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FINAL

Range Environmental Vulnerability Assessment

Marine Corps Base Camp Pendleton

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Executive Summary

The United States Marine Corps (Marine Corps) Range Environmental Vulnerability Assessment (REVA) program meets the requirements of the current 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 has been 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 the use of fate and transport screening-level modeling / analysis of the REVA indicator MC. The modeling and analysis is based upon site-specific environmental conditions at the operational ranges and training areas. In addition, environmental sampling is performed, where applicable, to determine whether an actual release of MC has occurred. Indicator MC selected for the REVA program include trinitrotoluene (TNT), cyclotetramethylene tetranitramine (HMX), cyclotrimethylene trinitramine (RDX), and perchlorate.

This report presents the assessment results for the operational ranges and training areas at Marine Corps Base (MCB) Camp Pendleton, California (MCB Camp Pendleton[1]). This report is the first comprehensive report on MC associated with the operational ranges at MCB Camp Pendleton and serves as the baseline of environmental conditions and potential vulnerabilities of the operational ranges. This report presents:

- details on the installation's operational ranges and use of military munitions;
- estimates of "loading rates" of MC at each range or training area based on records of munitions use;
- a prioritization of operational ranges and training areas for evaluation through the REVA process;
- a description of the Conceptual Site Model (CSM) for MCB Camp Pendleton that forms the basis of most assumptions for potential surface water and groundwater pathways for off-range migration of MC;
- screening-level methods for analysis of surface water and groundwater pathways and the results of those analyses;
- a separate, qualitative assessment of selected Small Arms Ranges (SARs); and

[1] All operational ranges and training areas occur on MCB Camp Pendleton; thus, this report reflects the MCB unless otherwise noted.

- results of the REVA field sampling effort in 2008.

REVA is a voluntary, conservative, and tiered process. It applies readily-available information or conservative assumptions on munitions use and physical conditions at the installation to EPA-approved screening-level models. The models are used to predict whether detectable concentrations of MC could migrate off the ranges to areas where human or ecological receptors could potentially be exposed to MC. If the screening-level models predict a detectable concentration of MC off-ranges, then further assessment, such as a field sampling effort, will be conducted. The results of the field activities are compared to screening values identified by the Department of Defense (DoD, 2009) to evaluate the potential for detected concentrations to affect human health or ecological receptors. The potential for off-range migration is assessed separately for SARs because the potential for lead migration and release is not reliably modeled without site specific information, which was not obtained during the baseline assessment.

At MCB Camp Pendleton, screening-level modeling was conducted in three watersheds, San Mateo, San Onofre, and Las Flores, as a first step to assess the potential off-range migration of MC from three high priority (primary) MC loading areas identified through REVA. The models predicted that some MC may be detected on an average annual basis just above the trigger value used for REVA in the surface water and groundwater in the San Onofre and Las Flores watersheds. This trigger value is based on the median value for a set of conservative laboratory method detection limits for individual MC (HQMC, 2006).

Although the MC concentrations were predicted below levels of potential concern, the Marine Corps conducted field sampling activities at off-range surface water and groundwater locations down gradient of the primary MC loading areas in the San Onofre and Las Flores watersheds. The field sampling was conducted to determine whether actual MC migration had occurred as well as provide a general, although not direct, confirmation of the modeling results. Trace concentrations of MC were detected in both watersheds below screening values identified by DoD to assess impact to human health and environment, with one exception for a slight exceedence of an ecological screening value. Nevertheless, to ensure the sustainability of MCB Camp Pendleton operational ranges, options for further management and assessment are being considered for high priority ranges identified through this REVA baseline assessment. In addition, subsequent vulnerability assessments will be conducted on operational ranges at MCB Camp Pendleton on a five-year cycle or when significant changes are made to existing operational ranges that potentially affect the determinations made during this baseline assessment, as described in the *REVA Reference Manual* (HQMC, 2006).

