3.0 PHYSICAL SETTING

3.1 Climate

Precipitation averages just over 10 inches annually at MCAS Miramar, generally associated with low intensity storms in winter and spring. Frosts are light and infrequent, with the growing season ranging from 345 to 360 days. Winds are usually gentle and come from the west, especially during summer afternoons. The average annual temperature is about 63 degrees Fahrenheit. The average daily high is 71 degrees, and the low averages 53 degrees. Weather patterns are dominated by a subtropical ridge with a shallow marine layer and pronounced low-level inversion and moderating effects of the California current off-shore. This Mediterranean climate creates a semi-arid condition, with warm, dry summers and mild winters. Weather data are available from the Marine Corps Meteorology and Oceanographic Command Detachment on MCAS Miramar and from the National Weather Service at Lindbergh Field, the commercial San Diego Airport.

Four climatic aspects affect erosion on the Station (Kellogg and Kellogg 1991):

- ***temperature mildness*** (*i.e.*, warm summers, cool winters), which results in comparatively immature Station soils with a low tolerance to erosive forces;
- ***Mediterranean semi-aridity*** (*i.e.*, Mediterranean precipitation pattern fosters high erosion rates because ground protection is least when precipitation peaks) (Kirkby 1980);
- ***winter storm progression*** (*i.e.*, the amount of soil moisture before an intense storm); such storms create significant sheet and rill erosion unless the ground is dry enough to absorb water quickly; and
- ***"fire weather"*** *(i.e.*, extremely dry, warm fall winds), which results in wildfires that create conditions conducive to extremely high soil loss during storms. Firebreaks[5] used to control wildfire damage are secondary erosion agents.

Hazardous fire conditions occur during fall when there are very dry, warm winds and vegetation is dry. High erosion rates can result when intense storms follow a fire. Fire is a natural component of the southern California landscape, thus, the vegetation at MCAS Miramar is adapted to occasional fires. However, the risk of large-scale, disastrous fire has increased with urbanization and past fire suppression policies.

3.1.1 Climate Change

DoD Instruction 4715.03 requires DoD to address potential impacts of climate change on natural resources in INRMPs using the best science available. The 2014 *DoD Climate Change Adaptation Roadmap*, and the Congressional Report's *National Security Implications of Climate-Related Risks and a Changing Climate*, identify risks of climate change on the mission and specific actions to strengthen planning for natural resource management to adapt to climate change.

Regional Climate Change

In general, the third National Climate Assessment published (May 2014) notes that certain types of weather events have become more frequent and/or intense, including heat waves, heavy downpours, and in some regions, floods and droughts. Sea levels are rising, oceans are becoming more acidic, and glaciers and arctic sea ice are melting. Scientists predict that these changes will continue and even increase in frequency or duration over the next 100 years.

[5] MCAS Miramar has converted its former firebreaks to fuelbreaks, which are less prone to significant erosion.

A few trends in California include a larger proportion of precipitation falling as rain instead of snow (CA Climate Change Center 2012), and in southern California, projections of pronounced springtime warming, a greater increase in summer vs. winter temperatures, and more frequent, hotter, and longer heat waves occurring earlier in the season and lasting through fall (CA Climate Change Center 2012). Several climate models predict that southern California will decrease in precipitation in the future. Some climate models show that in the San Diego region, the 30-year average precipitation will decrease by more than 8 percent by 2050 compared to historical conditions (CA Climate Change Center 2012). Under this scenario, the already highly variable rainfall pattern would continue, but with drier soils there would be less vegetation overall and increased erosion and runoff during large storms.

Future Climate Change Projections

Due to the high complexity and high uncertainty involved with climate change adaptation planning and implementation, the use of best available climate-monitoring data for the region is key. Some of the information that will be used in this INRMP include: historical regional trends, projections of future climate or sea level rise, information from regional collaboration to develop vulnerability assessments, and information developed for other purposes that can be used to assess climate change impacts (DoD Manual 4715.03, 2013).

