taken:

Northwest

Description:

View of firing lines, overhead baffling, and target frames of Range 5.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 5	San Diego, CA

Photo No. 39	Date: 3/20/2012

Direction Photo Taken:

East

Description:

Close-up view of impact berm at Range 5. Note drainage trench at foot of berm installed by the Sheriff's Department.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 6	San Diego, CA

Photo No. 40	Date: 3/20/2012

Direction Photo Taken:

East

Description:

View of target frames and impact berm at Range 6.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 6	San Diego, CA

Photo No.	Date:
41	3/20/2012

Direction Photo Taken:

North

Description:

View of side wall and firing line at Range 6.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 6	San Diego, CA

Photo No.	Date:
42	3/20/2012

Direction Photo Taken:

Southwest

Description:

Floor drain at the base of the sidewall between Range 6 and Range 7.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 6	San Diego, CA

Photo No. 43	Date: 3/20/2012

Direction Photo Taken:

Southwest

Description:

View of drainage trench at the foot of the impact berm at Range 6 leading across the foot of the impact berm of Range 7.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 7	San Diego, CA

Photo No. 44	Date: 3/20/2012

Direction Photo Taken:

Southeast

Description:

View of target frames and impact berm at Range 7.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 7	San Diego, CA

Photo No.	Date:
45	3/20/2012

Direction Photo Taken:

Southwest

Description:

View of drainage trench at foot of impact berm at Range 7.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 7	San Diego, CA

Photo No.	Date:
46	3/20/2012

Direction Photo Taken:

South

Description:

Close-up of impact berm at Range 7.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 7	San Diego, CA

Photo No.	Date:
47	3/20/2012

Direction Photo Taken:

Southwest

Description:

Range floor drain in southeastern corner of Range 7.

ARCADIS MALCOLM PIRNIE
Infrastructure · Water · Environment · Buildings

PHOTOGRAPHIC LOG

Installation Name:	Site Name:	Location:
MCAS Miramar	Range 7	San Diego, CA

Photo No.	Date:
48	3/20/2012

Direction Photo Taken:

West

Description:

View of outfall of drainage trench at foot of impact berms at Ranges 5, 6, 7, and the Duffytown Range.

Appendix B

Screening-Level Analysis Parameters

Table B-1: Climate Data used in the CalTOX Model

Data Type	Value	Reference(s)
Annual Average Precipitation (in/yr)	12.4	MCAS Miramar, 2007; Izbicki, 1985
Recharge Rate for SW transport (% ppt)	7	Heaton and Giesick, 2002
Annual Average Wind Speed (mph)	5.7	MCAS Miramar, 2007
Annual Average Ambient Environmental Temperature (^{0}F)	63	MCAS Miramar, 2007

Note:

in/yr = inches per year

% ppt = percent precipitation

mph = miles per hour

^{0}F = degrees Fahrenheit

Table B-2: Soil Types, Hydrologic Properties and Parameters used to estimate Soil Erosion

Soil Types and Hydrologic Properties at the EOD Training Range MC Loading Area	
MC Loading Area	EOD Training Range
Land Cover[a]	Sparsely vegetated with DCSS and BSMC
Slope (%)[a]	44
Predominant Soil Type Name and Map Symbol[b]	Stony land (SvE) and Redding Cobbly loam (RfF)
Soil Description[b]	Unweathered bedrock, cobbly loam, cobbly clay and cobbly clay loam
Soil Water Content [c]	0.3
Soil Air Content [d]	0.13
Hydrologic Soil Group[b]	D
Soil Organic Carbon Content (%)[e]	0.29
Soil Bulk Density (kg/m^3)[b]	1550
Runoff Coefficient [f]	0.64
Parameter Values used to Estimate Soil Erosion	
MC Loading Area	EOD Training Range
Area (m^2)	6,313
R [g]	35
K [b]	0.32
LS [h]	5.77
C [i]	0.475
P [j]	1
A (kg/m^2/d)	1.89E-02
Subwatershed Area	West Sycamore Canyon
Area (m^2)	13,454,791
R [g]	35
K [b]	0.32
LS [h]	5.29
C [i]	0.19
P [j]	1
A (kg/m^2/d)	6.91E-03