Military Munitions Training and Operations

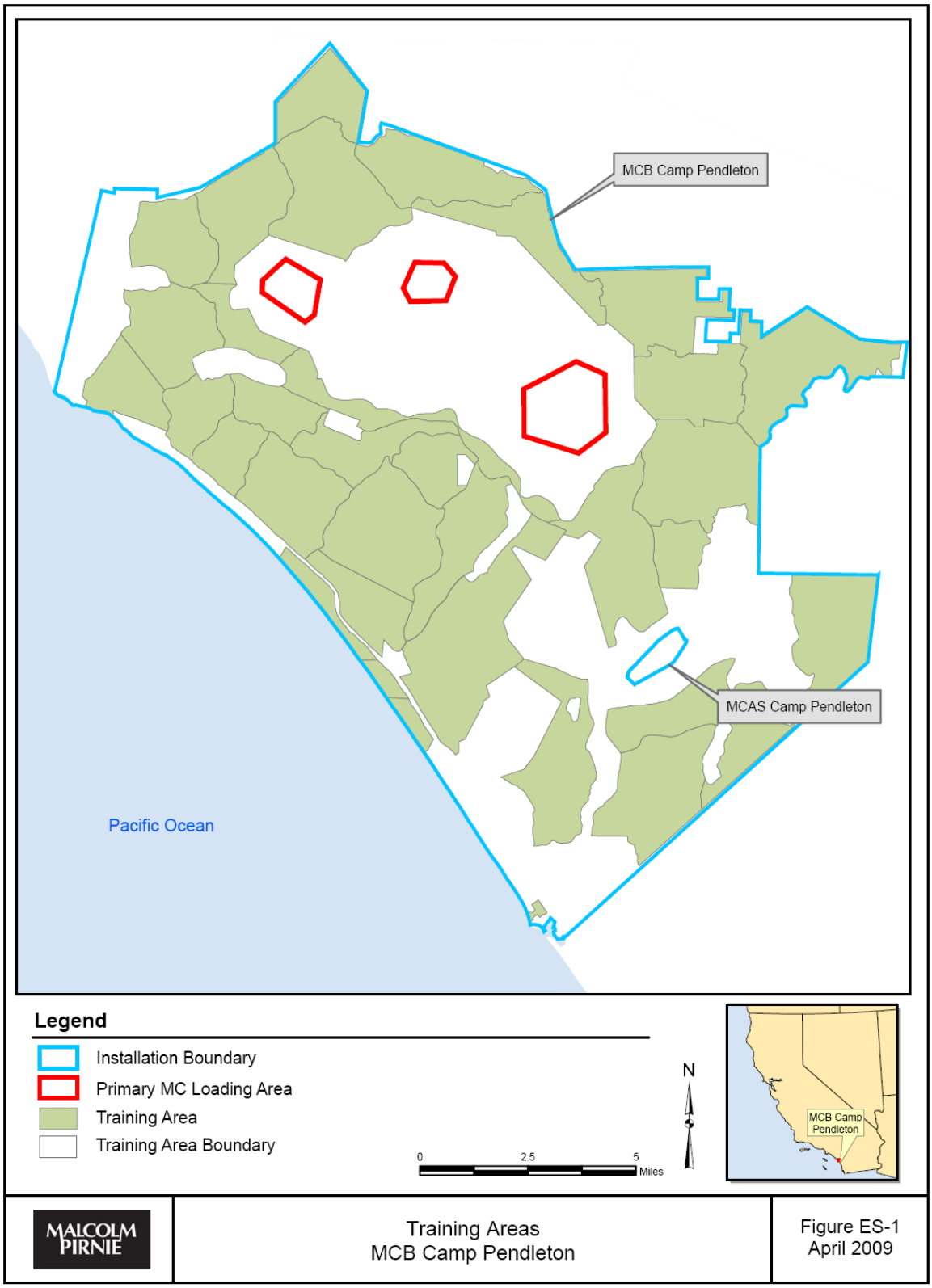
MCB Camp Pendleton is a Marine Corps live-fire training facility that encompasses approximately 125,000 acres of coastal San Diego County, California. MCB Camp Pendleton is located about halfway between San Diego and Los Angeles and has been in existence since 1942. The mission of MCB Camp Pendleton is "to operate the finest amphibious base possible; to promote the combat readiness of Marines and Sailors by providing necessary facilities and services; to support the deployment of the Fleet Marine Force and other organizations; and to provide support and services responsive to the needs of the Marines, Sailors, retirees and families aboard Camp Pendleton" (MCBCP, 2006). The installation is administratively subdivided into 37 Range Training Areas (RTAs), 7 impact areas, approximately 100 live-fire facilities, and 5 amphibious assault beaches (MCB Camp Pendleton, 2006). Three hundred thirty-eight operational range, historical use areas, and fixed ranges are located within the 37 RTAs identified under MCB Camp Pendleton. These training ranges are heavily used, not only by active Marine and Navy units, but also by the Marine Corps Reserve, Army National Guard, local community law enforcement agencies, and private research firms. In addition, the installation includes a number of SARs. The outlines for RTAs and primary impact areas at MCB Camp Pendleton are shown in Figure ES-1.