The U.S. Climate Resilience Toolkit (http://toolkit.climate.gov/) and the California Climate Change Research Center (http://www.climatechange.ca.gov/research/index.html) are good sources for the latest status and trends of climate data and potential risks in the MCAS Miramar region.

Climate Change Management at Miramar

Climate-informed Monitoring (CIM) is a climate change adaptation strategy 1) to develop and deliver essential climate and biodiversity data sets to natural resource managers to enable more robust decision-making in the face of climate change and 2) which involves a process for evaluating, adjusting, and optimizing existing monitoring programs to facilitate tracking of ecological change and evaluating efficacy of management actions in the face of climate change.

MCAS Miramar staff attended an INRMP Climate Change Adaptation Workshop at Naval Weapons Station Seal Beach, Detachment Fallbrook on August 28 and 29, 2013. The goals of the workshop were to develop CIM strategies to support adaptation planning and to develop a process to facilitate integration of climate change adaptation into INRMPs within the context of the military mission and existing threats and management. Key outcomes of the workshop included 1) agreement on conceptual ecological models for coastal sage scrub and riparian ecosystems, 2) identification of practical adaptation strategies that can build ecosystem resilience and support the military mission, 3) identification of information gaps, and 4) development of a shared vision for strategic climate-informed monitoring.

Natural Resources Division staff continue to implement CIM in natural resources management processes and procedures at MCAS Miramar and continue to track the latest status and trends of climate change in the area using the best tools available.

3.2 Geology and Soils

Present day San Diego County soils have developed over millions of years from earth's plate tectonics, uprising magmas, crustal uplift, and erosion. The geologic setting of the general San Diego region consists of a basement complex of granitic rocks associated with the Southern California Batholith that developed during the Jurassic and Cretaceous geologic periods, and mildly metamorphosed volcanic rocks.

Eocene marine and non-marine sedimentary rocks generally have been eroded into flat-lying wave-cut platform surfaces overlying the basement rocks. In many areas, the Eocene sedimentary rocks are capped with Pleistocene sediments. Quaternary alluvial sediments are present in canyon bottoms. Based on a review of geologic literature (Kennedy 1975), the upper 200 feet at the main facility of MCAS Miramar consists of Quaternary Linda Vista Formation (the main formation throughout much of MCAS Miramar), Tertiary Stadium Conglomerate, and Friars Formation. The Quaternary Linda Vista Formation and the Tertiary Stadium Conglomerate are exposed within canyon walls, with the Linda Vista Formation stratagraphically above the Stadium Conglomerate.

The Linda Vista Formation consists of interbedded sandstones and conglomerate deposited as near shore marine and non-marine sediments on a 10 kilometer wide wave-cut platform. The formation is strongly to weakly cemented by iron oxide (ferruginous cement) resulting in its characteristic reddish-brown color. The Linda Vista Formation also contains moderate amounts of clay and fines. Its resistance to weathering is responsible for the formation of most of the mesas around the main portion of MCAS Miramar; therefore, the formation is the surface unit exposed on the tops of these mesas and marine terraces. The formation is estimated to be a maximum of 10 feet thick (Kennedy 1975). A relatively thin, discontinuous, well-cemented layer is also present in many areas of MCAS Miramar at depths ranging from 4 to 10 feet below ground surface. This well-cemented layer, referred to as a “caliche” or “hardpan” layer, has extremely low-permeability. The hardpan accounts for the numerous vernal pool basins and mima mounds distributed across west and central Miramar. The hardpan is not continuous or uniform and is primarily in the western portion of Miramar.

The Stadium Conglomerate consists of matrix-supported, cobble conglomerate with localized sand lenses that are devoid of the cobble-size clasts. The deposits are moderately well sorted, with the average clast size in the cobble range. The sandstone matrix consists of a dark yellowish brown coarse-grained sandstone and generally comprises less than 20 percent of the unit, but locally up to 50 percent. The conglomeratic clasts are slightly metamorphosed volcanics (rhyolitic to dacitic) and volcaniclastics and up to 20 percent quartzite. The deposit is difficult to excavate.

