Integrated Natural Resources Management Plan for the Camp Santiago Joint Training Center Puerto Rico Army National Guard

May 2022

Prepared for:	Camp Santiago Joint Training Center Puerto Rico Army National Guard
Prepared through:	Interagency Agreement between the Puerto Rico Army National Guard and U.S. Army Corps of Engineers under MIPR 9IAPV90175
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Abstract: This Integrated Natural Resources Management Plan is the Camp Santiago Joint Training Center Commander's adaptive plan for managing natural resources to support and be consistent with the military mission, while protecting and enhancing those resources for multiple use, sustainable yield, and biological integrity. The purpose of this management plan is to ensure that natural resources conservation measures and military activities conducted within Camp Santiago are integrated and consistent with federal stewardship requirements. This management plan provides guidance for the stewardship of natural resources within the Camp Santiago Joint

Training Center for a five-year period (2021-2025). The management plan is a dynamic document that will be reviewed annually and revised, as needed, to incorporate new information and/or requirements.

INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN (2021-2025)

for the

Camp Santiago Joint Training Center
Puerto Rico Army National Guard

APPROVAL

We approve the implementation of all activities in this Integrated Natural Resources Management Plan for the Camp Santiago Joint Training Center as supporting the military mission while sustaining natural resources for future generations.

Signature Page

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ACRONYMS AND ABBREVIATIONS

AEC	U.S. Army Environmental Center
APHIS	USDA Animal and Plant Health Inspection Service
AR	Army Regulation
ARNG	Army National Guard
ARNG JA	Judge Advocates
ASP	Ammo Supply Point
BMP	Best Management Practice
CFMO	Construction and Facilities Management Office
CFMO	Construction and Facilities Management Office
CMP	corrugated metal pipe
CNF	Caribbean National Forest
CPQC	Combat Pistol Qualification Course
CSJTC	Camp Santiago Joint Training Center
DCA	Defense Communications Area
DCSOPS	Deputy Chief of Staff for Operations
DNRE	Department of Natural Resources and the Environment
DoD	Department of Defense
DZ	Drop Zone
EA	Environmental Assessment
EPM	Environmental Programs Manager
FDR	Fire Danger Rating
FONSI	Finding of No Significant Impact
FY	Fiscal Year
GIS	Geographical Information System
GPS	Global Positioning System
IDT	Interdisciplinary Team
IITF	Internal Institute of Tropical Forestry
INRMP	Integrated Natural Resources Management Plan
ITAM	Integrated Training Area Management
LCTA	Land Condition Trend Analysis
LEED	Leadership in Energy and Environmental Design
LRAM	Land Rehabilitation and Maintenance
MILCON	Military Construction
MOU	Memorandum of Understanding
MOUT	Missions Military Operations on Urban Terrain
MP BDE	Military police brigade
mph	miles per hour
NEPA	National Environmental Policy Act
NG	National Guard
NGB	National Guard Bureau
NGB-ARE	NGB Director of Environmental Programs
NGB-ART	NGB Director of Operations Training and Readiness
NGB-JA	NGB Judge Advocate
NHPA	National Historic Preservation Act
NRHP	National Register of Historic Places
PAO	Public Affairs Officer
PRARNG	Puerto Rico Army National Guard

RAWS	Remote Automated Weather Station
RCMP	Range Complex Master Plan
RDP	Range Development Plan
RER	Record of Environmental Review
RPMP	Real Property Master Plan
RSG	Regional support group
RTLP	Range and Training Land Program
SHPO	State Historic Preservation Office
SJA	Staff Judge Advocate
TAG	The Adjutant General
TBD	To Be Determined
TRI	Training Requirements Integration
TRP CMD	Troop Ccommand
TSI	Timber Stand Improvement
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Camp Santiago Joint Training Center
Integrated Natural Resource Management Plan

May 2022

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EXECUTIVE SUMMARY

ES.1 BACKGROUND

The Puerto Rico Army National Guard (PRARNG) Camp Santiago Joint Training Center (CSJTC), hereafter referred to as "Camp Santiago," is the only Army training installation in the Caribbean Operating Area. The 12,649-acre facility is located in the south-central coast of Puerto Rico near the town of Salinas (see **Figure 2-1**).

Training resources and support provided by Camp Santiago include 24-hour operations of maneuver-training areas, ranges for an assortment of individual, military police, and light infantry weapons and aviation systems, billeting, mess facilities, medical support, and logistical support. These training resources support the mobilization readiness for one Army National Guard (ARNG) military police brigade (MP BDE), one troop command (TRP CMD) and its supporting units, and one regional support group (RSG) and its supporting units. In addition to PRARNG units, units from the U.S. Virgin Islands, U.S. Army Special Operations Command (South), and other reserve units based in the Puerto Rico area conduct most of their inactive and active training at Camp Santiago. National Guard units from the states, Forces from the Regional Security System, and nations such as France, Holland, and Great Britain are also forecasted to conduct training at Camp Santiago.

In accordance with the *Sikes Act* (16 U.S. C. 670 et seq.), as amended in 2012, and Department of Defense (DoD) policy, PRARNG completed the development of an Integrated Natural Resources Management Plan (INRMP) for Camp Santiago in May 2022.

Section 101(b)(2) of the *Sikes Act* [16 U.S.C. 670ab(2)], states that each INRMP "must be reviewed as to operation and effect by the parties thereto on a regular basis, but not less often than every 5 years." In accordance with this direction, PRARNG completed a formal review of the current INRMP. The findings of this review indicated that the INRMP is:

- In compliance with applicable regulations and policies,
- In compliance with DoD policy,
- Consistent with applicable cultural and natural resources Laws and Regulations, and
- Legally sufficient.

ES.2 PURPOSE

The purpose of the 2021-2025 INRMP is to support Camp Santiago's military mission and ensure sound land management and compliance with all relevant regulations.

As stated in the Army Memorandum entitled *Army National Guard Installations and Environment Directorate Policy for Integrated Natural Resource Management Plans* (2 March 2019), an effective INRMP provides for the management of the State ARNG's Natural Resources Conservation program, as required by the *Sikes Act*, by establishing goals for natural resources centered on the military mission and ecosystem health. Goals are broad statements of desired future conditions, flexible enough to incorporate a measure of uncertainty, and are able to evolve as conditions and knowledge base changes. Goals are supported by objectives which serve as the road map for knowing when and whether a goal is being achieved (i.e., measurable targets for achieving goals). "S.M.A.R.T." objectives are Specific, Measurable, Achievable, Relevant, and

Timebound actions that are implemented to achieve a goal. All natural resources projects occurring on ARNG lands, regardless of funding type, shall be described in the INRMP Project Implementation Table and identified as to which goals and objectives they support.

ES.3 ENVIRONMENTAL COMPLIANCE

The *Sikes Act* requires DoD to prepare and implement an INRMP for each DoD military installation, unless the absence of significant natural resources on a particular installation make preparation of such a plan inappropriate or unnecessary. Several laws and Army directives regulate the preparation of INRMPs. DoD Instruction 4715.03, *Natural Resources Conservation Program* (14 February 2011) and Army Regulation (AR) 200-1, Environment Protection and Enhancement, require that all military installations that have habitat suitable for conserving and managing natural ecosystems prepare INRMPs.

The *Sikes Act* requires that the Army manage the natural resources of its military installations to provide:

- Sustained multipurpose use of natural resources, and
- Public access that is necessary or appropriate for designated uses to the extent that such uses are consistent with the military mission.

The *Sikes Act* requires that the Army manage the natural resources of its military installations to provide for the following:

- No net loss in the capability of military installation lands to support the military mission;
- Integration of land (forest and range) management with the various activities conducted under the plan;
- Management of fish and wildlife and protection and/or enhancement of their habitat;
- Wetland protection, enhancement, and/or restoration necessary for support of fish, wildlife, or vegetation;
- Establishment of specific natural resources management goals and objectives;
- Subject to requirements necessary to ensure safety and military security, provide appropriate and necessary public access to the military installation;
- Enforcement of applicable natural resources laws and regulations; and
- Other activities as the Secretary of the military department determines appropriate.

ES.4 SCOPE

The INRMP provides a comprehensive five-year planning document that will be reviewed annually and revised as needed. The plan identifies management actions that will provide stewardship for natural resources, promote ecosystem health, maximize biodiversity, and provide sustained use of the training lands. The INRMP describes Camp Santiago and its physical and natural resources, management goals, objectives, policies, and the future direction of the program.

ES.5 RELATIONSHIP TO THE MILITARY MISSION

The INRMP supports the Camp Santiago military mission by providing measures to maximize the stewardship of natural resources.

The INRMP supports the military mission by identifying management actions required for the protection and conservation of natural resources. Implementation of these management actions not only provides protection and conservation of training land in the future, but also provides for the restoration of natural resources damaged by past training activities.

Provisions of this INRMP enable the conservation and protection of natural resources and the military mission at Camp Santiago to be mutually supporting.

The INRMP supports and incorporates the environmental awareness initiatives, operational requirements, and responsibilities outlined in the Range Complex Master Plan (RCMP), Camp Santiago Range Standard Operating Procedures, Installation Real Property Master Plan (RPMP), and Integrated Cultural Resources Management Plan.

ES.6 PARTNERSHIPS

The roles of the partners in the development and implementation of the Camp Santiago INRMP are summarized in the following table:

Table ES-1. Partners in the Development of the Camp Santiago INRMP

Partner	Role
U.S. Army Corps of Engineers	Through coordination with the Puerto Rico Army National Guard, conduct a review of the 2021-2025 INRMP.
U.S. Fish and Wildlife Service	Consult and provide information on flora and fauna; concurrence with the NEPA documentation.
Puerto Rico Department of Natural Resources and Environment	Consult and provide existing information on flora and fauna; concurrence with the NEPA documentation.
U.S. Geological Service	GIS support, maps, and aerial photos.
USDA Natural Resources Conservation Service	Conduct soil surveys of the Camp Santiago area.
U.S. Army Engineer Research and Development Center, Waterways Experiment Station	Conduct planning level wetlands and other regulated waters inventory of the Camp Santiago area.

ES.7 MAJOR INITIATIVES

Detailed descriptions of the recommended initiatives and associated benefits and costs are provided in **Chapter 8**. The major initiatives proposed are summarized below:

- Survey the Camp Santiago boundary;
- Install fence along portions of the Camp Santiago boundary;
- Eliminate erosion, sediment sources, and safety hazards associated with the primary convoy routes;
- Ensure that any future gravel extraction operation meets all environmental laws and standards and incorporates timely restoration of disturbed sites;

- Inventory secondary convoy routes and streams to develop a prioritized program-of-work for the elimination of erosion and sediment sources; schedule and perform restoration and rehabilitation projects;
- Reforest selected riparian and forested areas by hand planting seedlings; and
- Acquire wildfire suppression equipment able to reach forested areas during a strong wildfire event and train personnel on wildfire prevention and suppression procedures.

ES.8 SUMMARY

The implementation of this INRMP will support the Camp Santiago training mission by ensuring that natural resources conservation measures and military activities conducted are integrated and are consistent with federal stewardship requirements.

1 GOALS AND POLICIES

1.1 INTRODUCTION

The *Sikes Act* (16 U.S. C. 670 et seq.), as amended in 2012, requires the Department of Defense (DoD) to prepare and implement an Integrated Natural Resource Management Plan (INRMP) for each DoD military installation, unless the absence of significant natural resources on a particular installation make preparation of such a plan inappropriate or unnecessary.

In accordance with the *Sikes Act* provisions and DoD Instruction 4715.03, *Natural Resources Conservation Program*, the occurrence of natural resources recognized as being significant and the presence of habitat suitable for ecosystem management within Camp Santiago require the implementation of an INRMP.

Conservation is an integration or blending of natural resources management and preservation designed to maintain ecosystem integrity. This blending occurs in the INRMP for the Camp Santiago Joint Training Center (CSJTC), hereafter referred to as "Camp Santiago", a dynamic document that will be maintained and adapted, as necessary, to reflect updated natural resources information. The development and implementation of the INRMP is a reflection of Camp Santiago's commitment to stewardship of natural resources as reflected in DoD Instruction 4715.03.

1.2 BACKGROUND

As part of its mission, the U.S. Army has chosen to be a national leader in environmental and natural resources stewardship both now and in the future. This commitment is documented in the *U.S. Army Environment, Safety, and Occupational Health Strategy* (2025). As a steward of natural and cultural resources, Camp Santiago acknowledges its commitment to be a conservation leader for its area.

Several laws and Army directives regulate the preparation of INRMPs. DoD Instruction 4715.03 requires all military installations that have habitat suitable for conserving and managing natural ecosystems prepare INRMPs. It requires DoD to demonstrate stewardship of natural resources in its trust by protecting and enhancing those resources for mission support, biodiversity conservation, and maintenance of ecosystem services.

Development and implementation of the INRMP is guided by Army Regulation (AR) 200-1, Environmental Protection and Enhancement. It provides that policy, procedures, and responsibilities for conservation, management, and restoration of land and the natural resources. Army Regulation 200-1 requires that the INRMP be reviewed annually and revised as necessary to incorporate new information and/or requirements.

An installation revises its INRMP only if there will be significant changes in management, and/or new missions that will have new impacts on resources. The installation must conduct a review of the INRMP for operations and effectiveness at least once every 5 years.

The *Sikes Act* requires that the Army manage the natural resources of its military installations within the United States to provide for the following:

- No net loss in the capability of military installation lands to support the military mission;

- Integration of land (forest and range) management with the various activities conducted under the plan;
- Management of fish and wildlife and protection and/or enhancement of their habitat;
- Wetland protection, enhancement, and/or restoration necessary for support of fish, wildlife, or vegetation;
- Establishment of specific natural resources management goals and objectives;
- Subject to requirements necessary to ensure safety and military security, provide appropriate and necessary access to the military installation;
- Enforcement of applicable natural resource laws and regulations; and
- Other activities as the Secretary of the military department determines appropriate.

The *Sikes Act* also requires coordination between each installation, the U.S. Fish and Wildlife Service (USFWS), and appropriate state agencies on plans that promote the development, maintenance, and conservation of fish and wildlife or the rehabilitation of habitat.

Policy and guidance on INRMPs for Army National Guard training sites are provided by the Army Memorandum entitled *Army National Guard Installations and Environment Directorate Policy for Integrated Natural Resource Management Plans* (2 March 2019). The All States letter also requires that Army National Guard installations follow state environmental regulations and address these regulations in their INRMPs.

1.3 PURPOSE AND GOALS

The purpose of this INRMP is to support Camp Santiago's military mission and ensure sound land management and compliance with all relevant regulations. As stated in Army Memorandum (2 March 2019), *Army National Guard Installations and Environment Directorate Policy for Integrated Natural Resource Management Plans*, an effective INRMP provides for the management of the State ARNG's Natural Resources Conservation program, as required by the *Sikes Act*, by establishing goals for natural resources centered on the military mission and ecosystem health.

Goals are broad statements of desired future conditions, flexible enough to incorporate a measure of uncertainty, and able to evolve as conditions and knowledge base changes. Goals are supported by objectives which are the road map for knowing when and whether a goal is being achieved (i.e., measurable targets for achieving goals). "S.M.A.R.T." objectives are Specific, Measurable, Achievable, Relevant, and Timebound actions that are implemented to achieve a goal. All natural resources projects occurring on ARNG lands, regardless of funding type, shall be described in the INRMP Project Implementation Table (see **Table 13-1**) and identified as to which goals and objectives they support.

The fundamental goal of natural resources management within Camp Santiago is to achieve optimum, sustainable use of training lands by protecting natural resources and providing for multiple uses. DoD has directed that ecosystem management be the guiding principle for developing and implementing the INRMP. The goal of ecosystem management is to preserve, improve, and enhance natural resources system integrity and bio-diversity conservation.

General goals of this management plan include:

- Supporting the operational mission of Camp Santiago,
- Meeting stewardship requirements, and

- Enhancing quality of life.

Specific goals of this management plan are summarized in the following table.

Table 1-1. Specific Goals of the Management Plan

Emphasis/Issue	Management Goal
Training	Maximize military training opportunities with no loss of training capabilities and support the Puerto Rico National Guard.
Safety	Increase soldier and public safety.
Scenery	Improve the visual qualities of Camp Santiago.
Stray Animals	Prevent stray domestic animals and livestock from entering Camp Santiago.
Forest Vegetation	Minimize impacts on forest vegetation and implement restoration/ reforestation projects.
Riparian Areas	Reduce human, domestic animal, and livestock activity within the riparian areas and implement riparian area restoration projects.
Stream Channels	Restore and protect stream channel and bank stability.
Water Quality	Reduce sediment and pollution sources.
Wildlife and Aquatic Species	Minimize wildlife and aquatic species displacement and impacts on habitat.
Wildfire Management	Improve wildfire prevention and suppression capabilities.

In his visitor's welcome briefing, the Camp's commander articulates his ideal operational environment for Camp Santiago as follows:

> *"…to be a clean, well-organized installation that is free of vandalism and is secure, respectful, and available; an installation that fosters and maintains a warm, peaceful environment that is appealing to the senses."*

Updating the Camp Santiago INRMP ensures that installation operations comply with the *Sikes Act* and other federal and state laws, especially those associated with human uses, watershed health, aquatic and plant species of concern (rare, sensitive, invasive), and wildlife habitat suitability and security for endangered, threatened, and sensitive species. It would also ensure that natural resource conservation measures and military activities conducted at Camp Santiago are integrated and consistent with federal stewardship requirements.

1.4 POLICIES

To attain the goals described in **Section 1.3** above, the following policies are in place:

- All personnel will comply with the environmental quality policies and procedures specified in AR 200-1, and all applicable laws.
- All personnel will be familiar with and comply with the environmental protection measures and environmental awareness as outlined in the Camp Santiago/Fort Allen Training Sites Range Standing Operations Procedures.

- Prior to conducting training missions at Camp Santiago, all unit personnel will attend an environmental awareness briefing provided by Camp Santiago personnel.
- Patrolling of Camp Santiago by Camp personnel will be a continuing operation to prevent illegal dumping of trash, domestic animal trespass, and unauthorized use of the training area by civilians.
- Monitoring, as specified below and detailed in **Chapter 9**, will be performed to provide a basis for evaluation of the effectiveness of the INRMP.

1.5 MONITORING PROGRAM

Monitoring is gathering information and observing management activities in order to provide a basis for periodic evaluation of INRMP effectiveness.

The purpose monitoring is to determine how well objectives have been met and how management standards have been applied. Evaluation of the monitoring results would assist in the review and update of the INRMP, as required by Army Regulation 200-1, Environmental Protection and Enhancement.

Chapter 9 provides additional information on the purpose, methods, and expected results and uses of the proposed monitoring activities.

2 LOCATION AND ACREAGE

2.1 LOCATION

Camp Santiago is located on the south-central coast of Puerto Rico, adjacent to the municipality of Salinas. The main gate is located off Highway 52, approximately 51 miles south of San Juan, the capital of Puerto Rico.

Figure 2-1 shows the general location of Camp Santiago in southern Puerto Rico, while **Figure 2-2** illustrates Camp Santiago in more detail. **Table 2-1** provides a summary of the designated training areas shown on the Camp Santiago Map

2.1 INSTALLATION HISTORY

The first training camp used by PRARNG was located near the boundary of Camp Santiago, where more than 1,000 troops of the 1st Infantry Regiment were stationed from December 6-20, 1920.

From 1920 to 1940, other areas were used for training around the island (e.g., the municipalities of Hato Rey, Ponce, Vega Baja, Arecibo, Santa Isabel, and Yauco).

During World War II and through the end of the Korean War, Camp Santiago (known as Salinas Training Area at the time) was the only official training area used for Advanced Military Training. Other training areas, such as Camp Tortuguero on the northern coast of the island, were heavily used until 1953.

The U.S. Government licensed Camp Santiago to PRARNG in 1967. Since then, it has grown and expanded considerably from a tent city with very few permanent facilities to an installation of more than 300 buildings. On July 17, 1976, it was named Camp Santiago in honor of Specialist Four Hector Santiago-Colon, who was born in the town of Salinas. He was posthumously decorated with the Congressional Medal of Honor for his extraordinary courage and bravery, sacrificing his life in the Republic of Vietnam.

Camp Santiago is the largest training site licensed for National Guard training activities in the Caribbean. Its mission is to provide support and services by means of training areas, firing ranges, billeting and maintenance facilities, and logistic support to the U.S. DoD and non-DoD users, such as state and federal law enforcement agencies. Additionally, it provides services to the Puerto Rican community by supporting numerous social and cultural groups to enhance and promote a better quality of life.

Camp Santiago also serves as a mobilization station during wartime as was done in 1990 for troops of Desert Shield/Desert Storm. In addition, the Central American Games of 1993 designated Camp Santiago as the "Olympic Village.” In 1994, Camp Santiago was the site for training the multinational force that served in Haiti’s “Uphold Democracy Operation.” The Camp is used on average 325 days per year.

Figure 2-1. Vicinity Map

Figure 2-2. Camp Santiago Map

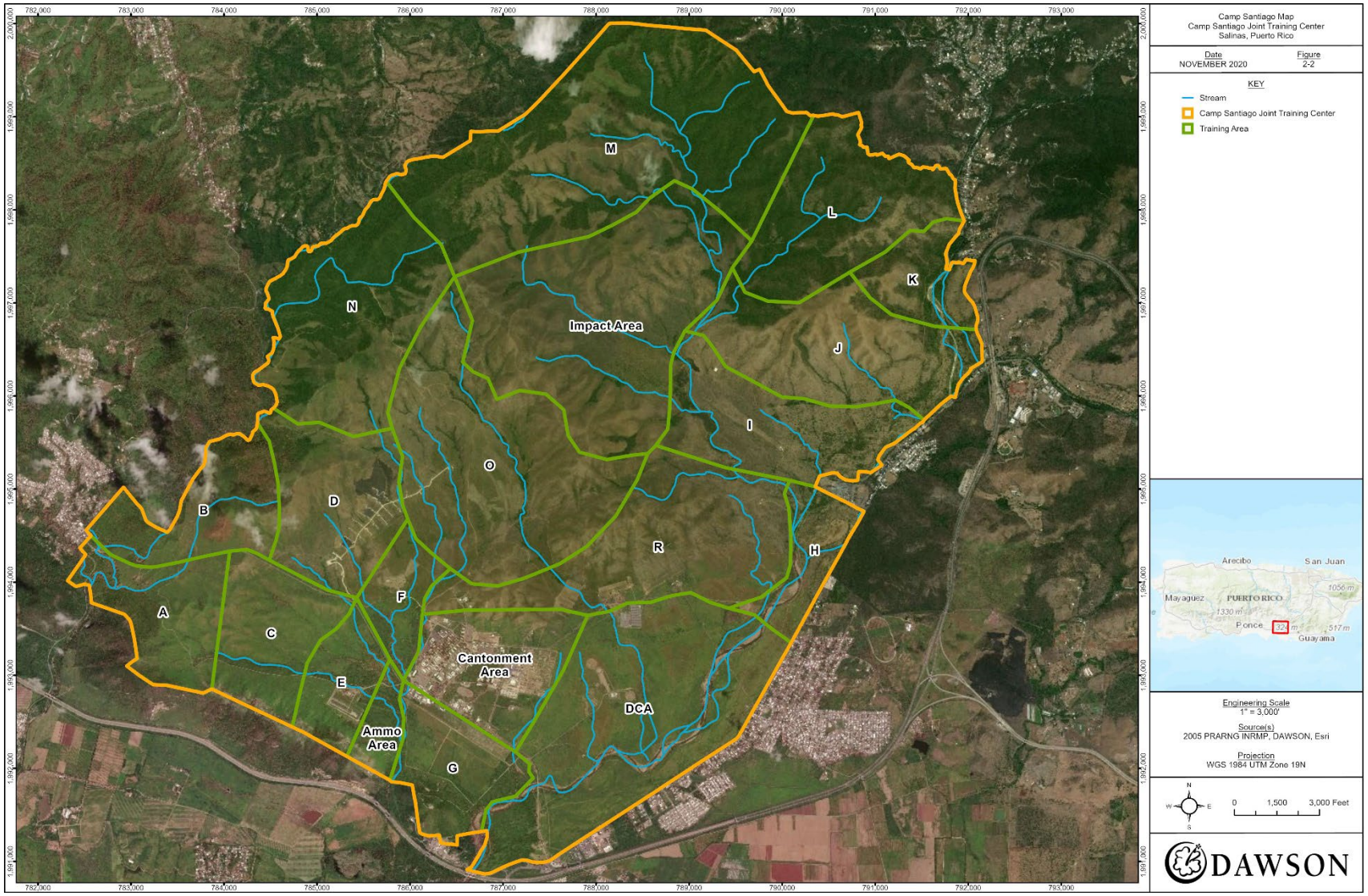


Table 2-1. Summary of Camp Santiago Designated Training Areas

Training Area	Acres	Designated Uses	Restrictions
Base Camp	470	Cantonment Area (administrative uses)	
A	396	Demolitions range; gas chamber; maneuver	Demolition up to 2lbs per pit; no digging
B	413	Firing points; maneuver	No digging
C	421	Firing points; maneuver; land navigation course	No digging
D	544	Mortar and firing points; maneuver; DZ (risky)	
E	240	140-acre Ammo Supply Point; 46 acres firing points; maneuver	No digging
F	195	Helicopter gunnery; maneuver	No digging
G	357	Airfield; shotgun range; rappel tower, maneuver	No digging
H	226	Maneuver	No digging
I	582	Mortar firing points; machinegun small arms range; DZ (nervous); maneuver	No digging
J	711	Mortar firing points; small arms range; DZ (nervous); maneuver	No digging
K	241	Mortar firing points; small arms range; maneuver	No digging
L	661	Maneuver	No digging
M	1,640	Maneuver *Note: Has not been used for several years*	Area is currently not used
N	840	Mortar firing points; maneuver	No digging
O	1,148	Ambush operations; company defensive training machine gun; squad live fire machine gun, Z (risky); aerial bomb drop zone; maneuver	
R	877	M16 machine gun; MG 10-M range; rifle marksmanship machine gun; At4 subcaliber machine gun; grenade launch machine gun, DZ (nervous); indirect firing points; maneuver	
IMPACT AREA	1,297	Impact Area	Off limits to all training activities and the public
DCA	1,280	Limited maneuver; combat and field trains operations	No digging
	10,854 1,795	Acres available for maneuver and ranges Acres not available for maneuver and ranges	

2.2 NEIGHBORS

The predominant land uses around Camp Santiago are agricultural and residential, with several civilian homes and developments located in close proximity to the borders of the training area. The major training concerns for Camp Santiago personnel are the control of noise and dust as well as the safety hazard posed by local residents who wander onto the property. Some of the land along the Camp border is not fenced off, allowing free entrance onto the training area and, in some cases, the impact area. The lack of permanent fencing poses a challenge; however, Camp Santiago personnel routinely patrol the training area to reduce the occurrence of trespassing civilians.

Camp Santiago maintains good relations with the community. The positive effect created from the income generated by the Camp's activities during the year is significant. The annual (fiscal year 2000) direct employment income generated by Camp Santiago was $2,776,800 and operational costs associated with Camp Santiago were $6,411,698.

In addition, the Camp provides logistical and social support to local institutions and communities. The overall image of the Puerto Rico National Guard as a supportive element during emergencies and natural disasters also exerts a positive attitude towards the Camp.

Camp Santiago is located within the municipality of Salinas and bordered by two other municipalities, Santa Isabel on the southwest and Coamo on the west (see **Figure 2-1**).

The following table provides 2019 Population and Housing information for the municipalities adjacent to Camp Santiago.

Table 2-2. 2010 Census of Population and Housing[1]

Municipality	2010 Population	Median Household Income[2]
Salinas	27,128	$16,887
Santa Isabel	21,209	$17,640
Coamo	38,336	$19,833
Puerto Rico	3,193,694	$20,166

1 - Updated with Revised Census Data through vintage year 2019 (2010 thru 2019).
2 – In 2018 dollars, 2014-2018

2.3 SATELLITE INSTALLATIONS

Fort Allen, located in southern Puerto Rico near the town of Juana Diaz, is a 940-acre satellite installation to Camp Santiago that was licensed to PRARNG in 1983. This INRMP addresses natural resource management at the Fort Allen Training Annex because cobana negra (*Stahlia monosperma*) was identified in the cantonment area.

3 MILITARY MISSION

3.1 OVERVIEW

Camp Santiago is the only Army training installation in the Caribbean Operating Area. Training resources provided by Camp Santiago support the mobilization readiness for one Army National Guard (ARNG) military police brigade (MP BDE), one troop command (TRP CMD) and its supporting units, and one regional support group (RSG) and its supporting units. Training resources and support include 24-hour operations of maneuver-training areas, ranges for an assortment of individual and light infantry weapon and aviation systems, billeting, mess facilities, medical support, and logistical support. Camp Santiago is the mobilization site for all Puerto Rico and U.S. Virgin Islands Army National Guard and U.S. Army Reserve units.

3.1.1 THE COMMANDER'S VISION STATEMENT FOR CAMP SANTIAGO

A vision statement generates a clear and concise description of a desired end state, and should capture the essence of the entire planning effort. Together, Camp Santiago and Fort Allen leadership and stakeholders developed the following vision statement.

> *"Camp Santiago will be recognized as a geographical partner of choice and premier Joint Interagency Intergovernmental & Multinational readiness training center offering modern facilities and resilient infrastructure capable of supporting the nation's war fighting posture, domestic response, and emerging training requirements. Camp Santiago promotes environmental stewardship by growing and operating sustainably while maintaining good relationships with the community. As a component of Camp Santiago, Fort Allen will be a premier educationally focused training center providing resilient, sustainable, and high-quality infrastructure and facilities promoting world-class training resources."*

3.1.2 CAMP SANTIAGO MISSION

The principal mission of Camp Santiago and Fort Allen is to provide support and training, to help equip ready forces in times of emergency and national conflict. The mission states the following.

> *"Command, Operate, Manage, and Administer resources of the Garrison Training Centers to accomplish all assigned missions. Provide year-round customer service through Administrative, Engineering, Logistical, Training and Operational Support to assigned, attached, transient, tenant units and Joint Forces activities for multiple formations."*

3.1.3 CAMP SANTIAGO USERS

Light infantry combat arms, field artillery, aviation, engineer, and Special Forces units are the primary users of Camp Santiago.

In addition to PRARNG units, units from the U.S. Virgin Islands, U.S. Army Special Operations Command (South), and other reserve units based in the Puerto Rico area are forecasted to conduct most of their inactive and active training at Camp Santiago. National Guard units from the States, Forces from the Regional Security System, and nations such as France, Holland, and Great Britain are also forecasted to conduct training at Camp Santiago.

Examples of non-military groups that use the Camp Santiago facilities include state and federal law enforcement agencies, local fire departments, Puerto Rico Correctional Administration, Youth Conservation Corps, Girl/Boy Scouts of America, and visitors from local schools to the museum and auditorium.

3.1.4 Available and Projected Training Support Assets

Training support assets currently available include:

- 11 basic weapons marksmanship ranges
- 6 collective live fire ranges
- 3 indirect fire facilities (27 mortar points, 24 artillery points, and 1 mortar-scaled range)
- 2 special live fire ranges
- 16 maneuver areas (light only)
- Shoothouse training facility
- Engagement skill trainer
- Rappelling tower
- Obstacle/confidence course
- Gas chamber
- Weaponer station
- Airborne drop zones
- Parade ground
- Military Operations on Urban Terrain (MOUT) training area
- 1 Ammunition Supply Point (ASP), approximately 140 acres within Training Area E
- Billets and mess facilities to support up to 4,751 troops
- Tactical airfield (currently is not operational)
- Army/Air Force Exchange (includes gas station)
- Wash rack
- Diesel Fuel Area

Training support assets projected to be available within the next three years include:

- New Rappel Tower

3.1.5 Camp Santiago Support Personnel

There are 62 authorized personnel providing operational support and support for the units in training, including 20 technical employees, 17 employees for morale, welfare, and recreation, 13 active guard reserve, and 12 military police. In addition, 66 state employees are currently working at Camp Santiago.

3.1.6 Camp Santiago Usage

The Camp Santiago ranges and maneuver training areas are used by Puerto Rico National Guard units nearly every weekend of the training year. The majority of these units conduct their 2-week annual training cycle at Camp Santiago from May to August.

U.S. Army Special Operations Command (South) units are currently planning to train on weekdays throughout the training year.

Training usage records show that, typically, Camp Santiago is used 325 days a year.

The following table summarizes Camp Santiago usage of person days by category for fiscal years 2017-2021.

Table 3-1. Camp Santiago Usage (Person Days for Fiscal Years 2017-2021)

Number of Person Days by Category							
Fiscal Year	**PRARNG**	**NG Units (from other States)**	**USAR**	**Active Component**	**Other Military**	**Civilians**	**TOTALS**
FY 2017	270,275	8,550	5,676	18,541	70	11,272	297,202
FY 2018	115,783	0	1,888	5,539	398	893	119,092
FY 2019	172,578	537	1,283	10,581	749	2,082	183,647
FY 2020	120,042	2,019	1,334	7,721	148	710	131,417
FY 2021	147,231	186	3,165	9,092	775	2,039	154,923

The RCMP provides the following conclusions regarding Camp Santiago usage:

- Camp Santiago is the only Army training installation in the Caribbean Operating Area.
- In addition to continued use of Camp Santiago by National Guard units, significant usage from other organizations is expected. Units, such as the U.S. Virgin Islands, U.S. Army Special Operations Command (South), 7th Special Forces, and other Reserve units based in the Puerto Rico area, are forecasted to conduct most of their inactive and active training at Camp Santiago.
- The demands on the firing ranges and training areas will increase as newer and more lethal weapons systems with greater engagement ranges are developed and fielded. These demands will require more effective range and training land management practices. Training facility managers will have to consider redesigning or renovating/relocating existing ranges and training land to meet the increased demand.

3.2 NATURAL RESOURCES NEEDED TO SUPPORT THE MILITARY MISSION

Camp Santiago has approximately 12,649 acres within its boundaries and is delineated into 19 training areas, each with designated uses and restrictions as illustrated in **Table 2-1**.