Note:

A = predicted soil loss
C = cover and magagement factor
K = soil erodibility factor
kg/m^2/d = kilogram per square meter per day
P = erosion control practice factor
% = percent
BSMC = burned southern mixed chaparral
DCSS = disurbed diegan coastal sage scrub
kg/m^3 = kilograms per cubic meter
LS = topographic factor (influence of length and steepness of slope)
R = rainfall and runoff factor

[a] GIS data (MCAS Miramar, 2012a)
[b] USDA NRCS, 2007
[c] Estimated field capacity (Fetter, 1994)
[d] Estimated from soil moisture and porosity
[e] Estimated based on soil organic content
[f] Caltrans, 2006
[g] Brady, 1984
[h] Slope length and gradient were used to select LS (USDA ARS, 1997)
[i] Estimated based on vegetation cover (USDA ARS, 1997)
[j] factor selected based on conservative assumption

Table B-3: Chemical Properties of TNT

Installation name:	MCAS Miramar
Date:	October, 2012
Munitions Constituent:	TNT

Row	Data Type	Description	Source Type	Rationale	Reference(s)	Value/Result		Units	Necessary Actions / Data Gaps
1	Molecular weight	Molecular weight of TNT	☑ Literature ☐ Site Data ☐ Assumption		Walsh et al., 1995		227.1	g/mol	
2	Solubility	Water solubility of TNT	☑ Literature ☐ Site Data ☐ Assumption		Walsh et al., 1995	Minimum: Average: Maximum:	 5.72E-01 	mol/m^3	
3	Vapor pressure	Vapor pressure of TNT	☑ Literature ☐ Site Data ☐ Assumption		Walsh et al., 1995	Minimum: Average: Maximum:	 1.47E-04 	Pa	
4	Henry's law constant	Henry's law constant of TNT	☑ Literature ☐ Site Data ☐ Assumption		HQMC, 2009	Minimum: Average: Maximum:	 1.10E-08 	atm-m^3/mol	
5	Kow	Octanol-water partition coefficient for TNT	☑ Literature ☐ Site Data ☐ Assumption		HQMC, 2009	Minimum: Average: Maximum:	 72.4 	unitless	
6	Koc	Organic carbon partition coefficient for TNT	☐ Literature ☐ Site Data ☑ Assumption		HQMC, 2009	Minimum: Average: Maximum:	 525 	mL/g	
7	K_D	Equilibrium distribution coefficient	☐ Literature ☑ Site Data ☐ Assumption	Estimated from the producte of Koc and soil organic carbon fraction	HQMC, 2009; USDA NRCS, 2007	Minimum: Average: Maximum:	 1.52 	mL/g	
8	Diffusion coefficient in air	Diffusion coefficient of TNT in air	☑ Literature ☐ Site Data ☐ Assumption		HQMC, 2009	Minimum: Average: Maximum:	 6.40E-02 	cm^2/sec	
9	Diffusion coefficient in water	Diffusion coefficient of TNT in water	☑ Literature ☐ Site Data ☐ Assumption		HQMC, 2009	Minimum: Average: Maximum:	 6.71E-06 	cm^2/sec	
10	Half-life in soil	Reaction half-life of TNT in soil	☑ Literature ☐ Site Data ☐ Assumption	A representative value selected by subjuect matter expert based on a compilation of academic, industrial and government references	HQMC, 2009	Minimum: Most likey: Maximum:	 23.1 	days	