The Friars Formation is observed beneath the Stadium Conglomerate in the southeastern portion of MCAS Miramar and consists of sandstone and claystone deposits that typically exhibit a high erosion potential. Quaternary alluvium and slope wash occupy the canyon bottoms and lower portions of the tributary drainages.

Undifferentiated alluvium and slope wash (or *colluvium*) consists of poorly consolidated stream deposits and surficial material derived from soils and decomposed bedrock sources that lay within or near the area. The material is deposited along canyon floors by the action of gravity and surface water.

The Natural Resource Conservation Service (NRCS) classifies Miramar’s upper surface soils as mostly Redding, Chesterton, Carlsbad, or Altamont series (Figure 3.2a for all soil types). Redding soil is shallow, cobbly, or gravelly loam that range from 2 to 50 percent slopes. Permeability is slow, and fertility is low. Erodibility of the Redding series is considered severe because of shallow depth to rock and, in some cases, steepness. Chesterton fine sandy loam, Carlsbad gravelly loamy sand, and Altamont clay are in the very western portion of Miramar and have characteristics appropriate for raising irrigated crops.

3.2.1 Erosion Hazard Ratings

In addition to the NRCS soil descriptions, a 1991 survey (Kellogg and Kellogg) identified 287 historic and/or active erosion sites on the Station; about 50 of the sites were classified as active. A more recent survey (URS 2005) assessed, documented, and prioritized 98 active erosion sites on Miramar's undeveloped areas and provided recommendations for restoration of 18 priority sites. Soils within the 2005 survey area had moderately severe to severe erosion hazard ratings. Almost all MCAS Miramar's soils are severely erodible, according to the NRCS, because of either steepness, shallow depth to rock, shallow depth to a hardpan, or excessive silt in surface texture composition.

3.2.2 Topography

Elevations on MCAS Miramar range from just over 1,178 feet above mean sea level in the east to 240 feet in the west (Figure 3.2b). Gently sloping, eroded plateaus or mesas where flight line and air operations are located are cut by southwesterly draining canyons. These give rise to a series of terraces, which, in turn, grade to the steep and dissected hills of Sycamore Canyon. The western mesa consists of alternating well-drained to moderately drained mounds and poorly drained swales forming randomly distributed groups of mima mounds and vernal pools.

3.3 Hydrology and Watersheds

3.3.1 Watersheds

Local watersheds drain to the south or southwest (Figure 3.2b). Murphy, Elanus, Oak, Spring, Quail, Little Sycamore, West Sycamore, and Sycamore canyons drain into the San Diego River and then to the coast. San Clemente Canyon enters Rose Canyon and then Mission Bay. Many of these watersheds wholly or partly originate on MCAS Miramar, the main exception being Sycamore Canyon. Most sub-basins are small, which contributes to a high sedimentation rate as particles have less opportunity for deposition before becoming part of a stream system.

3.3.2 Floodplains and Impoundments

One-hundred-year return period floodplains have been completely mapped at a planning level scale for MCAS Miramar (Smith and Lichvar 2001). Areas of potential flooding are narrow because of canyon topography, but these narrow canyons have significant high-water flooding potential. Peak flows (2-year, 24-hour) for Rose Canyon were calculated at between 165 and 268 cubic feet per second (Woodward-Clyde 1986), and more than 14,000 cubic yards per year of sediment were estimated to be deposited into channels (confirmed by City of San Diego dredging records).

