

1 4.3 Naval Munitions Site

2 4.3.1 General Physical Environment

3 4.3.1.1 Climate

4 The climate at the NMS is the same as the climate for Guam as a whole. See **Section 4.1.1.1** for a
5 description of the climate on Guam.

6 4.3.1.2 Geology and Topography

7 The NMS is in the southern structural province of Guam (see **Figure 4-1**). The western boundary of this
8 site coincides with a range of low mountains orientated on a north-to-south axis. This range includes
9 Mount Alifan; Mount Almagosa; Mount Lamlam, which attains a height of 1,334 feet (407 meters) above
10 msl; and Mount Humuyong (see **Figure 4-2**). This range lies on the Bolanos structural block, which
11 consists of rock from the Miocene-aged Umatac Formation. The Umatac Formation is composed of
12 east-dipping (5–10 degrees) volcanic rocks, including flow basalts (Dandan Member) and tuff breccia or
13 tuff-derived conglomerate, sandstone, and shale (Bolanos Member). The tuff is consolidated volcanic ash
14 that was marine-deposited and uplifted. Breccia refers to the angular fragments of the conglomerate.
15 Portions of the range have alternated between periods of submergence and emergence as evidenced by the
16 presence of the Alifan Limestone (U.S. Navy 2009).

17 4.3.1.3 Seismology

18 The Talofofa Fault Zone crosses the NMS in a northwest-southeast direction (GHS 2008). Several
19 smaller faults cross the site in a north-south direction (GHS 2008). The NMS is not in an area vulnerable
20 to liquefaction, nor is it in danger of tsunami inundation (GHS 2008).