Natural resources needed to support the military mission include the following:

- Vegetation for Concealment and Noise Abatement - Existing vegetation provides limited concealment and noise abatement.
- Diverse Terrain and Vegetation Conditions for Dismounted and Mounted Land Navigation - Existing terrain and vegetation conditions support dismounted and limited mounted land navigation.

- Open Areas for Individual and Crew Served Weapons Training and Drop Zones - Camp Santiago has adequate open areas to support firing range and drop zone (DZ) requirements.
- Stable Roadbeds with Appropriate Stream Crossings for Conducting Convoy Operations - Camp Santiago roads are suitable for conducting convoy operations.
- Stable Soils for Cross-Country Vehicle Maneuver and Assembly Area Operations - With the exception of riparian areas, soils conditions are stable and support cross-country vehicle maneuver and assembly area operations.
- Areas Suitable for the Construction and Maintenance of Cantonment/Support Facilities - Camp Santiago offers excellent areas for construction and maintenance of support facilities.
- Suitable Water Sources for Water for Drinking and Food Processing - Water sources provide suitable water for drinking and food processing purposes after conventional treatment for removal of naturally present impurities. Water quality must be suitable for bathing and recreation as well as agricultural and industrial uses. Water sources and treatment facilities are adequate to support the current level of operations.

3.3 EFFECTS OF THE MILITARY MISSION ON NATURAL RESOURCES

Military training and associated activities can have both negative and positive effects on natural resources. For example, mounted maneuver and mission-related wildfires cause the most significant negative effects on natural resources at Camp Santiago.

Stewardship practices implemented by Camp Santiago's National Guard have had beneficial effects on natural resources. Examples of these beneficial effects include:

- Planting of vegetation in accordance with the U.S. Army Environmental Center's *Tactical Concealment Area Planning and Design Guidance Document*; and
- An aggressive and progressive command climate in which existing and potential environmental stewardship conditions, issues, and constraints are fully integrated into all mission training support and installation planning activities.

The impacts or potential impacts of the current military mission on natural resources identified and addressed in this document are summarized in the table below by ecosystem element.

Table 3-2. Potential Impacts of the Military Mission on Natural Resources

Ecosystem Element	Feature/Process	Impacts
Human Dimension	Recreation Opportunity Feature	Public recreation opportunities are limited and/or restricted by military activities.
	Scenery (Visuals) Feature	Construction of military facilities and training activities may degrade the scenery of the landscape.
	Commodities and Other Land Use Feature	Unauthorized cattle grazing impacts riparian vegetation, stream channel characteristics, and water quality.
Watershed Health	Erosion Process: - Soil Productivity - Erosion	Military activities may contribute to the loss of soil productivity, erosion, and increased nutrient (nitrogen and phosphorus) levels in surface waters.

Ecosystem Element	Feature/Process	Impacts
	- Nutrients	
	Hydrology Process: - Hydrology - Stream Channel	Military activities may disturb stream discharge and channel characteristics.
	Water Quality	Military activities may degrade surface and ground water quality.
	Aquatic Species: - Biology - Habitat	Military activities may disturb aquatic species and their habitat.
Vegetation	Forest Vegetation: - Cover Type - Patch Size & Pattern - Insects & Disease	Military activities have altered vegetation cover type, patch size and pattern from historical condition, and contributed to increased presence of insects & disease.
	Special Habitats	Military activities may disturb special habitats (small, isolated plant communities).
	Riparian/Wetlands	Military activities may disturb riparian and wetlands.
	Species of Concern: - Rare Plants - Invasive Plant Species	Military activities may disturb rare or sensitive plants and contribute to the presence of invasive plant species.
Fire & Air	Fire Disturbance and Risk	Range and wildland fires associated with military training activities may disturb vegetation, wildlife habitat, contribute to erosion and sediment sources and degrade air quality.
Wildlife	Habitat Suitability and Security	Military activities may disturb wildlife species and their habitat.

3.4 EFFECTS OF NATURAL RESOURCES OR THEIR MANAGEMENT ON THE MISSION

Training activities at Camp Santiago are conducted in accordance with federal and commonwealth environmental laws as well as DoD and Army National Guard policies and regulations.

Regulations that apply to natural resources management for Camp Santiago are maintained in the Environmental Office library which is available to personnel involved in natural resources management at Camp Santiago.

Examples of natural resources that impact or could potentially impact Camp Santiago's mission include:

- Dense Vegetation Limits Mounted Maneuver Training - This is especially a factor in Training Areas L, M, and N.

- Management of Ground Fuels and Wildfire Suppression - Considerable training time is lost while suppressing wildfires caused by firing range operations and extremely hot and dry weather conditions.
- Riparian Areas - Vehicle travel restrictions have been imposed on training activities for the protection of riparian areas.
- Vegetation - Vehicle travel, bivouac, and use of vegetation for camouflage restrictions have been imposed to protect existing vegetation and plantations.
- Soils - Travel and bivouac restrictions have been imposed to protect sensitive soils.

Examples of additional existing restrictions include:

- Restricted Area Designations – All restricted areas (no training activities or digging allowed) are recorded at Range Control and delineated on a map that is available to all users. Restricted areas include impact areas, tree plantations, and historic sites.
- Off Road Restrictions - All vehicles will use established roads and trails unless otherwise approved.
- Vegetation Cutting Band - Cutting vegetation or evergreens is not permitted and damage to trees will not be tolerated.

3.5 FUTURE MILITARY MISSION IMPACTS ON NATURAL RESOURCES

The following conclusions on Camp Santiago's future military mission are extracted from the RCMP:

- The mission of the installation is not expected to change in the foreseeable future.
- The demands on ranges and training areas will increase as newer and more lethal weapon systems with greater engagement ranges are developed and fielded.
- These demands will require more effective range and training land management practices. Training facility managers will have to consider redesigning, renovating, or relocating existing ranges and training land to meet the increased demands.
- Camp Santiago's light maneuver training land will not increase in size or availability due to increasing environmental stewardship responsibilities.
- As environmental considerations continue to affect plans and training, the growth and future direction of the Integrated Training Area Management (ITAM) program along with current trends in land management planning will help to control the impacts of training on existing assets. Improved land and natural resources management practices that closely support training requirements will provide opportunities to accomplish all required training objectives with minimal impact on current land assets.

The implementation of this INRMP is expected to protect and, in some situations, rehabilitate and restore Camp Santiago's natural resources.

4 FACILITIES

4.1 OVERVIEW

Camp Santiago's Cantonment Area is approximately 470 acres in size and is located about one mile from the center of the town of Salinas. There are 156 buildings in the Cantonment Area; facilities within the cantonment can support up to 4,000 troops (see **Figure 4-1**). The Camp is a self-supporting facility with finance, quartermaster, medical, and other support and services normally available at military installations. Troop morale, welfare, and recreational facilities are also available.

4.2 TRANSPORTATION SYSTEM

Camp Santiago is easily accessible by highway from virtually all points on the island.

The San Juan International Airport provides airline service for the island. The largest military-type transports that can utilize the airport are C-17s.

4.2.1 ROADS

Within Camp Santiago, there are approximately 12 miles of improved roads and 150 miles of unimproved roads. The improved roads (asphalt paved) are primarily comprised of Highway 154, streets and avenues in the Cantonment Area, and a stretch of road to Firing Range 22. Six primary convoy routes were identified by Camp Santiago Range Control for training purposes. These routes are designated by color: Blue, Brown, Green, Orange, Red, and Violet convoy routes (see **Figure 4-2**). These primary convoy routes comprise approximately 20 miles of improved and unimproved roads.

A summary of the six primary convoy routes is provided below. The remaining unimproved secondary routes (approximately 135 miles) were surveyed in 2013. **Chapter 8** includes recommendations for these routes.

Blue Convoy Route

The Blue Convoy Route is approximately 4.83 miles long. The route begins in the southwest corner of the Cantonment Area, follows the western edge for approximately 0.10 miles, and then heads in an easterly direction and out of the Cantonment Area for approximately 2 miles to the Rio Nigua, where the route turns to a northerly direction for approximately 2 miles (see **Figure 4-2**).

The Blue Convoy Route provides access to the Cantonment Area, Impact Area, and Training Areas DCA, R, H, I, J, K, L, M, and O. The Green and Brown Convoy Routes can be accessed from this route. The following ranges are accessed directly from the Blue Convoy Route: 17, 18, 19, 20A, 20B, 22, 23, 25, 26, 27, 28, and 30.

The Blue Convoy Route is paved through the Cantonment Area to Range 22. After this point, the route is native material/gravel. Along the west end of the Cantonment Area, general channel migration of the Quebrada Honda is eroding into the Blue Convoy Route. There are six culvert

Figure 4-1. Cantonment Area

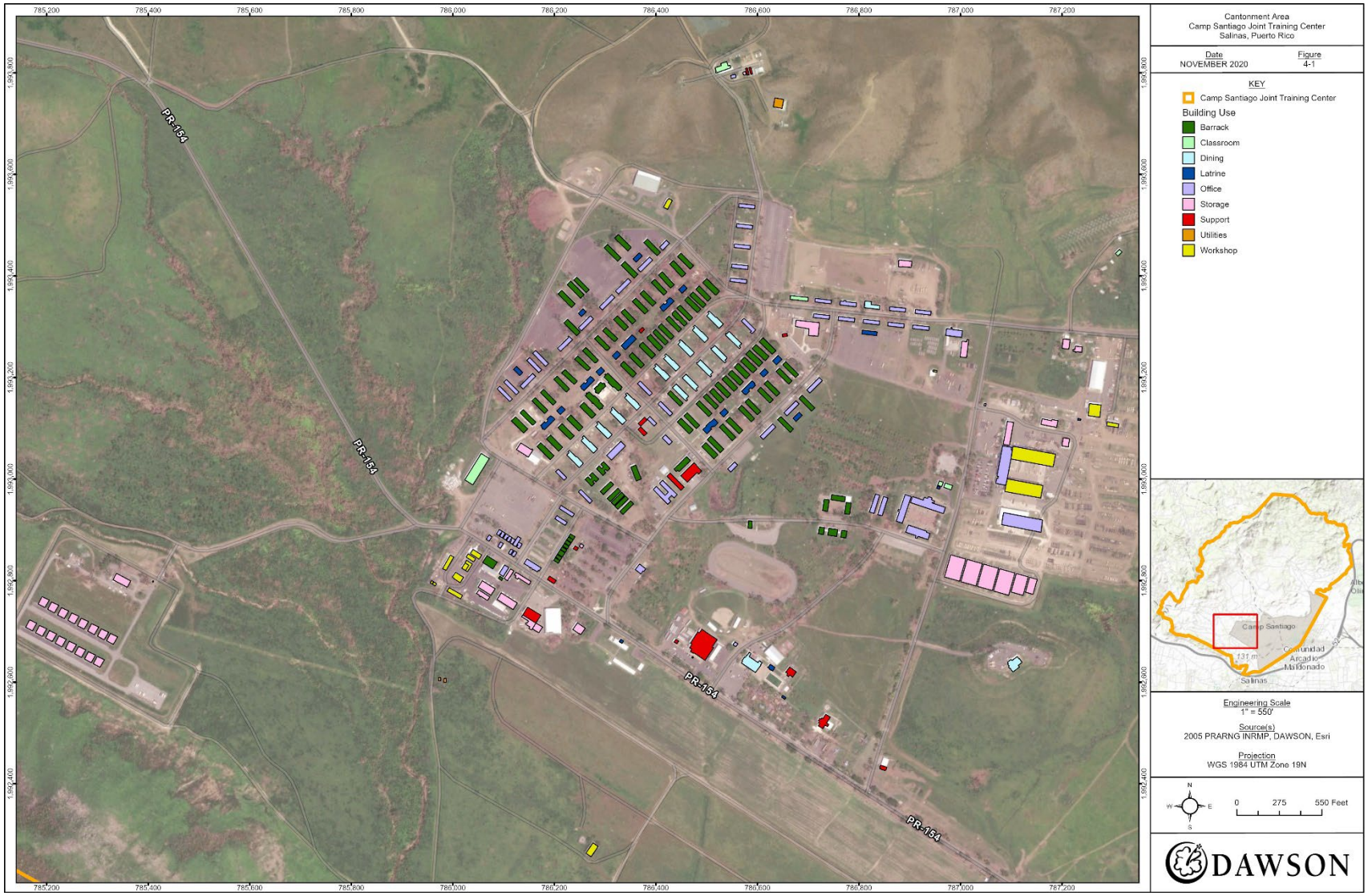
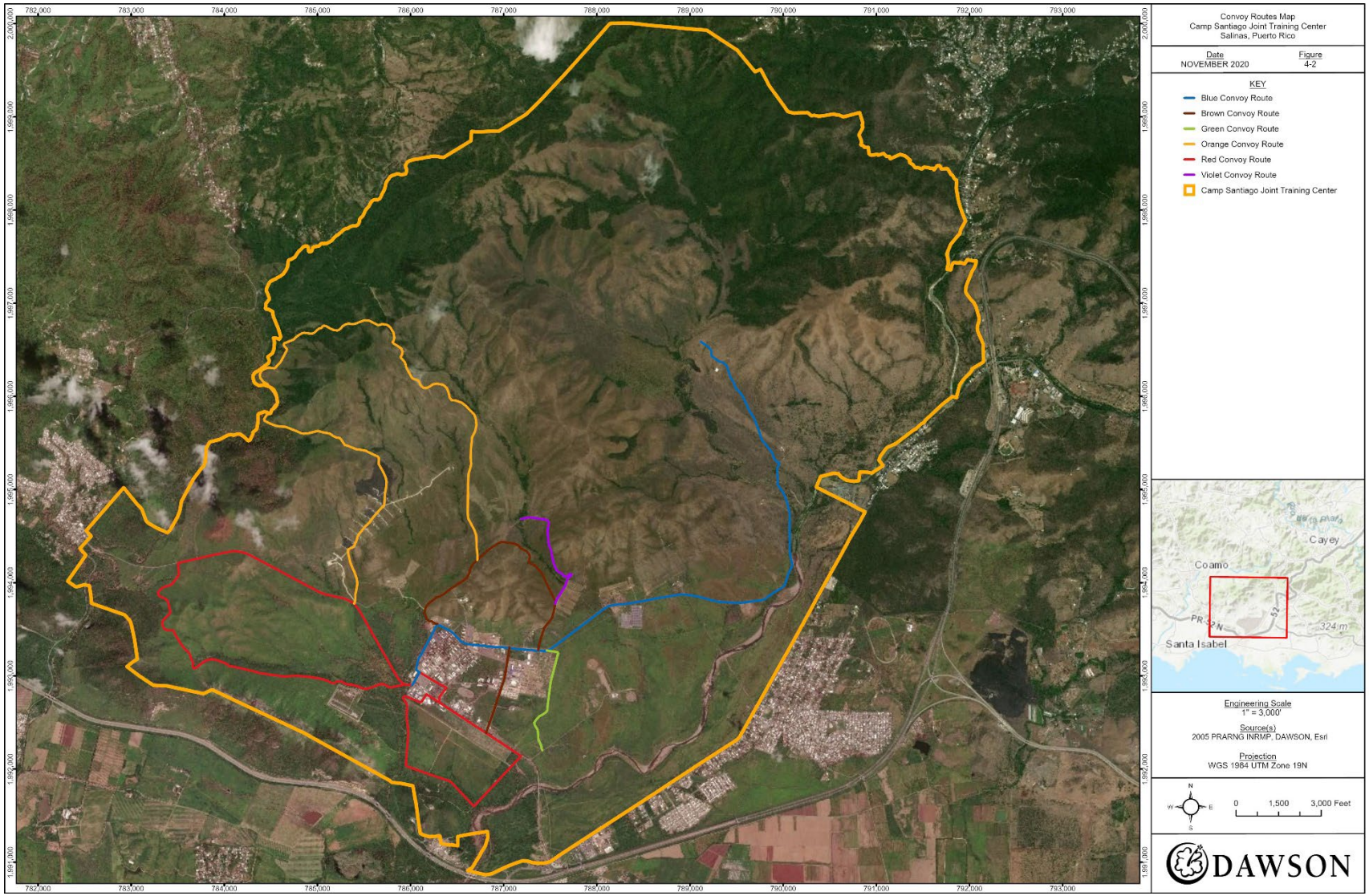


Figure 4-2. Convoy Routes



stream crossings on this route and a low water bridge over the Rio Nigua. **Chapter 8** includes recommendations for this route.

Brown Convoy Route

The Brown Convoy Route is approximately 2.36 miles long. The route begins northwest of the Cantonment Area off of the Blue Convoy Route and makes a loop to the north through Training Areas F, O, and R where it again intersects the Blue Convoy Route. The route then heads west on the Blue Convoy Route and south to its intersection with Highway 154 (see **Figure 4-2**).

The Brown Convoy Route provides access to Training Areas F, O, R, and DCA, and to Ranges 7, 15 and 18. The Violet Convoy Route is accessed from the Brown Convoy Route and the Orange Convoy route can be accessed through the Brown Convoy Route as well.

The Brown Convoy Route has a native material travel surface through most of the loop portion and is asphalt paved on the portion from the Blue Convoy Route to Highway 154. Unexploded ordinances have been identified along the western portion of the loop. There are no culvert stream crossings on this route.

Green Convoy Route

The Green Convoy Route is approximately 0.75 miles long, starts at the Blue Convoy Route, provides access to Training Area DCA, and heads in a southerly direction to the intersection with the road to the U.S. Air Force High Frequency Global Communications System (see **Figure 4-2**). The Green Convoy Route seems to be in disuse or abandoned.

Orange Convoy Route

The Orange Convoy Route is approximately 5.4 miles long and comprised of native surface material. The route begins off the Red Convoy Route and makes a loop through Training Areas D, N, and O to its intersection with the Brown Convoy Route (see **Figure 4-2**).

The Orange Convoy Route provides access to Firing Range 40. It begins off the Red Convoy Route and makes a loop through Training Areas D, N, and O until reaching its intersection with the Brown Convoy Route. The Orange Convoy Route has one culvert stream crossing, fords the Río Jueyes twice, and crosses the Cerro Pío Juan twice. It also uses the Río Jueyes' streambed as part of the route. A portion of this route was realigned to accommodate for proper access, thus improving the training area.

Red Convoy Route

The Red Convoy Route makes two loops, one west of the Cantonment Area to the gas chamber and one south of the Cantonment Area around the airfield. The total route length is approximately 7.5 miles (see **Figure 4-2**).

The Red Convoy Route provides access to the Cantonment Area and Training Areas A, B, C, D, E, F, and G. Ranges 3, 4, and 5 are also accessed directly from this route.

Only approximately 2 miles of the Red Convoy Route's west loop is currently paved (the portion coincident with Highway 154). Approximately 1.5 miles of the west loop's southernmost part are

under contract for paving and placement of road drainage features every 300 feet. A contract to pave and provide surface drainage for the remaining 1 mile of the west loop has been prepared and is waiting for funding. When completed, the entire west loop of the Red Convoy Route will be hardened and surface drainage features will be put in place.

Approximately 1.5 miles of the Red Convoy Route's east loop is currently paved (the portion coincident with Highway 154 and through the Cantonment Area). The remaining approximate 1.5 miles of the east loop are gravel and native surface. The eastern and western sides of the east loop have problems associated with overland flows, channel incision, and channel migration. Flows coming from the airfield are intercepted by the Red Convoy Route and then follow the route's surface until entering drainages at stream crossings.

Additionally, general channel degradation in the Río Nigua and excessive flows in the streams appear to have caused headcuts at streams at their confluence with the Río Nigua and up to the stream culverts on the Red Convoy Route. The stream culverts act as "grade control". Additionally, on the western end of the east loop, general channel migration of the Quebrada Honda is eroding into the Red Convoy Route.

Violet Convoy Route

This native material route originates from the Brown Convoy Route, along the west side of Range 18, and heads northeast before heading north for a total route length of approximately 0.5 miles (see **Figure 4-2**). The Violet Convoy Route provides access to the western portion of Training Area R, and direct access to Ranges 15A and 18.

4.2.2 AIRPORTS

A tactical airfield is located near the Cantonment Area (see **Figure 4-1**). Due to safety concerns, fixed-winged aircrafts have not been used on the airstrip since 1983. For this airfield to become operational, it must be expanded and re-aligned. If this could be accomplished, it would greatly reduce the substantial time and expense currently required for transporting troops to and from San Juan Airport. This would also maximize available training time.

4.3 WATER SUPPLY

Camp Santiago has a self-sufficient water supply system consisting of two wells, a water treatment plant, and a water distribution system.

In the past, a sewer line system was connected into the Salinas municipal sewage system.

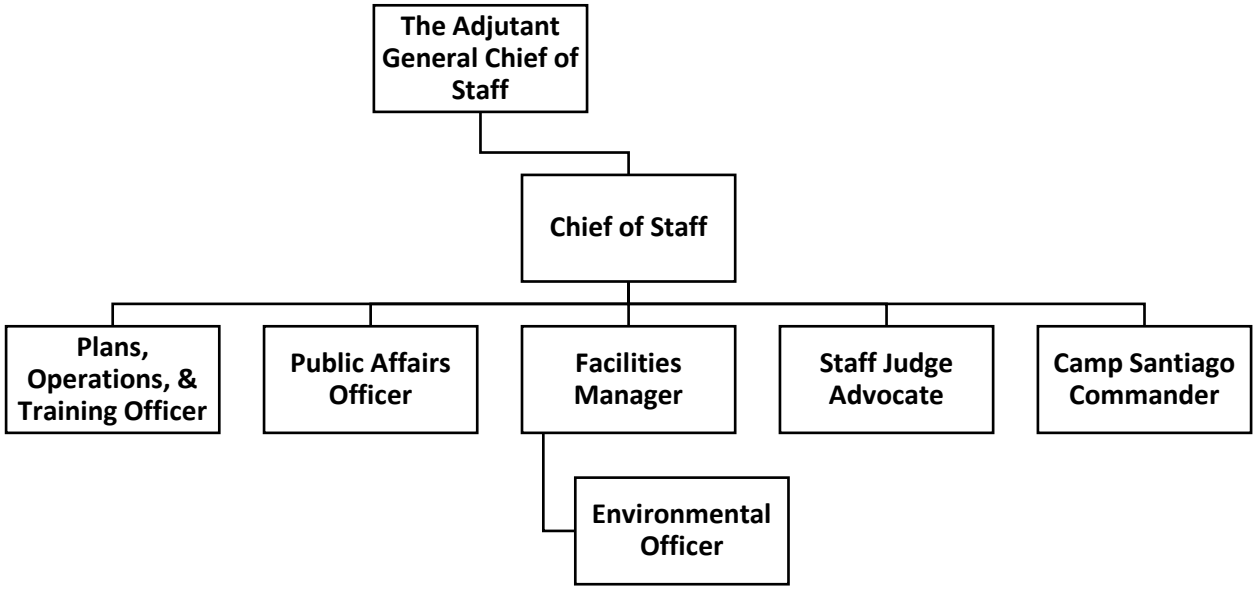
5 RESPONSIBLE PARTIES

5.1 PUERTO RICO ARMY NATIONAL GUARD

The Adjutant General (TAG) is directly responsible for the operation and maintenance of Camp Santiago, which includes implementation of the INRMP. Responsibilities of TAG include:

- Ensuring that all installation land users are aware of and comply with procedures, requirements, and/or applicable laws and regulations that accomplish the objectives of the INRMP, and
- Ensuring coordination of the INRMP initiatives between environmental, training, and engineering staffs.

As reflected in the organizational chart below, resources assisting TAG in the implementation of the INRMP include:



The following is a summary of the responsibilities of each position shown above:

- Chief of Staff – The Chief of Staff serves as the chairman of TAG's Environmental Quality Control Committee which provides overall guidance and policy direction to the environmental program, including the management of Camp Santiago's natural resources.
- Deputy Chief of Staff for Operations (DCSOPS) – The DCSOPS has the primary responsibility of determining the range, training land, and facilities training and operational requirements, and is responsible for the scheduling of military training and the safety of all personnel while training exercises are being conducted. The DCSOPS is responsible for coordinating the ITAM program, developing a baseline of current and projected training requirements and training lands/facilities for Camp Santiago, assisting the Facilities Manager Office in determining the carrying capacity for Camp Santiago by providing military usage and training data, planning land use to accomplish training requirements while minimizing negative environmental effects, prioritizing and scheduling Land

Rehabilitation and Maintenance (LRAM) projects with the Facilities Manager Office and the Camp Santiago Commander, and allocating funds and resources to accomplish ITAM requirements.

- Construction and Facilities Management Office (CFMO) – The CFMO provides a full range of financial and engineering disciplines for Camp Santiago facilities. The CFMO is responsible for master planning and ensuring that all construction projects comply with environmental regulations by consulting with the Environmental Office prior to any construction at Camp Santiago. The State Environmental Specialist, EPAS Environmental Manager, and Hazardous Waste Specialist report to the CFMO and are responsible for characterizing flora, fauna, air quality, and water quality on Camp Santiago, identifying compliance needs, and advising PRARNG on the best way to comply with federal and state environmental laws and regulations.
- Environmental Programs Manager (EPM) – The EPM provides technical assistance to the Camp Santiago Commander including developing projects, securing permits, conducting field studies, providing environmental awareness materials, locating and mapping natural and cultural resources, preparing plans such as INRMPs, and developing subsequent required revisions of INRMPs.
- Public Affairs Officer (PAO) – The PAO provides expertise in the development and production of environmental awareness materials for distribution to troop commanders. The PAO prepares news releases, develops and implements public involvement, and acts as the liaison between other government agencies and the public during public meetings and community educational events.
- Staff Judge Advocate (SJA) – The SJA advises TAG, the DCSOPS, the CFMO, and the Environmental Officer on laws and regulations that affect training land use and environmental compliance.
- Camp Santiago Commander – The Commander is responsible for the operation and maintenance of Camp Santiago, including the preparation and implementation of the INRMP.

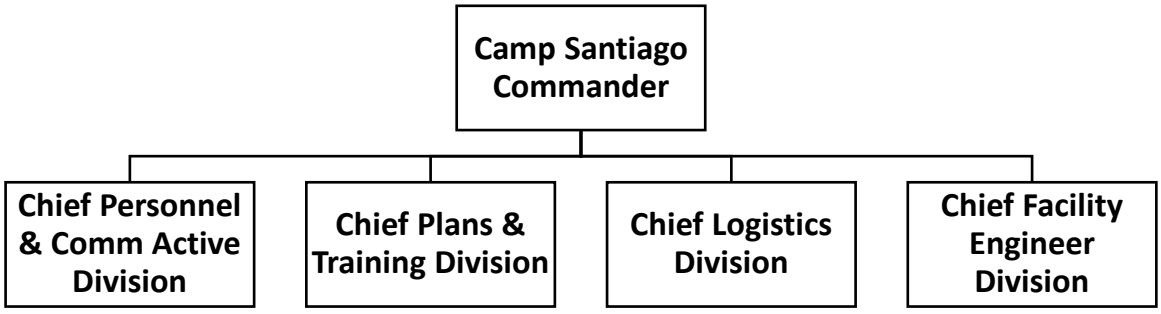
5.2 CAMP SANTIAGO ORGANIZATION

As reflected in the organizational chart below, Camp Santiago resources assisting the Commander in the implementation of the INRMP include:

- Chief Personnel and Comm Active Division,
- Chief Plans and Training Division,
- Chief Logistics Division, and
- Chief Facility Engineer Division.

Camp Santiago operations staff, including the Camp Santiago manager, range control personnel, and civilian personnel, is the primary stakeholder who ultimately implements the INRMP and ensures its success.

CAMP SANTIAGO OPERATIONS STAFF



In addition to the divisional functional areas shown above, the Command Sergeant Major, Provost Marshal, and Detachment Commander assist the Commander in the implementation of the INRMP.

5.3 NATIONAL GUARD BUREAU

The National Guard Bureau (NGB) is the headquarters for PRARNG. Natural resources are managed by ARNG G9, whose responsibilities include reviewing the INRMP and advising the PRARNG Environmental Office before formally submitting the INRMP to USFWS. ARNG G9 ensures operational readiness by sustaining environmental quality and promoting the environmental ethic. They are also responsible for tracking projects, providing technical assistance and quality assurance, and executing funds.

ARNG G9 provides policy guidance and resources to create, sustain, and operate facilities that support ARNG, as well as environmental management directly related to property maintenance (e.g., grounds maintenance, pest control).

5.4 OTHER FEDERAL AGENCIES CONTRIBUTING TO THE INRMP

Federal agencies contributing to the development and implementation of the INRMP are summarized in the following table.

Table 5-1. Federal Agencies Contributing to the INRMP

Agency	Role
U.S. Fish and Wildlife Service	Consultation and provide existing information on flora and fauna; concurrence with National Environmental Policy Act (NEPA) documentation.
U.S. Geological Service	Provide maps and aerial photos.
USDA Natural Resources Conservation Service	Conduct planning level soil survey of the Camp Santiago area.
U.S. Army Engineer Research and Development Center, Waterways Experiment Station	Conduct planning-level wetlands and other regulated waters inventory of the Camp Santiago area.

5.5 COMMONWEALTH AGENCIES

Commonwealth agencies contributing to the development and implementation of the INRMP are summarized in **Table 5-2** below.

Table 5-2. Commonwealth Agencies Contributing to the INRMP

Agency	Role
Puerto Rico Department of Natural Resources and Environment	Consultation and provide existing information on flora and fauna; concurrence with NEPA documentation; provide nursery stock for forest re-vegetation and riparian restoration initiatives.

5.6 OTHER INTERESTED PARTIES

Parties interested in or possibly affected by the development and implementation of the INRMP include:

- The public and residents of Puerto Rico.
- Neighboring Land and Livestock Owners - Livestock owned by adjacent neighbors are currently trespassing and grazing within Camp Santiago. A neighboring landowner currently has a permit to cut and harvest hay from designated areas within Camp Santiago.
- Puerto Rico Conservation Trust Fund – The Puerto Rico Conservation Trust Fund is concerned about maintaining the unique scenic and visual values that the landscape provides.

6 NATURAL RESOURCES AND CLIMATE

6.1 SETTING

Camp Santiago is located on the south-central coast of Puerto Rico, adjacent to the municipality of Salinas. The main gate is located off Highway 52, approximately 51 miles south of San Juan, the Capital of Puerto Rico, and 30 miles east of Ponce, the second biggest city in Puerto Rico. The Camp is accessible by highway from virtually all points on the island (see **Figure 2-1**).

According to the classification of ecological life zones made by Holdridge (Ewel and Whitmore 1973), Camp Santiago and the south-central coast of Puerto Rico is located within the Sub-tropical Dry Forest Life Zone, the driest of the six life zones defined for Puerto Rico. The vegetation in this life zone tends to form a complete ground cover and is almost entirely deciduous on most soils. Leaves are often small and succulent or coriaceous, and species with thorns and spines are common. Tree heights usually do not exceed 15 meters and the crowns are typically broad, spreading, flattened, and have sparse foliage. Fire is common on the better soils where successional vegetation includes many grasses.

The landscape of Camp Santiago presents a highly scenic view of the southern slope of the Cordillera Central Mountains. Key viewing points include Highway 1, just south of Camp Santiago, and the communities of Salinas, Sabana Llana, and Parcelas Penuelas. Camp Santiago entered into a Memorandum of Understanding (MOU) with the Puerto Rico Conservation Trust Fund in order to preserve and maintain the unique and unspoiled scenery and vista of Camp Santiago both by day and night above the 100-meter topographic contour.

Predominant land uses around Camp Santiago are agricultural and residential. There are several civilian homes and developments located near the borders of Camp Santiago.

6.2 TOPOGRAPHY AND GEOLOGY

Camp Santiago is situated on the southern slope of the Cordillera Central that forms the main drainage divide of Puerto Rico (see **Figure 6-1**). The rugged mountains of the northern portion of the camp rise to 2,000 feet above sea level. In the southeast portion of the Camp, the San Lorenzo Batholith is present which was formed during the Maastrichtian age (72.1 to 66 million years ago). It has few lineaments that are generally north-south and occasionally east-west. This lineament pattern is different from that of the surrounding terrain and may represent fracturing caused by the cooling of intrusive rocks (Maacann 2002).

A long east-west escarpment separates the Tertiary carbonate rocks of northern Puerto Rico from the mountainous central core of volcanic rocks and intrusive granodiorites of Cretaceous and early Tertiary age (Briggs 1964) named the Cariblanco Formation. The central highlands in Puerto Rico include exposures of Cretaceous and lower Tertiary volcanic and sedimentary rock sequences, various intrusive rock bodies, Oligocene and Miocene sediments, large areas of floodplain deposits, terrace deposits, and landslide debris (Monroe 1980).

The only documented occurrences of hydrocarbons (including crude oil) on the island of Puerto Rico are carbonate concretions of the Cariblanco Formation. Hydrocarbons are preserved as inclusions within calcite cements and light mature oil is present in voids in the concretions (Gonzalez 2005). Petroleum exploration efforts in Puerto Rico have focused on Tertiary basins

Figure 6-1. Topography Map of Camp Santiago

that are believed to hold the greatest potential of yielding exploitable hydrocarbons, yet, in these basins neither hydrocarbons nor potential source rocks have been discovered (Gonzalez 2005).

6.3 CLIMATE

Camp Santiago enjoys a warm subtropical dry forest climate due to its location near the equator. The temperature is mediated by trade winds that blow constantly from the east. Daily temperatures rarely drop below 70 degrees Fahrenheit in the winter and seldom exceed 95 degrees Fahrenheit in the summer.

Camp Santiago has a generally uniform climate and experiences few cloudy days. The average rainfall is 25 to 40 inches per year and primarily occurs from September through December. **Table 6-1** below provides the monthly precipitation and temperature distribution for the Camp Santiago area.

Table 6-1. Mean Monthly Temperature and Precipitation for Camp Santiago

Month	Mean Precipitation (inches)	High Mean Temperature (ºF)	Low Mean Temperature (ºF)
January	1.48	85.8	67.1
February	1.1	85.6	67.5
March	1.15	85.9	67.8
April	1.37	87	69.7
May	4.43	88	72.4
June	3.44	88.7	74.1
July	3.64	89.4	74.1
August	3.98	90.2	74.1
September	6.32	89.7	73.2
October	6.28	89.1	72.2
November	4.65	88.2	70.7
December	1.88	86.6	68.3
Mean Annual	3.31	--	--

Source: MilBase 2020

The destructive force and frequent occurrence of hurricanes in the Caribbean plays a major role in shaping the vegetation composition. The passage of Hurricane Georges in 1998 and Hurricane Maria in 2017 caused intense widespread damage to Camp Santiago.