MC Loading Rates

The REVA fate and transport screening-level modeling / analysis requires estimation of the amount of indicator MC deposited on operational ranges over time in order to predict if there is a potential release or substantial threat of a release of MC. Within the REVA program, this deposition is referred to as MC loading. Operational range usage, boundaries, and other characteristics typically change over time; therefore, an analysis of their history must be performed to map the affected areas over time and to estimate the historical and current MC loading. The MC loading for the operational ranges was estimated separately for each area and period of interest and for each REVA indicator MC.

For the purposes of the REVA program, MC loading estimates were expressed as the average mass deposited annually in the defined area of interest (kilograms per square meter) for the duration of the period that the operational range activities generating the MC loading were conducted. Based on MCB Camp Pendleton interviews, the Quebec, Whiskey and Zulu impact areas were identified as areas where most military munitions were deposited.

Figure ES-1: Training Areas



Range Control estimates that approximately 95% of all current munitions expenditures (excluding small arms) are deposited within the Zulu Impact Area. Although MC loading estimates did not always reflect the information provided through interviews, these areas were identified as the primary target areas receiving the majority of high explosive (HE) munitions. Surface water and groundwater screening-level modeling were performed for these three impact areas.

Fate and transport of lead at SARs is strongly influenced by site-specific geochemical conditions that cannot be determined solely by physical observation. Therefore, MC loading and fate and transport modeling were not conducted for the SARs. Rather, the SARs were qualitatively assessed through the Small Arms Range Assessment Protocol (SARAP). This assessment employs a consistent qualitative approach to identify and assess factors that influence the potential for lead migration at an operational range. As noted above, over 100 live-fire ranges are present at MCB Camp Pendleton. Fifteen small arms ranges were identified with concurrence from Assistant Chief of Staff, Environmental Security (AC/S-ES) and Range Operations & Training Department for qualitative assessment using the SARAP. These SARs were selected using the following general guidelines: the presence of berms; current munitions use, as well as those locations of high munitions expenditures at the installation; and representative of the varied range designs present at MCB Camp Pendleton.

Conceptual Site Model

The REVA process examines surface water and groundwater flow at MCB Camp Pendleton in order to evaluate the potential off-range migration of MC. To this end, a CSM was developed that characterizes the representative physical features of the installation. Key assumptions about surface water and groundwater flow are derived from the CSM and used in the screening-level modeling for MCB Camp Pendleton, such as the following physical descriptors.

The installation area includes about 17 miles of coastline and portions of the Peninsular Range and Coastal Plains physiographic provinces in Southern California. The Coastal Plain extends from the base of the San Onofre Mountains to the Pacific Coast. These mountains occur as erosionally-resistant ridges that rise above the coastal plain to a maximum height of nearly 1800 feet (ft) above mean sea level (amsl). The Peninsular Range extends eastward from the San Onofre Mountains and is characterized by northwest striking faults. Steep-sided river canyons have been incised into the mountains by creeks. The Santa Margarita Mountains are separated from the coastal mountains by low-rolling topography and rise higher than 2000 ft amsl within the boundaries of the installation. The eastern edges of these mountains are part of the Cleveland National Forest.

The area has a mild climate with an annual average daily high temperature of 75 degrees Fahrenheit (°F) and a low of 51°F at lower elevations (NOAA, 2008). Based on 100 years of data, the 2007 Integrated Natural Resources Management Plan (INRMP) reports that lower areas of the base receive an average of about 14 inches of rain each year, with wide swings of minimum/maximum precipitation. Precipitation at higher elevations averages approximately 22 inches, based on 40 years of records. Wide variability in minimum and maximum occurs at the higher elevations as well. Approximately 75% of the installation's precipitation occurs between November and March of each year. The area's year-to-year variability is an important climate characteristic (MCB Camp Pendleton, 2007b). Periods of drought, heavy seasonal rains, and fire are common. Wildfires occur seasonally from May through November, typically during hot, dry Santa Ana wind conditions and when a heavy vegetative fuel load exists.