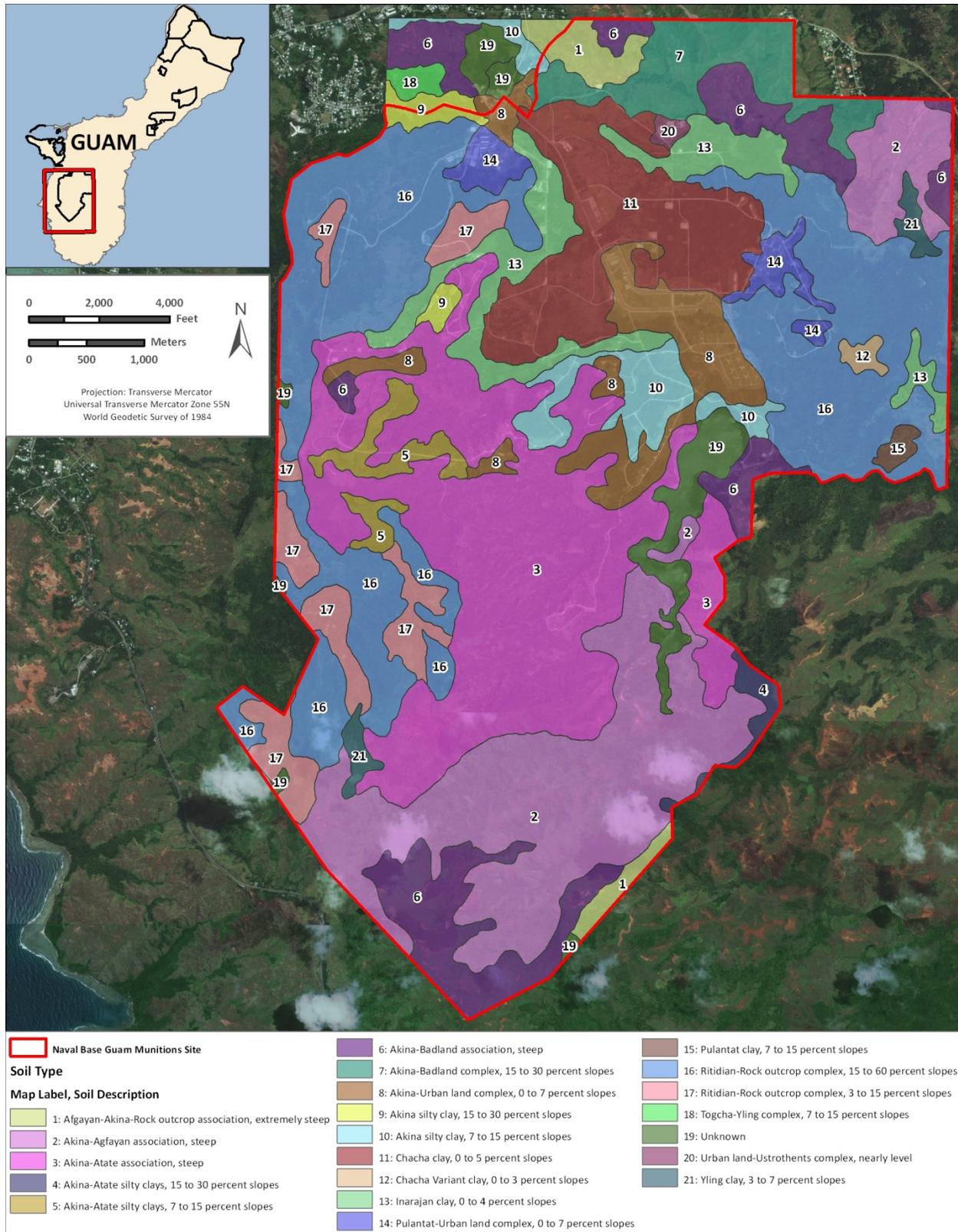
21 4.3.1.4 Soils

22 The landscape of the NMS is more complex than the other JRM sites, and includes soils formed on
23 bottomland, volcanic plateaus, and limestone plateaus. The soils found at the higher elevations along the
24 mountain range from Mount Alifan to Mount Lamlam consist of shallow, well-drained limestone soils.
25 Extensive areas of highly weathered volcanic soils are present in the central and southern portions of the
26 NMS. Soils along the broad river bottoms tend to be poorly drained soils formed from sediment eroded
27 from the upland limestone and volcanic soils (see **Figure 4-10**).

28 4.3.1.5 Hydrology

29 **Groundwater.** Groundwater on the NMS occurs in volcanic rocks and older limestone with low
30 permeability. The water table occurs at elevated levels in places and discharges as springs where the
31 groundwater intersects the ground surface.