6.4 PETROLEUM AND MINERALS

There are no known commercially valuable petroleum resources within Camp Santiago.

6.5 SOILS

The 2020 NRCS Web Soil Survey data provides maps of soil taxonomic units. The survey's objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map assists with the development of resource plans. The survey includes general facts about available soil units and provides an overview of hazards and limitations.

The 2020 NRCS Web Soil Survey data provides numerous tables summarizing the potential of each soil type to accommodate various land use activities including farming, recreation, wildlife habitat, building site development, sanitary facilities, construction materials, water resource related projects, and military trafficability (in wet and dry seasons). There are also numerous tables providing physical, chemical, and engineering properties/analyses of selected soils. A summary of the soil types follows:

AnC - Annaberq gravelly clay loam, 5 to 12 percent slopes

These are shallow, well drained soils of the uplands between elevations 150 to 500 feet. They are found on summits, shoulders, and backslopes of mountains and hills. They are unconsolidated, weathered, or partly weathered mineral material that has accumulated as volcanic and siltstone rock disintegrated in place.

AnE - Annaberq cobbiv clay loam, 20 to 40 percent slopes

These are shallow, well drained soils of the uplands between elevations 250 to 650 feet. They are found on summits, shoulders, and backslopes of mountains and hills. They are unconsolidated, weathered or partly weathered mineral material that has accumulated as volcanic and siltstone rock disintegrated in place.

ArF - Annaberg-Rock outcrop complex, 40 to 60 percent slopes

These are shallow, well drained soils of the uplands between elevations 250 to 1,800 feet. They are found on summits, shoulders, and backslopes of mountains and hills. They are unconsolidated, weathered or partly weathered mineral material that has accumulated as volcanic and siltstone rock disintegrated in place.

CaB - Camp Santiago loam, 2 to 5 percent slopes

These are very deep, well drained soils of the dry coastal plain and valleys between elevations 190 to 330 feet. They are found in footslopes and toeslopes of alluvial fans and are formed from mixed alluvium derived from volcanic and limestone rock. These soils are rated good for potential grain and seed crop, grasses and legumes, herbaceous plants, and shrub wildlife habitats. They are rated fair as a potential source for sand, reclamation, and topsoil material and have a good potential as a source for roadfill. These soils have somewhat limited potential for developing pond reservoir areas and embankments, dikes, and levees.

CIB - Coama clay loam, 2 to 5 percent slopes

These are very deep, well drained soils of the dry coastal plain and valleys between elevations 65 to 360 feet. They are found in footslopes and treads of alluvial fans and terraces and are formed from mixed alluvium derived from volcanic and limestone rock.

These soils are rated good for potential grain and seed crop, grasses and legumes, herbaceous plants, and shrub wildlife habitat. These soils have a fair potential as a source for reclamation and roadfill material.

GAA - Guamani and Arenales soils, 0 to 2 percent slopes, occasionally flooded

These are very deep, well to excessively drained soils of the dry coastal plains between elevations 30 to 330 feet. They are found in convex to concave positions of flood plains. These soils are formed of medium-textured sediments over sand, pebbles, and cobbles or stratified mixed alluvium derived from volcanic and limestone rock. These soils are rated fair to good for potential grasses and legumes, herbaceous plants, and shrub wildlife habitat. There is a fair potential to develop sand and reclamation material sources and fair to good potential to develop roadfill and topsoil material sources. They have a somewhat limited potential for developing embankments, dikes, and levees.

JaB - Jacana clay loam, 2 to 5 percent slopes

These are moderately deep, well drained soils of the uplands between elevations 130 to 400 feet. They are found in the footslopes and toeslopes of volcanic hills and alluvial fans. These soils are unconsolidated, weathered or partly weathered mineral material, alluvium, and colluvium derived from volcanic rock. These soils are rated fair for potential grain and seed crop, grasses and legumes, herbaceous plants, and shrub wildlife habitat. There is a somewhat limited potential for developing pond reservoir areas and embankments, dikes, and levees with these soils.

JcC - Jacana-Camp Santiago complex, 5 to 12 percent slopes

These are moderately deep to very deep, well drained soils of the uplands between elevations 160 to 820 feet. They are found in the footslopes and toeslopes of hills and alluvial fans. These soils are formed from weather material volcanic rock and mixed alluvium from volcanic and limestone rock. These soils are rated fair to good for potential grain and seed crop, grasses and legumes, herbaceous plants, and shrub wildlife habitat. There is a fair potential to develop sand, reclamation, and topsoil material sources from these soils and a good potential to develop roadfill material sources. There is a somewhat limited potential for developing pond reservoir areas and embankments, dikes, and levees with these soils.

PrC - Pozo Blanco clay loam, 5 to 12 percent slopes

These are very deep, well drained soils of the uplands between elevations 130 to 390 feet. They are found in the summits, shoulders, backslopes, and footslopes of alluvial fans and limestone hills. They are derived from clayey and loamy marine sediments. These soils are rated fair to good for potential grain and seed crop, grasses and legumes, herbaceous plants, and shrub wildlife habitat. There is a fair potential to develop reclamation and topsoil material sources from these soils and a good potential to develop roadfill material sources. There is a somewhat limited potential for developing pond reservoir areas and embankments, dikes, and levees with these soils.

SdF - San German-Duey complex, 20 to 60 percent slopes

These are shallow, well drained soils of the uplands between elevations 300 to 700 feet. They are found on the summits, ridgetops, and side slopes of limestone hills and mountains. These soils are formed from colluvium and weathered mineral material derived from limestone rock.

SkG - San German-Duey-Rock outcrop complex, 60 to 90 percent slopes

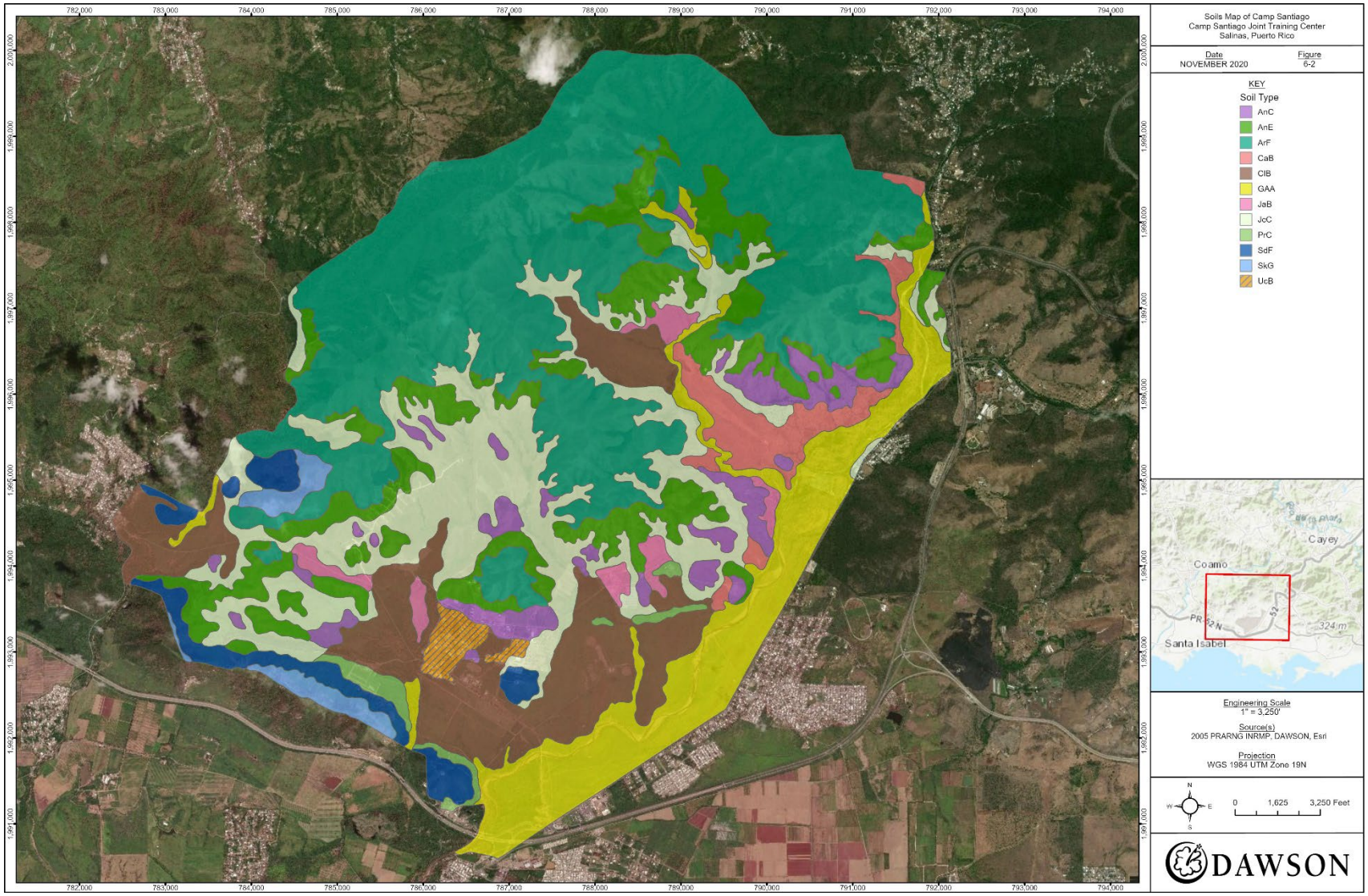
These are shallow, well drained soils of the uplands between elevations 500 to 750 feet. They are found on the summits, ridgetops, and side slopes of limestone hills and mountains. These soils are formed from colluvium and weathered mineral material derived from limestone rock.

UcB - Urban land-Coamo complex, 2 to 5 percent slopes

These are very deep, well drained soils of the dry coastal plains between elevations 130 to 165 feet. They are found on toeslopes and treads of alluvial fans and terraces. These soils are formed from mixed alluvium that weathered from limestone and volcanic rock. These soils are rated good for potential grain and seed crop, grasses and legumes, herbaceous plants, and shrub wildlife habitat. There is a fair potential to develop reclamation and roadfill material sources from these soils.

Camp Santiago is comprised primarily of Arf, JcC, CIB, and AnE soils types, containing 34.7, 13.0, 11.5, and 10.8 percent of the acreage, respectively (see **Figure 6-2**).

Figure 6-2. Soils Map of Camp Santiago



6.6 WATER RESOURCES

6.6.1 DELINEATION OF WETLANDS AND OTHER REGULATED WATERS

The U.S. Army Corps of Engineers, Jacksonville District conducted and published their findings of a wetland survey for Camp Santiago. This publication, entitled *Sediment Source and Wetland Survey Report for Camp Santiago, Puerto Rico*, dated October 2014, is on file at the PRARNG Headquarters in San Juan, Puerto Rico. The published report found the following within Camp Santiago:

- There are no jurisdictional wetlands.
- There are approximately 114.4 miles of intermittent and perennial streams.
- There is one human-made pond (approximately 0.2 acres in size).

Though there are no jurisdictional wetlands within Camp Santiago, surveys investigated six specific sites which had the potential to be jurisdictional.

6.6.2 SURFACE WATER

As illustrated in **Figure 6-3**, there are approximately 114 miles of perennial and intermittent streams within the boundaries of Camp Santiago. Most of the steams flowing through active training areas are intermittent or ephemeral, with low gradients and sizable deposits of loosed gravels and sand. The unconsolidated material is very movable during high stream flow periods.

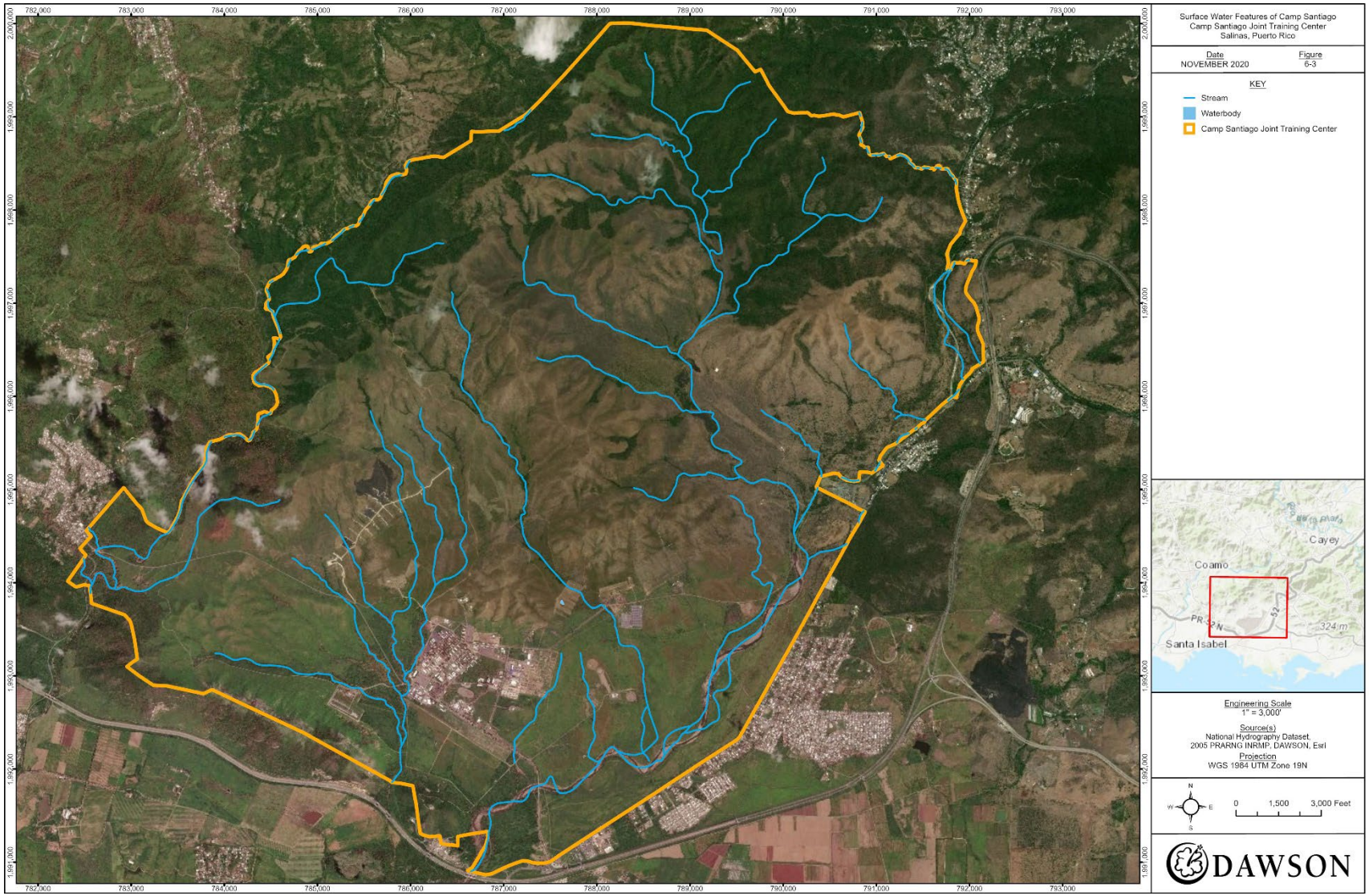
Where fires and live ammunition have removed native plants, only grass, herbaceous plants, and shrubs grow along the stream courses. These historic riparian areas can be observed in aerial photos as linear features that are greener than the surrounding areas. The old stream course topography is shaped by the Rio Nigua and fed by precipitation events. Numerous springs flow to the surface, but most run dry before accumulating any significant amounts of water, except during seasonal storm events.

The steep topography and shallow soils that occupy the upper elevations of Camp Santiago are along the southern slopes of the Cordillera Mountain Range. Here, boulders and bedrock outcrops form streambeds. Large, deeply-rooted trees help hold the stream banks in place. The boulders in the channel act as natural flow dissipaters and moderate the runoff intensity of rainstorms. Similar conditions exist in the upper watershed of the Rio Nigua and Rio Jueyes outside the boundary of Camp Santiago.

Only short sections of the Rio Jueyes and Rio Nigua within the Camp Santiago boundary have water throughout the year. Field reviews in 2000, 2004, 2005, and 2013 indicated that most of the surface water of the Rio Nigua sinks below the surface soon after it enters Camp Santiago in the section of stream channel that is made of unconsolidated material and extracted for gravel and fill material.

Active erosion is present in many sections of the stream channels, especially where altered by vehicle use. Where the stormwater runoff is concentrated in narrow valleys, brush and other vegetation is ripped out of the stream beds and carried downslope. While conducting the inventory of convoy routes and sediment sources, many locations were found where gullies are enlarging.

Figure 6-3. Surface Water Features of Camp Santiago



This is also caused by changes in elevation of the streambed at the convergence of two stream courses. This type of uphill erosion of gullies is called a "head cut."

When severe runoff conditions occur and block stream crossing structures at Camp Santiago with rubble, stream water flow may push itself to the sides of stream channels and cause road erosion. Similar conditions occur north of El Coco and other narrow valleys in surrounding areas. Water that flows down tire ruts in convoy routes has contributed to the erosion of the stream channel. The expansion of excavated areas next to stream crossings also contributes to stream channel erosion. Excavated areas collect rainwater and route it directly into the stream at crossings, thereby increasing stream flow downhill from each excavation. Together, such situations are causing repeated damage to roads and road crossing structures and impairing access to Camp Santiago.

The use of small diameter gravel rubble from building demolition to patch eroded stream crossings is a continuous source of sediment to the stream and is aggravating the erosion problems downslope. Deposition of eroded material in low gradient areas blocks stream channels and contributes to channel shifting.

6.6.3 GROUNDWATER

Water is currently piped to Camp Santiago from Salinas. Water usage and increased salinity in the shallowest aquifer which is used as a drinking source for the area is a cause of concern to all water users as Puerto Rico has been dealing with severe drought for years.

6.6.4 STORMWATER MANAGEMENT

The southern portion Camp Santiago (the area most heavily used for training maneuvers) is situated at the bottom of a gently sloping valley. Most of the water flowing through Camp Santiago flows through streams from the northern-most mountainous portions of the Camp (see **Figure 6-3**). Within the Cantonment Area most rain runs off the paved roads and parking lots into grassy fields throughout the encampment, which helps filter out sediment. A Stormwater Pollution Prevention Plan was developed in March 2017 for Camp Santiago. This document states that no erosion or sedimentation is evident at the sites and that the natural layout of the facilities allow for slow infiltration of stormwater.

6.6.5 WETLANDS AND FLOODPLAINS

Camp Santiago contains no jurisdictional wetlands within its boundaries, though there are many areas that are wet on a seasonal basis. Most of the training areas within Camp Santiago are relatively dry with highly permeable soils supporting grasses and desert-like vegetation except during seasonal tropical rainstorms.

Floodplain maps provided by FEMA dated 2019 (FEMA 2019) show flood prone areas along the Rio Nigua within the eastern and southern boundaries of Camp Santiago and south through Salinas. No flood prone areas were mapped along the Quebrada Honda or its tributaries draining the western side of the Cantonment Area. Some floodplains also occur along the Rio Jueyes where the valley bottoms are broader and less steep. Most flood prone areas are only occupied during intense rainstorms, when several inches of rain fall during a short period of time and the water exceeds the infiltration rate of the soils and runs off as overland flow. Berming along several

waterways concentrates the flood flows in the lowest areas. As previously described, rain at Camp Santiago may be light and of short duration, but it receives a large volume of water from the upper watershed including tributaries of the Rio Majada, such as the Rio Jajome.

Intense runoff events (mostly in the mountainous area to the north and east of Camp Santiago) create flash flood conditions in the lower elevations. All low elevation areas can be flooded within hours of the onset of a storm, including convoy routes and shooting ranges within Camp Santiago and neighboring areas. The local geology and drainage patterns indicate that both portions of the Camp and the adjacent communities of El Coco and Salinas occupy historic floodplains.

Flooding in the lowest areas has been aggravated by alterations in the stream course and filling of the floodplains for development.

These “floods” or “over-bank” conditions have increased in intensity and frequency where urbanization has paved the earth causing water to run off instead of infiltrating into the ground. Brush fires across the island regularly burn ground cover and cattle browsing has replaced native vegetation with grasses and shallowly rooted shrubs, both of which increase runoff rates and volumes.

6.6.5.1 Rio Nigua at Salinas Flood Control Project Design Documentation Report

In 2001, the Army Corps of Engineers, in conjunction with the Puerto Rico Department of Natural and Environmental Resources, finalized a detailed study focused on the formulation and evaluation of flood control plans to solve the serious flooding problems resulting from the overflow of Rio Nigua into the vicinity of the town of Salina, Puerto Rico. The *Rio Nigua at Salinas Flood Control Project Design Documentation Report* recommends improvements for the Rio Nigua south of Highway 52 consisting of a 3.0-kilometer levee along the east bank of the river extending southward ending east of the mouth of the river in the coastal area. The plan includes protection measures against erosion for the east abutment of the highway bridge, a new bridge and ramp at Highway 1, and a levee segment to protect the intersection between Highways 52 and 1. The recommended plan also includes a 4.5-kilometer earthen levee to provide flood protection to the Coco community, upstream along Highway 52. The proposed levee projects are expected to contain the 100-year flood. The project calls for the use of a primary borrow area on the river's west bank, immediately adjacent to the Coco Levee and an auxiliary borrow site further from for the project site, both within the boundary of Camp Santiago.

In September 2020, the Army Corps of Engineers requested that the Camp Santiago Commander permit entrance to the premises to carry out the geological and archaeological studies needed to design the flood control project. Camp Santiago personnel and the CFMO Office will participate in the meetings and request information on how this project will affect Camp Santiago.

6.6.5.2 Fort Allen Training Center Stormwater Project

In September 2015, Jacksonville District USACE performed a site visit at Fort Allen to inspect, evaluate, and collect data for the existing watershed conditions, structural components, and drainage features. The follow-on trip report, dated 27 October 2015, included four conceptual strategies/potential solutions to address the flooding issues being experienced by PRARNG. PRARNG requested the first potential solution which included on-site interior drainage and storage options.

Jacksonville District USACE began a design feasibility study for Fort Allen in 2019. PRARNG requested a target 100-year flood protection design. An interior base survey was completed as well as several geotechnical boring and test pits. A copy of the 65% Master Plan Submittal for Fort Allen dated September 2018 was provided to Jacksonville District USACE in September 2019. After a review of the master plan, it was discovered that Fort Allen has several new military construction (MILCON) projects that are proposed. Hydraulic modeling was conducted for a 25-year 24-hour, 50-year 24-hour, and 100-year 24-hour storm events. The model included interior drainage channels throughout the base perimeter and two large stormwater storage ponds. Due to the water table depth, proposed channel bottom slope elevations and the soil conditions of the base, the pond depths were limited to 2 meters below existing grade. This limiting factor required pond sizes to be very large (Pond 1 was 196,059 meters squared [48.45 acres], Pond 2 was 48,561 meters squared [12 acres]). Due to lack of an on base soil disposal area, PRARNG directed Jacksonville District USACE to dispose of the excavated soils off site. The offsite disposal requirement increased the cost of the project two alternatives to non-feasible levels ($51.1 million and $37.8 million respectively). Even with the largest of pond sizes, the 50-year and 100-year storms would still cause up to 0.82 meters of flooding to occur at multiple location throughout the base. On 27 February 2020, a briefing of the feasibility design was given to PRARNG.

As of 21 January 2022, the Army Corps of Engineers Jacksonville District has completed the alternative analysis of recommended action and modeling efforts for the Fort Allen Training Center stormwater mitigation project. The next phase of the project consists of additional modeling on the selected alternative plan, data gathering, environmental coordination and design of the new stormwater runoff conveyance system.

6.6.5.3 Camp Santiago MILCON Barracks, Dining Facilities, HQ Stormwater Drainage Section

The Camp Santiago MILCON barracks, dining facilities, and headquarters southwest drainage project is located in the Salinas municipality of Puerto Rico. The proposed project will replace existing barracks and supporting facilities that were severely damaged during Hurricane Maria in 2017. The project consists of facilities funded under three separate 1391 documents as provided below:

- Enlisted Barracks (10 buildings),
- Company Headquarters (17 buildings), and
- Dining Facilities (2 buildings).

Civil design for this project will include site demolition, site grading, pedestrian walkways, storm drainage systems, parking lots, domestic water, and sewer connections.

Site survey data indicates that the general direction of drainage is to the south/southeast. Site grading and roadway profiles will take advantage of the existing site grades and shall generally drain to the south/southeast with grades similar to existing grades allowing for positive water flow into proposed detention/retention areas. Site drainage design shall include porous concrete pavers, storm sewer inlets, and storm sewer and enlargement of an existing detention/retention pond to conform to Stormwater BMPs, low impact development standards, and local and federal laws.

The goal of the storm water design is to manage storm water up to the 25 year 24-hour storm efficiently while reducing outlet flows to the site's pre-development hydrology. The design storms

used are the 10-year 24-hour storm and the 25-year 24-hour storm. The precipitation values for these storms were found from the National Oceanic and Atmospheric Agency website. The pre-development and post-development peak flows were found by utilizing Civil3D Hydraflow Hydrographs using the TR-55 Hydrograph calculator.

In order to achieve Leadership in Energy and Environmental Design (LEED) credits for the design; it is the goal to retain on-site 100% of the 95th percentile storm. The required rainfall depth was found by analyzing the three rain gauges closest to Camp Santiago and averaging the three 95th percentile rainfall depths found. The total required retention will be made through the use of permeable interlocking concrete pavers, infiltration basin, and detention/retention basins.

Storm water management will be coordinated with systems developed for the barracks and headquarters areas, using similar methods and structures as appropriate. Storm water flow will generally follow existing patterns and will be intercepted by detention basins and swales prior to off-site discharge through a storm sewer collection system as necessary.

6.6.5.4 Rio Nigua CW Project

The Army Corps of Engineers Kansas City District, Saint Louis District, and Mississippi Valley District team is working on civil works Rio Nigua at Salinas Supplemental Project. Preliminary hydrologic and hydraulic model runs were reviewed against Camp Santiago training operations, main gate relocation project, main power supply to base and Army Aviation Support Facilities operations. Based on those results, it appears minimal impacts to these areas will be present, however the MVS team will have to design ramps for operational continuity for Camp Santiago personnel to access power, training, and operable areas. The Army Corps of Engineers project delivery team is currently working on finalizing the modeling and preparing the intermediate design submittal.

6.6.6 WASTEWATER TREATMENT SITES

Camp Santiago is connected to the Salinas sewage treatment system. In the past, however, Camp Santiago managed its own wastewater treatment plant that has since been shut down. The old treatment plant has not been completely reclaimed, and plastic pipes still protrude from an eroded bank along the lower segment of the Red Convoy Route.

6.7 FLORA

6.7.1 VEGETATIVE COVER

Vegetative covers in Camp Santiago include seven groups of plant formations, nine habitat types based on biological and physical characteristics, and eight ecosystem types based on plant species dominance.

As early as 1860, vegetative descriptions for the Salinas Municipality describe the area as dedicated to raising cattle for which it has “good and plentiful pastures.” In 1897, it was estimated that 93 percent of the municipality was in “pasture for 10,314 head of cattle". After 1898, the land use activities turned to sugarcane production. Analysis of 1937 aerial photographs show that Camp Santiago lands were comprised of open pasture, shrubs, and two patches of closed forest (Cerro Modesto and Cerro Respaldo). The 1950 aerial photographs show an increase in closed forest and shrub areas. More recently, 1996 aerial photographs show a continuation of the same

successional trend, but the original closed forest had been mostly burned over by fire. The forest remnant on Cerro Respaldo has been reduced due to uncontrolled grass fires.

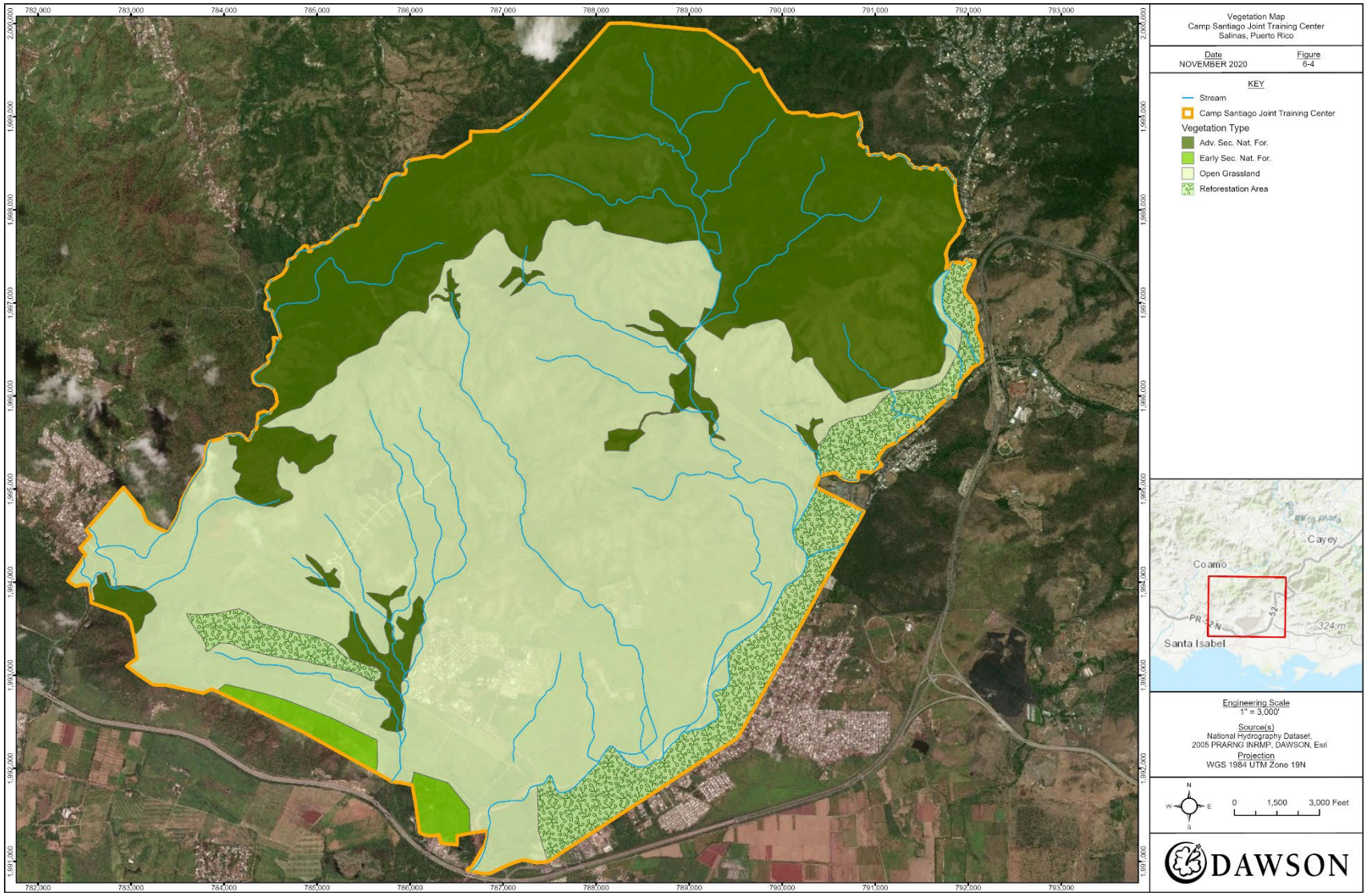
Camp Santiago's vegetation is a seral community which is an intermediate stage in an ecosystem that will eventually progress to a climate community to include the following types of habitat: Advanced Secondary Natural Forest, Early Secondary Natural Forest, Open Grasslands, and Artificial Regeneration Forest. This classification mode will facilitate and simplify future vegetation management directions.

Figure 6-4 identifies actual and potential areas of floral seral stages for the purpose of vegetative description and management directions. The following table illustrates the current vegetative seral stage classification of the 12,649 acres within Camp Santiago.

Table 6-2. Current Seral Stage Classification of Vegetation within Camp Santiago

Seral Stage Classification	Acres	Percent of Total Acreage
Advanced Secondary Natural Forest	4,100	32%
Early Secondary Natural Forest	189	2%
Open Grassland	7,425	59%
Artificial Reforestation Forest	934	7%

Figure 6-4. Vegetation Map



Vegetative analyses from 1936, 1950, and 1996 aerial photography show advanced secondary forest increments in the drainage areas, some riparian zones, and the foothills north and west of the Camp. Most of the plant communities associated with the Subtropical Dry Forest at Camp Santiago are represented in these advanced secondary forest areas.

6.7.2 Plant Species of Concern

A survey completed in August 2014 located four special status plant species in Camp Santiago including *Myrciaria myrtifolia Alain*, *Mimosa quadrivalvis L.*, *Eugenia woodburyana Alain*, and *Maytenus cymose*. *Myrciaria myrtifolia Alain, Mimosa quadrivalvis L.*, and *Maytenus cymose* are listed as Commonwealth Critical Element (Potential Candidate) while *Eugenia woodburyana Alain* is listed as federally endangered and Commonwealth Critically Endangered.

Three locations at Camp Santiago with a high number of endemic species deserve special protection including Piedras Chiquitas, Cerro Cariblanco, and Cerro Pio Juan. Precipitous cliffs and rock outcrops in these areas are notably important for endemic plants.

6.7.3 Riparian Areas

Riparian areas have distinctive resource values and characteristics that are comprised of an aquatic ecosystem and adjacent upland forest areas that have direct relationships with the aquatic system. This includes flood plains and all areas within 100 feet of the normal high waterline of a stream channel.

The riparian ecosystem is a transition between the aquatic ecosystem and the adjacent upland terrestrial ecosystem. It is identified by soil characteristics and distinctive vegetation communities that require free or unbounded water.