There are seven major watersheds within MCB Camp Pendleton, two of which extend up gradient beyond the boundary of the installation. They include Aliso, Horno/Coastal, San Luis Rey, Santa Margarita, Las Flores, San Onofre, and San Mateo. Of the seven watersheds, the Santa Margarita watershed has the largest drainage area; however, a large percentage of this drainage area is located outside of the installation boundary. The San Onofre and Las Flores watersheds occur almost entirely within the boundaries of MCB Camp Pendleton. Several of the watersheds on the installation form broad alluvial plains as they approach the Pacific Ocean. The three largest estuaries on the installation are situated at the mouths of the Santa Margarita, Las Flores, and San Mateo streams. Most of the streams on the installation are ephemeral and only flow following successive, major rain events. As noted above, lower precipitation generally occurs in the coastal areas of the installation rather than in the western mountainous areas. Due to the extreme variability of precipitation and runoff, the potential for large floods is high on MCB Camp Pendleton (MCB Camp Pendleton, 2007b).

The CSM prepared for MCB Camp Pendleton depicts a generalized east-west trending geologic cross section for the installation just north of the Las Flores watershed (Ehlig, 1979). The Las Flores watershed is associated with the Zulu Impact Area. This impact area was selected for the development of the generalized CSM because the general physical, topographical, geologic, and hydrologic features in the CSM are similar to those of the other watersheds at the installation where non-small arms are utilized.

The generalized CSM is also used to reflect physical conditions at the San Onofre and San Mateo watersheds on the installation, where the Whiskey and Quebec impact areas are located. The CSM does not reflect the Santa Margarita watershed; however, this watershed was not subject to screening-level modeling through the REVA program due to very low loading of HE and the predominant use of small arms ammunition on operational ranges within that watershed. Selected SARs associated with this watershed were assessed qualitatively.

The CSM for MCB Camp Pendleton strongly suggests that surface water flow drives the potential for off-range migration of MC to human and threatened and endangered (T/E) ecological receptors. In order to migrate to groundwater where drinking water supply wells are located, the CSM suggests that MC must first be present in surface water. Then, surface water must carry MC to the points where alluvial groundwater basins occur and, ultimately, where drinking water wells are found. The steep topography, soil characteristics, fire frequency, and climatic variability at MCB Camp Pendleton produce high erosion rates in many areas. Slopes are particularly vulnerable to erosion following wildfires (MCB Camp Pendleton, 2007b). Erosion and transport of MC from the impact areas to the alluvium may represent an important mechanism for movement off range.

Human and Ecological Receptors

The presence of human and T/E ecological receptors along potential off-range MC migration pathways is central to the MCB Camp Pendleton REVA evaluation. Human receptors may be impacted through potable water supply and recreational water use. Ephemeral streams and other surface water bodies, such as coastal lagoons and freshwater lakes that are located in and around MCB Camp Pendleton, are not used as a potable water supply. Humans potentially use these waters for recreational purposes (such as swimming and fishing), but because a large majority of the water bodies only contain water during the wet season when rain events occur, the potential for their recreational use is limited. In addition, no direct pathways were identified between loading areas and freshwater lakes. The ephemeral streams rarely carry enough flow to reach coastal lagoons or the ocean.

Ephemeral streams draining from MC loading areas largely recharge alluvial groundwater basins that are used as drinking water sources located in the coastal plain downstream of MC loading areas. The alluvial groundwater basins that are located downstream of MC loading areas evaluated through REVA include San Mateo, San Onofre and Las Flores basins. Drinking water supply wells for MCB Camp Pendleton are located in each of these basins. For this reason, ephemeral streams draining from MC loading areas have potential human receptors (through drinking water use).

Additionally, the ephemeral streams can provide temporary support to aquatic/wildlife habitat during wet periods of the year. Federally and state-listed T/E species may consume surface water and shallow groundwater in habitat areas along San Mateo, San Onofre, and Las Pulgas (Las Flores) creeks and the Santa Margarita River; in lagoons shoreward of the beach; and in the Pacific Ocean.

Surface Water Analysis Summary

Under REVA, the screening-level surface water analysis is used to estimate the MC concentrations potentially in surface water runoff at the edge of the MC loading areas. If this analysis predicts impacts at the edge of the loading area, then further calculations are performed to estimate the MC concentration at a downstream receptor.

At MCB Camp Pendleton, surface water screening-level analysis was conducted for three watersheds that receive the most MC loading: the San Mateo, San Onofre, and Las Flores watersheds. Ranges and impact areas were grouped by each of these watersheds for modeling. For each watershed, MC contributions in runoff from the three primary MC loading areas (Quebec, Whiskey and Zulu) were used to estimate the total loads reaching potential human and ecological receptors.