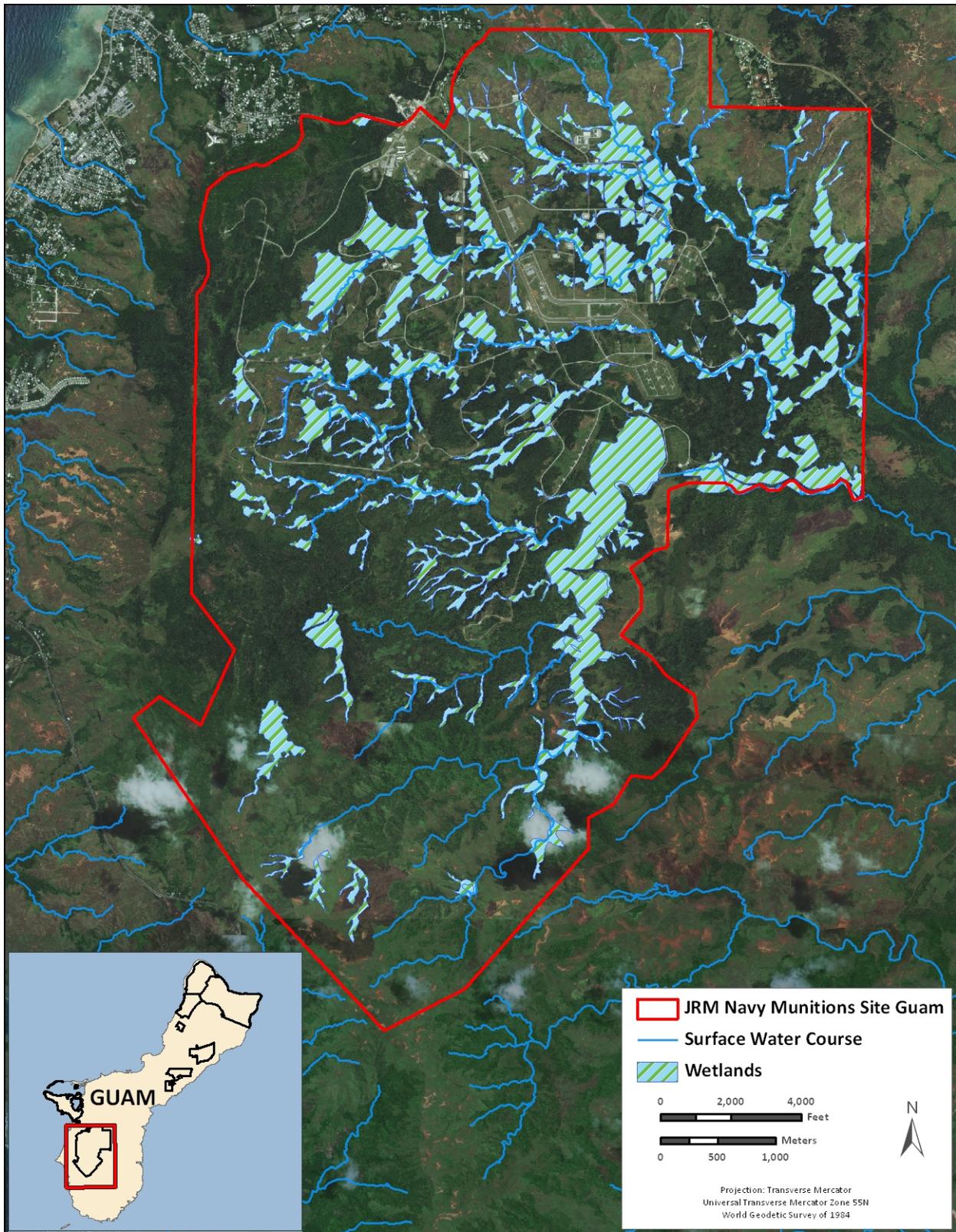
32 **Surface Water.** A total of nine major perennial stream courses exist within the NMS (see **Figure 4-11**).
33 Four of the streams (Imong, Sadog Gago, Maulap, and Almagosa) have relatively steep gradients and
34 flow into Fena Reservoir, which was formed from the construction of a dam. Three of the perennial
35 streams (Bonya, Talisay, and Maemong) converge with the Maagas River before meeting the Talofofa
36 River east of the NMS. The Maagas River is also known as the Lost River because it disappears
37 underground and resurfaces again. The Mahlac River flows southeast out of the NMS eventually joining
38 the Maagas River. The Mahlac, Bonya, Talisay, Maemong, and Maagas rivers have more gentle
39 gradients than the streams flowing into Fena Reservoir, which results in broad river basins. See **Section**
40 **4.3.2.2** for additional information regarding freshwater ecosystems on the NMS.