3.3.3 Sedimentation Effects on Water Quality

Streambank erosion problems along San Clemente and Rose canyons were identified in a sedimentation study commissioned by the City of San Diego (Woodward-Clyde 1986). Rose Canyon has wide drainages in East Miramar with a defined stream channel. Rose Canyon is narrow through the developed areas of MCAS Miramar and returns to a wide drainage west of Obregon Avenue. Stream banks vary in size through the canyon with stream banks in East Miramar and through the developed area of MCAS Miramar. West of Obregon Avenue Rose Canyon has meandering stream channel with variable stream bank heights. San Clemente Canyon has a wide drainage with a defined stream channel through most of East Miramar. Stream banks are approximately 5 to 10 feet high. West of Highway 15, the stream channel does not have steep banks except due to channelization from flow over dammed areas near the manmade ponds. Channel sides and bottoms are of cobble alluvium. Loose colluvial sand is common in canyon bottoms (Lloyd-Reilly 1987; Woodward-Clyde 1986).

Figure 3.2a. MCAS Miramar Soils

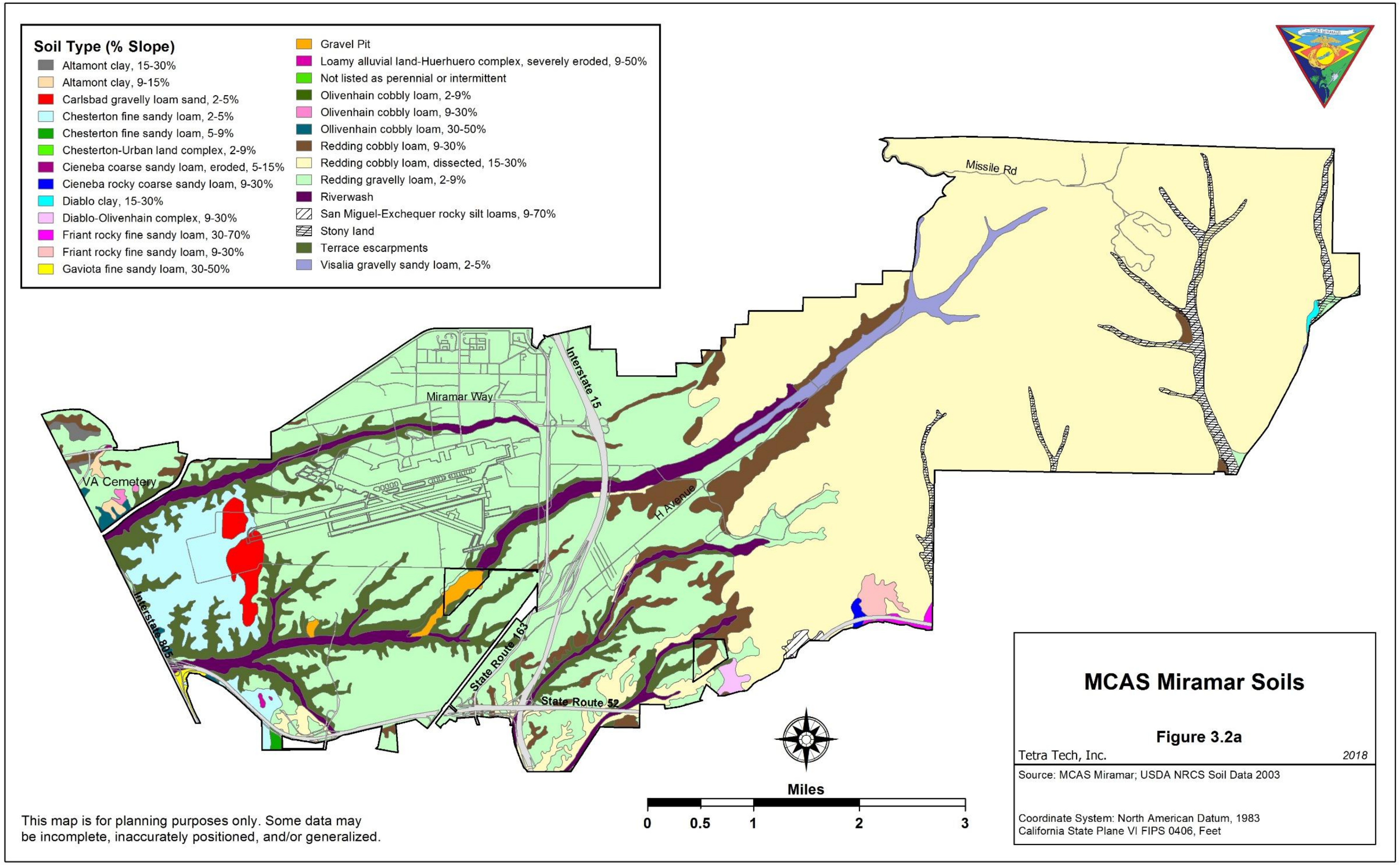

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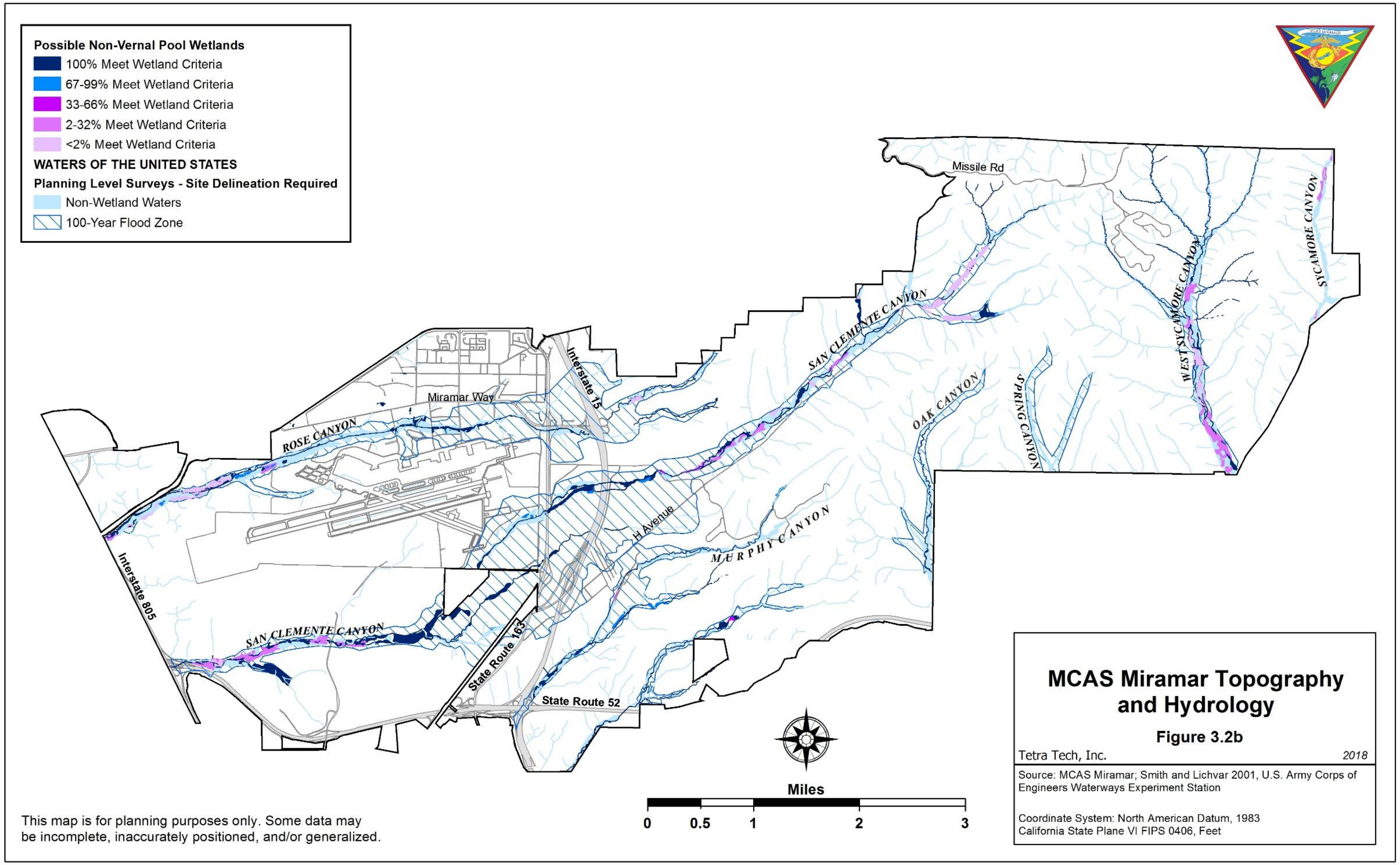
Figure 3.2b. MCAS Miramar Topography and Hydrology



