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FINAL

Range Environmental Vulnerability Assessment

Marine Corps Air Station Yuma

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Report Prepared By:

Malcolm Pirnie, Inc.

5975 Castle Creek Parkway North Drive
Suite 355
Indianapolis, IN 46250
317-594-0989

4418024

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 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, development of conceptual site model (CSM), and, where applicable, screening-level fate and transport modeling of the REVA indicator MC. Indicator MC selected for the REVA program include octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), trinitrotoluene (TNT), and perchlorate.

This report presents the assessment results for the operational land-based ranges and training areas managed by Marine Corps Air Station (MCAS) Yuma, which include the Chocolate Mountain Aerial Gunnery Range (CMAGR) located in Riverside and Imperial counties, California, and the western portion of the Barry M. Goldwater Range (BMGR West) located in Yuma County, Arizona. This report is the first comprehensive report on MC associated with the operational ranges at MCAS Yuma, also referred to as Yuma Training Range Complex (YTRC), and provides a baseline assessment of environmental conditions and potential vulnerabilities associated with the operational ranges. Subsequent vulnerability assessments will be conducted on operational ranges at MCAS Yuma on a five-year cycle or when significant changes are made to existing ranges that potentially affect the determinations made during this baseline assessment, as described in the *REVA Reference Manual* (Malcolm Pirnie, 2006).

Military Munitions Training and Operations

YTRC is a military aviation training facility composed of airspace and lands located in southwestern Arizona and southeastern California. YTRC includes CMAGR and about 5,000 square miles of airspace designated for military use in California and BMGR West and approximately 5,000 square miles of airspace designated for military use in Arizona. YTRC is the only location available to and operated by the Marine Corps where the primary mission is to provide full spectrum support for Marine Corps tactical aviation training.

Together, CMAGR and BMGR West comprise more than 1,900 square miles of lands that have been employed as aerial gunnery and bombing training areas since they were established during the World War II period. CMAGR is approximately 469,000 acres, while BMGR West is approximately 679,000 acres. Ongoing military use of the land is authorized under various federal Public Laws and Public Land Orders. Examples of some of the existing facilities used for training include an auxiliary airfield complex, realistic targets for air-to-ground attack, air-to-air firing ranges, and electronic warfare training ranges.

All YTRC range areas are managed by the Range Operations Section / Range Control. Air-to-ground fire in YTRC is directed at discrete target areas. Targets in BMGR West are restricted to inert munitions and/or electronic scored weapons only. A wide variety of high explosive (HE) munitions are authorized for targets in CMAGR, except for areas within 8 nautical miles of the town of Niland, which are restricted to inert munitions only. In addition, the installation manages two small arms ranges (SARs) in BMGR West. The Navy Sea, Air, and Land forces (SEALs) maintain 27 range training areas within CMAGR, including four SARs. Range Control provided military munitions expenditure data for the installation from 2001 through

2005 and noted the training areas that received the greatest level of use for both current and historical periods.

A total of 81 range areas were identified on YTRC. These were screened to eliminate ranges operating under Resource Conservation and Recovery Act permit authority, ranges where no HE use is authorized, SARs, and ranges for which insufficient data are available to permit MC loading calculations. The 52 ranges that passed this screening were designated MC loading areas, and numerical estimates of MC loading rates were calculated for each area. The MC loading rates at 27 of these sites were found to be potentially significant (greater than 1 milligram per square meter per year); these ranges were designated medium or high priority MC loading areas on the basis of the total estimated annual mass of MC deposited in each area (Table ES-1). The potential for off-range MC transport from the priority MC loading areas was assessed using screening-level surface water and groundwater models developed on the basis of the CSM.

Table ES-1.
YTRC MC Loading Prioritization

Area	MC Loading Area	MC Loading Priority
CMAGR North	2N (Punchbowl)	High
	3N (Deadman)	Medium
	9N	High
	10N (Punchbowl)	High
	11N (Punchbowl)	High
	13N (Iris Pass)	Medium
	14N (Iris Pass)	High
	Rockeye (ICM Box)	High
	Navy SEAL SWTA S-4-1	High
	Navy SEAL SWTA S-4-2	Low
	Navy SEAL SWTA S-4-3	Low
	Navy SEAL SWTA S-4-4	Low
	Navy SEAL SWTA S-4-8	Low
	Navy SEAL SWTA S-4-9	Low
	Navy SEAL SWTA S-4-10	Low
	Navy SEAL SWTA S-4-11	Low
	Navy SEAL SWTA S-4-12	Low
	Navy SEAL SWTA S-4-13	Low
	Navy SEAL SWTA S-4-14	Low
	Navy SEAL SWTA S-4-15	Low
	Navy SEAL SWTA S-4-16	Low