1

2

Figure 4-10. Soils on Naval Munitions Site



Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

1
2
3

Figure 4-11. Surface Water and Wetlands on Naval Munitions Site

1 4.3.2 General Biotic Environment

2 4.3.2.1 Terrestrial Ecosystems

3 *Flora*

4 Vegetation communities on the NMS include limestone, ravine, wetland, and savanna communities. See
5 **Figure 4-12** for a map of the terrestrial vegetation communities occurring on the NMS.

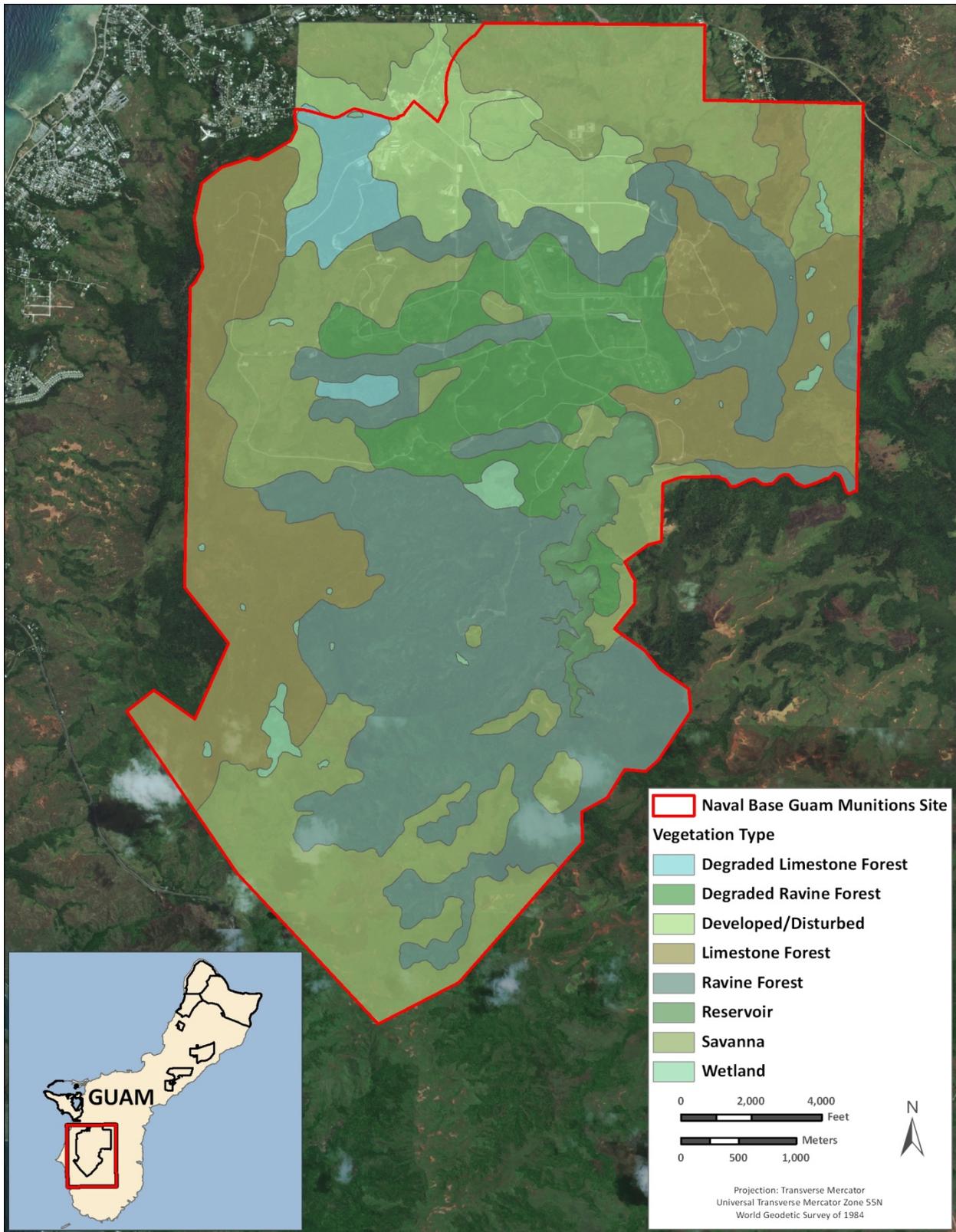
6 ***Limestone Communities.*** Limestone communities are situated on elevated limestone terraces, plateaus,
7 and slopes and found within the NMS. The NMS has the largest extent of interior limestone communities
8 on JRM lands on Guam. These limestone communities persist on the ridge tops and upper slopes from
9 Mount Lamlam northward to Mount Alifan. A narrow band of a halophytic-xerophytic scrub plant
10 community occurs near Mount Almagosa on the NMS (U.S. Navy 2009).

11 ***Ravine Communities.*** Ravine forest plant communities are abundant in the NMS, occupying much of the
12 south-central portion of the installation. Swamps, which are delineated as ravine communities, are often
13 present on argillaceous limestone soils, bottomlands, and in depressional areas. *Hibiscus tiliaceus* and
14 *Pandanus* spp. are the most common woody plants associated with these communities, often forming
15 dense thickets. *Barringtonia racemosa*, a tall forest tree, dominates bottomland forest in areas along the
16 Talofofu River. Extensive areas of disturbed ravine forest are also present in the NMS, especially in areas
17 subjected to low-intensity ground fires and past human disturbance. Several acres of coconut plantations
18 still exist within the NMS (U.S. Navy 2009).

19 Twelve native species were documented along transects during the 2008 vegetation surveys within the
20 ravine forests in the northern sector of the NMS: screwpine, *H. tiliaceus*, *Calophyllum inophyllum*,
21 *Glochidion marianum*, *Melastoma malabathricum*, *Cycas micronesica*, *Morinda citrifolia*, *Cynometra*
22 *ramiflora*, *Cerbera dilatata*, *Pandanus dubius*, *Discocalyx megacarpum*, and *Eugenia reinwardtiana*
23 (NAVFAC Pacific 2010b). Native tree species dominated the relative density of trees in all transects
24 performed in the northern sector. Screwpine and *H. tiliaceus* were the most dominant native species in
25 the northern sector (NAVFAC Pacific 2010b). Common introduced tree and shrub species within the
26 northern sector include the betelnut palm, *Vitex*, the invasive bay rum tree (*Pimenta racemosa*), and
27 limeberry (NAVFAC Pacific 2010b).