As previously mentioned in the description of surface water, there are approximately 144 miles of stream channels and approximately 1,270 acres of riparian areas that provide streamside buffer vegetation within Camp Santiago (see **Figure 6-5**).

6.8 FAUNA

Faunal surveys at Camp Santiago have been documented in a July 2014 report entitled *Biological Resources Assessment for Puerto Rico National Guard Camp Salinas Training Site* (see **Appendix A**). The updated inventory for the INRMP includes 51 unique species including 33 birds, 5 amphibians, 5 lizards, 3 mammals, and 10 fish. Included are domesticated and feral animals present at Camp Santiago that are also addressed as pests in **Section 6.10**. For more information on the control and management of non-native species, see Camp Santiago's *Integrated Pest Management Plan*.

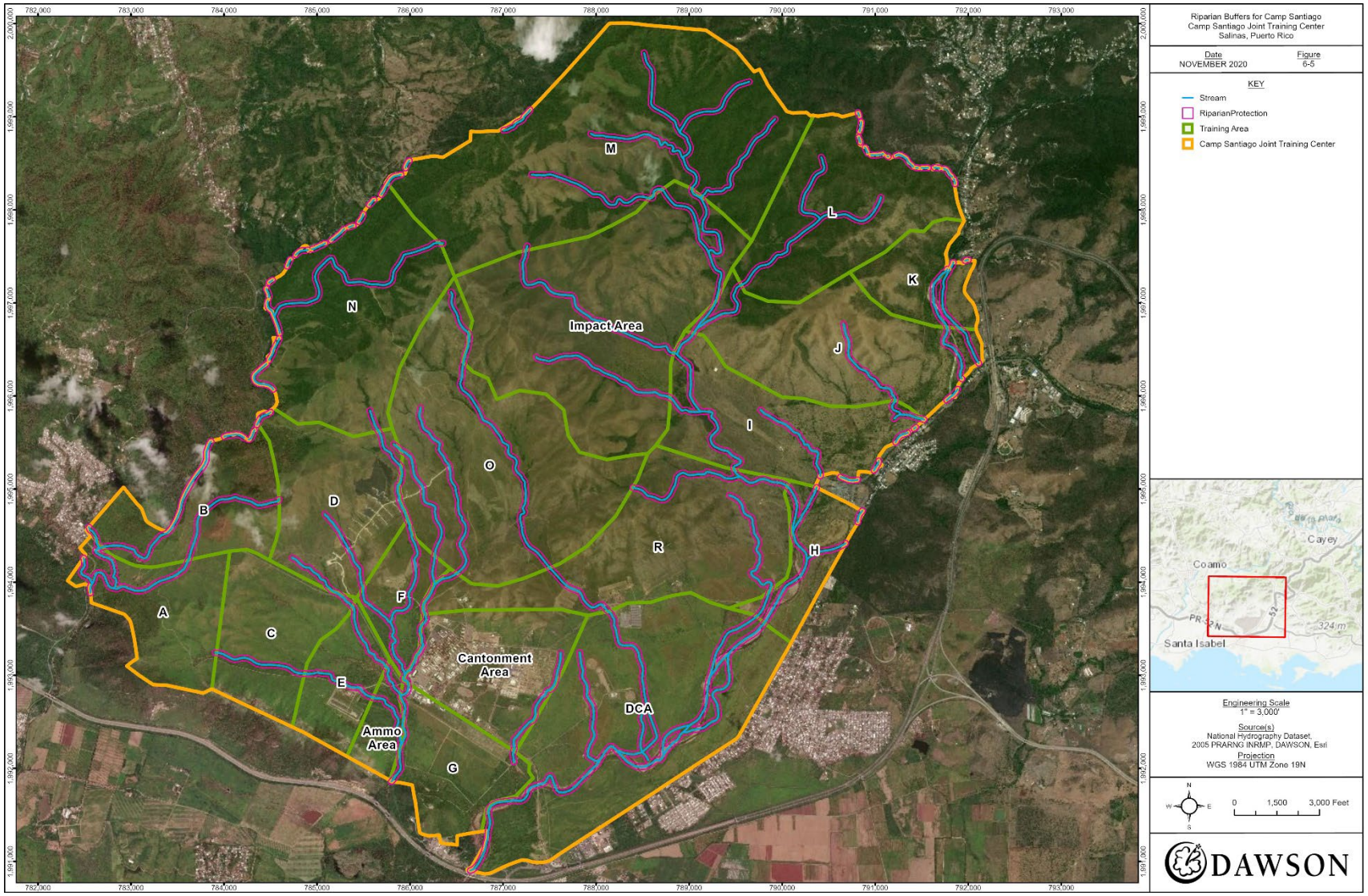
All of the animal species recorded within Camp Santiago are commonly found in Puerto Rico. Abundance and diversity of animal species across the Camp is higher in forested and riparian areas.

6.8.1 Birds and Mammals

Birds comprise the majority of individual species (29 of 51) documented within Camp Santiago. Nearly all of the bird species observed at Camp Santiago are common to Puerto Rico and

generally associated with the forest ecosystem. Relative to other vegetative types at Camp Santiago, forest environments offer more diversified foraging and nesting habitats to support a larger assemblage of bird species.

Figure 6-5. Riparian Buffers for Camp Santiago



For mammals, only bats are native to Camp Santiago and the island of Puerto Rico. Previous surveys for bats at Camp Santiago resulted in the documentation of only one species, the Pallas's mastiff bat (*Molossus molossus*). It is suspected that two other bat species, the Jamaican fruit bat (*Artibeus jamaicensis)* and red fruit bat (*Stenoderma rufum)* could also be present based on the suitability of habitat. Bats have been previously observed in several of the building structures in the Cantonment Area.

All other mammals were brought to the island as domesticated livestock and pets, or introduced for pest control. Rats and mice were introduced to the island as stowaways on ships. Mongoose were then brought to the island and released to manage the rat population. Feral dogs and cats are common within Camp Santiago. Additionally, an undetermined number of unauthorized cattle, horses, goats, and sheep currently forage on portions of Camp Santiago lands.

6.8.2 WATERFOWL

Since no jurisdictional wetlands are present at Camp Santiago, waterfowl are not found at Camp Santiago for the majority of the year. During seasonal rainstorms, small riparian systems expand and water-habitat dependent bird species occur in higher numbers within Camp Santiago.

6.8.3 AMPHIBIANS AND REPTILES

Reptiles found at Camp Santiago are represented by five species including lizards (four species), and geckos (one species). Lizards, especially the Annolis types, are the most common and abundant. Both arboreal and ground lizards are present.

Existing habitat conditions at Camp Santiago support five amphibian species including two native species of coqui tree frogs, one native terrestrial toad, and one imported toad. The latter species, the giant toad (*Bufo marinus)*, was imported to Puerto Rico between 1920 and 1926 to control a particular type of sugarcane grub. The giant toad is considered a problem predator for some native species.

River, wetland, and aquatic environments that provide the primary habitats for amphibians are limited within Camp Santiago. There are no designated wetlands found within the general perimeter of Camp Santiago.

6.8.4 AQUATICS

Aquatic invertebrates are found throughout the rivers of Camp Santiago. During the dry season, small insects and freshwater shrimp are found in and adjacent to bodies of water. These aquatic invertebrates are also accompanied by native and exotic fish species, such as the goby (*Sicydium plumieri*) and tilapia (*Oreochromis aureus*). Existing river water conditions are dependent on rainfall patterns feeding the headwaters of the two major rivers, the Rio Nigua and Rio Jueyes. Use of the riparian areas by permitted industrial users is the limiting factor for the local aquafauna populations within Camp Santiago.

6.9 THREATENED AND ENDANGERED SPECIES

6.9.1 FLORA

A November 2021 field survey recorded a total of eight threatened, endangered, and special status species occurrences on Camp Santiago; including two occurrences of *Phlebotaenia cowellii* in Training Areas A and B, two occurrences of *Mimosa quadrivalvis var. urbaniana* in Training Areas J and M, three occurrences of *Cyperus urbanii* in Training Areas M and N, and one occurrence of *Maytenus cymosa* in Training Area N (see **Appendix E**).

6.9.2 FAUNA

One federally listed endangered reptile, the Puerto Rican Boa (*Epicrates inornatus*) is not known to occur at Camp Santiago, but instead within the mountainous area to the north, outside of Camp Santiago boundaries (USFWS 2020).

Five migratory bird species have been known to occur in the Camp Santiago area (USFWS 2020). These species and their corresponding breeding seasons which occur in Puerto Rico are as follows: the Antillean Mango (*Anthracothorax Dominicus*) (March 1 to August 20), Lesser Yellowlegs (*Tringa flavipes*) (has not been known to breed in Puerto Rico), Mangrove Cuckoo (*Coccyzus minor*) (April 20 to August 20), Puerto Rican Vireo (*Vireo latimerid*) (April 8 to August 1), and Wilson's Plover (*Charadrius wilsonia*) (April1 to August 20).

6.10 PESTS

6.10.1 FLORA

In relation to the vegetation present at Camp Santiago, no plant pests (which impact overall health) were reported or detected during surveys and field visits conducted in 2000 and 2013.

Currently, no vegetative species present pose a risk to health or life of personnel or animals. Exotics and/or naturalized vegetation species are present at Camp Santiago. Two exotic grasses, *Panicum maximum* and *Bothriochloa pertusa*, occupy a large proportion of the Camp and prevent the colonization of pioneer species that would normally advance to the secondary succession process.

Uncontrolled fires and unregulated livestock grazing continue to keep this area of open grassland devoid of trees by killing young seedlings (a product of natural dispersion). These grasses, once overcome by forest trees, become another member of the ground cover and lose their dominance in the ecosystem, allowing a more diverse community to establish.

A *Camp Santiago Planning Level Floristic Survey Report* was in draft form during this INRMP's development and was not complete at the time of this INRMP's completion.

6.10.2 FAUNA

Feral dogs and cats roam at large within Camp Santiago and have direct impacts on native fauna through predation. Cats are known predators of birds and other small animals, while dogs will kill and injure other animals. In addition, dogs can get into garbage, causing sanitation problems.

Domesticated livestock use vegetative and water resources at Camp Santiago. The maximum number of stock animals within Camp Santiago is in the hundreds. The actual numbers will vary as the livestock roam on and off Camp Santiago lands. There is no management program in place to control the numbers, system, or seasons of foraging. In some areas of Camp Santiago, grazing is thought to occur at levels adversely affecting forest recovery (i.e., succession). Livestock graze in many areas of Camp Santiago and are only limited by fenced areas, dense vegetation, or very steep ground.

Rats are considered pests and pose problems for nesting birds. They can also cause problems for building maintenance and sanitation for humans. Rats have the potential to carry and transmit diseases to other mammals including humans. Bats are desired at Camp Santiago for their value in the natural ecosystem, though they are considered a pest species when they roost in buildings.

6.11 FIRE REGIMES

6.11.1 DESCRIPTION OF FIRE REGIMES WITHIN CAMP SANTIAGO

The savannah grass fuel type is the major vegetation cover type within Camp Santiago. This fuel type is common within the region and three general primeval fire regimes have been identified including:

- A non-lethal regime with mean intervals of 2 to 10 years,
- A mixed-severity regime ranging from non-lethal underburns to stand replacing fires at mean intervals of 7 to 25 years, and
- A regime of less frequent stand-replacing fires at mean intervals of 25 to 50 years.

Fire has been the major influence on vegetative patterns, composition, structure, age, and development of both individual stands and the larger landscape. The mixture of vegetation types found in this analysis area developed under mixed severity fire regimes, varying with moisture, temperature, and vegetative composition.

Vegetation within Camp Santiago has undergone changes during the 20th century. The evidence is unmistakable from aerial photography interpretation and vegetation stand reconstruction. These changes are most profound in the lethal fire regime, where the advanced secondary natural forest found at the upper elevations within Camp Santiago has decreased dramatically.

Currently, savannah grass type with a thick brush component has replaced much of the old growth vegetation. Fires start on the ground, spread quickly, and then climb through the branches of small trees, creating a “ladder” to the larger trees in the vegetation canopy.

Currently, approximately 60 percent of Camp Santiago would experience non-lethal or mixed severity fire regimes (see **Figure 6-6** and **Table 6-3**). The following table breaks down the current fire regimes within Camp Santiago.

Table 6-3. Percentage of Current Fire Regimes

Fire Type	Acres	Percent
Non-lethal	7,425	59%
MS-I	189	2%
Lethal	4,100	32%
Plantations	934	7%
TOTAL	12,649	100%

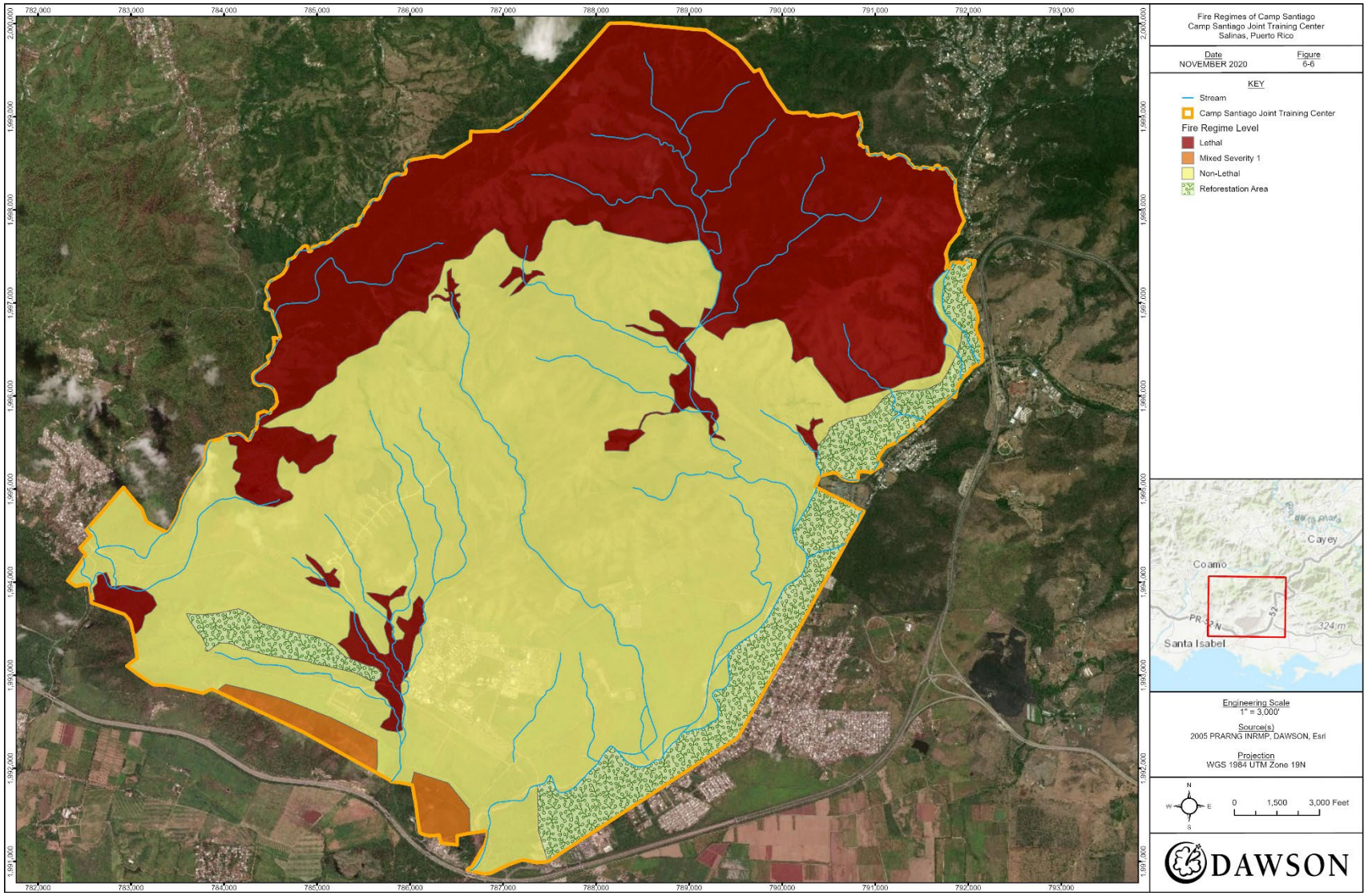
The three generalized fire regimes that occur within Camp Santiago are: a non-lethal, mixed-severity, and stand-replacement regime. Mixed-severity fire regime areas can experience the full range of severities. Mixed-severity fire regime areas may experience fires of intermediate effects, often consisting of fine-grained spatial patterns resulting from a mosaic of varying severity. The mixed-severity fire regime within Camp Santiago is predominately of a moderately low frequency with moderate to high severity. In contrast, stand-replacement fire regimes typically have lethal fires with less than 10 percent of the vegetated canopy cover remaining after the fire. Within Camp Santiago, these are low frequency with high severity events.

6.11.2 Vegetation Management and Fire Suppression

Wildfire has created fuel mosaics, which are breaks or changes in vegetation and surface fuel patterns. These fuel mosaics, along with road access, increase the success of initial attack, allow for effective fire suppression under the appropriate management response, and decrease the risk of high intensity stand-replacement wildfire. The appropriate management response for wildland fires under the existing Camp Santiago Fire Management Plan requires that all fires be suppressed using the appropriate management response. Within Camp Santiago, the appropriate management response is suppression using aggressive initial attack actions to control a wildland fire with safety of fire management personnel being the first priority.

There is a moderate to high probability of ignition within Camp Santiago. The highest probability of ignition occurs within training areas and gunnery ranges. Ongoing fire prevention, pre-suppression, and information measures should continue to reduce the risks associated with wildland fire in this area. Fire risk has an important role in determining the acceptability of the current vegetative conditions. There is increasing risk of a fire starting in the non-treated areas of Camp Santiago.

Figure 6-6. Fire Regimes of Camp Santiago



6.11.3 Fire Behavior and Resistance to Control

The difficulty of controlling a fire can be estimated from the flame length and rate of spread. The existing fuel profiles using Behave Models and Aids to Determining Fuel Models for Estimating Fire Behavior (Anderson 1982) indicate rates of spread of 13 chains (66 feet) per hour and flame lengths of 4 to 8 feet. Fires with flame lengths of 4 feet or less can generally be managed by firefighters using hand tools. Fires with flame lengths of 4 to 8 feet typically require equipment such as dozers, fire engines, helicopters, and/or retardant aircraft to effectively control.

Fuels, weather, and topography together determine how hot and fast a fire burns. Fuel conditions are described by quantity, arrangement, and size and are used as one of the inputs in the BEHAVE computer model to determine flame height and the rate of spread for a wildfire. BEHAVE runs are based on an average bad day: during average worse fire conditions, when dead fuel moisture averages 2 to 8 percent, live fuel moisture is 100 percent dry matter content, and the effective wind speed at mid-flame height is 6 miles per hour.

The bulk of the biomass found in Camp Santiago is accumulated grass or savannah fuels. When ignited under severe fire conditions, the combination of dead fuel and continuous to mosaic live vegetation from the vegetation floor to the upper vegetation canopy creates a complex of fuel that would leave little or no surviving above ground vegetation.

Wildfires would still occur and may escape initial attack during severe fire conditions. The intensity of these fires would be dependent upon weather, fuels, and topography. Data suggests that wind, regardless of fuel moisture and relative humidity, is the driving force during fire events. When burning conditions are less than severe, fires may be of low to moderate severity and result in only moderate or no damage to overstory vegetation.

Fire behavior is also influenced by fuels, weather, and topography. Of these three factors, only the fuel can be controlled by fire management. Fuels consist of vegetation components, including litter and duff layers, grasses and forbs, shrubs, and regeneration.

Fuel component characteristics contribute to fire behavior properties. Fuel loading, size class distribution of the load, and its arrangement (compactness or bulk density) govern whether an ignition will result in a sustaining fire. Horizontal continuity influences whether a fire will spread or not and how steady the rate of spread will be. Loading and vertical arrangement influence flame size and the ability of a fire to torch into the overstory. With the proper horizontal continuity in the overstory, the fire may develop into a crown fire. Fuel moisture content has a substantial impact upon fire behavior affecting ignition, spread, and intensity. Fuel models are a tool to help the user realistically estimate fire behavior. Each fuel model is described by:

- The fuel load and the ratio of surface area to volume for each size class,
- The depth of the fuel bed involved in the fire front, and
- Fuel moisture, including that at which the fire will not spread (called the moisture of extinction) (Albini 1976).

The criteria for choosing a fuel model includes the fact that the fire burns in the fuel stratum best conditioned to support the fire. The 13 fuel models for fire behavior estimation are for the severe period of the fire season, when wildland fires pose greater control problems and impacts to land resources.

The fuel models generally occurring within Camp Santiago are described below.

6.11.4 GRASS GROUP

Fire Behavior Fuel Model 1

Fire spread is governed by the fine, very porous, and continuous grasses and herbaceous fuels that have cured or are nearly cured. Fires are surface fires that move rapidly through contiguous cured grass and associated material if untreated. Very little shrub or timber is present, generally occupying less than one-third of the area. This would be the Non-Lethal Fire Regime.

Fire Behavior Fuel Model 2 (Post Timber Harvest Stands; Nonstocked and Seedling)

Fire spread is primarily through the fine herbaceous fuels, either curing or dead. These are surface fires where the herbaceous material, in addition to little and dead-downstream wood from the open shrub or timber overstory, contribute to the fire intensity.

Fire Behavior Fuel Model 3 (Riparian Marsh Grass)

Fires in this fuel model are the most intense of the grass group and display high rates of spread under the influence of wind. Wind may drive fire into the upper heights of the grass and across standing water. Stands are tall, averaging about 3 feet (1 meter), but considerable variation may occur. In this fuel model, approximately one-third or more of the stand is considered dead or cured and maintains the fire.

6.11.5 SHRUB GROUP

Fire Behavior Fuel Model 5 (Sapling Stands and Riparian Shrub)

Fire is generally carried in the surface fuels consisting of litter cast by the shrubs and the grasses or forbs in the understory. The fires are generally of low intensity because surface fuel loads are light, shrubs are young with little dead material, and foliage contains little volatile material. The riparian shrub portions of this fuel model in the analysis area are usually intermingled with riparian marsh grass. This would be the Mixed Severity Fire Regime.

7 LAND USES AND MANAGEMENT

7.1 LAND USES

Camp Santiago has a total of 12,649 acres within its boundaries (see **Figure 2-2**). The following table illustrates current land use allocations.

Table 7-1. Camp Santiago Land Use Allocations

Land Use Allocation	Acres	Percent of Total Acres
Cantonment Area	470	4%
Ammunitions Storage Area	107	0.8%
Light vehicle and dismounted maneuver	10,435	82%
Individual and crew served weapons ranges (23 separate ranges)	400	3.2%
Restricted Impact Area	988	8%
U.S. Air Force Operations – Defense Communications Area (DCA). Limited light vehicle and dismounted maneuver	249	2%

The Cantonment Area has 160 structures that can support up to 8,000 garrison soldiers on a daily basis (see **Figure 4-1**).

The road system includes approximately 12 miles of improved roads and 150 miles of unimproved roads (see **Figure 4-2**).

There are no non-Army lands within the Camp Santiago boundary, although 249 acres are currently utilized by the U.S. Air Force for communication purposes.

Camp Santiago's primary users are light infantry combat arms and Special Forces units. Support provided to users of Camp Santiago includes 24-hour operation of maneuver-training areas and ranges for an assortment of individual and light infantry weapon and aviation systems.

Land uses for military training include weapons training, indirect (mortar and artillery firing), dismounted navigation and patrolling, assembly area operations (bivouacking), drop zones, and light vehicle convoy and cross-country maneuver training.

There are no opportunities for the local public to hunt, fish, hike, or camp within the Camp Santiago boundary.

Examples of non-military groups that use Camp Santiago land include state and federal law enforcement agencies, local fire departments, Puerto Rico Correctional Administration, Youth Conservation Corps, and Girl/Boy Scouts of America.

Camp Santiago has issued a permit to allow the harvest of hay within portions of the Camp for reducing the hazard of range fires.

The impacts to natural resources resulting from land use allocations are described in the following table by ecosystem element.

Table 7-2. Impact on Natural Resources as a Result of Land Use Allocations

Ecosystem Element	Impacts

Human Uses	• Limited and/or restricted public recreation opportunities.
	• Disturbance and/or limiting public access to important areas within Camp Santiago that are locally significant and important contributors to the sense of place of the area.
	• Degrade the scenery of the landscape.
	• Disturb or degrade historical sites and artifacts. Commodities:
	  ○ Commercial extraction of gravel and fill-dirt creates sediment and degrades stream channel characteristics.
	  ○ Unauthorized cattle and horse grading impacts vegetation, stream channel characteristics, and water quality.

Watershed Health	• Disturb soils, loss of soil productivity, and create sediment sources. • Alter natural stream flow and discharge characteristics. • Damage stream banks and degrade stream channel stability. • Increase nutrient (nitrogen and phosphorus) levels in surface waters. • Impact aquatic species and their habitat.
Vegetation	• Alter vegetation cover type, patch size and pattern from historic conditions. • Degrade special habitats, such as small isolated plant communities. • Degrade riparian areas. • Contribute to the presence of non-native, invasive plant species, and disturb rare or sensitive plants.
Fire and Air	• Fires associated with land uses impact vegetation and wildlife habitat. • Contribute to erosion and sediment sources. • Smoke and dust associated with land uses degrade air quality.
Wildlife	• Impact wildlife species and their habitat.

7.2 MANAGEMENT UNITS

7.2.1 FUNCTIONAL AREAS A, B, C, E

Functional Areas A, B, C, and E are tactical training areas (totaling approximately 1,470 acres). These sites are mostly open grassland with portions of artificial reforestation areas. There is a small inclusion of advanced secondary natural forest in Functional Area A. Protected stream courses are also found within these functional areas.

Desired Future Condition:

Tactical Training Area

Goal:

Maximize military training opportunities while protecting natural resources.

Objectives:

- Maintain training areas for optimum use.
- Minimize impacts to advanced secondary natural forest habitats.
- Minimize impacts to artificial reforestation forest.
- Protect stream channel and steam bank stability.
- Improve wildfire prevention and suppression capabilities.
- Minimize wildlife displacement.

7.2.2 FUNCTIONAL AREAS D, F, G, O, R

Functional Areas D, F, G, O, and R are tactical training areas (totaling approximately 3,121 acres). These sites are mostly open grassland. There are protected stream courses within these functional areas.

Desired Future Condition:

Tactical Training Area

Goal:

Maximize military training opportunities while protecting natural resources.

Objectives:

- Maintain training areas for optimum use.
- Improve wildfire prevention and suppression capabilities.
- Protect stream channel and stream bank stability.
- Minimize wildlife displacement.

7.2.3 FUNCTIONAL AREAS H, I, DCA

Functional Areas H, I, and DCA are tactical training areas (totaling approximately 2,088 acres). These sites are mostly open grassland and artificial reforestation sites. There are protected stream courses within these functional areas.

Desired Future Condition:

Tactical Training Areas

Goal:

Protect forest succession in the advanced secondary natural forest areas, reforestation areas, and stream courses, while providing military training opportunities.

Objectives:

- Maximize training area for optimum use.

- Minimize wildlife displacement.
- Minimize impacts to artificial reforestation areas.
- Protect stream channel and steam bank stability.

7.2.4 Functional Area Cantonment Area

The Cantonment Area is a base camp used for administrative purposes (totaling approximately 470 acres). The site is mostly open grassland. There is an opportunity for bat habitat management in this area and there is one protected stream course.

Desired Future Condition:

Administrative Use

Goal:

Support PRARNG in their mission to maximize military training opportunities.

Objectives:

- Support training opportunities.
- Improve bat habitat where appropriate.
- Maintain administrative site for optimum use.
- Protect stream channel and stream bank stability.

7.2.5 Functional Area Ammo Area

The Ammo Area is used for munitions storage (totaling approximately 107 acres). The site is a mix of open grassland, early secondary natural forest, advanced secondary natural forest, and artificial reforestation.

Desired Future Condition:

Munitions Storage

Goal:

Support PRARNG in their mission to maximize military training opportunities.

Objectives:

- Munitions storage area and ammunitions supply point.
- Support logistical and security training.
- Support individual/crew serviced weapons training.
- Troop security and safety.

7.2.6 Functional Area Impact Area

The Impact Area is Camp Santiago's main impact area (totaling approximately 1,297 acres). The site consists of open grasslands and has unexploded ordinances on site. For safety reasons, this area is restricted and not used for maneuvers. The public is not allowed into the Impact Area.

Desired Future Condition:

Impact Area

Goal:

Support PRARNG in their mission to maximize military training opportunities.

Objectives:

- Support gunnery training.
- Protect military and civilian personnel from unexploded ordinances.
- Prevent stray domestic animals and livestock from entering the Impact Area.

Table 7-3 below describes all functional training areas.

Table 7-3. Functional Training Area Description

Training Areas	Acres	Projected Use	Restrictions
A	396	Tactical training area, maneuvering, and bivouac area. Includes demolitions range, gas chamber, and artillery firing points.	Demolition up to 2 lbs. No digging without previous clearance and authorization from the Plans, Operations, and Training Office. Reforestation areas (tree plantations) are restricted areas.
B	413	Tactical training area, maneuvering, and bivouac area. Includes artillery firing points.	No digging without previous clearance and authorization from the Plans, Operations, and Training Office.
C	421	Tactical training area, maneuvering, and bivouac area. Includes artillery firing points.	No digging without previous clearance and authorization from the Plans, Operations, and Training Office. Reforestation areas (tree plantations) are restricted areas.
D	544	Tactical training area, maneuvering, and bivouac area. Includes mortar and artillery firing points, and M52 and M6 Range.	No digging without previous clearance and authorization from the Plans, Operations, and Training Office.
E	240	Tactical training area, maneuvering, and bivouac area. Includes artillery firing points and an AMMO Supply Point (ASP); approximately 140 acres.	The ASP is off limits to training. On the remaining 46 acres, there is no digging without previous clearance and authorization from the Plans, Operations, and Training Office. Reforestation areas (tree plantations) are restricted areas.
F	195	Tactical training areas, maneuvering, and bivouac area.	No digging without previous clearance and authorization from

Training Areas	Acres	Projected Use	Restrictions
			the Plans, Operations, and Training Office.
G	357	Tactical training area, maneuvering, and bivouac area. Includes and airfield, shotgun mg, combat pistol mg, drop zone (DZ), and rappel tower.	No digging without previous clearance and authorization from the Plans, Operations, and Training Office.
H	226	Tactical training areas, maneuvering, and bivouac area.	No digging without previous clearance and authorization from the Plans, Operations, and Training Office. Reforestation areas (tree plantations) are restricted areas.
I	582	Tactical training area, maneuvering, and bivouac area. Includes mortar firing points and a small arms mg.	No digging without previous clearance and authorization from the Plans, Operations, and Training Office. Reforestation areas (tree plantations) are restricted areas.
J	711	Tactical training area, maneuvering, and bivouac area. Includes mortar firing points and a small arms mg.	No digging without previous clearance and authorization from the Plans, Operations, and Training Office. Reforestation areas (tree plantations) are restricted areas.
K	241	Tactical training area, maneuvering, and bivouac area. Includes mortar firing points and a small arms mg.	No digging without previous clearance and authorization from the Plans, Operations, and Training Office. Reforestation areas (tree plantations) are restricted areas.
L	661	Tactical training areas, maneuvering, and bivouac area.	No digging without previous clearance and authorization from the Plans, Operations, and Training Office.
M	1,640	Tactical training areas, maneuvering, and bivouac area.	No digging without previous clearance and authorization from the Plans, Operations, and Training Office.
N	840	Tactical training areas, maneuvering, and bivouac area. Includes mortar firing points.	No digging without previous clearance and authorization from the Plans, Operations, and Training Office.
O	1,148	Tactical training and maneuvering area. Includes live fire range, ambush operations, aerial bomb DZ, company defensive training	Restrictions on types of munitions

Training Areas	Acres	Projected Use	Restrictions
		machine gun, aerial gunnery, and squad live fire machine gun.	
R	877	Tactical training and maneuvering. Includes M16 machine gun area. NGC fam, MG 10-M machine gun, rifle marksmanship machine gun, AT4 subcaliber machine gun, grenade launch machine gun, and indirect firing points.	No digging without previous clear and authorization from the Plans, Operations, and Training Office.
DCA	1,280	Tactical training area, maneuvering, and bivouac area.	No digging without previous clearance and authorization from the Plans, Operations, and Training Office. Reforestation areas (tree plantations) are restricted areas.
Impact Area	1,297	Impact Area	Off limits to all training activities and the public.
Ammo Area	107	Munitions storage	Off limits to all training activities.
Cantonment Area	470	Administrative use; base camp	
Totals	11,056	Acres available for maneuver and ranges.	

8 NATURAL RESOURCES MANAGEMENT

8.1 INTRODUCTION

The purpose of this section is to outline initiatives that will be implemented to conserve natural resources for ecosystem integrity and to support sustainable military training. A description of existing conditions, identified initiatives, and expected benefits resulting from implementation of the initiatives are summarized by natural resource component; however, this section addresses issues that cross traditional definitions of discreet resource areas, allowing for more effective ecosystem management.

Table 8-1 provides a summary of the initiatives and their associated benefits; maps and illustrations located at the end of this chapter provide additional details.

The effectiveness of the decisions made will be evaluated on an annual basis and the INRMP will be revised at the end of the five-year period. **Chapter 9** provides a description of the monitoring initiatives.

Chapter 13 provides the strategy for initiative implementation and **Table 13-1** provides a summary of the implementation of the initiatives.

8.2 OBJECTIVES

The fundamental goal of this INRMP is to achieve optimum, sustainable use of Camp Santiago while protecting natural resources.

General objectives of the INRMP include:

- No net loss in the capability of Camp Santiago lands to support the military mission.
- Protect the ecosystem and maintain biological diversity.
- Improve the quality of wildlife habitat.
- Protect and improve watershed health.
- Restore damaged training areas and maintain training areas for optimum use.