Average annual surface water concentrations of the indicator MC (TNT, RDX, HMX, and perchlorate) were estimated based on the average annual MC loading of each indicator MC to each MC loading area. The concentrations draining from MC loading areas to surface water entering the alluvial groundwater basins were also estimated. These estimated concentrations were compared to established REVA trigger values for each MC (Table ES-1).

Table ES-1
REVA Trigger Values

MC	REVA Trigger Value (µg/L)[a]
HMX	0.08
RDX	0.16
TNT	0.08
Perchlorate	0.98

Note:
µg/L – micrograms per liter
[a]REVA trigger values are the median representative screening threshold values, for surface water or groundwater modeling, obtained from certified analytical laboratories for each indicator MC as defined in the *REVA Reference Manual (HQMC,2006).*

Surface water modeling results indicate that surface runoff could potentially exceed REVA trigger values for one or more indicator MC at all modeled MC loading area boundaries and at locations where the surface water recharges groundwater in the San Onofre and Las Flores watersheds. Potentially complete pathways exist for both human and T/E ecological receptors. Drinking water supply wells are installed in the alluvial groundwater basins in the San Onofre and Las Flores watersheds, where MC concentrations in surface water recharging the groundwater are expected to be above the REVA trigger values. Based on these predicted results, surface water sampling was conducted down gradient of operational ranges in the San Onofre and Las Flores

watersheds. A background surface water sample was collected up gradient of operational ranges in the San Mateo watershed.

Groundwater Analysis Summary

Based on the CSM and the results of the surface water modeling, fate and transport modeling of potential MC concentrations in groundwater through screening-level analysis was conducted for the San Onofre and Las Flores alluvial groundwater basins. These groundwater basins are located within MCB Camp Pendleton and are down gradient of the primary MC loading areas (Quebec, Whiskey and Zulu).

Ranges and impact areas were grouped by watershed for modeling. For each watershed, MC contributions in runoff from the three primary MC loading areas were used to estimate the total loads reaching potential receptors. The results of the surface water screening-level model were used as the input for the groundwater modeling based on the analysis of the CSM. The screening-level groundwater methodology was used to estimate the concentration of MC at drinking water wells located down gradient of the surface water recharge points. These estimated MC concentrations were compared to established REVA trigger values for each MC.

Screening-level model results for MCB Camp Pendleton watersheds predicted the groundwater concentration of RDX within the San Onofre alluvial groundwater basin above the REVA trigger value in the drinking water supply well located closest to the up gradient groundwater recharge area. The concentration of TNT in the San Onofre groundwater basin and the concentrations of RDX and TNT in the Las Flores groundwater basins are predicted to be below the REVA trigger values. Based on the screening-level analysis that predicts the concentration of RDX above the REVA trigger value, a conservative decision was made to conduct groundwater sampling in both the San Onofre and Las Flores alluvial groundwater basins.

SAR Assessments

Lead is the primary MC of concern at SARs because it is the most prevalent (by weight) potentially hazardous constituent associated with small arms ammunition. As previously mentioned, modeling parameters for lead fate and transport are contingent upon site-specific geochemical data that are generally unavailable during a baseline assessment. Therefore, SARs are qualitatively assessed under the REVA program's SARAP to identify factors that influence the potential for lead migration.

There are 15 SARs located at MCB Camp Pendleton assessed using the REVA SARAP. Two are located within the Santa Margarita watershed, one is located in the Las Flores watershed, five are within the San Onofre watershed, and one is located in the San Mateo

watershed. Six of the SARs are located in the Aliso watershed; however, no drinking water wells are located in this watershed.

These SARs were selected to correspond with a separate small arms study conducted by the installation in 2007 with concurrence from AC/S-ES and Range Operations & Training Department. The SARs represent a cross-section of range designs, with SAR-only use, as well as locations of high munitions use and environmental sensitivity related to potential lead migration. The name, size and orientation of each range were collected from the MCB Camp Pendleton Final Range Identification and Preliminary Range Assessment (RIPRA) (MCB Camp Pendleton, 2001a) and Installation Map (MCB Camp Pendleton, 2001b).[2]

The installation's small arms study was completed as a voluntary pollution prevention program in response to reporting requirements for facilities that manufacture, process, or otherwise use listed constituents above certain thresholds. Consequently, the purpose of the installation's small arms study was to proactively identify and assess opportunities to implement engineering controls at selected small arms ranges at the installation to reduce potential migration of lead and other constituents related to small arms munitions. The information compiled for the installation's study, together with these REVA SARAP results, forms a basis for prioritizing SARs for further action and provides an assessment of potential control options to prevent lead migration from these ranges.