Area	MC Loading Area	MC Loading Priority
	Navy SEAL SWTA S-4-17	Low
	Navy SEAL SWTA S-4-18	Low
	Navy SEAL SWTA S-4-19	Low
	Navy SEAL SWTA S-4-20	Low
	Navy SEAL SWTA S-4-21	Low
	Navy SEAL SWTA S-4-22	Low
	Navy SEAL SWTA S-5-1	Low
	Navy SEAL SWTA S-5-2	Low
	Navy SEAL SWTA S-5-3	Low
	Navy SEAL SWTA S-5-4	Low
	Navy SEAL SWTA S-5-5	Low
	Deadman	Medium
	Iris Wash	Medium
	Punchbowl	High
CMAGR South	1S	Medium
	2S (Blue Mountain)	Medium
	3S	Medium
	4S	Medium
	5S	Medium
	6S (Blue Mountain)	Medium
	7S	Medium
	8S (Blue Mountain)	High
	10S	Medium
	11S	Medium
	12S (Blue Mountain)	Medium
	13S	Medium
	14S	Medium
	15S (Blue Mountain)	High
	Mt. Barrow	High
BMGR West	Yodaville	Low
	Cactus West	Low

Note:

BMGR = Barry M. Goldwater Range
CMAGR = Chocolate Mountain Aerial Gunnery Range
Mt. = Mount
SEAL = Sea, Air, and Land
SWTA = Special Warfare Training Area
Navy SEAL SARs and BMGR West rifle and pistol ranges were qualitatively assessed using the REVA SAR Assessment Protocol.

SARs were qualitatively assessed using the REVA SAR Assessment Protocol (Malcolm Pirnie, 2006). SAR assessments focus on the potential for lead migration in surface water and groundwater.

CSM

Operational range areas managed by MCAS Yuma consist of airspace and land ranges in CMAGR and BMGR West, two areas separated by at least 100 miles and located in different states (California and Arizona). CMAGR is located in the Lower Colorado River Valley Subdivision of the Sonoran Desert and is characterized by rugged terrain consisting of desert, mountains, and dry washes. BMGR West is located in the Sonoran Desert and is characterized by terrain consisting of desert, mountains, and broad dry washes.

Aerial gunnery, bombs, and rocket training activities are directed at discrete target complexes within CMAGR North and South and in BMGR West. The target complexes are located on relatively flat alluvial deposits, but may be flanked by more rugged mountain and wash terrain. All of the CMAGR target complexes are located north and east of the Chocolate Mountains ridgeline, away from any populated areas. Drainage from most of the target areas is to the Salton Sea, although several drain to the Colorado River. Target complexes in the BMGR West are located in the flat-lying Yuma Desert portion of the range.

CMAGR and BMGR West receive an average of less than 3 inches of precipitation per year. The majority of precipitation is lost to evaporation without producing any runoff, but during heavy rainfall events, flash flooding can occur in major washes, which discharge off the installation. Some runoff from the range area is also lost to shallow groundwater through sinks, which typically are located near the toe of the alluvial fans that border the mountain ranges, and especially in areas where the drainages are blocked by dune fields.

Groundwater in CMAGR and BMGR West is found in the alluvium-filled basins that flank the bedrock uplands. Very little information on groundwater within CMAGR is available, while water resources underlying the Yuma Desert have been more extensively investigated. Known groundwater usage in areas potentially affected by activities within the YTRC occurs only in the Milpitas Wash Basin east of the CMAGR, where wells associated with an unregistered subdivision are used for water supply; however, only two wells are located directly down gradient from any MC loading areas. These wells are classified as obstructed.

Screening-Level Surface Water Transport Analysis

Fate and transport analysis of potential MC migration via surface water was conducted as part of the vulnerability assessment for MCAS Yuma. The screening-level fate and transport analysis was conducted for all 25 current primary MC loading areas in CMAGR. The Cactus West and Yodaville MC loading areas in BMGR West are also included to assess the potential MC migration from those areas. Historical MC loading areas were not modeled separately because most historical MC loading coincides with areas of current loading. This methodology was selected to provide conservative estimates of the average annual dissolved-phase and sorbed-phase concentrations of MC in runoff. MC concentrations in surface water were estimated under two scenarios:

- At the edge of the MC loading areas
- At the final discharge locations (e.g., the range boundary), accounting for down gradient mixing

For surface water modeling of discharge at the range boundary, the MC loading areas were grouped by watershed. MC loading areas that contribute runoff to a common discharge point at the CMAGR boundary were modeled together. In some cases, portions of an individual MC loading area drain to two separate points of discharge at the range boundary; in such cases, the MC loading was split according to the percentage of the MC loading area in each watershed. Model results were compared to REVA trigger values, which are set equal to the average analytical detection limit for each MC of interest.