Specific objectives of the INRMP include:

- Improve the visual/scenic qualities of Camp Santiago.
- Prevent stray domestic animals and livestock from entering the training area and causing damage to natural resources.
- Minimize impacts to forest vegetation and implement actions to restore and/or re-establish vegetation communities.
- Reduce human and livestock activity within riparian areas and implement riparian area restoration projects.
- Restore and protect stream channel and streambank stability.
- Reduce sediment and pollution sources.
- Minimize wildlife and aquatic species displacement and impacts on their habitat.
- Minimize the impact to training and natural resources resulting from wildfires by improving wildfire prevention and suppression capabilities.

8.3 SUMMARY OF INITIATIVES

The following table summarizes the benefits of the major initiatives identified:

Table 8-1. Initiatives and Associated Benefits

Initiative	Description	Benefits
Restore and Protect Riparian Areas	Ensure future extraction operations meet applicable environmental laws and standards.	• Protect habitats for riparian-dependent species • Improve water quality by eliminating a major sediment source and protect stream channel stability and critical habitat for aquatic species. • Reduce the risk of accidental petroleum and toxic material spills.
	Plant approximately 200 acres of riparian areas.	• Restore habitats for riparian dependent species. • Improve water quality by stabilizing stream banks with deeply rooted woody plants. • Restore stream channel stability and protect critical habitat for aquatic species.
	Modify Training Area Map to show sensitive riparian areas as "restricted, off limit areas."	• Protect habitats for riparian dependent species. • Improve water quality by eliminating a sediment source and protect stream channel stability and critical habitat for aquatic species. • Reduce the risk of accidental petroleum and toxic material spills.
	Restrict livestock grazing in riparian areas.	• Protect habitats for riparian dependent species. Improve water quality by eliminating a sediment source. • Protect stream channel stability and critical habitat for aquatic species.
Restore and Protect Forest Vegetation	Conduct vegetation cover survey. Inventory all Camp Santiago lands on 5-year cycle (establish permanent plot clusters in all vegetation classification types and conduct walk-through inventories).	• Provide base-line information on forest vegetation. Subsequent surveys will help in identifying forest vegetation trends and will provide information to: ○ Assess the effectiveness of the management initiatives to restore and maintain forest vegetation and wildlife habitat, and ○ Help determine and prioritize future management actions.
	Conduct plantation surveys. Inventory plantations (forest and riparian areas) to determine seedling survival and the need to replant and/or thin.	• Use plantation surveys to help determine the effectiveness (survival rate) of the hand planting and subsequent plantation care. These findings will be useful in modifying, as necessary, hand planting and plantation management procedures to increase their effectiveness.

Initiative	Description	Benefits
Identify Sediment Sources	Conduct sediment source surveys every 5 years or as needed.	• Maintain access needed for training operations and emergency medical evacuation during and after intense rainstorms. • Improve water quality onsite and downstream by reducing the amount of soil erosion at road/stream intersections. • Restore critical habitat for aquatic species.
	Inspect road drainage structures to identify required repair and/or replacement; work includes preparing a road-log and inventory of drainage structures.	• Maintain 'safe' and reliable access needed for training operations and emergency medical evacuation, especially during and after intense rainstorms. • Improve water quality onsite and downstream by reducing the amount of soil erosion and road/stream crossings. • Restore and maintain critical habitat for wildlife and aquatic species.
Eliminate Sediment Sources	Improve stream crossings by repairing and/or replacing existing drainage structure.	• Maintain 'safe' and reliable access needed for training operations and emergency medical evacuation, especially during and after intense rainstorms. • Improve water quality onsite and downstream by reducing the amount of soil erosion and road/stream crossings. • Restore and maintain critical habitat for wildlife and aquatic species.
	Reconstruct and/or relocate segments of existing roads to eliminate sediment sources.	• Maintain 'safe' and reliable access needed for training operations and emergency medical evacuation, especially during and after intense rainstorms. • Improve water quality onsite and downstream by reducing the amount of soil erosion and road/stream crossings. • Restore and maintain critical habitat for wildlife and aquatic species.
	Restrict cross-country vehicle maneuver within riparian areas.	• Improve water quality by eliminating a sediment source. • Protect habitats for riparian-dependent species. • Protect stream channel stability and critical habitat for aquatic species. • Reduce the risk of accidental petroleum and toxic material spills.
Conduct Stream Channel Surveys	Conduct stream channel stability surveys to determine current stream channel and bank conditions and to monitor changes over time. Surveys will identify restoration opportunities.	• Use the findings of stream channel stability surveys to assist in identifying and prioritizing stream channel and riparian restoration work.

Initiative	Description	Benefits
	Establish permanent stream cross-section stations; stations to be located above and below stream segments where gravel has being extracted and where channel cleaning operations are routinely conducted.	• Use the findings of the permanent stream cross-section stations to provide baseline (current conditions), help identify water quality and aquatic habitat trends, and help identify and prioritize stream channel and riparian restoration work.
Protect and Enhance Wildlife Habitat	Improve bat habitat. Construct and place 5 bat boxes within the Cantonment Area.	• Minimize the health and safety hazards created by bats nesting in cantonment structures. • Maintain and enhance wildlife habitat and species diversity within Camp Santiago.
	Document presence of threatened or endangered, neotropical migratory and local resident birds. If resources allow, conduct inventories every 5 years as resources allow; schedule inventories from December through the breeding season of native species.	• Use findings to provide baseline information on the presence of wildlife species. Subsequent surveys will help in identifying wildlife occurrence trends and will provide information to: ○ Assess the effectiveness of the management initiatives to restore and wildlife habitat, and ○ Help determine and prioritize future management actions.
Range (Wildfire) Fire Suppression	Construct and maintain fuelbreaks (to prevent fire from encroaching into the plantation areas).	• Minimize lost training time due to disruptions caused by wildfire. • Force protection – minimize the safety hazards and threat to equipment from a potential range fire. • Reduce the threat from a potential range fire to Camp Santiago facilities and to the local community. • Minimize the damage to natural resources caused by a potential range fire.
	Provide fire suppression training for selected personnel. Acquire fire suppression personal protective items and fire suppression equipment (Nomex clothing, hardhats, gloves, eye protection, fire hoses, hand tools, etc.).	• Minimize the safety hazards to firefighters and the threat to equipment from a potential range fire. • Minimize lost training and damage to natural resources caused by a potential range fire.

8.4 FOREST VEGETATION MANAGEMENT

8.4.1 INTRODUCTION

The primary purposes of forest vegetation management at Camp Santiago are ecosystem restoration and protection. The direct benefits of these initiatives include soil protection, biological diversity, watershed health, increased wildlife habitat, and maintenance/enhancement of landscape scenery values.

The main instruments required to implement these management practices are artificial regeneration (direct planting), protection of advanced secondary natural regeneration areas, control of grassland fires, and uncontrolled grazing.

These directions will increase the participation of PRARNG in the mission of stewardship of natural resources actually present and/or potentially capable of being developed on the lands at Camp Santiago.

8.4.2 EXISTING CONDITION

There is limited potential for commercial use of the Camp Santiago forest; select species such as *Guaiacum sanctum* (Guayacan) or *Bucidas bucera* (Ucar) are used for timber and/or aircraft manufacturing. Some species could also be used for charcoal production or fence posts.

The current vegetation conditions of Camp Santiago are classified with four seral stages including advanced secondary natural forest, early secondary natural forest, open grassland, and artificial reforestation forests (see **Figure 6-6**).

The areas targeted for artificial reforestation, consisting of approximately 65 acres during this planning period, are currently classified as open grassland.

Almost all of the advanced secondary forest is within the high terrain (over the 100 meters of elevation contour line) of Camp Santiago and on protected drainage areas.

Insects and diseases are not a significant concern for the ecosystem, but fire and grazing activities are considerably shaping natural succession. Forest patches are shrinking from fires on forest edges. Natural regeneration from seedlings is declining due to selective grazing and an increase in species densities that are nonpalatable to grazing animals and resistant to fire disturbance.

No tree species at Camp Santiago can be considered fire resistant as exposure to repeated fires or grazing can kill the most resilient trees allowing for exotic grasses to overcome the ecosystem and arrest natural succession.

8.4.3 MANAGEMENT INITIATIVES

- Prepare and hand plant approximately 55-65 acres every five years within forest areas at Camp Santiago.
- Conduct plantation surveys to determine seedling survival and the need to re-plant and/or thin.
- Re-plant and/or thin within plantations.
- Purchase an irrigation system capable of watering 11 acres.
- Conduct vegetation surveys of all Camp Santiago lands on a five-year cycle. This initiative includes the re-measurement of permanent plot clusters and walk-through surveys.
- Make restriction of cross-country vehicle maneuver within plantation areas mandatory.
- Monitor plantation areas. It is expected that the diversity in planting species used will reduce the risk of severe damage by insects and diseases, but an annual monitoring survey for this type of damage to the plantations areas is required until the planted site is considered established.
- Restrict cross-country vehicle maneuver in Training Areas M and L to protect the existing advanced secondary forest stages within these two training areas (see **Figure 2-2**).

- With the exception of designated stream crossings, restrict cross-country vehicle maneuver in riparian areas (see **Figure 6-5**).

The potential and need for salvage activities resulting from hurricane damage is an element to incorporate in any vegetation management plan associated with Puerto Rico. Camp Santiago will require Timber Stand Improvement (TSI) activities to reduce fuels, thin the forest, salvage usable products, maintain drainage channels integrity, and restore scenery landscape. After a hurricane event, an assessment will be prepared to address natural resource impacts and mitigation recommendations.

8.4.4 EXPECTED BENEFITS

Implementation of the forest vegetation management initiatives previously described will provide and maintain camouflage and concealment for training conditions. In addition, plantations will provide vegetation to buffer noise and dust resulting from training activities from adjacent public zones.

The initiatives will directly allow natural forest succession to continue. Thus, total forest cover and its associated benefits are expected to increase over time.

With a reduction of fire and grazing impacts to the vegetation, species diversity is expected to increase, species densities will begin to show natural populations dynamics, forest structure will evolve, and wildlife habitat and its associated faunal populations will increase.

8.5 AGRICULTURAL/GRAZING OUTLEASES

8.5.1 EXISTING CONDITION

Domestic livestock occurring at Camp Santiago includes cattle, horses, sheep, and goats. These animals forage and use water resources throughout many areas of Camp Santiago. Currently, there is no management system in place to regulate the kind, numbers, and distribution of livestock for conservation of vegetative and water resources.

Cattle are able to roam over large areas of Camp Santiago and may be limited only by fences, dense vegetation, or steep ground. Roads and trails currently allow livestock to move freely across the training areas. Along portions of the Camp Santiago boundary, such as near Rio Jueyes, fences were constructed for livestock restriction on private lands. Access to water remains an important issue for livestock owners in the surrounding communities.

There is concern that grazing occurs at levels which inhibit forest recovery and succession. Grazing pressures and ground disturbance from livestock can be readily observed in the field. The amount of barren ground, livestock trails, and bedding sites indicate that livestock cause degradation to soil and forest vegetation resources, most notably on steeper grounds.

Free roaming livestock can pose problems for military operations. Livestock can interfere and hamper the efficiency of training exercises. Cattle manure may present unpleasant experiences for soldiers training in the field. Recent command emphasis has reduced the amount of livestock grazing dramatically.

Hay cutting and harvest is currently conducted by permit in portions of Camp Santiago to help reduce the risk of fire and use a renewable agricultural resource.

In 2000, some stock water troughs were observed along the banks of the Rio Jueyes. These structures were not reviewed in 2005, though they were originally thought to be filled by water piped from springs. Regardless, their presence draws livestock to the river course and encourages the livestock to use the riparian area, which in turn makes the cattle paths deeper and more likely to intercept rainfall, increasing erosion.

8.5.2 MANAGEMENT INITIATIVES

Management initiatives include the survey and install of boundary fence to include approximately 3 miles of cyclone fence and 11 miles of barbed-wire fence (see **Figure 8-1**).

In order to minimize potential conflicts between livestock and military operations, as well as to limit damage to land resources caused by livestock, Camp Santiago must completely restrict grazing. This will require fencing to control the drift of livestock from adjacent private lands onto Camp Santiago. Fence locations will generally coincide with the exterior perimeter of Camp Santiago. However, fence line construction can be located to facilitate maintenance and take advantage of natural barriers to livestock movement.

All future hay-cutting and harvest permits will be prepared and administered in accordance with Army Regulation 200-1, Environmental Protection and Enhancement, Army Regulation 405-80, Management of Title and Granting Use of Real Property, and 10 U.S.C. 2667.

8.5.3 EXPECTED BENEFITS

The fencing initiative will improve training conditions by providing increased security and control of training lands and reducing the amount of training time lost caused by unauthorized domestic animal and civilian use of Camp Santiago lands. This initiative will increase public and soldier safety by helping prevent unauthorized entry of civilians onto Camp Santiago maneuver and weapons impact areas.

The fencing initiative will help eliminate unauthorized livestock grazing and associated impacts to riparian and upland forest habitats. Forest and riparian wildlife habitat will improve and associated faunal populations are expected to increase.

In addition, this initiative will help reduce illegal dumping of trash within Camp Santiago, prevent stray domestic animals (primarily dogs) access into Camp Santiago, deter unauthorized collection of commodities from Camp Santiago, and lessen the risk of military security compromise.

8.6 HABITAT MANAGEMENT

8.6.1 INTRODUCTION

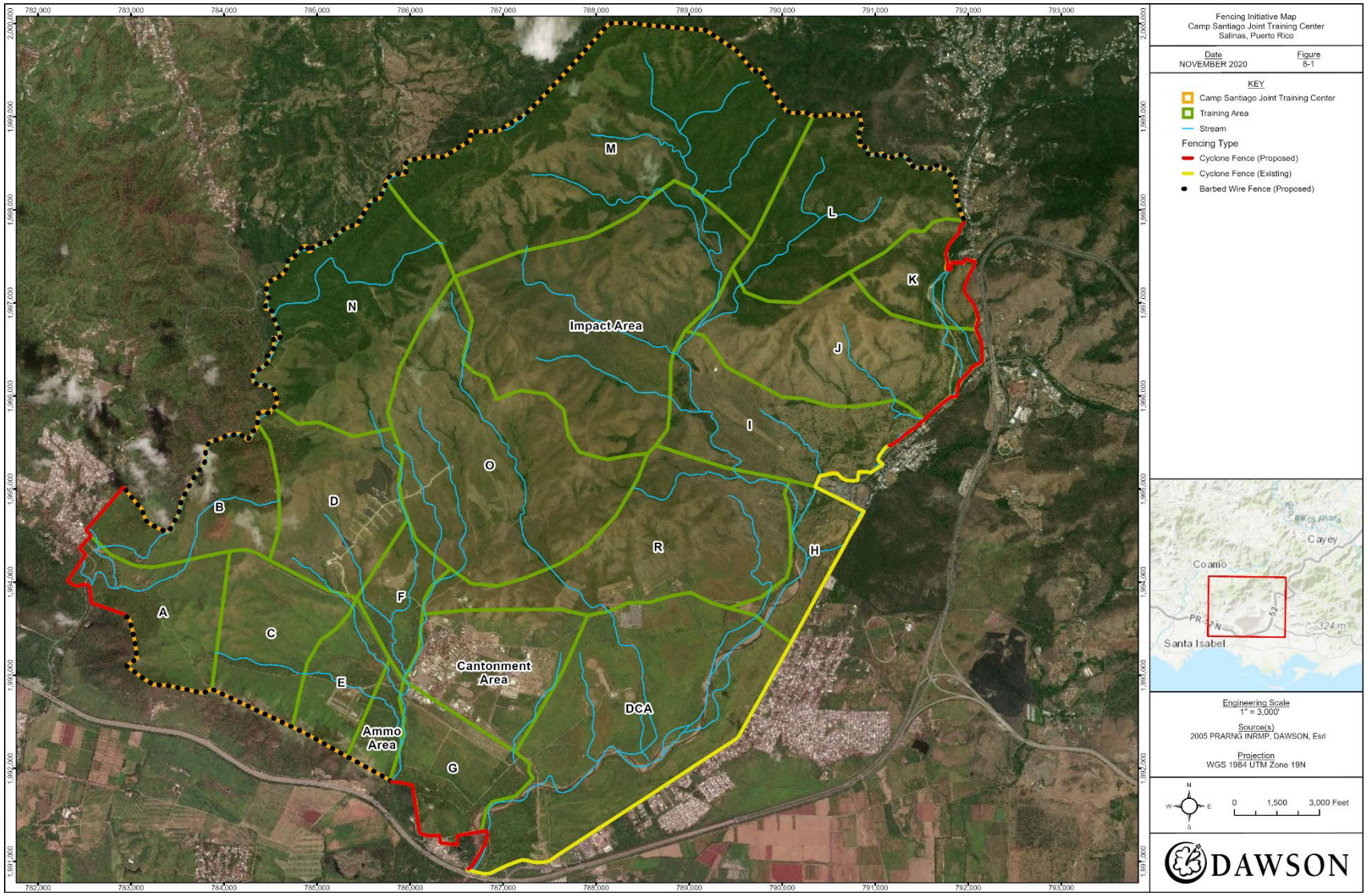
In general, conserving habitats for wildlife at Camp Santiago must focus on:

- Land uses that conserve existing forest habitat,
- Promoting the recovery of forest succession (reforestation) in areas designated to provide habitat for forest species, and

- Limiting physical impacts and restoring tree conservation in stream course environments.

Forests found in Training Areas M and L are considered important for habitat conservation. In the remainder of the training areas, riparian areas along the stream courses and river channels are of special importance to retaining fauna diversity.

Figure 8-1. Fencing Initiative Map



8.6.2 Special Habitats

8.6.2.1 Existing Condition

Special habitats within Camp Santiago include the cliffs and rock outcrop areas consisting of Cerro Pio Juan, Cerro Cariblanco, Cerro Piedras Chiquitas, and an old growth forest patch area at Cerro Respaldo.

Photo analysis from 1936 indicates the presence of forest at Cerro Modesto and Cerro Respaldo. These two points were expected to presently contain old growth forest within Camp Santiago but uncontrolled fires have completely destroyed the Cerro Modesto forests and greatly reduced the vegetation at Cerro Respaldo.

Cerro Pio Juan, Cerro Cariblanco, and Cerro Piedras Chiquitas are unique types of habitat present within Camp Santiago that contain several endemic species of the region and located at the highest elevations of Camp Santiago. Cerro Pio Juan and Cariblanco are overgrassed and invasive grasses have invaded most of these Cerros.

Cerro Piedras Chiquitas is the least impacted by grazing but is not excluded from grazing activities as it is surrounded by secondary advanced vegetation that is difficult, but not impossible, to access by grazing animals. With the presence of grasses in these Cerros, there is a continuous threat of wildfires. The remoteness of the sites, particularly in Cerro Cariblanco and Piedras Chiquitas, makes controlling fires that ignite in these areas difficult.

8.6.2.2 Management Initiatives

The initiatives shown in **Table 8-1** respond to the need to protect special habitats. Proposed initiatives include fencing, restoration/protection of forest vegetation, and wildland fire suppression.

8.6.2.3 Expected Benefits

The implementation of the proposed initiatives, particularly the control of fires and grazing, will directly benefit the vegetative conditions of the special areas mentioned.

Biodiversity will increase, natural succession will initiate reforestation of the areas, and rare and endemic species populations will increase and be protected in the remote forest patches. Species previously reported to exist in those areas may also return once microhabitat conditions are restored and grazing pressure is eliminated.

Natural habitat restoration will be the most obvious cumulative effect expected from the implementation of these initiatives. Re-introduction or development of healthy populations of highly specialized habitat species will occur naturally.

8.6.3 Riparian Areas

8.6.3.1 Existing Condition

There are approximately 1,270 acres of riparian area within Camp Santiago (see **Figure 6-5**).

The Camp Santiago watershed drains the Rio Jueyes, Rio Nigua, Rio Lapa (tributary to Rio Nigua River), and other unnamed tributaries to Rio Nigua, including Quebrada Honda.

There is a well-developed, advanced secondary forest patch to the west, where the Rio Lapa meets Rio Majada (both tributaries to Rio Nigua), that represents an excellent example of a riparian gallery forest and likely includes old growth remnants of *Guaiacum sanctum* (*Guayacan*).

Other good examples of advanced secondary forest are at Rio Jueyes near La Zanja, where *Bucida buceras* (Ucar) is the predominant species, and at an area of Quebrada Honda between Cerro Modesto and Respaldo, where *Guaiacum sanctum (Guayacan)* specimens are abundant and well developed. These areas deserve special attention and provide excellent seed sources toward efforts of re-vegetating riparian gallery forests at Camp Santiago.

Most of the Camp Santiago watershed drainage system is devoid of trees necessary to protect the banks from erosion, maintain stream integrity, produce quality water and aquatic habitat, and regulate the flow of water from Camp Santiago to the town of Salinas. This is particularly noted in the drainage system of the Rio Nigua, whose flow during the Hurricane Georges event in 1998 dislodged and destroyed the main access bridge to Camp Santiago.

8.6.3.2 Management Initiatives

- Re-establish native, deeply rooted vegetation along watercourses by planting approximately 200 acres of riparian area with native or naturalized plant species (see **Figure 8-3**).
- Restrict livestock grazing within flood plain and riparian areas (fencing initiative) (see **Figure 8-1**).
- Restrict cross-country vehicle maneuver within riparian areas.
- Complete a detailed survey and map of locations and extent of stream channels, ephemeral draws, and riparian areas based on environmental characteristics (soils, topography, vegetation, and hydrology). This needs to be completed to estimate the amount of funding and time needed to implement the riparian restoration and protection measures.
- Conduct surveys on primary and secondary road systems to identify and map environmental characteristics such as soils, topography, vegetation, and hydrology, as well as problems with erosion and road/stream intersections.

Sediment source surveys need to be completed to estimate the amount of funding and time required and to prioritize the following sediment reduction initiatives:

- Install additional drainage structures and/or repair and maintain existing road drainage structures.
- Schedule road reconstruction and watershed improvement projects based on prioritization process. This may include identification of critical areas for sensitive aquatic habitats, magnitude of water quality impacts, and a cost versus benefit analysis.

8.6.3.3 Expected Benefits

The drainage structure and road improvement initiatives will improve vehicle maneuver training conditions by increasing road stability and eliminating safety hazards.

Implementation of these initiatives will protect the existing riparian areas and create additional acres of this type of forest by natural and artificial means, resulting in a reduction of riverbank erosion.

The quality of water that drains out of Camp Santiago lands will increase and enhance the overall landscape. Also, several unique examples of riparian forest patches on the region will be preserved.

There will be an overall improvement of Watershed health and aquatic habitat rehabilitation, and the impacts from the flooding of Camp Santiago facilities and the neighboring town of Salinas will be reduced. Biodiversity and wildlife habitat will also increase.

8.6.4 FLOODPLAINS AND WETLANDS

8.6.4.1 Existing Condition

Camp Santiago contains no areas meeting the criteria for jurisdictional wetlands within its boundaries, though there are many areas that are wet on a seasonal basis.

Most of the area occupied by the Camp is relatively dry, with highly permeable soils supporting desert-like vegetation.

Broad floodplains occur along the Rio Nigua and Rio Jueyes where the valley bottoms are broad and flat.

Most flood prone areas are only inundated during intense rainstorms, when several inches of rain fall during a short period of time, and the water exceeds the infiltration rate of the soils and runs off as overland flow.

Most of the time, rain is of short duration and low intensity, allowing for water to percolate into the soil.

Floodplain maps, “Mapas de Zonas Susceptibles a Inundaciones” dated 20 February 1988, were inspected by the Puerto Rico Planning Board. These maps show flood prone areas along the Rio Nigua within the eastern and southern boundaries of Camp Santiago and south through Salinas. No flood prone areas were mapped along the Quebrada Honda or its tributaries that drain the western side of the Cantonment Area.

Floodplains are currently being impacted by livestock grazing, gravel extraction, stream channel clearing, and offroad vehicle use. Intense runoff events are able to overflow banks and wash out roads. Large amounts of gravel and sediment are deposited in flood prone areas during runoff events and then later cleared out by bulldozers. This causes a constant state of streambed and stream channel instability that adversely affects the aquatic environment.

8.6.4.2 Management Initiatives

In addition to the initiatives listed in **Section 8.5.2**, the Camp Santiago Map (see **Figure 2-2**) will be modified to show sensitive riparian areas as “restricted, off-limit areas” for cross-country vehicle maneuver.

8.6.4.3 Expected Benefits

The improved stream crossings will enhance training conditions by providing better and more reliable access to training areas and eliminating existing safety hazards.

The implementation of the initiatives will greatly reduce the amount of alterations being made to vegetation and soils within the floodplains. The direct effect will be the reduction of habitat

destruction along the waterways. The indirect effect will be the reconnection of travel ways for species dependent on the streamside environment.

Overall, the initiatives will lead to improvement of streamside habitats and an improved ability for the stream to handle storm flows without damaging stream crossing structures.

8.7 GAME HARVEST MANAGEMENT

Currently, hunting is not permitted at Camp Santiago. There are no game animals present within or adjacent to the Camp. While potential game species are limited to birds (primarily doves), hunting is deemed incompatible with operations at Camp Santiago.

A manageable fisheries resource is not present within the streams and rivers at Camp Santiago.

8.8 RARE, THREATENED, OR ENDANGERED SPECIES MANAGEMENT

8.8.1 FLORA

8.8.1.1 Existing Condition

Two federally listed threatened plant species, cobana negra and Beautiful goetzea, have a low potential to occur within Camp Santiago and Fort Allen. Various specimens of federally listed threatened plant species were observed as planted specimens in the northern extent of the cantonment area during a 2019 species-specific survey. Additionally, two federally listed endangered plant species, Woodbury's stopper and St. Thomas prickly-ash, have a low potential to occur within Camp Santiago. Camp Santiago contains several sites that can be classified as potential habitat for these two species. These same sites contain several endemic and rare species (Floral Inventories 1984, 1994, 1996, and 2013).

Potential habitat is at risk due to uncontrolled grazing activities and fire hazard potential which could affect federally listed species.

The presence of exotic grasses creates the potential for continuous disturbance which may shift grass populations to take over sites.

8.8.1.2 Management Initiatives

Initiatives shown in **Table 8-1** respond to the need to preserve and enhance rare, threatened, or endangered plant species. They include the fencing, restoration/protection of forest vegetation, restoration and protection of riparian areas, and wildland fire suppression initiatives.

8.8.1.3 Expected Benefits

The implementation of the initiatives, particularly the control of fires and grazing, will directly benefit the vegetative conditions of the special areas mentioned.

Biodiversity will increase, natural succession will initiate reforestation, and rare and endemic species populations will increase and be protected in those remote forest patches. There is a good chance that species previously reported to exist in those areas would return once microhabitat conditions are restored and grazing pressure is eliminated.

Natural habitat restoration is expected to be produced over time by the implementation of these initiatives. Re-introduction or development of healthy populations of highly specialized habitat species will occur naturally.

8.8.2 FAUNA

8.8.2.1 Existing Conditions

Based on previous detection surveys, federally listed threatened or endangered animals in the vicinity of Camp Santiago are limited to one reptile species, the endangered Puerto Rican Boa (*Epicrates inornatus*).

No specific requirements are necessary to pro-actively manage habitats and environments for rare, threatened, or endangered animal species. Therefore, there is no requirement for an endangered animal species management plan for the Camp Santiago INRMP. However, monitoring for the presence of the endangered Puerto Rican Boa will be conducted in conjunction with additional migratory bird surveys and any reported sighting of this species will be forwarded to USFWS for further discussion regarding the conservation of this species, if needed, at Camp Santiago.

Migratory birds also use Camp Santiago for breeding, resting, foraging, nesting.

8.8.2.2 Management Initiatives

Initiatives shown in **Table 8-1** respond to the need to preserve and enhance rare, threatened, or endangered plant species. They include the fencing, restoration/protection of forest vegetation, restoration and protection of riparian areas, and wildland fire suppression initiatives. The following BMPs will also be implemented in order to minimize impacts to migratory birds during any construction activities:

- Evaluate the potential short-term, long-term, and cumulative effects of projects on migratory bird habitats.
- During nesting season (February 15 through September 15), a survey for migratory birds will be conducted prior to the start of all maintenance and repair activities in areas where migratory birds might be nesting.
- Initial mechanical and chemical vegetation control and subsequent mechanical vegetation control should be timed to avoid the migration, breeding, and nesting timeframe of migratory birds (February 15 through September 15). Prior to the start of the initial mechanical and chemical vegetation control, a survey for nesting migratory birds should be conducted.
    - If no active nests are found, vegetation clearing should be conducted quickly. Exact timeframe between surveys and clearing depends on the bird species.
    - If active nests are found, a buffer zone of at least 35 feet will be established around each nest and no activities will occur within that zone until nestlings have fledged and abandoned the nest. Certain species including the Antillean Mango, Lesser Yellowlegs, Mangrove Cuckoo, Puerto Rican Vireo, and Wilson's plover may require greater buffer zones.
- Herbicide treatments may occur throughout the year.

- If maintenance is scheduled during the migratory bird nesting season, appropriate steps must be taken to prevent migratory birds from establishing nests in the potential impact area. These steps may include:
    - covering equipment and structures,
    - noise,
    - gels and paints,
    - netting, and
    - harassing birds.
- Once a nest has eggs and/or young in it, it cannot be intentionally removed or destroyed. If nesting birds are found during a supplemental survey, intrusive maintenance activities must be deferred until the birds have left the nest. Confirmation that all young have fledged should be made by qualified personnel.
- To avoid migratory bird roosting, it is permissible to remove and dispose of unoccupied or partially constructed nests. Nests may not be removed if they possess eggs or nestlings.
- Temporary light poles and other pole-like structures used for maintenance activities should possess anti-perch devices to discourage roosting by birds.
- To minimize animal collisions during maintenance and repair activities, construction speed limits should not exceed of 35 miles per hour (mph) on major unpaved roads (i.e., graded with ditches on both sides) and 25 mph on all other unpaved roads. During periods of decreased visibility (e.g., night, poor weather, curves), speed should not exceed 25 mph.
- Use of netting to cover wastewater retention and evaporation ponds could mitigate impacts to migratory bird populations and habitats.
- Engage USFWS in early project planning and scoping relative to potential impacts of a proposed action on migratory birds; proactively address migratory bird conservation and initiate appropriate actions to avoid or minimize the unintentional take of migratory birds.
- Construct buildings in a manner to avoid/minimize bird-window collisions.
- Refit power poles where birds are electrocuted and fit lines with devices to deter collisions with power lines.
- Establish a program to address impacts of feral cats on migratory birds.
- Establish a program to monitor the Puerto Rican boa and Puerto Rican nightjar and improve habitat if presence of either is observed.

8.8.2.3 Expected Benefits

The implementation of the fencing and wildland fire initiatives as well as the implementation of BMPs for migratory birds will enhance wildlife habitat and species diversity at Camp Santiago.

8.9 OTHER NON-GAME SPECIES MANAGEMENT

8.9.1 EXISTING CONDITION

Species diversity and abundance at Camp Santiago are greater in forested areas and along stream courses.

Past treatment and management of the landscape has resulted in deforestation and conversion to grasslands. Tree cuttings, former agricultural practices, grazing, military operations, and fires have allowed grasslands to dominate as the most common vegetative type.

Hurricanes have also affected forest vegetation by causing damage to trees and stream channels. Hurricane Georges impacted Camp Santiago in 1994 and likely impacted wildlife habitats. Similarly, Hurricane Maria caused widespread damage to trees and stream channels in 2017.

Because of past and more recent events, forest remnants and secondary forest on Camp Santiago lands remain important habitats for fauna species. The larger occurrences of forest habitat are found in the areas of Las Piedras Chiquitas, Cerro Pio Juan, and Cerro Respaldo. The urban forest in the Cantonment Area also offers a cultivated type of habitat suitable for birds, bats, and reptiles.

8.9.2 MANAGEMENT INITIATIVES

Initiatives shown in **Table 8-1** respond to the need to maintain and enhance wildlife habitat including the fencing, restoration/protection of forest vegetation, restoration and protection of riparian areas, and wildland fire suppression initiatives.

Because bats are important to the environment, as they are pollinators and seed dispersers, it is recommended that bats be conserved at Camp Santiago. The installation will focus on and prioritize the conservation of these species. This can be facilitated by the construction and placement of bat boxes in the Cantonment Area, which will encourage bat roosting in boxes rather than buildings. Larger buildings in the Cantonment Area can be searched for bats and boxes placed in proximity to those where bats are found.

Natural rock piles and outcrops are to be left undisturbed to the greatest extent feasible. These sites often provide refuge and shelter to small animals such as lizards and snakes.

Dead standing trees are to be left on site unless they pose a safety hazard to humans or facilities. Dead standing trees are used for perching and observation posts by birds, particularly isolated trees in open environments, which are used extensively by raptors. Woodpeckers excavate dead trees and provide benefits to other species of cavity nesting birds.

To better manage the natural biological resources of Camp Santiago, the Caribbean National Forest (CNF) is proposing a structured approach to measuring local populations. The approach is based on the CNF monitoring plan that tracks the trends of management indicator and exotic species through annual indices. Improvements to wildlife and aquatic habitats are monitored for effectiveness in reaching desired conditions of local fauna populations to ensure that proper stewardship is provided. Appropriate administration of natural resources will enhance the quality of training and security for all users and fauna monitoring will enable PRARNG to rapidly and consistently evaluate biological resources at Camp Santiago throughout the planning session. The following monitoring initiatives are proposed to be conducted on an annual basis:

- Conduct annual monitoring during the wet season (August to September) of populations of river shrimp (*Atya lanipes*), rosy barb (*Barbus conchonius*), and tilapia (*Tilapia mossambica*) in the Rio Nigua. The monitoring protocol includes electrofishing at long-term reaches. The findings from this monitoring will provide a long-term dataset of the river's native aquatic species composition, assist in predicting trends, and help in evaluating the effectiveness of management initiatives designed to protect and improve water quality and aquatic habitat values.
- Conduct annual monitoring of populations of the common coqui (*Eleutheryldactylus coqu)* to measure occurrence of native amphibians. The monitoring protocol includes evening

50-meter coqui call point counts conducted for three nights within the late spring timeframe. The findings of this monitoring will provide a long-term dataset of the occurrence of native amphibians (coqui and other possible species presence) at Camp Santiago, assist in predicting trends, and help in evaluating the effectiveness of management initiatives designed to protect and improve forest and riparian area habitat values.