The analysis of 15 SARs at the installation resulted in minimal, moderate, or minimal to moderate environmental concern rankings for surface water, based on the SARAP and professional judgment. These SARs received minimal to moderate, moderate, or moderate to high environmental concern rankings for groundwater. Eight ranges located in the San Onofre, San Mateo, and Santa Margarita watersheds received a moderate to high environmental concern ranking for groundwater, primarily based on uncertainties in groundwater information used in the assessment. Where uncertainties exist, a conservative scoring approach is used in the SARAP. The differences in rankings for the ranges were due primarily to the amount of lead loading (based on number of rounds fired and type of small arms ammunition use) and factors that may increase or decrease the potential for lead migration and bioavailability, such as soil type, slope of berm, condition of berm, drainage and vegetation, and engineering controls or berm maintenance applied at each SAR.

Field Sampling Activities

The initial assessment of the screening-level surface water and groundwater modeling

[2] Visual estimates of range size and orientation are provided based on site visit measurements and observations and GIS mapping when RIPRA sizing did not match current range operations.

predicted low levels of explosives potentially present within the Las Flores and San Onofre watersheds. As a result, groundwater and surface water sampling was recommended for these watersheds. Sampling events were conducted between December 2007 and April 2008.

The field sampling effort did not include the Santa Margarita watershed because the operational ranges within this watershed are primarily SARs, which were assessed qualitatively. Further assessment of the watershed for lead by field sampling or the application of best management practices is continually being evaluated by the Marine Corps based on the results of the SAR assessments. The installation routinely samples drinking water at MCB Camp Pendleton for lead and reports results in accordance with U.S. Environmental Protection Agency (USEPA) and California requirements.

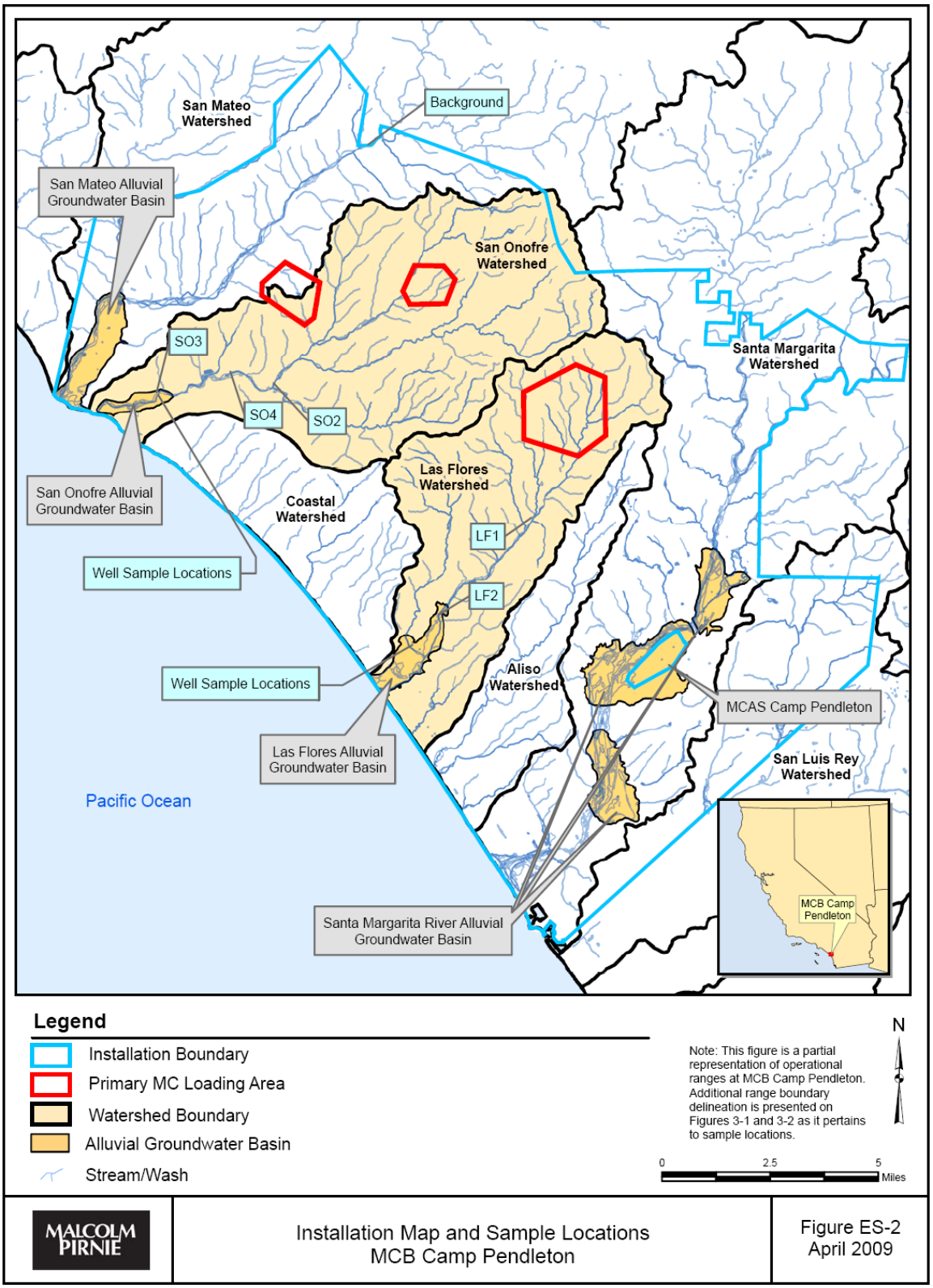
Field activities included sampling of off-range surface water and groundwater at the following locations (Figure ES-2):