28 The ravine forest in the valley slopes surrounding Mount Almagosa in the southern sector of the NMS is
29 characterized by the dominant native *Merrilliodendron megacarpum* (known as faniok in Chamorro) that
30 composed more than 63 percent of the relative density during the 2009 vegetation survey. The ravine
31 forest along the Sadog Gagu River in the southern sector of the NMS is dominated by coconut and two
32 introduced species, *V. parviflora* and betelnut palm. The overall relative density of native species along
33 the Sadog Gagu River was approximately 33 percent, which is lower than the densities observed in ravine
34 forest transects in the northern sectors of the NMS. In the ravine forest in the southwestern sector of the
35 installation, south and west of the explosive ordnance disposal range, the introduced species coconut and
36 betelnut palms and native screwpine are dominant (NAVFAC Pacific 2010b).

37 ***Wetland Communities.*** The NMS has the greatest delineated area of wetlands on JRM (U.S. Navy
38 2009). Based on the 2007 wetland survey and previous wetland delineations, the NMS has 1,149 acres
39 (465 hectares) of wetlands, composing approximately 13 percent of the installation (see **Figure 4-11**)
40 (AECOS and Wil Chee 2009). Most of these freshwater wetlands are adjacent to the rivers or their
41 tributaries. Wetlands on the NMS occur in limestone forest, ravine forest, and savanna communities.
42 Common forested wetland species include *Hibiscus tiliaceus*, coconut, screwpine, and the betelnut palm
43 (AECOS and Wil Chee 2009).



1

Source: Data and Imagery provided by NAVFAC GRC Marianas and Air Force GeoBase

2

Figure 4-12. Vegetation Communities on Naval Munitions Site

1 **Savanna Communities.** Erosion in savanna communities is particularly evident within the NMS. Large
2 areas of bare ground are present primarily due to wildland fires and destruction of vegetation by feral
3 ungulates. The Navy has been working to reestablish vegetation in these “badlands” with some success.

4 **Fauna**

5 **Birds.** The following avian species were identified during the 2008–2010 roadside and forest bird
6 surveys performed on the NMS: island collared dove, black francolin, Pacific golden-plover, black
7 drongo, white tern, yellow bittern, and gray-tailed tattler. The island collared dove and black francolin
8 were the most commonly observed species on the NMS. In addition, even though the island swiftlet was
9 not observed during the 2008–2010 avian species roadside and forest bird surveys, the species is known
10 to occur at the site. The island collared dove, black francolin, black drongo, and Eurasian tree sparrow
11 are common, introduced, breeding residents in Guam (NAVFAC Pacific 2010b). The white tern is an
12 uncommon, native, breeding resident of Guam. The Pacific golden-plover and gray-tailed tattler are
13 common, nonbreeding visitors to Guam (NAVFAC Pacific 2010b).

14 **Mammals.** There are rare reports of Mariana fruit bats from southern Guam around the Fena Reservoir.
15 Between 1985 and 1999, there were only 38 confirmed sightings of Mariana fruit bats in the upper
16 Talofofu River watershed. Twenty-three of these occurred at or near Fena Reservoir. Other sightings of
17 bats were fairly well-distributed across the NMS. No sightings were reported outside the NMS (Morton
18 and Wiles 2002). Despite restricted public access to the NMS and the relative remoteness of this
19 watershed, illegal entry by hunters might be frequent. Introduced Philippine deer and carabao are the
20 main game hunted, but hunters presumably also take fruit bats when the opportunity arises (Morton and
21 Wiles 2002). Other mammal species on the NMS include pigs, rats, feral dogs, and feral cats.

22 **Reptiles and Amphibians.** Twelve herpetofauna species were documented on the NMS during 2008–
23 2009 herpetofauna surveys. Of these, five species are native to Guam: Pacific blue-tailed skink, moth
24 skink, mourning gecko, stump-toed gecko, and Pacific slender-toed gecko; and seven species are
25 introduced to Guam: curious skink, house gecko, brown treesnake, marine toad, eastern dwarf tree frog,
26 crab-eating frog, and Gunther’s Amoy frog (NAVFAC Pacific 2010b). The capture of two Guam-listed
27 endangered species (i.e., moth skink and Pacific slender-toed gecko) on the NMS is noteworthy. The
28 distribution and abundance of the moth skink on Guam is unknown, due to the variability of information
29 presented by authors. The Pacific slender-toed gecko is a rarely seen gecko (NAVFAC Pacific 2010b).
30 The continued widespread presence of the brown treesnake, the curious skink, and other introduced
31 amphibian species is of concern because of each species’ potential deleterious impacts on Guam’s native
32 fauna (NAVFAC Pacific 2010b).