- Conduct annual monitoring for the occurrence of the black-faced grassquit (*Tiaris bicolor*) at Camp Santiago. The monitoring protocol includes evening 50-meter bird call point counts conducted for three days within the late spring timeframe. The findings of this monitoring will provide information on native bird species composition, assist in predicting trends, and help in evaluating the effectiveness of management initiatives designed to protect and improve forest and riparian area habitat values.
- Conduct annual monitoring for the Pallas' Mastiff Bat (*Molossus molussus*) at Camp Santiago. The monitoring protocol includes evening bat mist netting for three nights within the summer timeframe. The findings of the monitoring would provide estimated bat populations, assist in predicting trends, and help in evaluating the effectiveness of management initiatives designed to maintain and improve wildlife habitat.

8.9.3 EXPECTED BENEFITS

The implementation of the fencing and wildland fire initiatives will help retain and potentially enhance habitats that provide for wildlife diversity at Camp Santiago.

8.9.3.1 Effects on Birds

Implementation of the initiatives will improve habitat conservation for native species of birds at Camp Santiago. Initiatives to conserve and enhance the forest ecosystem, both through protection measures and reforestation, will increase habitat availability for local bird species dependent upon trees and tall shrubs.

Efforts to control the spread of fire to prevent the destruction of forest types at Camp Santiago will add to the level of conservation and management of habitat important to many birds that inhabit the area.

The elimination of livestock will reduce impacts on birds caused by grazing, trailing, bedding, and watering. The long-term trend of forest succession in areas where livestock use is excluded will lead to an increase of forest habitat availability and quality for avian species.

8.9.3.2 Effects on Mammals

Measures to attract and promote bat occurrence at Camp Santiago will benefit bats and many other species of wildlife. The plant pollination and seed dispersal activities of bats would help to establish tree growth and habitat.

It is expected that trees established from bat dispersal would be damaged by training operations. However, over time some of the trees would survive to maturity and provide habitat for bats, birds, and arboreal lizards.

Implementation will also enhance control of non-native mammals, including feral cats and dogs and mongoose. For more information on pest control, see Camp Santiago's *Pest Management Plan*.

8.9.3.3 Effects on Amphibians

Protection of aquatic areas by limiting activities in such areas (e.g., off limits to vehicle travel) will reduce direct and indirect impacts to sites containing a greater abundance of fauna species diversity. This is especially important for amphibians that are limited by the small amount of suitable aquatic habitat within Camp Santiago. However, there are management initiatives for the restoration of such sites that have been damaged in the past or are impacted by non-native species.

8.9.3.4 Effects on Reptiles

The species composition of reptiles found at Camp Santiago would remain the same. The proposed initiatives are expected to enhance forestland protection over time. Habitat for arboreal lizards would increase with reforestation over time.

8.10 TRANSPLANTS AND STOCKS

8.10.1 FLORA

As part of the AoN MILCON construction projects at Camp Santiago, approximately 40 trees will be removed in the Cantonment Area which will then be mitigated by the planting of approximately native 90 trees around the Cantonment Area. This planting project is intended to create additional vegetation to enhance future tactical concealment training. Refer to **Appendix B** for a listing of recommended plant species to be used in the reforestation projects outlined in this INRMP.

The forest restoration and protection initiatives include the planting of 40 acres during this planning period in open grassland with native or naturalized plant species (see **Figure 8-2**).

The riparian area restoration and protection initiatives include the planting of 100 acres in riparian areas with native or naturalized plant species (see **Figure 8-3**).

8.10.2 FAUNA

Currently, there are no specific conservation needs to re-introduce or augment animal and fish populations at Camp Santiago.

8.11 WETLANDS MANAGEMENT

Camp Santiago contains no areas that meet the criteria for jurisdictional wetlands within the training boundaries, though there are many areas that are very wet on a seasonal basis.

Refer to riparian area management (**Section 8.6.3**) and floodplains and wetlands management (**Section 8.6.4**) for more detail on wetland management.

Figure 8-2. Forest Restoration Map

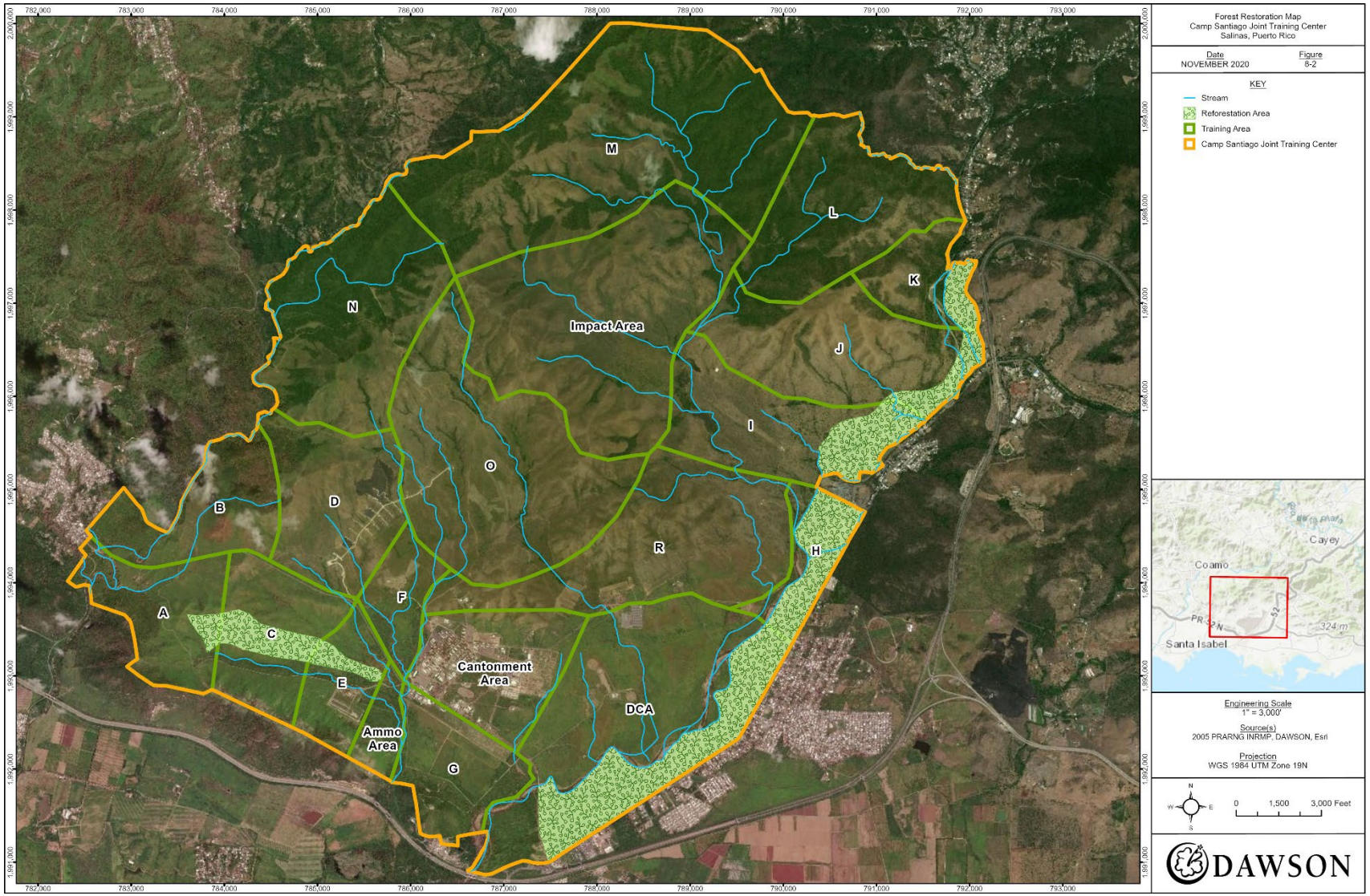
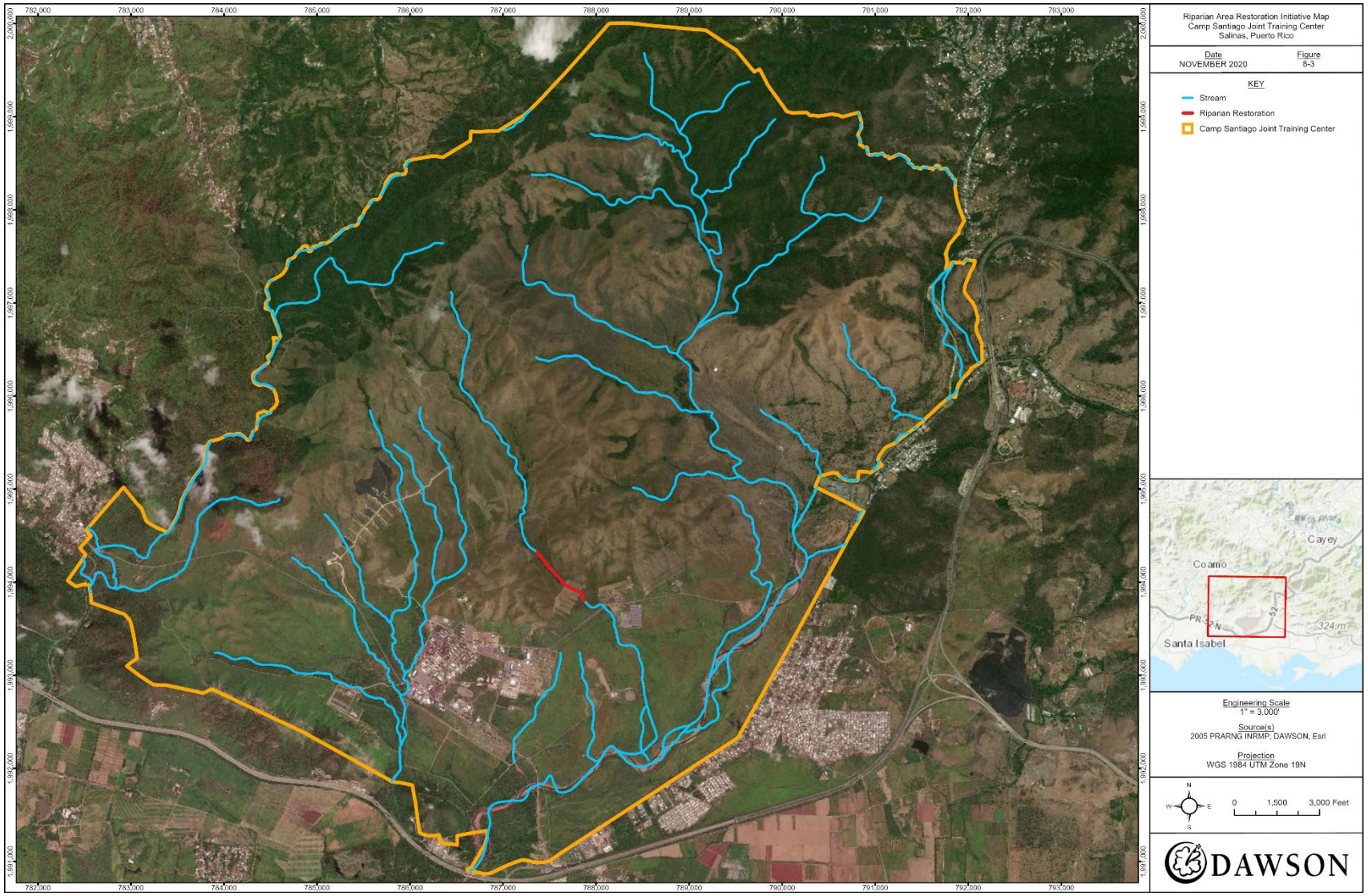


Figure 8-3. Riparian Area Restoration Initiative Map



8.12 WATER QUALITY MANAGEMENT

8.12.1 EXISTING CONDITION

Water quality is impacted by sediment eroded from roads, channel cleaning, ongoing gravel and fill-dirt extraction operations, and livestock grazing within riparian areas. Sediment is also being recruited into waterways from upland forest areas where frequent wildland fires and cattle grazing have prevented trees and brush from re-establishing on the hillsides.

Active erosion is most evident in the steepest portions of the streams within the active training areas of Camp Santiago. In some cases, water runoff has formed gullies that have migrated up to the tops of ridges, while in the most confined areas, brush and other vegetation has been ripped out and carried downstream during rain events. This situation is not occurring in Training Areas L, M, and N where mostly native woody plants with deep roots line the streams. It is also not apparent in the upper watershed outside of Camp Santiago where there has been less continuous soil disturbance.

Active erosion upslope from stream crossing structures contributes to the rate of pipe erosion, clogging, and failure. When pipes plug, it forces rain-swollen stream water to flow along the roadbeds and across downslope stream crossing structures, which damage both roads and streams.

Though “channel cleaning” is not occurring at the same level that it was as recently as 2000, there were some ditches noted within the Cantonment Area being bladed to mineral soil and small streams being cleared with equipment. These practices still cause large surges in sediment to be transported downslope during rain events, which changes the natural stream shape and size downstream and also hinders the stream’s ability to handle large rain events. Implementation of best management practices (BMPs) along convoy routes would greatly reduce sedimentation problems (see **Chapter 13**).

Gravel and fill-dirt extraction operations along the Rio Nigua have impacted water quality, riparian area vegetation, and thereby flood flow dissipation. GPS coordinates for these three sites have been recorded for monitoring and were photo-documented in February 2005. The location furthest downstream is the point where the last signs of water disappear into the stream bank. It appears that the water is following the stream’s historic flow path. The upper two sites show a significant amount of water still flowing. The primary source of the water is the Rio Majada above its confluence with the Rio Nigua. Rio Majada is very large watershed, while the upper Rio Nigua (3,540 acres) is perhaps a third its size and dry most of the year. It appears the streambed areas that have not had active extraction in the recent past are growing over with grasses and herbaceous plants relatively quickly. The recommendation for a moratorium on specific reaches of the river may be an effective mitigation in site-specific areas.

Other sources of sediment are secondary cross-country trails used by military and private vehicles and convoy routes used for heavy equipment when the trails and routes are wet or boggy. This has caused damage to riparian areas, resulting in deep ruts and gullies, and created dangerous training conditions for those using the facilities. To reduce this damage and creation of unsafe training conditions, areas with a potential for rutting and gullying should be delineated on maps and alternate routes should be found for training.

Eventually, all designated convoy routes and training sites need to be “storm proofed” with proper drainage to handle storm flows. All vehicles should stay 100 feet from stream courses and valley bottoms to avoid damaging seasonal wet areas or changing the course of groundwater. Encampments should stay a minimum of 50 feet from stream courses and trampling of riparian vegetation should be avoided. “Borrow” areas need to be reshaped and revegetated immediately after use. Regularly used soil extraction areas should always be designated and designed to include proper drainage.

Sediment generated from roads, livestock grazing within riparian areas, uncontrolled vehicular traffic, and soil extraction impact streams and water quality. This, in turn, impacts aquatic habitat both in the stream’s increased sediment delivered to the bays in nearby Salinas and where the rivers enter the sea.

8.12.2 Management Initiatives

8.12.2.1 Sediment Source Surveys

A field survey was conducted in December 2019 to identify erosion and sediment sources associated with traveled surfaces, or convoy routes, within Camp Santiago. This Sediment Source Survey includes an evaluation of the previously reported condition found at each of the six convoy routes, as depicted on a survey performed on 2013. It also includes newly identified sediment sources and problem areas along the convoy routes that are experiencing degradation or failure, such as damaged or blocked culverts and crossings, foundation failures, landslides and severe bank and toe erosion, among others. Most of these newly identified sediment sources are possibly associated to the impacts of Hurricane María in September 2017.

8.12.2.2 Culvert Inspection and Cleaning

Primary convoy routes could be inspected during severe rainstorm events to allow timely identification and clearing/cleaning of debris above, within, and below culverts to prevent potential erosion issues. The inspections and culvert maintenance would be accomplished by PRARNG. This initiative supports the timely identification and corrective actions required to minimize erosion and potential damage to stream crossings and is responsive to the INRMP goals related to troop safety, maximizing available training time and resources, and the protection of natural resources.

8.12.2.3 Stream Channel Surveys

Stream channel surveys could be conducted to determine current stream channel (i.e. baseline) conditions, monitor over time, and predict trends. The surveys would be expected to help identify stream channel and riparian area restoration opportunities. They would be conducted at least annually during the 2021-2025 period in February and October, by means of a contract and/or MOU with local universities. The initiative is responsive to the INRMP goals related the protection of riparian and aquatic habitat.

8.12.2.4 Stream Monitoring

As of 2021, stream monitoring activities were halted.

8.12.2.5 Overview Eliminate Sediment Sources Associated with Camp Santiago Primary Convoy Routes

General annotations and recommendations are provided to facilitate the design and construction of surface drainage and sediment reduction improvements. These improvements follow general BMPs that protect water quality, control water quantity and provide stabilization to watershed soils. BMPs are not only aimed at reducing sediment sources, but also provide solid guidance in designing safe convoy routes. Incorporating BMPs and installing proper drainage control features into travel routes allow controlled surface drainage through outsloping, insloping, or crowning roads. The drainage features are spaced so that peak drainage flow will not erode surface, drainage, or shoulder material.

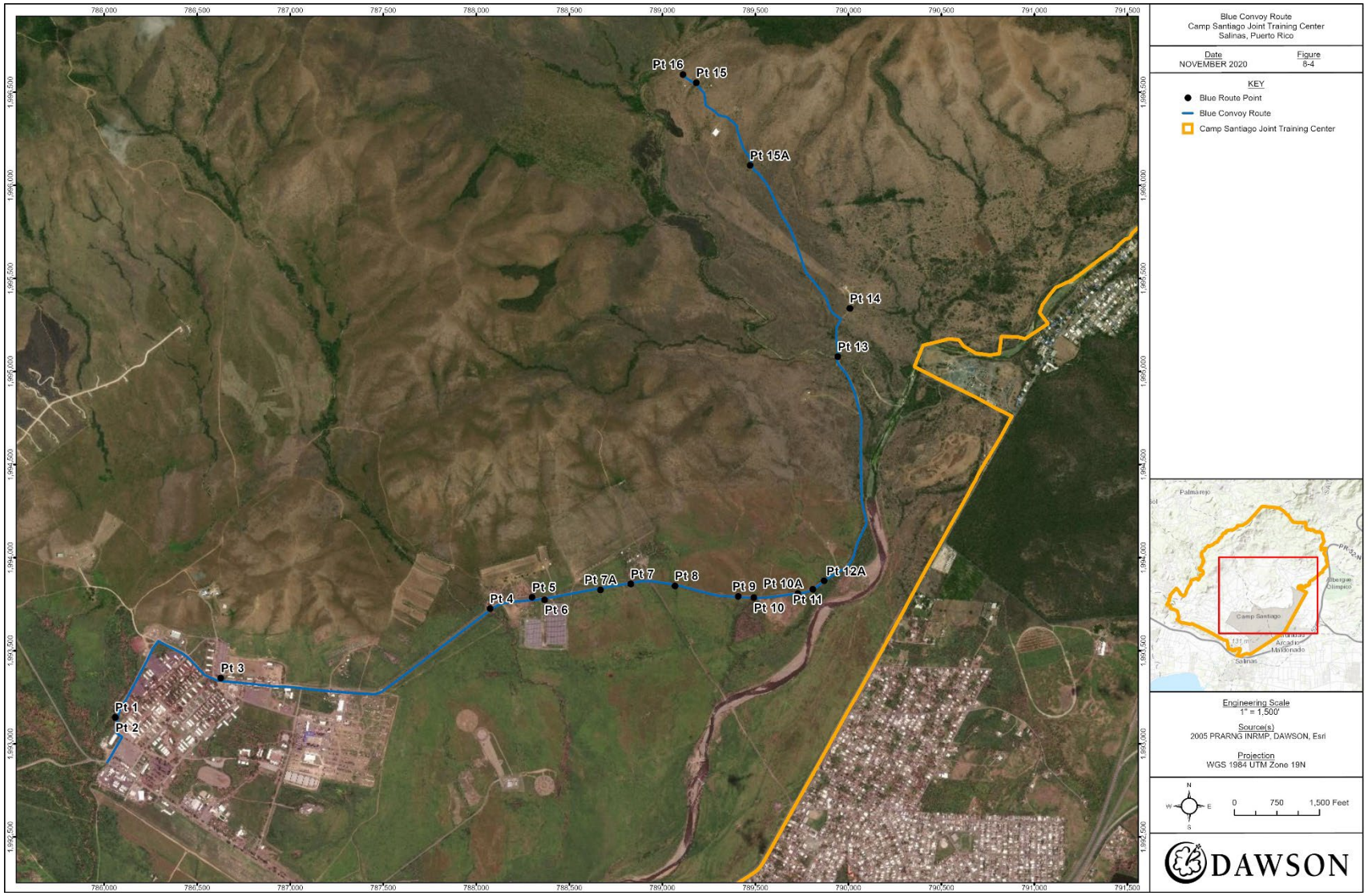
The overall survey observations reveal most of the problem areas detected on the previous 2013 survey remain under similar conditions or have worsened. It is evident how a lack of vegetation maintenance along convoy routes, and within and near drainage control structures, has caused blockages that are diverting the flow of water, increasing erosion in adjacent areas, and obstructing the view of drainage structures and gullies. In some areas, the obstruction of the drainage features and structures is creating safety hazards and structural failures. Vegetation should be cleared away from the inlets and outlets of all structures so flow is not impeded and stormwater management devices can work properly and be observed. The blockage of flow forces water to alternate drainage routes and create new channels around the drainage structures. This condition leads to erosion of the road and sedimentation of streams in the immediate vicinity of the drainage structure. Additionally, vegetation encroaching and growth of plant roots into drainage structures aggravate the potential of structure failure. This is especially true with concrete structures. Mechanical and chemical (herbicide) treatment of roots and stumps may be necessary to protect structures and to leave soils undisturbed.

These recommendations are responsive to the INRMP goals to maximize military training opportunities by eliminating lost training caused by blocked convoy routes and to protect and improve water quality by reducing existing sediment sources.

Blue Convoy Route – Elimination of Sediment Sources

The Blue Convoy Route is approximately 4.83 miles long and provides access to the Cantonment Area, Impact Area, and Training Areas DCA, R, H, I, J, K, L, M, and O. **Figure 8-4** shows the location of the Blue Convoy Route. The Green and Brown Convoy Routes can be accessed from this route. The following ranges are accessed directly from the Blue Convoy Route: 17, 18, 19, 20A, 20B, 22, 23, 25, 26, 27, 28, and 30. The Blue Convoy Route (see **Figure 8-4**) requires maintenance of concrete gutters, installation of surface drainage structures, and repair or reconstruction of various culvert structures. Grading and filling of trail gullies and installation of surface drainage structures is needed on the upper end of the trail between points 15A and 15B

Figure 8-4. Blue Convoy Route



(see **Figure 8-4**). Vegetation should be managed on a regular basis and care should be taken during these activities not to disturb soil.

During field survey, the following points along the Blue Convoy Route were identified as specific areas of concern, interest, or reference:

Blue Convoy Route Point 1

This drainage crossing consists of a double drain from the Cantonment Area with a concrete outlet wingwall and an apron. Excessive scouring, with a depth that reached up to 7 feet, is observed at the toe of the apron. Erosion of the left bank has caused it to appear nearly vertical and is approximately 10 feet in height, the eroded area extends approximately 20 feet downstream. The left wingwall on the outside face of the culvert is exposed and showed signs of erosion. Concrete slap, possibly from the old apron, is observed in the stream bed.

- The left bank should be stabilized. Some alternatives could include installing gabions, rearranging the slope, and installing an erosion control mat, followed by planting erosion control vegetation, such as *Chrysopogon zizanioides* (Vetiver). The apron scour should be armored with filter and riprap material.
- Local drainage features should be installed to keep surface flows from draining through the side of the wingwalls, thus avoiding erosion.

Blue Convoy Route Point 2

Channel migration continued erosion of the left bank of the Quebrada Honda approximately 107 feet downstream from Point 2, making the bank appear nearly vertical and approximately 30 feet in height. This appeared to be due to natural channel migration processes. Erosion of the creek bank seems to be encroaching on the convoy route.

- Gabions, or riprap, should be installed along the toe of the bank to prevent additional bank erosion. Gabions/riprap should be keyed into the channel bed and extend at least 10 feet beyond the upstream and downstream ends of the erosion problem area; these installations should extend approximately 10 feet in height. The remaining bank should be sloped at a 1.5:1 ratio, and stabilized by installing an erosion control mat, followed by planting erosion control vegetation, such as *Chrysopogon zizanioides* (Vetiver).

Blue Convoy Route Point 3

This drainage crossing consists of a 36-inch concrete pipe with a concrete outlet apron. Observations show the area is now stable and no erosion is visible.

- No action required.

Blue Convoy Route Point 4

This stream crossing consists of four, 80-inch diameter and 40-feet long concrete pipes. Approximately, 4 feet of scour are observed at the toe of the outlet concrete apron. The 2013 survey reported no erosion upstream, and minor erosion at the southern shoulder. The curb on the north abutment appeared to be damaged. During the 2019 survey, both upstream channel banks were observed to be eroded up to 20 feet upstream, to a height of approximately 6 feet, and has affected the right side wingwall. Vegetation debris that can potentially clog the inlet has

accumulated near the pipes and trees are growing in the channel downstream. In addition, erosion at the southern shoulder has significantly increased, has reached the outlet foundation of the pipes, and has undercut the asphalt, compromising route stability. Heavy erosion on the southern shoulder of the route is observed.

- All vegetation debris and growing trees found at the inlets and outlets should be cleared so flow is not diverted or impeded.
- Gabions, or riprap, should be installed along the toe of the upstream banks to prevent additional bank erosion. The installed gabions, or riprap, should be keyed into the channel bed and extend at least 10 feet more than that of the upstream and downstream ends of the erosion problem area; these installations should extend approximately 6 feet high. The remaining bank should be sloped at a 1.5:1 ratio and stabilized with an erosion control mat, followed by planting erosion control, like *Chrysopogon zizanioides* (Vetiver).
- Riprap should be installed to stabilize the southern route shoulder.
- Riprap toe protection should be provided at the outlet wingwall and apron, and minor bank stabilization should be installed to include riprap.
- Fill material (gabions or riprap) will be needed to fill the eroded structure foundation and the potholes, followed by a concrete or asphalt patch to repair the crossing.

Blue Convoy Route Point 5

The 2013 survey reported a gabion drain under the access to Range 22, but conditions during the 2019 survey suggest this drain has been clogged with sediment and could not be observed. Also, there is evidence of water impoundment and erosion at the intersection of the Blue Convoy Route with the Range 22 access route. Asphalt is damage due to water impoundment.

- If the gabion drain is functional, it should be maintained. Vegetation should be cut to the ground surface, and excess sediment should be removed on a routine basis where the inlet and outlet are located so the structure can remain efficient.
- If the gabion drain is completely clogged, a replacement, with the additional installation of filter geotextile, is needed to avoid further damage to asphalt.

Blue Convoy Route Point 6

This stream crossing consists of a 36-inch concrete culvert. The inlet and outlet pipe rims are damaged; this was also reported on the 2013 survey. In addition, vegetation is observed growing at the outlet, and some erosion is occurring on the inlet wingwall side.

- The rims of the pipes should be repaired; patching is necessary since they show signs of crumbling.
- Vegetation should be managed on a regular basis and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures, especially during the rainy season. Care should be taken not to disturb the soils during these activities.

Blue Convoy Route Point 7

Conditions reported on the 2013 survey persist. The existing 36-inch pipe has failed structurally and hydrologically; interior sections of the pipe crossing appear to be collapsing and separating, the internal rings seem to have failed, and the pipes seem to be misaligned. There is steel and

wood molding material attached to the structure that could block water flow. Riprap material was placed at the outlet, but it does not cover the scour. Also, soil that needed stabilization is observed in this area of the outlet.

- Pipes should be repaired or replaced, and riprap rocks should be placed over the scour.
- Seeding is recommended to stabilize the terrain.

Blue Convoy Route Point 7A

The 2013 survey reported this as a structurally and hydrologically failed pipe. The damaged pipe was replaced, and riprap rocks placed on the outlet.

- Seeding and BMPs are recommended on the outlet to stabilize recently disturbed terrain.

Blue Convoy Route Point 7B

Based on the 2013 survey, the existing culvert at the time was decommissioned, and water was observed pooling on the route. During the 2019 survey, dry conditions prevented any observations of the former culvert or water pooling. No concerns or problems were observed in this area during site reconnaissance.

Blue Convoy Route Point 8

Conditions reported on the 2013 survey persist. The existing 36-inch pipes are misaligned and the joints are separating because of the sediments inside. Also, the inlet and outlet pipe rings are broken. A considerable amount of sedimentation was observed in the outlet. Runoff seems to be causing erosion around the abutment and wingwalls. A large scour hole at the toe of the outlet apron was observed. Overgrown vegetation can reduce and obstruct the flow. Conditions may suggest the pipe size is under the needed capacity.

- The existing system should be hydrologically evaluated to increase its capacity.
- Local drainage features should be installed to avoid erosion from runoff draining through the side of the wingwalls.
- Vegetation should be managed on a regular basis and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures, especially during the rainy season. Care should be taken not to disturb the soils during these activities.

Blue Convoy Route Point 9

Vegetation is encroaching both the inlet and outlet. Some erosion is observed on the outlet's right wingwall, likely because of runoff draining from the route. The existing 24-inch concrete pipe may be undersized. A small scour hole at the outlet apron is observed. The outlet abutment has been damaged.

- Replacement of the existing 24-inch culvert pipe for a wider 36-inch one should be considered. Also, the outlet abutment should be repaired.
- Local drainage features should be installed to avoid erosion from surface water flow draining through the side of the wingwalls.
- Filter cloth and riprap should be installed at the toe of the outlet to address the scour hole.

Blue Convoy Route Point 10

Runoff draining from both directions of the route appears to be eroding soil along both outlet wingwalls. The drainage concrete gutter foundation is damaged and eroded in the immediate area of the pipe. New erosion is observed at the right inlet wingwall. The route is heavily eroded on the outlet area.

- The drainage gutter should be repaired along the route to prevent runoff from draining directly from it into the inlet and outlet.
- Re-grading and installation of riprap are recommended to address erosion problems at wingwalls.
- Vegetation should be managed on a regular basis and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures, especially during the rainy season. Care should be taken not to disturb the soils during these activities.
- Although dry conditions were dominant during the 2019 survey, and no other issues were observed, the 2013 survey suggests a drain should be constructed on the northwest side of the crossing to prevent overland flows from reaching and crossing the convoy route.

Blue Convoy Route Point 10A

The southernmost concrete drainage gutter is sedimented, has overgrown vegetation, and its foundation is eroded. In general, concrete gutters in this convoy route segment are sedimented and vegetation is altering water flow. Evidence suggests recent route maintenance has created soil mounds over the concrete ditches; these mounds prevent the proper water drainage.

- Sediments and vegetation should be removed from the concrete ditches for proper water drainage.
- Grading and installation of riprap should be conducted at the concrete drainage gutter foundation to prevent it from failing.

Blue Convoy Route Point 11

Runoff seems to be flowing throughout the route and outside the earthen draining ditch causing erosion and sedimentation. Erosion is observed on the hill slope adjacent to drainage ditch.

- The draining ditch surface should be graded to outslope, so as to take advantage of natural drainage patterns. Seeding may be required to stabilize grading.
- Stabilization by grading, erosion control mat installation, and seeding should be performed at the eroded hill slope.

Blue Convoy Route Point 12

As reported in the 2013 survey, the inlet abutment, outer ring, and wingwall appear to be damaged. The headwall of the inlet is broken, and its structural steel rods are exposed creating a hazard for both pedestrian and vehicle traffic. Erosion is observed at both wingwalls of the outlet, probably due by runoff draining from the route. Debris and vegetation are encroaching the structure's inlet and outlet. The apron and scour are not visible due to dense vegetation growing in the area. Drainage gutter erosion is observed on the north side of the convoy route.

- Local surface drainage features (gutters, dips, water bars) should be installed.

- The inlet structural features (headwall, wingwalls, ring) should be repaired or replaced.
- Riprap should be installed at eroded areas.
- Vegetation should be managed on a regular basis and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures, especially during the rainy season. Care should be taken not to disturb the soils during these activities.

Blue Convoy Route Point 12A

Heavy erosion between the concrete drainage gutter and the outlet headwall is observed. This erosion has exposed the gutter foundation and the culvert pipe. Debris and dense vegetation are impeding water flow at both the inlet and outlet.

- Riprap should be installed at eroded areas of gutter and headwall.
- Vegetation should be managed on a regular basis and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures, especially during the rainy season. Care should be taken not to disturb the soils during these activities.

Blue Convoy Route Point 13

This stream crossing consists of a low water bridge, composed by five, 24-inch concrete pipes located at a higher elevation than the natural stream bed, and two, 30-inch corrugated metal pipes (CMP) located at an elevation where only one pipe is receiving the normal flow of the stream. This crossing appears to be in a degraded condition as during the 2019 survey the concrete pipes were observed to be blocked with sediment reducing their capacity to below 50 percent. Currently, only the southernmost metal corrugated pipe is receiving water flow; the other pipe was observed to be clogged. The curbs were damaged or destroyed. There is evidence of a recent high water flow event overtopping the crossing and depositing debris over the route. Severe erosion at both sides of the outlet, and along the route, was observed. The crossing is a safety hazard due to the deteriorated curbs, the eroded outlet, and the high potential for overtopping during heavy rain events. Scour at outlet reaches up to three feet in some sections.

- A hydrologic and hydraulic analysis should be performed to determine the required capacity needed to manage flows in order to design a new structure.
- A new bridge structure should be considered to replace the existing crossing.
- Drainage features should be constructed at both sides of the convoy route.
- Concrete scraps placed at both sides of the outlet as a temporary solution should be removed, since the new structure may require the installation of riprap or gabions in this area.

Blue Convoy Route Point 14

At this point, there is a junction with another dirt road which is within the training limits, but not depicted as a convoy route in previous documents. No concerns are found at this location.