Table B-4: Chemical Properties of HMX

Installation name:	MCAS Miramar
Date:	October, 2012
Munitions Constituent:	HMX

Row	Data Type	Description	Source Type	Rationale	Reference(s)	Value/Result		Units	Necessary Actions / Data Gaps
1	Source-term to ground surface soil	Yearly load to soil per unit MC loading area (from MC loading analysis)				Minimum:	3.26E-09	Kg/m^2	
						Average:			
						Maximum:	4.89E-09		
2	Molecular weight	Molecular weight of HMX	☑ Literature ☐ Site Data ☐ Assumption		Walsh et al., 1995		296.2	g/mol	
3	Solubility	Water solubility of HMX	☑ Literature ☐ Site Data ☐ Assumption		Walsh et al., 1995	Minimum:		mol/m^3	
						Average:	1.69E-02		
						Maximum:			
4	Vapor pressure	Vapor pressure of HMX	☑ Literature ☐ Site Data ☐ Assumption		Walsh et al., 1995	Minimum:		Pa	
						Average:	4.40E-12		
						Maximum:			
5	Henry's law constant	Henry's law constant of HMX	☑ Literature ☐ Site Data ☐ Assumption		HQMC, 2009	Minimum:		atm-m^3/mol	
						Average:	2.63E-15		
						Maximum:			
6	Kow	Octanol-water partition coefficient for HMX	☑ Literature ☐ Site Data ☐ Assumption		HQMC, 2009	Minimum:		unitless	
						Average:	1.15		
						Maximum:			
7	Koc	Organic carbon partition coefficient for HMX	☑ Literature ☐ Site Data ☐ Assumption		HQMC, 2009	Minimum:		mL/g	
						Average:	3.47		
						Maximum:			
8	K_D	Equilibrium distribution coefficient	☐ Literature ☑ Site Data ☐ Assumption	Estimated from the producte of Koc and soil organic carbon fraction	HQMC, 2009; USDA NRCS, 2007	Minimum:		mL/g	
						Average:	0.0101		
						Maximum:			
9	Diffusion coefficient in air	Diffusion coefficient of HMX in air	☑ Literature ☐ Site Data ☐ Assumption		HQMC, 2009	Minimum:		cm^2/sec	
						Average:	6.30E-02		
						Maximum:			
10	Diffusion coefficient in water	Diffusion coefficient of HMX in water	☑ Literature ☐ Site Data ☐ Assumption		HQMC, 2009	Minimum:		cm^2/sec	
						Average:	6.02E-06		
						Maximum:			
11	Half-life in soil	Reaction half-life of HMX in soil	☑ Literature ☐ Site Data ☐ Assumption	A representative value selected by subjuect matter expert based on a compilation of academic, industrial and government references	HQMC, 2009	Minimum:		days	
						Most likely:	51.3		
						Maximum:			

Table B-5: Chemical Properties of RDX

Installation name:	MCAS Miramar
Date:	October, 2012
Munitions Constituent:	RDX

Row	Data Type	Description	Source Type	Rationale	Reference(s)	Value/Result		Units	Necessary Actions / Data Gaps
1	Source-term to ground surface soil	Yearly load to soil per unit MC loading area (from MC loading analysis)				Minimum: Average: Maximum:	2.12E-07 3.18E-07	Kg/m^2	
2	Molecular weight	Molecular weight of RDX	☑ Literature ☐ Site Data ☐ Assumption		Walsh et al., 1995		222.1	g/mol	
3	Solubility	Water solubility of RDX	☑ Literature ☐ Site Data ☐ Assumption		Walsh et al., 1995	Minimum: Average: Maximum:	 1.90E-01 	mol/m^3	
4	Vapor pressure	Vapor pressure of RDX	☑ Literature ☐ Site Data ☐ Assumption		Walsh et al., 1995	Minimum: Average: Maximum:	 5.47E-07 	Pa	
5	Henry's law constant	Henry's law constant of RDX	☑ Literature ☐ Site Data ☐ Assumption		HQMC, 2009	Minimum: Average: Maximum:	 1.20E-05 	atm-m^3/mol	
6	Kow	Octanol-water partition coefficient for RDX	☑ Literature ☐ Site Data ☐ Assumption		HQMC, 2009	Minimum: Average: Maximum:	 6.45 	unitless	
7	Koc	Organic carbon partition coefficient for RDX	☑ Literature ☐ Site Data ☐ Assumption		HQMC, 2009	Minimum: Average: Maximum:	 7.76E+00 	mL/g	
8	K_D	Equilibrium distribution coefficient	☐ Literature ☑ Site Data ☐ Assumption	Estimated from the producte of Koc and soil organic carbon fraction	HQMC, 2009; USDA NRCS, 2007	Minimum: Average: Maximum:	 0.023 	mL/g	
9	Diffusion coefficient in air	Diffusion coefficient of RDX in air	☑ Literature ☐ Site Data ☐ Assumption		HQMC, 2009	Minimum: Average: Maximum:	 7.40E-02 	cm^2/sec	
10	Diffusion coefficient in water	Diffusion coefficient of RDX in water	☑ Literature ☐ Site Data ☐ Assumption		HQMC, 2009	Minimum: Average: Maximum:	 7.15E-06 	cm^2/sec	
11	Half-life in soil	Reaction half-life of RDX in soil	☐ Literature ☐ Site Data ☑ Assumption	A representative value selected by subjuect matter expert based on a compilation of academic, industrial and government references	HQMC, 2009	Minimum: Average: Maximum:	 14.2 	days	