33 **4.3.2.2 Freshwater Ecosystems**

34 The NMS contains the greatest areas of freshwater habitats of JRM. There are nine rivers that cross
35 portions of the NMS (i.e., Talisay, Maemong, Bonya, Mahlac, Maagas, Maulap, Almagosa, Sadog Gago,
36 and Imong). Fena Reservoir is the largest freshwater body on Guam, spanning 200 acres (81 hectares)
37 (U.S. Navy 2009). **Section 4.3.1.5** provides a description of rivers associated with the NMS.

38 **Flora**

39 During the 2009–2010 natural resources survey, some transects passed over streams and swampy ground
40 where trees including coconut palm, pandanus, and sea hibiscus were dominant. One transect was
41 dominated by Pacific Island silvergrass, a tall grass species that can grow to a height of 13 feet (4 meters)
42 (NAVFAC Pacific 2010b).

1 Much of the shoreline of Fena Reservoir supports wetland plant communities. As the water depth
2 increases within the lake, the wetland communities are replaced with floating aquatic plants. Floating
3 aquatic flora found in Fena Reservoir and some streams includes hydrilla (*Hydrilla verticillata*), curly
4 pondweed (*Potamogeton crispus*), bladderwort (*Utricularia* sp.), and aquatic ferns (*Ceratopteris* sp.).
5 Water current is a major limiting factor in the development of plant communities in lotic habitats. Water
6 depth and current in streams varies with location and are strongly influenced by storm events (U.S. Navy
7 2009). Hydrilla has overwhelmed the Fena Reservoir and restricts sunlight to native plants (GDAWR
8 2006a). The native water fern, *Ceratopteris thalictroides*, is common in Fena Reservoir. This water fern
9 might be an endemic species (GDAWR 2006a).

10 **Fauna**

11 **Birds.** Migratory birds, which are protected under the MBTA, are frequently observed foraging and
12 resting on Fena Reservoir and along its shores. The largest population of the Mariana common moorhen,
13 federally listed as endangered, is known to inhabit the shoreline of Fena Reservoir (U.S. Navy 2009).

14 Bird species observed during the 2009 natural resources survey on the NMS that could use the freshwater
15 habitats on the installation include the yellow bittern and Pacific golden-plover (NAVFAC Pacific
16 2010b).

17 **Fish.** In order to control the growth of pondweed and bladderwort in shallow waters of Fena Reservoir,
18 two species of tilapia (the Mozambique tilapia and *Tilapia zillii*) were introduced into the reservoir in the
19 1950s. Mosquito fish and guppies were also introduced to the reservoir for the control of mosquitoes.
20 During the 1960s, other species, including tucunare (*Cichla ocellaris*), small mouth bass (*Micropterus*
21 *dolomieu*), largemouth bass (*Micropterus salmoides*), and channel catfish (*Ictalurus punctatus*) were
22 introduced to control the stunting of the tilapia and to increase angling opportunities. Surveys to monitor
23 the status of the introduced species ended in 1969, and, since that time, no stock assessments have been
24 conducted in Fena Reservoir. Additionally, other species, such as unwanted aquarium pets, have been
25 deposited in the lake over the years (GDAWR 2006b). These include peacock bass, tilapia, Hydrilla, and
26 soft-shell turtles. These introduced species pose a threat to the indigenous and endemic species within the
27 reservoir and downstream waters (U.S. Navy 2009). Currently, there are no efforts being made to control
28 established exotic fishes (GDAWR 2006a). Marbled eels have also been observed in Fena Reservoir
29 (U.S. Navy 2009).

30 All of the indigenous fish occurring within the rivers on Guam are diadromous, requiring access to both
31 salt water and fresh water during their life cycles. Although the streams have not been well-studied on
32 the NMS, it is assumed that numerous species of native gobies (family Gobiidae), all of which are
33 amphidromous, occur within the nine rivers that cross portions of the Annex (U.S. Navy 2009).