- Five surface water locations, down gradient of operational ranges, in the Las Flores and San Onofre watersheds, following three rain events in the 2007–2008 rainy season
- Raw water from seven operational or proposed drinking water supply wells (three wells in Las Flores and four wells in San Onofre watershed)
- Surface water at one background location, upgradient of operational ranges, in upper San Mateo Creek

Sample locations were selected based on modeling results for HE at mixed use ranges, not on the results of the SARAP.

All samples were analyzed for the full suite of explosives, excluding perchlorate, and total and dissolved lead. Perchlorate was not included in these REVA sampling events for two reasons. First, concentrations were not predicted in the conservative REVA modeling results. In addition, drinking water supply wells are routinely sampled and analyzed for perchlorate to comply with the Unregulated Contaminant Monitoring Rule (UCMR).

Figure ES-2: Installation Map and Sample Locations



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On the basis of that sampling program, the installation reports that water supply wells do not contain detectable concentrations of perchlorate (MCB Camp Pendleton OWR, 2008).

Lead was included in the field sampling as a proactive measure at locations already selected on the basis of predicted HE concentrations. Lead is also known to be a constituent of HE munitions, therefore, its inclusion was expected to provide an indicator of possible heavy metal constituents.

Groundwater Sampling Results

Nine groundwater samples were collected from seven wells on December 12, 2007, and six groundwater samples from three wells on April 30, 2008. Samples collected on December 12, 2007, were analyzed for the full suite of explosives as described above and total and dissolved lead. Follow-up samples collected on April 30, 2008, were analyzed for the full suite of explosives or total and dissolved lead, based on earlier sampling results. Follow-up samples were collected from wells and analyzed for the corresponding analyses (explosives or lead) that were detected in the initial sampling event.

The analytical results were compared to DoD Range and Munitions Use Subcommittee (RMUS) screening values (DoD, 2009), which were developed from existing USEPA or state standards and guidelines to promote consistency across the services' operational range assessment programs.

Sample results within Las Flores indicate that no explosives were detected in drinking water supply wells. Total and dissolved lead were detected in raw groundwater at one well for samples collected in December 2007 and April 2008, but these detections are below DoD RMUS screening values.

Sampling results within the San Onofre watershed indicate trace amounts of explosives (2-nitrotoluene, 3-nitrotoluene, and RDX), but concentrations are below DoD RMUS screening values. The explosive 2-nitrotoluene, a daughter product of TNT, was detected in only one groundwater well during the December 2007 sampling event. It was re-sampled in April 2008, and no explosives were detected. This well is not yet used as a water supply well. Trace concentrations of total lead were positively identified in two other wells in December 2007, but were not detected in one of the two wells in April 2008. The second well was not available for re-sampling in April 2008 due to mechanical issues with the pump.

Surface Water Sampling Results

Surface water sampling events were timed to occur within 24 hours of three separate storms that produced surface flow in either or both of the watersheds selected for field activities. Two sampling events were conducted at each watershed. The events provide insight to surface water quality in the early and middle part of the 2007–2008 rainy season. All samples were analyzed for the full suite of explosives and total and dissolved lead, excluding perchlorate, as discussed earlier.