The screening-level analysis concluded that average annual concentrations of all indicator MC would exceed REVA trigger values in runoff at the edges of all CMAGR MC loading areas modeled. Concentrations of HMX from all CMAGR MC loading areas were predicted to be below the REVA trigger value at the range boundary. Concentrations of RDX and TNT at modeled CMAGR MC loading areas were predicted to potentially exceed their respective trigger value at the range boundary. The perchlorate concentration was predicted to exceed the REVA trigger value at the range boundary in the 9N and Blue Mountain watersheds only. The screening-level analysis also concluded that average annual concentrations of all indicator MC, except for RDX, would be below REVA trigger values at the edge of all BMGR West MC loading areas. RDX is predicted to slightly exceed the REVA trigger value. All MC are predicted to be below REVA trigger values at the BMGR range boundary. Table ES-2 summarizes the results of surface water modeling. The surface water modeling results, together with groundwater modeling results, were used in a receptor analysis, as discussed below.

Table ES-2.
Estimated Concentrations of MC from Surface Water Screening-Level Analysis

MC Loading Area	Watershed	Predicted MC Concentrations, µg/L							
		MC Loading Zone Boundary				Range Boundary			
		HMX	RDX	TNT	Per-chlorate	HMX	RDX	TNT	Per-chlorate
REVA Trigger Value		0.08	0.16	0.08	0.98	0.08	0.16	0.08	0.98
ICM Box, 13N	Siphon 9	**1.56**	**156**	**126**	**13.5**	0.0685	**6.84**	**5.52**	0.594
2N, 14N, SWTA S-4-1, portions of 10N and 11N	Siphon 10	**1.10**	**510**	**440**	**37.1**	7.63E-3	**3.53**	**3.04**	0.257
3N, portions of 10N and 11N	Siphon 12	**0.423**	**161**	**160**	**14.5**	9.20E-3	**3.50**	**3.47**	0.315
9N	9N	**1.39**	**495**	**374**	**50.5**	0.0318	**11.3**	**8.57**	**1.16**
1S–8S and 10S–15S	Blue Mountain	**0.524**	**126**	**101**	**19.9**	0.0375	**8.98**	**7.18**	**1.41**
Mt. Barrow	Mt. Barrow	**0.952**	**239**	**230**	**23.6**	0.0133	**3.34**	**3.22**	0.329
Yodaville, Cactus West	Yuma Desert	NA	**0.204**	8.91E-3	0.712	NA	5.52E-4	2.41E-5	1.93E-3

Note:
Siphon: drainage structure designed to separate surface runoff from flow in the Coachella Canal, on the western CMAGR boundary
Bold indicates that the predicted concentration exceeds the REVA trigger value.
HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
ICM = Improved Conventional Munitions
MC = Munitions Constituents
Mt. = Mount
NA = not applicable (no loading for the MC)
RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine
REVA = Range Environmental Vulnerability Assessment
SWTA= Special Warfare Training Area
TNT = Trinitrotoluene
µg/L = micrograms per liter

Screening-Level Groundwater Transport Analysis

Screening-level groundwater modeling was conducted only for the Blue Mountain watershed because Blue Mountain is the only watershed with potential human groundwater receptors. MC concentrations in groundwater were assumed to be equal to MC concentrations in surface water at the range boundary. The model BIOSCREEN was used to assess MC transport from the range boundary to the nearest potential groundwater point of exposure 1 mile down gradient. No MC were predicted to exceed REVA trigger values at the nearest potential groundwater point of exposure.

Receptor Analysis

Because surface water in the washes draining from the CMAGR and BMGR West is not used as a potable water source, as an irrigation water source, or for any contact activity, either on range or off range, no human receptors were identified. Because there is no complete exposure pathway to MC in surface water draining from the YTRC, there is no potential risk to human health via this pathway.

Potential receptors for MC dissolved in surface water are limited to ecological receptors with habitat areas on range and within or near the microphyll woodlands associated with the major washes outside the range boundary. Habitat for the federally threatened desert tortoise is found throughout broad areas of CMAGR. However, this species is unlikely to consume the intermittent surface water within the washes, as it typically obtains all of its water requirements through consumption of plants and prey. Potential receptors utilizing surface water washes within the installation boundaries were not considered because the REVA program is limited to the assessment of off-range MC releases. MCAS Yuma maintains other programs to minimize the impacts of training to on-range wildlife and natural resources.

An ecotoxicity analysis conducted for identified threatened and endangered ecological receptors potentially interacting with surface water outside the range boundary (e.g., the Sonoran pronghorn) indicates that the toxicity threshold for these receptors is several orders of magnitude above the estimated MC concentrations reaching the range boundary. Therefore, no further action is warranted for potential MC releases from YTRC target complexes.

SAR Assessments

Qualitative assessment of the two SARs in BMGR West indicates minimal potential for lead migration from these facilities in the surrounding surface water or groundwater. The lack of nearby receptors, moderately alkaline soil and groundwater pH, and well-maintained engineering controls at the facilities limit the potential for lead migration in the environment. The SARs operated by the Navy SEALs in CMAGR North were not evaluated because available data were not sufficient to complete the analysis. The SEAL facilities share many of the structural and environmental characteristics of the BMGR West SARs and are not anticipated to present any immediate environmental concerns.

To view the complete report, please go to:
http://www.yuma.usmc.mil/services/environmental/documents/reva.pdf