34 **Reptiles and Amphibians.** Four introduced amphibian species were observed on the NMS during the
35 2009 natural resources survey: marine toad, eastern dwarf tree frog, crab-eating frog, and Gunther's
36 Amoy frog. The continued widespread presence of these introduced amphibians is of concern because of
37 each species' potential deleterious impacts on Guam's native fauna (NAVFAC Pacific 2010b).

38 **Macroinvertebrates.** Crustaceans, including Tahitian prawn, three species of native freshwater crabs
39 (*Varunid* spp.), and several species of mollusks (snails) are present in freshwater streams on Guam. The
40 native freshwater prawn, freshwater crabs, and nerite snails are especially common in the upper reaches
41 of rivers on Guam, and likely occur within the nine rivers that cross the NMS (U.S. Navy 2009, GDAWR
42 2006a).

1 4.3.2.3 Estuarine Ecosystems

2 There are no estuarine ecosystems on the NMS.

3 4.3.2.4 Submerged Lands

4 No JRM-managed submerged lands are associated with the NMS.

5 4.3.2.5 Protected Species

6 ***Fauna***

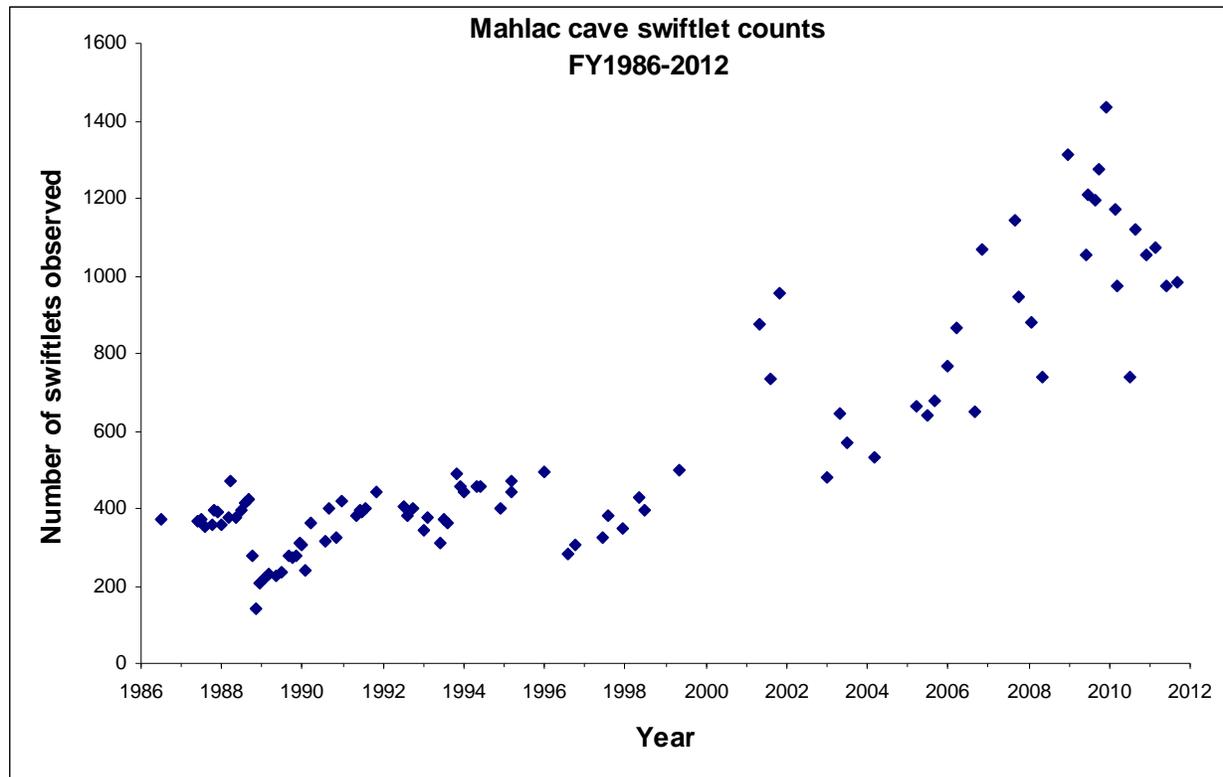
7 Terrestrial Species

8 **Birds**

9 ***Mariana swiftlet.*** The Mariana swiftlet was once the most common bird on Guam (USFWS 1991b). It is
10 currently known from only three caves, Mahlac, Maemong, and Fachi, all on the NMS. This is the only
11 known roosting location for this species on Guam except for an unconfirmed report of a few birds in a
12 cave near Janum Point in northern Guam (GDAWR 2006a). The Navy, USFWS, and GDAWR have
13 been monitoring the population of swiftlets at these caves for 23 years. The Mariana swiftlet has
14 maintained a small population of about 400 to 500 birds through the 1980s and 1990s. Although small
15 fluctuations in the population have been documented during this period, there was no significant growth.
16 Brown treesnake traps were initially deployed outside of Mahalac cave in 2000 and the population of
17 swiftlets appears to be increasing (see **Figure 4-13**). The population of Mariana swiftlet in 2010 was
18 estimated to be between 1,100 and 1,500 birds. Swiftlet populations on Saipan are also increasing and
19 brown treesnakes are not believed to be present in those caves; therefore, recovery could be attributed to
20 other things.

21 ***White-throated ground-dove.*** This species was extirpated from Guam along with several other forest
22 bird species in the mid-1980s. In 2003, two male ground-doves were observed in the Tarague Basin area
23 of Andersen AFB. These birds are assumed to be dispersing from neighboring Rota. Previously, the last
24 white-throated ground-dove was sighted in northern Guam in 1987. The white-throated ground-dove has
25 not been recently documented on the NMS, but suitable habitat for this species exists in the native forests
26 surrounding Fena Reservoir and on the eastern slopes of the southern mountains from Mount Alifan to