Explosives and total lead were not detected in the background sample taken in surface water in the upper San Mateo watershed. Due to issues with sample preservation, the result for dissolved lead is not usable for project objectives; however, the analytical results for total lead suggest that concentrations of dissolved lead were below the laboratory method detection limit.

The analytical results for the surface water samples collected in the Las Flores watershed are summarized as follows:

- Explosives were not detected in surface water samples.
- Dissolved lead was detected at one downstream sampling location in December 2007 at concentrations above the DoD RMUS ecoreceptor screening value for surface water of 2.5 µg/L.[3] However, when the screening value was adjusted to reflect site-specific water hardness, dissolved lead concentrations were below the adjusted screening value.
- Dissolved lead was not detected in either Las Flores surface water sampling location in the February 2008 sampling event.

The analytical results for the surface water samples collected in the San Onofre watershed are summarized as follows:

- Trace amounts of explosives were detected in some surface water samples. All detections were below DoD RMUS screening values for these MC or an applicable screening value was not available.
    - 2-Nitrotoluene was detected in surface water at two of the downstream locations in this watershed; however, one detection was slightly above the laboratory reporting limit (RL). There is no DoD RMUS screening value for 2-nitrotoluene in surface water at this time.
    - 3-Nitrotoluene was detected below the laboratory RL at a downstream location in the February 2008 sampling event.

[3] Values are based on DoD RMUS screening values as Surface Water Values-Ecological Receptors (DoD, 2009)

  - RDX was detected above the laboratory RL at all three sampling locations in the January 2008 sampling event, but was not detected in the February 2008 sampling event. The detections were below the DoD RMUS screening value of 190 µg/L.[4]

- Total lead was detected in all surface water samples during both sampling events. Total lead results in surface water were above the laboratory RL at all three sampling locations in January 2008. Corresponding nephelometric turbidity units (NTU) values for turbidity were also high in this early season event (70 to greater than 999 NTU).
- Dissolved lead was detected in all samples collected during the January 2008 sampling event, but was not detected during the February 2008 sampling event. All dissolved lead concentrations were above the DoD RMUS ecoreceptor screening value of 2.5 µg/L.[5] However, when the screening value was adjusted to reflect site-specific water hardness, the dissolved lead concentration at one sample location slightly exceeded the adjusted screening value.

Following a review of the sample results, a literature review was conducted in concert with installation natural resources personnel in order to evaluate whether the concentrations of lead in surface waters in the watersheds at MCB Camp Pendleton would affect threatened and endangered species. The literature review indicated that adverse effects were unlikely to occur because: exposure was unlikely due to the intermittent nature of the surface water creeks, species studied would not be exposed to waters in the creeks, or concentrations of lead were below levels that would adversely affect certain species.

However, base flow had been observed by the REVA assessment team at the upstream sampling location in the Las Flores watershed prior to the 2007–2008 rainy season.

Conclusions and Further Action

The results suggest that a seasonal first flow of MC may have been followed by diminished concentrations as the rainy season continued. Comparing the seasonal first flow results to the DoD RMUS screening values reflects a conservative approach because the values are calculated based on exposure over long periods of time. For example, hydrologists at MCB Camp Pendleton have observed that surface water flow in the San Onofre watershed is, at a maximum, sustained for only a few days per year, depending on

[4] Ibid.
[5] Ibid.

seasonal rainfall. At the San Onofre watershed sampling locations, no surface water flow had occurred for three years prior to starting these field activities.

Overall, the field sampling effort generally confirmed modeling results, which were based on conservative assumptions. Although modeling results reflects concentrations over an average year, the conditions prior to field sampling are not reflective of average conditions. There had been little to no rainfall for three years, potentially allowing for accumulation of indicator MC and lead. Severe wildfires had burned through both watersheds just prior to sampling, increasing the potential for erosion and runoff. It is of note that concentrations decreased from the December 2007 sampling event to the February 2008 sampling event. From this perspective, sampling results may be considered a conservative snapshot of off-range MC migration at the time they were collected and are not necessarily representative of a long-term trend.

Based on the assessment results presented in this report, no immediate environmental concern was identified through the screening level models, field sampling activities, or the use of the SARAP. Nevertheless, the Marine Corps is evaluating further actions to continue to mitigate the possibility of MC migration from operational ranges at MCB Camp Pendleton and to ensure future range sustainability.

To view the complete report, please go to http://www.pendleton.usmc.mil/base/environmental/REVA/CPEN_REVA_September_2009.pdf