Table B-6: Chemical Properties of Perchlorate

Installation name:	MCAS Miramar
Date:	October, 2012
Munitions Constituent:	Perchlorate

Row	Data Type	Description	Source Type	Rationale	Reference(s)	Value/Result		Units	Necessary Actions / Data Gaps
1	Source-term to ground surface soil	Yearly load to soil per unit MC loading area (from MC loading analysis)				Minimum:	1.42E-09	Kg/m^2	
						Average:			
						Maximum:	2.13E-09		
2	Molecular weight	Molecular weight of perchlorate	☑ Literature ☐ Site Data ☐ Assumption		Walsh et al., 1995		99.45	g/mol	
3	Solubility	Water solubility of perchlorate	☑ Literature ☐ Site Data ☐ Assumption		Walsh et al., 1995	Minimum:		mol/m^3	
						Average:	2.01E+03		
						Maximum:			
4	Vapor pressure	Vapor pressure of perchlorate	☑ Literature ☐ Site Data ☐ Assumption		Walsh et al., 1995	Minimum:		Pa	
						Average:	3.75E-09		
						Maximum:			
5	Henry's law constant	Henry's law constant of perchlorate	☐ Literature ☐ Site Data ☑ Assumption	No reported values available; Estmated by CalTOX from vapor pressure and solubility values		Minimum:		atm-m^3/mol	
						Most Likely:	1.85E-17		
						Maximum:			
6	Kow	Octanol-water partition coefficient for Perchlorate	☑ Literature ☐ Site Data ☐ Assumption		Walsh et al., 1995 Meylan and Howard, 1995	Minimum:		unitless	
						Average:	1.40E-06		
						Maximum:			
7	Koc	Organic carbon partition coefficient for Perchlorate	☐ Literature ☐ Site Data ☑ Assumption	Estimated by the CalTOX model based on the Kow for perchlorate		Minimum:		mL/g	
						Average:	6.94E-07		
						Maximum:			
8	K_D	Equilibrium distribution coefficient	☐ Literature ☐ Site Data ☑ Assumption	Estimated from the producte of Koc and soil organic carbon fraction		Minimum:		L/Kg	
						Average:	2.01E-09		
						Maximum:			
9	Diffusion coefficient in air	Diffusion coefficient of perchlorate in air	☐ Literature ☐ Site Data ☑ Assumption	No reported values available, input variables used are based on conservative assumptions		Minimum:		cm^2/sec	
						Average:	7.00E-10		
						Maximum:			
10	Diffusion coefficient in water	Reaction half-life of perchlorate in water	☐ Literature ☐ Site Data ☑ Assumption	No reported values available, input variables used are based on conservative assumptions		Minimum:		cm^2/sec	
						Average:	1.90E-12		
						Maximum:			
11	Half-life in soil	Reaction half-life of perchlorate in soil	☐ Literature ☐ Site Data ☑ Assumption	No reported values available, input variables used are based on conservative assumptions		Minimum:		days	
						Average:	1.00E+07		
						Maximum:			