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An earlier study (Tetra Tech, Inc. 1983) had concluded that Rose Canyon was a source of high concentrations of organically rich fine sediments draining into Mission Bay, aggravating the silting of the bay and degrading bottom sediments. In an aerial photo of stream channel conditions in 1928 (when these lands were used for ranching), most channels were found to be well-defined, flowing with water and full of sediment. By 1991, these areas were almost completely vegetated with no defined channel, probably due to bed aggradation (Kellogg and Kellogg 1991). Section 7.2.1, General Vegetation Management and Soil Conservation, has more detail on erosion on MCAS Miramar and programs to reduce its impacts.

Soil Erosion and Revegetation Restoration Projects have been programmed via Marine Corps Headquarters to address identified erosion sites. Nine MCAS Miramar sites are in the process of renovation.

3.4 Potentially Contaminated Sites and Areas Containing Munitions and Explosives of Concern

Areas of MCAS Miramar have been identified as sites where the disposal or discharge of hazardous wastes has resulted in potential environmental contamination. There are also sites where munitions and explosives of concern are potentially and/or confirmed to be present. Description of both types of sites, Installation Restoration Sites and Munitions Response Sites, are summarized in Community Relations Plan. Such sites potentially affect natural resources on the Station, primarily though the following issues: 1) concern about natural resources, particularly restoration work that could unexpectedly encounter contamination or unexploded munitions; 2) execution of a natural resource management action could further complicate a clean-up action; and 3) contamination could result in poor success with a natural resource management action. Further information can be obtained by contacting Installation Restoration and Munitions Response Program manager.

3.4.1 Installation Restoration Program Sites

Sites where hazardous materials disposal or discharge may have resulted in contamination were identified under the Installation Restoration Program, which addresses the identification, investigation, research, and cleanup of contaminated sites. Of the 19 identified Installation Restoration Program sites on MCAS Miramar, 12 have been closed because cleanup action is unnecessary or removal has already been conducted.

Of the remaining seven active Installation Restoration sites on MCAS Miramar, five are actively undergoing investigation, a limited removal action was completed in 2014 at one site, and removal activities are occurring at one site:

- ***IR1 - Fuel Farm Operations Area*** (seven non-contiguous areas, including the existing fuel farm where waste petroleum, oils, lubricants, and tank bottom sludges were sprayed on vegetated areas and bare soil for weed and dust control during early 1940s-1975. In preparation for the construction of the new fuel farm, a hot spot Removal Action removed the soil identified to have the highest concentrations of Polychlorinated Biphenyls and Total Petroleum Hydrocarbons. A limited removal action was completed 2014.);

- ***IR2 - Rose Canyon*** (1940s-1960s industrial materials were commonly discharged into Rose Canyon via storm drains. Concentrated wastes, including oils, greases, hydraulic fluid, fuel, solvent, paint thinners, plating waste water, corrosive wastes, and beryllium dust were reportedly disposed of on this sight. Work on an extended site inspection began in FY 2014.);

- ***IR5 - Old San Clemente Canyon Disposal Site*** (1940s-1972 dump on south side of flight line that received refuse that included hazardous materials (*e.g.*, waste paints, pesticides, solvents, spent lead acid batteries. An interim removal action was completed in 2012 which included the installation of a landfill cover. A remedial investigation began in FY 2015, followed by a feasibility study.);