Blue Convoy Route Point 15

As reported in the 2013 survey, this point is a low laying area that would fill with standing water during the wet season.

- Riprap material or gravel should be placed within the low laying area to prevent deep ruts or gullies from forming during vehicle crossing.

Blue Convoy Route Point 15A to 15B

This segment of the convoy route is overgrown with shrubs and herbaceous vegetation. This segment appears to have been previously rutted and gullied, but vegetation has since stabilized the area. There is no evidence this segment of the convoy route is in use. This convoy route is intersected by another alternate route that leads to the same training area and to Point 15, Point 16, as well as to the end of the route. This route realignment does not affect PRARNG mission requirements.

- Should PRARNG decide to use this convoy route segment, grading should be performed and drainage ditches, dips, and waters bars should be installed.

Blue Convoy Route Point 16

No concerns at this point.

Brown Convoy Route – Elimination of Sediment Sources

The Brown Convoy Route is approximately 2.36 miles long and provides access to Training Areas F, O, R, and DCA, and to Ranges 7, 15 and 18. **Figure 8-5** shows the location of the Brown Convoy Route. The Violet Convoy Route is accessed from the Brown Convoy Route and the Orange Convoy route can be accessed as well.

Erosion, gullies, sedimentation, and rutting are observed in various areas of the Brown Convoy Route. Recommendations include grading, creation of outlets for both the surface drainage structures, and the hardening of water collection areas, as well as the creation of ditches with riprap to prevent convoy route erosion. Outsloping of the convoy route will be needed in some areas to facilitate surface drainage. Vegetation around drainage structures should be cut to ground surface on a regular basis without disturbing the soils.

During the field survey, the following points along the Brown Convoy Route were identified as specific areas of concern, interest, or reference:

Brown Convoy Route Point 1

At this point, the Brown Convoy Route intersects a paved section of the Blue Convoy Route. Erosion and rills are observed forming at the junction of this intersection

- Riprap material or gravel should be placed at the junction of the two routes to prevent erosion, sedimentation and rill formation.

Figure 8-5. Brown Convoy Route

Brown Convoy Route Point 1A

Water shading occurring in a low laying area of the route, close to a local drainage collection channel, is causing erosion, sedimentation, and rutting and rills formation. A gully is forming at the adjacent northern hill.

- Drainage features should be constructed at both sides of the convoy route.
- Riprap material or gravel should be placed within the low area to prevent deep ruts or gullies from forming during vehicle crossing.
- Grading and water bar creation is recommended.

Brown Convoy Route Point 2

Heavy erosion, with the formation of gullies, rills, and even a “Bog” trail, are observed at the intersection. The Brown Convoy Route is acting as a ditch from this point to Point 1A.

- Grading, creation of stormwater ditches, and riprap installation are recommended.

Brown Convoy Route Point 3

This point is the junction of the Brown Convoy Route with an access road to the Range Control Building. Erosion, gullies, rills, and rutted areas are present throughout this access road.

- Grading, creation of stormwater ditches, and riprap installation are recommended to allow for improved drainage.

Brown Convoy Route Point 4

This point is a low laying area on the route that collects sediment and stormwater; rooting is observed as well. This point is lower in elevation than its outlet ditch, which is also completely covered with vegetation.

- The route should be raised so that runoff water can reach the adjacent drainage ditch.
- Drainage features should be reconstructed with filter cloth and riprap to manage high volume runoff and sedimentation from entering the drainage collection channel at the crossing.

Brown Convoy Route Point 5

This route junction with the Orange Convoy Route at this point. No concerns are observed at this point.

Brown Convoy Route Point 5A

The route is eroded, gullies are observed in the east shoulder, and a rutted area approximately 135 feet long and 10 inches deep has formed

- Grading, creation of ditches, and riprap installation is recommended to allow for improved drainage.

Brown Convoy Route Point 6

At this point, the route is eroded, and a gully approximately 55 feet long and 8 inches deep has formed in the east shoulder.

- Grading, creation of ditches, and riprap installation is recommended to allow for improved drainage.

Brown Convoy Route Point 6A

Water shedding and impoundment was observed in a low laying area and some areas are rutted.

- Construction of an outlet and installation of riprap and gravel is recommended.

Brown Convoy Route Point 7

This area appears to be stable. No concerns observed during this survey.

- Monitoring of the area is recommended.

Brown Convoy Route Point 8

Some gullies are observed along the north side of the route. The 2013 survey observed surface flow crossing the route and surface water gullying down from this point toward Brown Route Point 9.

- Some water bars may be required to prevent gully formation.
- Monitoring of the area is recommended.

Brown Convoy Route Point 8A

Water rills, gullies, and some rutted areas are observed.

- Grading, creation of stormwater ditches, and riprap installation is recommended to allow for improved drainage.

Brown Convoy Route Point 9

This point is the junction between the Brown Convoy Route and the Violet Convoy Route, which borders Range 18 and leads north to the Urban Assault Course. No concerns observed at this point.

Brown Convoy Route Point 14

The inlet ring has been bent, probably during prior repairs. Erosion and formation of a gully approximately 25 feet long and 18 inches deep was observed upstream. The outlet is located at a lower elevation than the downstream ditch. Sedimentation and impoundment were observed.

- Water bars installation and seeding is recommended upstream.
- The ditch should be graded to create positive flow; seeding after grading is recommended.

Brown Convoy Route Point 14A

Sediment deposition is observed at this double 24-inch culvert. The western inlet pipe is 75 percent clogged. Vegetative debris (cut grass) was observed inside the pipes. A ditch coming

from the Cantonment Area abuts near the outlet and is causing erosion to an electrical pole foundation.

- Sediment and debris buildup should be removed so flow is not impeded.
- Installation of riprap is recommended.

Brown Convoy Route Point 14B

The inlet has structural damage at the wingwall. The drainage ditch is dredged upstream causing exposure of tree roots. Observed erosion is 30 feet long and 30 inches deep. The outlet pipe is clogged reducing capacity by at least 20 percent and is located at a lower elevation than the downstream ditch creating a negative flow.

- The ditch should be graded to create positive flow; riprap and seeding after grading is recommended.
- Pruning of affected tree roots is recommended.

Brown Convoy Route Point 14C

This crossing is almost completely clogged with sediments and has collapsed in some areas.

- A hydrologic and hydraulic analysis should be performed to determine the required capacity needed to manage flows in order to design a new structure.

Brown Convoy Route Point 14D

Ditch migration towards the fence is causing erosion at its foundation. The outlet headwall is cracked.

- The headwall should be repaired, and the drainage ditch should be graded and realigned to avoid erosion at fence foundation. Seeding is recommended following grading and realignment.

Brown Convoy Route Point 14E

The crossing consists of two 18 inches wide and 20 feet long pipes at the entrance of the officer's club. The inlet's west wingwall and the outlet's east wingwall are eroded. The inlet is not aligned with the drainage ditch, and the outlet is at a lower elevation that the downstream drainage ditch resulting in negative flow.

- Realignment and grading of ditch should be performed to create positive flow.
- Repairs to wingwall, and riprap installation should be performed in both the inlet and outlet.

Brown Convoy Route Point 15

Erosion is observed at both sides of the outlet coming from adjacent drainage ditches. The ditch appears to have a higher downstream elevation than the outlet. The inlet is eroded (scour) under the pipe and the headwall.

- Riprap should be installed at both the inlet and outlet to create an apron-like structure, and at abutting ditches from adjacent drainage to avoid erosion at these points.
- The drainage ditch should be graded to create positive flow.
- The damaged outlet pipe should be repaired.

Brown Convoy Route Point 16

At this point, the Brown Convoy Route ends and junctions with the Red Convoy Route. No concerns are observed at this point.

Green Convoy Route – Elimination of Sediment Sources

The Green Convoy Route is approximately 0.75 miles long, starts at the Blue Convoy Route, provides access to Training Area DCA, and heads in a southerly direction to the intersection with the road to the U.S. Air Force High Frequency Global Communications System. **Figure 8-6** shows the location of the Green Convoy Route. The Green Convoy Route appears to be in disuse or abandoned.

During the field survey, the following points along the Green Convoy Route are identified as specific areas of concern, interest, or reference:

Green Convoy Route Point 1

At this point, the Green Convoy Route starts from the junction with the Blue Convoy Route. This area appeared stable due to the heavy vegetation observed along the convoy route. No concerns are observed.

- The inlet and outlet ditches should be monitored. The outlets should be hardened with riprap material if erosion should occur.

Green Convoy Route Point 2

At this point, the Green Convoy Route intersects the U.S. Air Force High Frequency Global Communications System paved access road. There is a 42-inch wide and 36-feet long culvert pipe managing waters from a drainage ditch that collects water from Training Area DCA. The culvert pipe is completely covered by overgrown vegetation. Some erosion is observed on the inlet southern bank; this bank erosion is approximately 4 feet high and extends approximately 5 feet upstream.

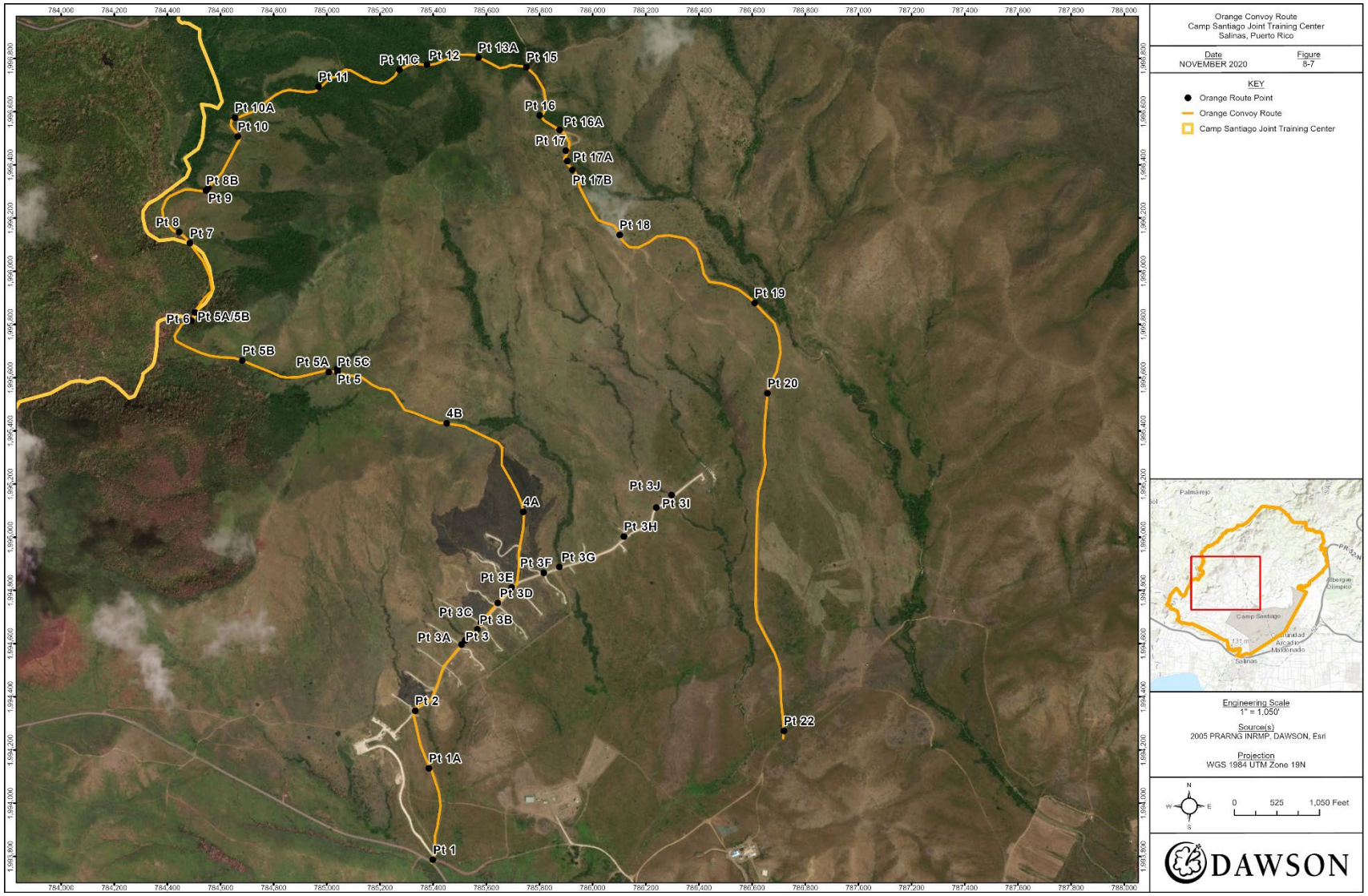
- Gabion and riprap should be installed in the eroded drainage ditch bank.
- Vegetation should be managed on a regular basis and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures, especially during the rainy season. Care should be taken not to disturb the soils during these activities.

Orange Convoy Route – Elimination of Sediment Sources

The Orange Convoy Route is approximately 5.4 miles long and provides access to Firing Point 40. It begins off the Red Convoy Route and makes a loop through Training Areas D, N, and O until reaching its intersection with the Brown Convoy Route. **Figure 8-7** shows its location. The Orange Convoy Route has one culvert stream crossing, fords the Río Jueyes twice, and crosses the Cerro Pío Juan twice. It also uses the Río Jueyes' streambed as part of the route. A portion of this route, from Point 2 to new Point 3F, was realigned to accommodate for proper access, thus improving the training area.

Figure 8-6. Green Convoy Route

Figure 8-7. Orange Convoy Route



In general, various segments of this route are severely eroded and require improvements to address problem areas, including headcuts, loss of trail, very deep gullies, rills and heavy rutting. Surface drainage structures (e.g., drain dips, water bars, outsloping) should be designed, constructed and installed over approximately three-quarters of its length.

For the Orange Convoy Route, a detailed hydrologic and hydraulic analysis, as well as a route survey, should be completed to specify the design of surface drainage improvements, and to address sediment source problems. To stabilize the route, headcuts may require grading, gabion installation, filling, hardening, and other measures. Route surface drainages should be diverted prior to stream crossings in order to protect water resources. Soil berms located to the side of the road, resulting from old grading activities, should be removed and/or pulled back onto the route to fill gullies in areas where a shoulder berm exists, and where berms make the route function as a drainage ditch. The interval of surface drainage structures should depend on route grade and local drainage patterns. Both, the inlet and outlet ditches of the surface drainage structures should be hardened with riprap to prevent erosion of the route shoulder. Vegetation should be managed on a regular basis and maintained at ground surface around drainage structures, especially during the rainy season. Care should be taken not to disturb the soils during these activities.

During field survey, the following points along the Orange Convoy Route were identified as specific areas of concern, interest, or reference:

Orange Convoy Route Point 1

This point is the beginning of the Orange Convoy Route from its intersection with the Red Convoy Route. The 2013 survey reported gullies in this area up to Point 1A. The area seems to have been patched, graded and hardened with well-graded material. No concerns were found at this point.

Orange Convoy Route Point 1A

A segment of approximately 100 feet shows rills and some erosion.

- Grading, deposit of well-graded aggregate, and hardening should be performed to improve the road.

Orange Convoy Route Point 2

At this crossing, consisting of a 24-inch CMP with concrete walls, the inlet wingwalls are broken. The upstream and downstream channels appear to be stable, but overgrown vegetation can obstruct water flow. Erosion is observed at the outlet wingwall. Water is currently eroding bank material at the edges of the gabion.

- The inlet wingwalls should be repaired.
- Riprap should be installed and hardening of surfaces around the inlet and outlet should be performed to avoid erosion.
- Local drainage features should be installed to keep runoff from draining through the side of the wingwalls, thus avoiding erosion.
- Vegetation should be managed on a regular basis and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures, especially during the rainy season. Care should be taken not to disturb the soils during these activities.

Orange Convoy Route Point 3 to 3F

These points are located along a new alignment of the route through the recently built (FY15) moving target training range area. Former Points 3 through 3B are locations of the route that were assessed in the past, during the 2013 survey, but were abandoned because of the new route alignment, and thus, were not found during the survey.

Points 3 to 3F are a series of crossings consisting of concrete pipes and box culvert structures that manages runoff from the training area hills. The pipe structure sizes range from 24- to 36-inches in diameter, while the box culvert sizes range from 4x2-feet to 7x7-feet.

Overgrown vegetation obstructs both the inlet and outlet in most structures. Some structures during the 2019 survey could not be evaluated in detail because of the presence of dense vegetation that included shrubs, spiny scrubs, herbs, and vines.

Sedimentation and vegetative debris accretion is observed inside various structures as well. In some structures, instead of having concrete inlet and outlet headwalls and wing walls, riprap is observed. There is evidence of debris accretion over some inlet riprap structures, possibly resulting from periodically leaving it behind after maintenance activities.

In some structures, specifically the box culverts, riprap material was placed at a higher elevation at both the inlet and outlet, obstructing water flow and causing erosion of the upstream channel. Sedimentation has caused improper soil elevation at the outlets. Both conditions cause a negative flow of the drainage structures.

In some portions of this route segment, low laying areas with soft soils show evidence of erosion. Erosion is also observed around both the inlet and outlet structures since a runoff management system is lacking along the route.

- Vegetation should be managed on a regular basis and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures, especially during the rainy season. Care should be taken not to disturb the soils during these activities.
- Sediments and debris inside the structures, and at riprap areas, should be removed and placed where they cannot reach the drainage system again.
- Drainage ditches should be graded to create positive flow; riprap should be installed at the same elevations of the inlet and outlet; seeding after grading is recommended.
- The practice of leaving behind debris from maintenance activities should cease.
- Concrete structures (headwalls, wingwalls and aprons) should be built or installed at the inlets and outlets where only riprap is present.
- Grading, deposit of well-graded aggregate, and hardening should be performed to improve the condition of some route points.
- Local drainage features should be built or installed to prevent route runoff from draining through the sides of the inlet and outlet, thus avoiding erosion.

Orange Convoy Route Point 4

During the 2019 survey, a segment of the road that gives access to Orange Convoy Route Point 4 and a segment of the road from this point in direction to Point 5, were observed with several problem areas.

The southern route segment starts at the intersection of the Orange Convoy Route with the Moving Target Training Range Area and extends approximately 280 yards north before reaching Point 4. At the beginning of this segment, erosion caused by runoff over the route, and over an adjacent drainage ditch, is encroaching the route. Some water bars are present, but they may not have been installed properly, as water is diverting through the route, which is now acting as a drainage ditch. Gullies and rills are observed at this segment.

This is a low laying area on the route and the route is heavily eroded. The installed gabion is barely functional. A very deep gully has formed, reaching a depth of up to 15 feet. The route is considerably encroached at this point and represents a hazard for the training convoys.

The northern route segment starts at Point 4 and extends north-northwest 0.2 miles until reaching the top of a hill in the route. At this segment, a series of very deep gullies (up to 30 inches deep) and rills are observed. Also, failed water bars are present.

- Grading, deposit of well-graded aggregate and hardening should be performed to improve the route at some points.
- Local drainage features (gutters, dips, water bars, inlets, and outlets) should be built to keep surface flows off the route, and from draining through it, thus avoiding erosion.
- Existing water bars should be reconstructed in order to be functional and properly manage runoff out of the route. More water bars may be needed.
- At Point 4, hardening the area with GeoCell filter material and gravel is recommended. Filter material should be placed and covered with 1.5 feet of rock. The repaired route would essentially be a hardened drive through a dip. The installation of a culvert should be considered. The outlet should be re-enforced with filter material and gabions or riprap. Grading and gabion installation will be needed to avoid a landslide.
- Vegetation should be managed on a regular basis and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures, especially during the rainy season. Care should be taken not to disturb the soils during these activities.

Orange Convoy Route Point 5

Drainage from the watershed seems to be crossing the route at this point and forming a large gully that extends towards the drainage channel. The gully headcut is migrating, thus encroaching the route, and should be considered a safety hazard. The gully is approximately 15 feet deep and approximately 20 feet wide. Bank erosion has continued migrating towards the route and seems to be more than that observed during the 2013 survey. Also, gullies are present from this point up to 120 feet towards the east. At approximately 100 feet west from Point 5, the route crosses an intermittent stream; stream bank erosion is observed upstream and downstream the crossing.

- Hardening the drainage area, and riprap and gabion installation at the gully headcut is recommended to address the route encroachment. Vegetation should be cleared from the headcut and the drop off should be clearly marked. Care should be taken to not disturb the soils during these activities. Seeding is recommended.
- Grading, deposit of well-graded aggregate and hardening should be performed to improve the route at some points.
- Local drainage features (gutters, dips, water bars, inlets, and outlets) should be built to keep surface flows off the route, and from draining through it, thus avoiding erosion.

- Gabions should be installed at the eroded intermittent stream banks.

Orange Convoy Route Point 5A to 5B

Gullies are very deep, more than 36 inches in some parts, which extend approximately 2,325 feet along the route until reaching the crossing of Río Jueyes. Within this segment, there is an approximately 50 feet long section where gullies have heavily eroded the route, and where ATVs and off-road vehicles can barely pass, representing a safety hazard for convoy training.

- The route should be graded to be outsloped. Deposit of well-graded aggregate and hardening should be performed.
- Local drainage features (gutters, dips, water bars, inlets, and outlets) should be built to keep surface flows off the route, and from draining through it, thus avoiding erosion.

Orange Convoy Route Point 6

At this point, the route drops into Río Jueyes and continues along the stream channel corridor for approximately 250 feet. The route makes two river crossings in this area and transitions in and out of the channel were drivable. The banks are gradual, although according to reports by the Forest Service personnel during past visits, the banks were reportedly 4 feet vertical drops in 2005.

- Coordination with appropriate agencies should be made to acquire permits for the establishment of a route through the channel. Permanent crossing locations with hardened approaches may be required to minimize sediment introduction to the river.

Orange Convoy Route Point 7

At this point, the route crosses again Río Jueyes and leaves its corridor. After the crossing, there is heavy sedimentation going into the stream during heavy rain events.

- Coordination with appropriate agencies should be made to acquire permits for the establishment of a route through the channel. Permanent crossing locations with hardened approaches may be required to minimize sediment introduction to the river.

Orange Convoy Route Point 8, 8A, and 8B

There are several gullies extending south, and north of Point 8, until reaching Point 8B. The first section of this segment has a large gully that makes the route dangerous and unsecure at this point. Beyond Point 8 and heading north-northeast, this segment of the route has several gullies, some of them covered with vegetation and not visible, thus representing a safety hazard. The approximate length of this gullied route segment from Point 8 to Point 8B is 1,080 feet.

- The route should be graded to be outsloped. Deposit of well-graded aggregate and hardening should be performed. Riprap material should be used at focal areas.
- Local drainage features (gutters, dips, water bars, inlets, and outlets) should be built to keep surface flows off the route, and from draining through it, thus avoiding erosion.

Orange Convoy Route Point 9

Shoulder erosion is occurring. In addition, there is a small berm that seems to have been placed along the edge of the outlet to divert water. However, the berm, along with the island of vegetation in the middle of the route, is diverting water downhill towards Point 8 and eroding the route.

- The berm and the vegetated island in the middle of the route should be removed.
- Creation of a hardened drain and outlet should be performed in a way that the new drain improves water flow off the route.

Orange Convoy Route Point 10

A large gully/headcut is located at the drainage outlet. The gully is approximately 15 feet deep and is eroding toward the route. This is considered a safety hazard.

- Riprap or gabion with filter material should be installed, and the outlet should be hardened.
- Vegetation should be cleared away from the headcut so that it is visible, and the drop off should be clearly marked. Care should be taken to not disturb the soils.

Orange Convoy Route Point 10A to 11C

This segment of the route consists of a series of continuous gullies along the route alignment. Also, rills were observed over the route surface. It seems the gully is conveying water like a stream for a length of approximately 2,300 feet (from Point 11C area). The gully is approximately 1 to 2 feet deep and should be considered a safety hazard. A partially vegetated headcut observed at the beginning of this segment (Point 10A) appears to be migrating toward the route and interconnecting with the gullies at Point 11. It seems the gully in this section (Point 11) has not migrated more towards the route and is partially covered with vegetation. This segment of the route continues in a northeast direction through a steep incline from Point 11, where several gullies and rills are present until reaching Point 11C. Some gullies are covered with vegetation and new gullies have been forming towards the route and encroaching it.

- The route should be graded to be outsloped. Deposit of well-graded aggregate and hardening should be performed. Riprap material should be used at focal areas.
- Local drainage features (gutters, dips, water bars, inlets, and outlets) should be built to keep surface flows off the route, and from draining through it, thus avoiding erosion.

Orange Convoy Route Point 12 to 13A

This segment of the route consists of a series of continuous gullies along the route alignment. These gullies were reported as separate sediment source points in the 2013 survey and are now interconnecting with each other. This segment continues in an east direction through a steep incline from Point 12, where several gullies and rills are present, until reaching Point 13A. It seems the gully is conveying water like a stream for a length of approximately 700 feet from Point 13A and downhill to Point 12, where sedimentation is occurring. At Point 12A (between Point 12 and Point 13), the outlet is eroded and encroaching the route in two locations. New gullies have formed at this segment through the sides and center of the route; nevertheless, they are partially covered with vegetation. Headcut on the route shoulder seems to be stable with vegetation growing over it.

- The route should be graded to be outsloped. Deposit of well-graded aggregate and hardening should be performed. Riprap material should be used at focal areas.

- Local drainage features (gutters, dips, water bars, inlets, and outlets) should be built to keep surface flows off the route, and from draining through it, thus avoiding erosion.

Orange Convoy Route Point 14

A gully is encroaching the travel way into Firing Range 40 at approximately 100 feet from the junction with the Orange Convoy Route. Some grading seems to have been recently performed; however, the gully is still present. Due to the lack of drainage structures removing water from the route surface, minor surface gullying is observed as well.

- The route should be graded to be outsloped. Deposit of well-graded aggregate and hardening should be performed. Riprap material should be used at focal areas.
- Local drainage features (gutters, dips, water bars, inlets, and outlets) should be built to keep surface flows off the route, and from draining through it, thus avoiding erosion.

Orange Convoy Route Point 15

At this point, a stormwater swale crossing the road is forming a gully and causing erosion and sedimentation.

- Filter cloth and riprap should be installed.

Orange Convoy Route Point 16

A gully along the route surface and on the east shoulder of the route has caused severe erosion where water veered to a nearby outlet. This condition seems to have worsened by the presence of a soil berm. Promoting route encroachment, the outlet has a large headcut that measures approximately 15 feet in depth and width.

- The route should be graded to be outsloped. The existing berm should be removed. Deposit of well-graded aggregate and hardening should be performed. Riprap material should be used at focal areas.
- Local drainage features (gutters, dips, water bars, inlets, and outlets) should be built to keep surface flows off the route, and from draining through it, thus, to avoid erosion.
- The outlet should be hardened with filter material and riprap. At the headcut, gabions should be installed to avoid route encroachment; vegetation should be cleared in this area and the drop-off should be clearly marked.

Orange Convoy Route Point 16A

The 2013 survey reported the presence of a gully. This condition has worsened considerably since this segment of the route currently has several gullies at both sides and at its center.

- The route should be graded to be outsloped. The existing berm should be removed. Deposit of well-graded aggregate and hardening should be performed. Riprap material should be used at focal areas.
- Local drainage features (gutters, dips, water bars, inlets, and outlets) should be built to keep surface flows off the route, and from draining through it, thus avoiding erosion.

Orange Convoy Route Point 17 to 17B

This segment of the route consists of a series of continuous gullies along the route alignment. These gullies were reported as separate sediment source points in the 2013 survey and are now interconnecting with each other. Also, new gullies have formed at this segment through the sides and center of the route, a condition worsened by berms are present at both sides of the route.

This segment continues in a south direction through a steep incline for approximately 275 feet, from Point 17 and downhill to Point 17B. Several gullies and rills are present.

At Points 17A and 17B, headcuts at the outlets are migrating into the route and encroaching it; these represent a dangerous condition and safety hazard.

- The route should be graded to be outsloped. Deposit of well-graded aggregate and hardening should be performed. Riprap material should be used at focal areas.
- Local drainage features (gutters, dips, water bars, inlets, and outlets) should be built to keep surface flows off the route, and from draining through it, thus avoiding erosion.
- To avoid route encroachment, headcuts at the outlets (Points 17A and 17B) should be hardened with filter material and riprap, and gabions should be installed.

Orange Convoy Route Point 18 to 18C

It appears gullies that were reported in the 2013 survey have significantly grown, and erosion is causing route encroachment. A headcut at an outlet is observed encroaching the route. Rills are also present in this segment.

- The route should be graded to be outsloped. Deposit of well-graded aggregate and hardening should be performed. Riprap material should be used at focal areas.
- Local drainage features (gutters, dips, water bars, inlets, and outlets) should be built to keep surface flows off the route, and from draining through it, thus avoiding erosion.

Orange Convoy Route Point 19

In the 2013 survey, a gully and headcut were reported at the outlet ditch and extending under the route. Severe erosion has occurred and the route has failed. The headcut is approximately 50 feet long, 10 feet deep, were deepest, and 15 feet wide, were widest.

- A hydrologic and hydraulic analysis should be performed to determine the required restoration design.

Orange Convoy Route Point 19A

The 2013 survey reported a gully next to the route. Sediment seems to have deposited at this point, probably from the heavily eroded Point 19; however, vegetation growth has stabilized the area. No concerns at this point.

Orange Convoy Route Point 20 to 22

This segment of the route consists of a series of continuous gullies along the route alignment. These gullies were reported as separate sediment source points in the 2013 survey and are now interconnecting with each other. Also, new gullies have formed through the sides of the route, a condition worsened by the presence of berms, which are present along both sides of the route. This segment starts as a moderate incline at Point 20 and continues in a south direction through a leveled route for approximately 4,200 feet, where it reaches the junction with the Brown Convoy

Route at Point 22. Several gullies and rills are present in this segment. At Point 22, the drainage outlet from the road has created a 4-feet long, 4-feet wide and 3-feet deep gully that's encroaching the road near the intersection with the Brown Convoy Route.

- The route should be graded to be outsloped. Deposit of well-graded aggregate and hardening should be performed. Riprap material should be used at focal areas.
- Local drainage features (gutters, dips, water bars, inlets, and outlets) should be built to keep surface flows off the route, and from draining through it, thus avoiding erosion.
- To avoid route encroachment, headcuts at the outlets (Points 17A and 17B) should be hardened with filter material and riprap, and gabions should be installed.

Red Convoy Route - Elimination of Sediment Sources

The Red Convoy Route makes two loops, one west of the Cantonment Area to the gas chamber and one south of the Cantonment Area around the airfield. The total route length is approximately 7.5 miles. **Figure 8-8** shows the location of the Red Convoy Route.

The Red Convoy Route provides access to the Cantonment Area and Training Areas A, B, C, D, E, F, and G. Ranges 3, 4, and 5 are also accessed directly from this route.

Only approximately 2 miles of the Red Convoy Route's west loop is currently paved (the portion coincident with Highway 154). Approximately 1.5 miles of the west loop's southernmost part are under contract for paving and placement of road drainage features every 300 feet. A contract to pave and provide surface drainage for the remaining 1 mile of the west loop has been prepared and is waiting for funding. When completed, the entire west loop of the Red Convoy Route will be hardened and surface drainage features will be put in place.

Approximately 1.5 miles of the Red Convoy Route's east loop is currently paved (the portion coincident with Highway 154 and through the Cantonment Area). The remaining approximate 1.5 miles of the east loop are gravel and native surface. The eastern and western sides of the east loop have problems associated with overland flows, channel incision, and channel migration. Flows coming from the airfield are intercepted by the Red Convoy Route and then follow the route's surface until entering drainages at stream crossings.

Additionally, general channel degradation in the Río Nigua and excessive flows in the streams appear to have caused headcuts at streams at their confluence with the Río Nigua and up to the stream culverts on the Red Convoy Route. The stream culverts act as "grade control". Additionally, on the western end of the east loop, general channel migration of the Quebrada Honda is eroding into the Red Convoy Route.

A detailed hydrologic and hydraulic analysis and a route survey should be completed to specify the design for improvements of surface drainage, failed stream crossings, and to address sediment source problems. Headcuts may require grading, gabion installation, filling, hardening and other measures to stabilize the route. Route surface drainages should be diverted prior to stream crossings in order to protect water resources. Soil berms to the side of the road, resulting from past grading activities, should be removed and/or pulled back onto the route to fill gullies in areas where a shoulder berm exists, and where berms make the route function as a drainage ditch. The interval of surface drainage structures should depend on route grade and local drainage patterns. Both the inlet and outlet ditches of the surface drainage structures should be hardened

Figure 8-8. Red Convoy Route

with riprap to prevent erosion of the route shoulder, and vegetation around drainage structures should be cut to the ground surface on a regular basis without disturbing the soils.

During field survey, the following points along the Red Convoy Route where identified as specific areas of concern, interest, or reference:

Red Convoy Route Point 1

This point is a route crossing structure over a tributary of the Río Nigua. The structure is a down slope concrete crossing. Vegetation is encroaching over the structure's side concrete barriers, which are also cracked at both the inlet and outlet. Concrete barriers at the side of the structure are very low in height, representing a hazard for pedestrians and vehicles alike. Erosion is evident at both the inlet and outlet wing walls. An undercut in the asphalt, with a deep hole that collects runoff water, suggests the structure has settled. This condition has exposed the structure's foundation. Also, there is a high chance of hidden erosion occurring at this area.

- A licensed structural engineer should evaluate the structure to verify its integrity and stability. If the structure is to remain, repairs to the cracked inlet and outlet barriers, and to the asphalt hole should be completed. Also, the concrete barrier should be repaired and raised.
- Route drainage features (riprap, gutters, dips, inlets, and outlets) should be built to the sides of the route to keep surface flows off the inlet and outlet structure, thus avoiding erosion.
- Vegetation should be managed on a regular basis, especially during the rainy season, and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures. Care should be taken not to disturb the soils during these activities.
- This site is considered a safety hazard and the steep drop-off at both the inlet and outlet should be clearly marked.