27 Mount Lamlam.

28 ***Mariana Common Moorhen.*** A survey of moorhens on Guam was conducted by Takano (Takano and
29 Haig 2004) in 2001. Three wetlands on the NMS were surveyed, including Fena Reservoir, Fena Dam
30 spillway, and the Naval Magazine Pond. Surveys were conducted during the dry season when moorhens
31 were expected to be more concentrated on perennial wetlands and therefore easier to count. Of the
32 90 birds estimated to be on Guam during the survey, 38 were located on wetlands in the NMS. The
33 majority of those birds, 33, were using the Fena Reservoir. Since 2001, eutrophication of Fena Reservoir
34 following a typhoon resulted in the loss of *Hydrilla verticillata*, a water plant used by moorhens as a
35 nesting substrate. The moorhen population at the reservoir declined following the loss of the plant
36 (USFWS 2009b). A comprehensive survey of wetlands on Guam, Tinian, and Saipan is necessary to
37 determine the redistribution and current population trend of the Mariana common moorhen following the
38 abandonment of Fena Reservoir as a perennial wetland habitat.



1
2 **Figure 4-13. Mariana Swiftlet Population Data from Mahlac Cave within Naval Munitions Site**
3 **from FY 1986–FY 2012. (Data provided by A. Brooke, NAVFACMAR)**

4 **Mammals**

5 **Mariana fruit bat.** A monthly census of fruit bat numbers on Guam began in 1962. Since that time
6 there have been no large fruit bat colonies recorded in the region of the NMS. Typically, solitary fruit
7 bats, or small groups are observed flying, foraging, or roosting in the NMS. Between 1963 and 1968 the
8 number of bat observations in the Fena Reservoir area of the NMS dropped from 53 bats per 100 acres to
9 approximately five bats per 100 acres (Perez 1972). Wiles (1987b) estimated as many as 25 to 50 fruit
10 bats occupied the interior forested region of the NMS and Talofof. Fruit bat surveys conducted at nine
11 stations on the NMS detected a single bat along Almagosa Road (Brooke 2008). Fruit bats have been
12 observed by natural resources staff at Fena reservoir since 2008. In addition, a fruit bat was observed at
13 Fire Break 3 road in 2010.

14 **Reptiles**

15 **Moth skink.** Moth skinks have an unknown distribution on Guam and are not frequently encountered.
16 Five moth skinks were captured during herpetofauna surveys in the NMS in 2008 (DoN 2010). The moth
17 skink is not a federally listed species, but GovGuam lists the species as endangered.

18 **Pacific slender-toed gecko.** Five Pacific slender-toed geckos were recorded during herpetofauna surveys
19 on the NMS in 2008 (DoN 2010). Two individuals were captured using glue-boards, and three were
20 observed during visual surveys. This species is rarely seen and has been listed as an endangered species
21 by GovGuam. It is not a federally listed species.