- ***IR10 - Old Sycamore Canyon Atlas Missile Test Site*** (East Miramar site contaminated with polychlorinated biphenyl [site assessment completed in 2006] and asbestos-containing material [abatement completed in 1997]; a portion of this facility is used for an Explosive Ordnance Demolition range [Section 2.4.2, Firing Ranges]. A limited removal action was conducted in 2010. An additional removal action is schedule for FY 2015 to remove polychlorinated biphenyl sediment and debris from inside the structures. A remedial investigation began in FY 2015, followed by a feasibility study.);

- ***IR16 - K212 Boiler Plant Mercury Spill*** (adjacent to the K212 Boiler Plant where during a tank excavation, evidence was found of a mercury release, most likely from broken mercury manometers and leaking waste tanks. A site investigation was completed in 2012, and an extended site inspection was completed.);

- ***IR18 - MCX Main Gas Station*** (located near the intersection of Miramar Court and Maxam Way, near the western entrance to MCAS Miramar where old, leaking, underground fuel storage tanks that were removed in 1998 resulted in soil and groundwater contamination. Groundwater sampling in early 2007 indicated additional investigation was required to assess the extent of groundwater contamination. Installation of additional wells was completed in December 2011, followed by an additional site characterization report. The implantation of a passive soil gas venting system pilot test began in FY 2015.); and

- ***IR19-Former Gun Club*** (includes the former San Diego Shotgun Sport Association lease area and the Overshot Area. Lead shot deposits have been observed in both portions of the site. Undocumented fill material resulting from demolition of power plants was used during construction of the western portion of the site. An Engineered Evaluation/Cost Analysis and an Action Memorandum were completed in 2014. A Data Gap Survey and interim removal action began in FY 2015.)

Additional information on these sites is available at http://www.miramar-ems.marines.mil/Portals/60/Docs/MEMS/Inst_Rest/Miramar%20CRP_Final_083112_FINAL.pdf.

3.4.2 Military Munitions Sites

The Military Munitions Response Program was established to manage the environmental, health, and safety issues presented by unexploded ordnance, discarded military munitions, and munitions constituents. The program maintains an inventory of non-operational ranges that contain or are suspected to contain these items, prioritizes site cleanup with site-specific cost estimates to complete the response, and programs and budgets for such cleanup response actions.

The primary concern with munitions and explosives of concern is the risk to installation personnel and visitors associated with the potential presence of unexploded live ordnance (armed with exploding warhead). If disturbed, unexploded live ordnance can be deadly. Inert practice ordnance with unexploded signal cartridges is not as dangerous as unexploded live ordnance, but it is also dangerous.

The second concern is potential for environmental contamination. Hazardous constituents contained in munitions and explosives are usually consumed in a series of chemical reactions that occur upon detonation. Occasionally, munitions do not fully detonate or do not detonate at all. If these non-detonated munitions are not recovered and the munitions case is damaged or eventually corrodes, hazardous constituents could leach into the environment.

Only non-operational ranges prior to 2002 are included in the Military Munitions Response Program. There are 12 of these sites on MCAS Miramar. Preliminary Assessments (PAs) of all 12 sites were completed in 2007. Military Munitions Response Program sites 2, 3, 7, 8, 9, 12, and 13 have received No Further Action Letters from the Department of Toxic Substances Control Department and/or are closed.

MCAS Miramar currently has five active Munitions Response Sites (MRS) on the air station:

- ***MRS1-Grenade Course*** (was used between 1941 and 1943 as a practice grenade range. This site is located approximately in the center of the installation. The 2007 PA resulted in no observations of Munitions Constituents [MC]; however, during Site Inspection [SI] fieldwork in 2010, munitions debris was present, including one grenade handle and one cap from a can. Although these items represent a relatively low risk, the SI recommended a Remedial Investigation/Feasibility Study (RI/FS) to ensure the site is clear of any potential hazards. An Extended SI began in FY 2015 for MRS1.);

- ***MRS5-Skeet Range 1980*** (overlapped MRS 2 at the former Naval Auxiliary Air Station Camp Kearney and was used between 1964 and 1980 for shot gun skeet shooting. Following the 2007 PA, SI Fieldwork in 2010 resulted in the observation of MC, including results above Human Health Project Screening Levels for metals associated with shotgun shell debris. The SI resulted in the recommendation of an RI/FS with a focus on MC. A Remedial Investigation began in FY 2015.);

- ***MRS6-Pistol Ranges 5-7*** (were in use for two or three years for small arms training with .45 caliber pistols between 1917 and 1920. These three ranges are located north of the airfield, south of Miramar Road, on the northern side of Rose Canyon, and approximately 2,000 feet north of the former Camp Kearny boundary. Since 1920, the site has remained undeveloped. No munitions and explosives of concern [MEC] was observed during SI fieldwork in 2010. Soil samples taken during the SI confirmed that the metals associated with munitions had concentrations above the range installation background metals for soil and ecological screening levels. In addition, concentrations of total lead were detected above human health project screening levels. Based on these results an RI/FS has been recommended for MRS 6.);

- ***MRS10-Pistol Ranges 9-11*** (were used between 1917 and 1920 for small arms training with .45 caliber pistols. This site is located in the southernmost portion of the installation, just north of the southern boundary, south of the airfield on the northern side of San Clemente Canyon, and north of the J. Harris Quarry site. The site currently consists of approximately 1.98 acres of undeveloped land, much of which is located within the area where lead shot from a recreational range would be anticipated to occur. Soil sampling conducted during the 2010 SI resulted in metals values above Human Health Project Screening Levels, possibly due to overshot from the recreational range. An RI/FS with a focus on MC has been recommended for MRS 10.); and

- ***MRS15-Rifle Range—200 Targets*** (used between 1917 and 1920 as a rifle range consisting of a target berm and three firing lines for .30 caliber rifle ammunition. The site is currently located beneath the installation golf course and its parking areas, associated buildings on the east side of Anderson Avenue, as well as beneath the recreational field on the northeast corner of Anderson Avenue and Bauer Road. A PA/SI for MRS was conducted in 2010. No evidence of MEC, munitions debris, or historical range features [berms] were observed during PA/SI fieldwork. However, elevated metals values resulted in recommendation for an RI/FS for MRS 15).

Additional information pertaining to potentially contaminated sites and areas containing MECs can be obtained by contacting the MCAS Miramar, Environmental Management Department, Engineering Division. Additional information on Military Munitions Response Program sites is available at http://www.miramar.usmc.mil/ems/environmental _ programs/mmrp/default.htm.

3.4.3 Historic Ranges

There are 79 historical ranges, testing areas, chemical warfare training areas and other training areas associated with MCAS Miramar. Nineteen of the historical ranges are partially or completely outside the current base boundary. Another 12 historical ranges, mostly on the main side of the base have been added to the Munitions Response Program. The remaining historical ranges are scattered throughout eastern portions of the base.

Most of the historical ranges date back to World War I or World War II. Range types include artillery, bombing, gunnery, combat training, and small arms. Though not likely, the potential to encounter munitions, either unexploded ordnance or discarded military munitions, does exist. High explosive munitions were used on some of the historical ranges. However, even the low explosive munitions used as propellants or for pyrotechnics, can be a safety concern. Furthermore, storm water has been known to wash munitions off a historical range and onto a non-range area or another historical range (MCAS Miramar Community Relations Plan 2012).

The location of the ranges, munitions, and explosives of concern that might be encountered are summarized in *Range Identification and Preliminary Range Assessment, Marine Corps Air Station Miramar* (U.S. Army Corps of Engineers, St. Louis District 2001).