Red Convoy Route Point 1A

This point is a route segment of approximately 700 feet. This segment starts where the route paving ends and there is a dirt road passing in front of a building area and ends just before reaching Point 2. This segment of the route has a built drainage system (gutter, inlets, and outlets) that need maintenance. Gravel and sediments have migrated into the drainage system causing sedimentation, obstruction and partial clogging at gutters, inlets, and outlets. In addition, vegetation has grown over gutters, inside the inlets and at outlets. Inlets grates are absent, representing a safety hazard.

- Paving this section of the route should be considered in order to reduce the sediment sources in this area. Apparently, a drainage system (gutters, inlets, and outlets) was built in order to pave afterwards but paving was postponed.
- Routine drainage system maintenance should be performed in order to allow the proper stormwater flows.
- Vegetation should be managed on a regular basis, especially during the rainy season, and maintained at ground surface until a distance of at least 5 feet from the sides of gutters and a 5-foot radius around box inlets, in addition to 10 feet downstream of the outlet structures. Care should be taken not to disturb the soils during these activities.

Red Convoy Route Point 2 to 3

This crossing consists of a 48-inch pipe with concrete wingwalls, and headwalls at the inlet and outlet. Storm events related to Hurricane Maria (2017) seem to have compromised the integrity of the crossing. Approximately one third of the route's south side has collapsed forming a deep headcut. The eroded headcut is exposing the route's guard rail foundation, which is now hanging in the air, supported by its easternmost and westernmost bases. In addition, heavy erosion in this area is completely exposing the outlet's wingwalls and headwall. The crossing pipe is also exposed by erosion at the west wingwall. The outlet has no apron present and its scour is 4 feet deep. The outlet pipe is misaligned and its inside ring broken. Shrubs and trees are growing inside the channel at the outlet. Channel banks are eroded downstream of the outlet. Storm water coming from southern areas of these points seems to be conveying into the outlet zone in a way that the outlet drainage and flow are affected. The inlet pipe is also misaligned, and its inside ring is also broken. At both the inlet and outlet, the inside rims are broken and riprap material and gravel are settling and getting inside the pipe. Dense vegetation of the species *Sansevieria hyacinthoides* (mother-in-law's tongue) is growing at the inlet, creating a negative flow and representing an obstruction. No bank erosion is observed upstream of the inlet. Based on the condition of the crossing, if it fails, it can affect the PRARNG mission requirements.

- The area should be clearly marked as a hazardous zone while repairs are planned and performed.
- A licensed structural engineer should evaluate the structure to verify its integrity and stability. If the structure is to remain, repairs to the pipes and their realignment should be conducted. In addition, gabion and riprap should be installed at both sides of the outlet in order to protect it and to properly reestablish the lost portion of the route.
- Route guard rail should be repaired and reinstalled.
- Route drainage features (riprap, gutters, dips, inlets, and outlets) should be built at the sides of the route to keep surface flows off the inlet and outlet structures, thus avoiding erosion.
- Conveying drainage water at the outlet area should be realigned to promote a positive flow.
- Vegetation should be managed on a regular basis, especially during the rainy season, and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures. Care should be taken not to disturb the soils during these activities.

Red Convoy Route Point 4

The 2013 survey reported severe erosion occurring on the outlet's west bank, in addition to the presence of the inlet being an open box culvert. The structure could not be found and is probably buried under soil mounds created during road grading after route sedimentation. Also, vegetation is growing over the soil mounds. At this point, some sections of the gutter are broken, probably as a result of grading activities. In addition, in some sections, the route is at a lower elevation than the gutters, allowing runoff to go through the route.

- This area may need partial reconstruction due to buried structures (inlet/outlet) and broken gutters. Route elevation should be higher than gutters in order for them to properly direct water off the route; paving the section should be considered.

- Routine drainage system maintenance should be conducted in order to allow proper stormwater flow.
- Vegetation should be managed on a regular basis, especially during the rainy season, and maintained at ground surface up to a distance of at least 5 feet from the sides of gutters, and a 5-foot radius around box inlets, in addition to 10 feet downstream of the outlet structures. Care should be taken not to disturb the soils during these activities.

Red Convoy Route Point 4A

The outlet is clogged reducing its capacity by 90 percent This segment of the route has a built drainage system (gutter, inlets, and outlets) that need maintenance and probably repairs. Gravel and sediments have migrated into the drainage system causing sedimentation, obstruction and partial clogging at gutters, and probably other inlets and outlets. In addition, vegetation has grown over gutters, inside the inlets and at outlets.

- Paving this section of the route should be considered in order to reduce sediment sources in the area. Apparently, a drainage system (gutters, inlets, and outlets) was built in order to pave afterwards, but paving was postponed.
- Routine drainage system maintenance should be conducted in order to allow proper stormwater flow.
- Vegetation should be managed on a regular basis, especially during the rainy season, and maintained at ground surface up to a distance of at least 5 feet from the sides of gutters, and a 5-foot radius around box inlets, in addition to 10 feet downstream of the outlet structures. Care should be taken not to disturb the soils during these activities.

Red Convoy Route Point 5

At this point, the box inlet is 95 percent clogged, causing water accumulation on the route. The outlet structure failed because of erosion that caused a deep headcut. The outlet wall foundation collapsed, and a segment of the outlet pipe is over the stream. Erosion exposed an old corrugated pipe, probably from the old crossing. This condition is encroaching the route and represents a safety hazard.

- The area should be clearly marked as a hazardous zone while repairs are planned and performed.
- A licensed structural engineer should evaluate the structure’s hydraulic capacity, and the integrity and stability of the not failed sections. Reconstruction with a higher capacity structure may be needed.
- If the structure is to remain, repairs to the outlet pipes, and reconstruction of the outlet walls should be conducted. In addition, gabion and riprap should be installed at both sides of the outlet in order to protect it and to properly reestablish the lost portion of the route. A route guard rail should be installed.
- Route drainage features (riprap, gutters, dips, inlets, and outlets) should be built to the sides of the route to keep surface flows off the outlet structure, thus avoiding erosion.
- Vegetation should be managed on a regular basis, especially during the rainy season, and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures. Care should be taken not to disturb the soils during these activities.

Red Convoy Route Point 6

Heavy erosion to the sides of the outlet is creating a deep headcut and compromising the shoulder of the route. The headcut is covered by vegetation and represents a safety hazard. The outlet corrugated pipe is damaged and is extending beyond the outlet walls. The inlet is probably covered with sediments and vegetation, but could not be observed.

- The area should be clearly marked as a hazardous zone while repairs are planned and performed.
- A licensed structural engineer should evaluate the structure to verify its hydraulic capacity, integrity, and stability. If the structure is to remain, repairs to the outlet pipe should be conducted. In addition, gabion and riprap should be installed at both sides of the outlet in order to protect it and to properly reestablish the lost shoulders of the route. Riprap material should be placed at the bottom of the stream bed to create an apron at the outlet. A route guard rail should be installed.
- Route drainage features (riprap, gutters, dips, inlets, and outlets) should be built to the sides of the route to keep surface flows off the outlet structure, thus avoiding erosion.

Red Convoy Route Point 7

The inlet's box frame is broken, lacking a grate, and clogged with sediment and vegetation reducing capacity by 90 percenty. Its feeding ditch or gutter is missing or buried under sediment. Erosion is present at both sides of the outlet wingwalls. Vegetation is obstructing the inlet and outlet.

- The inlet should be repaired, and a grate should be installed.
- Route drainage features (riprap, gutters, dips, inlets, and outlets) should be built to the sides of the route to keep surface flows off the inlet and outlet structure, thus avoiding erosion.
- Gabion and riprap should be installed at the sides of the outlet wingwalls to address erosion problems.
- Vegetation should be managed on a regular basis, especially during the rainy season, and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures. Care should be taken not to disturb the soils during these activities.

Red Convoy Route Point 8

The inlet is clogged with sediment, debris, branches and vines. This crossing is a 48-inch CMP which has no walls at the outlet but instead a concrete pipe was installed inside it as an extension. A route shoulder landslide is present at the inlet. This landslide is encroaching the route. Vegetation is encroaching the pipe and covering view of the inlet and outlet, presumably impeding flow.

- The inlet should be cleared and unclogged.
- Wingwalls and a headwall should be built at the outlet around the CMP. The concrete pipe should be replaced by an outlet structure. A rail guard is needed at the outlet side of the route. Gabions and riprap should be installed to address the landslide and headcut problem.

- Route drainage features (riprap, gutters, dips, inlets, and outlets) should be built to the sides of the route to keep surface flows off the inlet and outlet structure, thus avoiding erosion.
- Vegetation should be managed on a regular basis, especially during the rainy season, and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures. Care should be taken not to disturb the soils during these activities.

Red Convoy Route Point 8A to 8B

A gully is present through a steep incline on the east side of the route causing erosion and sedimentation. Rills are present along the route.

- The route should be graded to be outsloped. Deposit of well-graded aggregate and hardening should be performed. Riprap material should be used at focal areas.
- Local drainage features (gutters, dips, water bars, inlets, and outlets) should be built to keep surface flows off the route and from draining through it, thus avoiding erosion.

Red Convoy Route Point 9

Evidence of water shedding in this route point is suggested by the presence of moist soils with dryness shrink cracks. The area is sedimented. This is a low laying area in the route, which collects runoff from an adjacent hill to the east, before reaching a draining ditch or stream to the west.

- The route should be graded to be outsloped. Deposit of well-graded aggregate and hardening should be performed. Riprap material should be used at focal areas.
- Local drainage features (gutters, dips, water bars, inlets, and outlets) should be built to keep surface flows off the route and from draining through it, thus avoiding erosion.

Red Convoy Route Point 10

No issues or concerns are observed.

Red Convoy Route Point 10A

This point is a concrete culvert consisting of a pipe 48 inches in diameter and 40 feet long. Erosion issues are present at the north inlet's wingwall. Also, vegetative debris and overgrown vegetation (tree trunks and branches) are partially obstructing the inlet and outlet.

- Gabion or riprap should be installed at the eroded inlet wingwall.
- Vegetation should be managed on a regular basis, especially during the rainy season, and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures. Care should be taken not to disturb the soils during these activities.

Red Convoy Route Point 11

This is a reference point at the route intersection with Road PR-154. No issues or concerns are observed.

Red Convoy Route Point 11A

No issues or concerns are observed.

Red Convoy Route Point 12

This point at the route is a crossing of road PR-154 over Quebrada Honda, known as Romero Bridge. It consists of two, 22-feet in diameter structural plate metal pipes. During the 2019 survey, one of the barriers was out of place, probably temporarily moved for maintenance activities. Sedimentation and vegetation are present at both the inlet and outlet aprons.

- Upstream and downstream concrete aprons should be maintained free of vegetation.
- Concrete barriers should be re-installed. Vehicle operations within the stream channel and riparian area should be restricted and enforced.
- Vegetation should be managed on a regular basis, especially during the rainy season, and maintained at ground surface for at least an additional 50 feet upstream and downstream of the inlet and outlet structures. Care should be taken not to disturb the soils during these activities.

Red Convoy Route Point 13

The crossing consists of double barrel, 60-inch concrete pipes 80 feet in length. The brick headwall at the outlet west wing wall is missing; erosion is present at this point. The outlet apron is cracked and with an undercut caused by erosion at its foundation; scour is 1 foot. Erosion is present at the inlet apron, exposing part of its foundation. Debris and overgrown vegetation are present at both the inlet and outlet. The upstream and downstream channels appear to be stable.

- Riprap should be installed and hardening of eroded areas should be performed.
- Missing headwall at wingwall should be reinstalled.
- Vegetation should be managed on a regular basis, especially during the rainy season, and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures. Care should be taken not to disturb the soils during these activities.

Red Convoy Route Point 14

The drainage crossing consists of a triple barrel system with 60-inch in diameter concrete pipes, the longest with a length of 80 feet. The outlet is collapsed and deposited in the downstream side of the crossing, creating a safety hazard. Dense vegetation is encroaching the outlet area and downstream channel. The inlet seems stable and receives flows from Point 13's drainage channel and from an airfield drain channel. The upstream channel appears to be stable. The outlet wingwalls and apron appears to have settled due to toe and base material erosion by the headcut. Scrap concrete from demolition projects is being used as bank protection. Apparently, the under erosion on the outlet side is causing the complete collapse of the structure and part of the route; stability of the route at this point is unknown. A rail guard was installed as protection and safety measure at this point. The entire outlet structure that extended into the downstream drainage area is collapsed. The wingwall on the inlet side appears to be stable; however, there is evidence of structural damage. The structure is not highly visible since vegetation growth obstructs the view.

- A hydrologic and hydraulic analysis should be performed to determine if the current's structure size is adequate, to design water diversions, and to designate the appropriate drainage structure.
- A licensed structural engineer should evaluate the structure to verify its integrity and stability.
- A section approximately 25 feet long and 10 feet high located at the south bank upstream of the inlet should be reshaped and stabilized with filter cloth and riprap.
- Debris and vegetation should be removed from the drainage system so that water can be directed in an appropriate direction.
- The north bank on the outlet side should be stabilized with gabion.
- All scrap concrete and construction debris being used as bank scour protection should be removed and replaced with riprap. This material is not appropriate or effective for bank protection and becomes a safety hazard when people and animals are walking in the area during high flow events.

Red Convoy Route Point 15

This point is a drainage crossing consisting of a single 60-inch concrete culvert approximately 56 feet long.

- Very little water is draining through this channel.
- Woody vegetation has established within the channel.
- It is likely, the water source for this drainage is being diverted by the berm at the airfield.
- The outlet wingwall is eroded, and the apron is observed to have approximately 1-foot of scour at the toe.

Flows diverted by the airfield berms that follow the airfield trail access to the Red Route, may have also followed the Red Route to this crossing and entered the downstream channel. The inlet pipe ring is broken, and there are cracks in the wingwalls.

- A hydrologic and hydraulic analysis should be performed to determine if the berms diverting water at the airfield should be removed. The broken inlet pipe ring and cracked wingwalls should be repaired.
- Vegetation should be managed on a regular basis, especially during the rainy season, and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures. Care should be taken not to disturb the soils during these activities.

Red Convoy Route Point 16

This crossing consists of two 60-inch diameter concrete pipes. The upstream channel appears to be stable, with defined banks, established vegetation, and no signs of backwater from the culverts. The inlet headwall is cracked. The downstream channel is severely eroded with a headcut at the northern bank, just at the outlet area. This eroded headcut is approximately 20 feet deep and extends approximately 60 feet downstream. Overgrown vegetation is present at the outlet, aggravating bank erosion by diverting water into the bank.

- The inlet headwall should be repaired.

- The north bank on the outlet side should be reshaped and stabilized with filter cloth, gabion and riprap.
- The toe of the outlet apron and both downstream banks should be stabilized for a length of 30 feet with filter material and riprap.
- All concrete scrap and construction debris being used as bank and scour protection should be removed and replaced with riprap. This material is not appropriate or effective for bank protection and becomes a safety hazard when people and animals are walking in the area during high flow events.
- Vegetation should be managed on a regular basis, especially during the rainy season, and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures. Care should be taken not to disturb the soils during these activities.

Red Convoy Route Point 17

At this point, there is an access ramp crossing the Quebrada Honda from the airfield into a road leading to a building area near Point 1A. There is also a pedestrian hanging bridge at this location. Channel migration is eroding the east bank and encroaching on the Red Convoy Route. The top of the bank migration into the route is at a distance of approximately 10 feet of it. The bank was nearly vertical and measured approximately 30 feet in height. Bank erosion appears to be caused by natural channel migration processes. However, due to the extent of channel incision, the entire channel has likely degraded in the past. Old sewage drainpipes and outlets are observed at the channel just downstream of the site but appeared to be no longer active. Some of these structures have failed by erosion; some are hanging by steel rods and others are in the riverbed.

- If access ramps are intended to be used as the route to cross Rio Nigua, coordination with appropriate agencies should be made to acquire permits for the establishment of an appropriate crossing through the channel. Permanent crossing with hardened approaches may be required to minimize sediment introduction to the river.
- Concrete barriers should be installed if this will not be used as a vehicle approach area. Vehicle operations within the stream channel and riparian area should be restricted and enforced.
- Approximately 200 feet of gabions or riprap should be installed along the toe of the bank to prevent additional bank erosion. Gabions/riprap should be keyed into the channel bed and into the bank for a length of at least 10 feet more than that of the upstream and downstream ends of the erosion problem area and should extend approximately 10 feet high. The remaining bank should be sloped at a 1.5:1 ratio and stabilized by installing an erosion control mat, followed by planting erosion control vegetation, like *Chrysopogon zizanioides* (Vetiver).
- The edge of the drop-off should be clearly marked with a rail or concrete structure.
- Old sewage pipes and outlets should be removed from the stream bank and stream bed. Care should be taken not to disturb the soils during these activities.

Red Convoy Route Point 18

The drainage crossing consists of a 36-inch CMP with a concrete abutment and wingwall upstream and a failed concrete wingwall downstream. The downstream channel is severely eroded and a headcut from the main channel may have been responsible. The distance from the

route surface to the channel bottom is approximately 15 feet. The distance from the outlet pipe to the channel bottom is approximately 5 feet. Erosion appears to have been increasing. Vegetation has overgrown and obstructed the view of this structure.

- At the outlet, the crossing pipe should be extended 20 feet, and the outlet structure should be stabilized. The banks should be hardened with filter material and riprap, sloped at a 2:1 ratio, and re-vegetated.
- Vegetation should be managed on a regular basis, especially during the rainy season, and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures. Care should be taken not to disturb the soils during these activities.

Violet Convoy Route - Elimination of Sediment Sources

This native material route originates from the Brown Convoy Route, along the west side of Range 18, and heads northeast before heading north for a total route length of approximately 0.5 miles. The Violet Convoy Route provides access to the western portion of Training Area R, and direct access to Ranges 15A and 18. **Figure 8-9** shows the location of the Violet Convoy Route.

During field survey, the following points along the Violet Convoy Route where identified as specific areas of concern, interest, or reference:

Violet Convoy Route Point 10

This point is an unimproved and heavy sedimented stream crossing. The stream channel passes through Range 18 at this point. The upstream channel appears to be stable. Gullies and rills are forming at both stream approach areas and along this segment of the route.

- A permanent stream crossing with hardened approaches (riprap and filter material) should be installed to minimize sediment introduction to the stream.
- Vegetation should be managed on a regular basis, especially during the rainy season, and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures. Care should be taken not to disturb the soils during these activities.

Violet Convoy Route Point 10A

At this point, a series of rills and deep gullies, reaching up to 30 inches in depth, are present. Route undercut erosion is also present along a segment approximately 120 feet long.

- The route should be graded to be outsloped. Deposit of well-graded aggregate and hardening should be performed. Riprap material should be used at focal areas.
- Local drainage features (gutters, dips, water bars, inlets, and outlets) should be built to keep surface flows off the route and from draining through it, thus avoiding erosion.

Figure 8-9. Violet Convoy Route

Violet Convoy Route Point 11

This point is a crossing consisting of a double-barrel 21-inch CMP encased in concrete. Both inlet and outlet headwalls and wingwalls are broken, creating a safety hazard. The inlet is sedimented. At both the inlet and outlet vegetation is encroaching the structures.

- The pipes should be repaired or replaced.
- The area should be marked as a safety hazard while repairs are planned and implemented.
- Vegetation should be managed on a regular basis, especially during the rainy season, and maintained at ground surface for at least an additional 10 feet upstream and downstream of the inlet and outlet structures. Care should be taken not to disturb the soils during these activities.

Violet Convoy Route Point 12

This is a reference point for the Urban Assault Course training site. No issues or concerns are observed.

Violet Convoy Route Point 12A

A deep gully, approximately 3 feet deep and 240 feet long, is present along a previously reported borrow area next to the route. Erosion is present on the north side of the route at the uphill slope.

- Deposit of well-graded aggregate and hardening should be performed. Riprap material should be used at focal areas.
- Local drainage features (gutters, dips, water bars, inlets, and outlets) should be built to keep surface flows off the route and from draining through it, thus avoiding erosion.

Violet Convoy Route Point 13

At this point, the route crosses a heavily sedimented drainage channel. There is a broken 36-inch concrete pipe located in the downstream drainage system.

- Coordination with appropriate agencies should be made to acquire permits for the establishment of a route through the channel. Permanent crossing with hardened approaches may be required to minimize sediment introduction to the river.

8.12.2.6 Firing Range 22 Drainage Improvements

Firing Range 22 has an elevated firing line that is approximately 15 feet above natural ground elevation. There is an 18-inch diameter concrete culvert through the embankment to drain water that is impounded on the north side of the structure. Water from overland flows are impounded by the firing line and either drain through the culvert or flow around the east end of the structure. Impounded water has been over 2 feet deep on occasion. The existing culvert appears to be undersized to adequately drain water. Additionally, the culvert outlet is below elevation and water must develop head (back up) to drain. Due to the water impounding behind the firing line and flowing east, the drainage on the east side of Range 22 experiences higher flows.

It is recommended that the drainage culvert through the firing line embankment be upsized to drain incoming flows with minimal backwater. A drainage ditch should be constructed from the

outlet of the new culvert to the nearby natural drainage channel. The outlet channel may need to be hardened to prevent erosion of its bed or banks.

This initiative would be accomplished by PRARNG in partnership with the Forest Service and/or through a public works contract. The initiative is responsive the INRMP goals to maximize military training opportunities by eliminating lost training caused by impounded water within the firing lanes and to protect and improve water quality by reducing existing sediment sources.

8.12.2.7 Ammo Area Drainage Improvements

The Ammo Area appears to be lacking in sufficient drainage features due to the rill erosion observed from overland flows coming off of the Ammo Area south of the Red Convoy Route. Additionally, the recent channel maintenance of the drainage located just south of the Red Convoy Route rectified eroded banks. The Ammo Area disrupts the natural drainage pattern of numerous drainages. A field survey of the Ammo Area, corresponding drainage patterns, and upper watershed was not completed in this supplemental INRMP. Therefore, recommended planning level improvements are not provided. However, it is recommended that a detailed survey and analysis of the Ammo Area drainage patterns be completed to identify possible deficiencies and sediment sources.

This initiative would be accomplished by PRARNG in partnership with the Forest Service and/or through an MOU with local universities. The initiative would help identify and subsequently eliminate existing sediment sources and is responsive the INRMP goal to protect and improve water quality.

8.12.2.8 Eliminate Sediment Sources at the Camp Santiago Entrance Bridges

This initiative would be accomplished by PRARNG in partnership with the Forest Service and/or through a public works contract. The initiative is responsive the INRMP goals to protect and improve water quality and maintain and enhance riparian area and aquatic habitat by eliminating existing sediment sources.

8.12.2.9 Lower Entrance Bridge

The lower entrance bridge appears to have been designed as a low water crossing that is overtopped during high flow events. The bridge no longer serves as the primary entrance into the camp, though it remains an alternate access route. The concrete structure has experienced severe erosion at each end (or approaches) and all along the downstream toe. The northern approach has been eroded away.

The structure contributes sediment to river flows due to inadequate toe and bank protection. Due to this toe and bank erosion, the northern approach to the bridge has washed away, there is up to 10 feet of toe scour, and the southern approach has severe shoulder and bank erosion. These erosion problems are threatening the structural integrity of the crossing and the long-term sustainability of this alternate access route.

It is recommended that a detailed survey and design be initiated to evaluate opportunities to protect the toe and banks of the low water crossing and provide stability during high water events. Current measures to reduce scour and erosion and to protect the structure (e.g., utilizing undersized fill, construction waste and scrap concrete) are not appropriate or effective in protecting erodible material and becomes a safety concern when people and animals walk in the

area. Toe and bank protection may include extensive use of large diameter riprap and filter material.

8.12.2.10 Main Entrance Bridge

The main entrance bridge is experiencing erosion along the north bank and general scour around the piers. It appears that construction debris and concrete have been used to slow the rate of erosion.

Construction material is not appropriate or effective in protecting erodible material and becomes a safety concern when people and animals walk in the area. It is recommended that a detailed survey and design be initiated to evaluate opportunities to protect the toe and banks of the low water crossing and provide stability during high water events. Toe and bank protection may include extensive use of large diameter riprap and filter material. The pier scour may not be excessive and within the design considerations of the bridge, this can be determined during further analysis.

8.12.3 Expected Benefits from the Implementation of the Initiatives

The implementation of the water quality management initiatives summarized above is expected to protect and improve Camp Santiago natural resources values. Specifically, these initiatives respond to the INRMP goals to:

- Increase soldier safety and help maximize military training opportunities by eliminating existing and potential safety hazards associated with the convoy routes,
- Improve water quality by reducing sediment sources, and
- Improve riparian area and aquatic habitat.

In addition, the implementation of the INRMP management initiatives designed to protect and enhance forest vegetation and riparian area habitat (e.g. planting of seedlings), increase range fire suppression operations, and eliminate domestic animal encroachment onto Camp Santiago lands (i.e. boundary fencing) would help stabilize and protect the soil resource, thereby improving water quality by reducing erosion and sediment flow into stream channels.

Removal of livestock and off-road vehicles will reduce stream bank slumping and further promote the establishment of bank vegetation. Eliminating livestock and cross-country travel from sensitive soils will allow trails to heal over and reduce the amount and speed of water that they transport. These actions will have a large positive direct and indirect effect on channel health and associated dependent aquatic biota.

8.13 LAND REHABILITATION AND MAINTENANCE

The Land Rehabilitation and Maintenance (LRAM) program plans, designs, and executes land rehabilitation, maintenance, and reconfiguration projects based on requirements and priorities identified in the Training Requirements Integration (TRI) component of the ITAM program. The objective of the LRAM program is to sustain training lands to ensure their availability to support U.S. Armed Forces training and mission requirements indefinitely. This is accomplished through active management to repair degraded areas in a timely manner and to minimize future damage. As a primary link between environmental and training considerations, LRAM will integrate projects with related programs to maximize resources allocations.

Specific land rehabilitation (i.e. restoration and maintenance actions) initiatives are discussed in the previous sections of this chapter. **Table 8-1** provides a summary of initiatives to be implemented. **Figures 8-1, 8-2, 8-3,** and **8-12** provide maps of the initiatives.

8.14 SOIL RESOURCES MANAGEMENT

8.14.1 EXISTING CONDITION

Soils types and classifications found within Camp Santiago are described in **Chapter 6**.

Long-term use of the terrain for vehicle maneuvering, assembly operations, and weapons training has altered the vegetation across much of the area within the boundaries of Camp Santiago. Where trees and shrubs once existed, there are now mostly grasses and short brush with isolated islands of trees across approximately two thirds of the area. This has resulted in accelerated erosion, especially where mineral soil is exposed.

The most severe erosion problems are on the road systems, especially on steeper slopes. Years of rutting and runoff during intense rainstorms have washed away the roadbeds not only at stream crossings, but wherever water accumulates and runs. Much of the primary road system is now incised into the land's surface, resulting in stormwater running down the roads and further eroding the driving surfaces. Washouts at stream crossings are a regular occurrence.

Cattle have also changed the soil properties. Trailing along the hillsides is evident through much of the Camp. In some areas the cattle trails give the hillsides the appearance of terraces. These trenches catch rainwater that would otherwise move downslope and create small streams. Gullies are formed where these small streams intersect with road systems and this has severely impacted road access to some areas of the Camp.

Channel clearing activities, both for commercial gains and road maintenance, have led to a continuous state of erosion at stream crossings and within stream channels. Fine textured soils that are bladed into piles are easily eroded. When this occurs in or near streams, they are an immediate source of sediment at the onset of the next rain event. These are readily transported downhill, downstream, and into the harbors and bays.

8.14.2 MANAGEMENT INITIATIVES

Management initiatives that directly or indirectly provide protection and enhancement of soil productivity at Camp Santiago include:

- All of the initiatives described for riparian area management in **Section 8.6.3**.
- All of the initiatives described for forest vegetation management in **Section 8.4.3**.
- All of the initiatives described for water quality management in **Section 8.12**.
- Wildland fire suppression initiatives described in **Section 8.17.2**.
- Use of recommended federal and commonwealth Soil and Water Conservation Measures.
- Roads and livestock trails will be included in a sediment source survey and the findings displayed on a map and prioritized for mitigation. Prioritization can be based on a cost versus benefit analysis and on the value of affected environments, i.e., if water quality is being affected by soil erosion at a given site, it may have a higher priority than soil that is being eroded but never reaching an aquatic environment.

8.14.3 Expected Benefits

Implementation of soil and water conservation measures will greatly reduce the amount of soils that are disturbed during road maintenance and storm repairs.

The planting of seedlings in open grasslands will reduce erosion and allow areas to become re-vegetated by native place communities.

The elimination of livestock grazing, repair of drainage structures, and road maintenance to fix erosion and spot sediment sources will reduce soil displacement and compaction and allow a vegetative cover to re-establish. This will help maintain the nutrient balance and productivity of the soil profile.

Eliminating the extraction of gravel from along the Rio Nigua will allow floodplain vegetation to be rejuvenated and reduce erosion of topsoil during seasonal floods. Elimination or restriction of off-road vehicles along the river bottom would have a similar positive effect.

Increasing the emphasis on fire prevention and suppression will have a positive direct effect on the soil profile of the steeper hillsides. By reducing the spatial distribution, intensity, and size of fires caused by training operations and access, less surface soil will be eroded during seasonal storms, especially in areas of steep slopes and shallow soils.

These actions also have positive indirect effects off site. By allowing vegetation to re-establish a continuous cover, less soil will be moved off site during intense rainstorms.

As more emphasis is placed on integrated resource management, less soil will become exposed to conditions that would lead to erosion and compaction. As increased efforts are made to re-vegetate exposed soils in all projects, there will be long-term site productivity and reduced off-site impacts.

8.15 CANTONMENT AREA MANAGEMENT

The Cantonment Area at Camp Santiago contains an urban forest, producing direct ecological benefits to the facilities. Benefits include production of shade, reduction of noise and dust, increase of wildlife habitat and biological diversity, and landscape values for scenery and leisure time. It also includes environmental education values and the potential for developing vegetation awareness areas by introducing regional endemic species.

Maintenance of this type of forest requires a more intensive management dealing with species on a one-by-one basis. This setting would require pruning to protect structures, thinning to maintain scenery values, and a long-term growth analysis to avoid problems in the future regarding the compatibility of tree size, etc. with the existing facilities and the proposed general use of the area surrounding the tree.

This forest requires a yearly tree condition and hazard analysis survey in order to prevent accidents or damage to humans and property. The results of this survey can also be used to develop maintenance plans and schedules of work for the area.

8.16 PEST MANAGEMENT

Camp Santiago has a Pest Management Plan (August 1998) to guide actions for the control of pests. The fencing initiative will help pest management immensely. The primary pests of concern are free roaming dogs, feral cats, rats, and mice.

Rats are controlled in Cantonment Area buildings and are not considered a sanitation problem.

Dogs are commonly found in the Cantonment Area and may present a nuisance. More specifically, dogs can get into garbage creating an undesirable sanitation condition. Without any form of dog control, it becomes a matter of securing refuse such that it is unavailable to dogs. Intentional feeding of feral dogs must be avoided. The local animal control warden could handle the removal of free roaming dogs from Camp Santiago.

Lizards observed in buildings are not necessarily considered pests as they play a major role in insect control in and around residential structures.

8.16.1 MANAGEMENT INITIATIVES

Pest management practices include conducting annual monitoring for the mongoose (*Herpestes auropunctatus*), feral dogs (*Canis familiaris*), feral cats (*Felis domesticus*), and rats (*Rattus spp.*) at Camp Santiago. The monitoring protocol includes live trapping (20 live traps and 20 bait stations) for an estimated 40 days during each fiscal year. The findings from the monitoring would provide a population estimate and distribution of pests within Camp Santiago and would be used to correlate the number of human-species interactions.

8.16.2 EXPECTED BENEFITS

Exotic species populations are becoming a greater threat to all users at Camp Santiago. Health concerns have prompted CNF to implement monitoring of the following non-native species including feral dogs and cats, mongoose, and rats. There is a need for assistance from the USDA Animal and Plant Health Inspection Service (APHIS) to train present technicians in deploying live-traps and bait stations. Global Positioning System (GPS) data points will be collected to visualize the dispersion of exotics. Fauna monitoring will enable the rapid and consistent evaluation of biological resources within Camp Santiago throughout the planning session.

8.17 FIRE MANAGEMENT

8.17.1 EXISTING CONDITION

As areas burn on a yearly basis, there is an annual increase in acres of grassland habitat and a decrease in forested areas.

Fire disturbance is one of several factors that maintain the ecosystem at Camp Santiago as secondary dry forest and secondary thornshrub types of vegetation. A 1984 study on the flora of Camp Santiago indicated that there are few remnants of the original climax forest. Fire, grazing, and disturbance by vehicle travel have all been a part of the gradual conversion of the old forest to drier, more open grass.

The risks associated with fire will continue to be a part of the ecosystem; fire presents a risk to the facilities, adjacent landowners, and those who use the land. The ecosystem at Camp Santiago is at risk as it continues to convert from a forested area to a drier grass type of vegetation.

Camp Santiago and the surrounding communities are affected by wildland fires and associated smoke. The areas most directly affected are the drier grasslands that have repeatedly burned in the past. With the continual burning cycle, little opportunity exists for new trees to regenerate and grow in the burned over areas.

While most of the acres burned are in the dry grassy areas, there are several sites of secondary forest areas that have burned in the last year. Fire on these sites will continue to keep the areas from moving towards the original vegetation types that previously existed within Camp Santiago. Each time one of these areas burns, there is a significant time lost for the area to reach a mature climax forest.

8.17.2 Management Initiatives

8.17.2.1 Prescribed Burning

At this time, prescribed burning is not proposed. A more detailed fire prevention and fire suppression plan would work to keep fire out of forested habitats where fires are damaging the forest ecosystems.

8.17.2.2 Fire Prevention and Suppression

Fire prevention is the best way to reduce fire starts within Camp Santiago. Almost all fires are caused by human activities such as debris burning, cigarettes, and activities associated with individual and crew-served weapons training. Fire prevention initiatives detailed in the Camp Santiago INRMP include the establishment of a permanent weather station at Camp Santiago. This is the preferred method for identifying the days and specific times of the days that hold a higher potential for new fire starts. Scheduling of different training activities could also be used to reduce the potential for wildfire starts. Activities that have a high potential to start fires could be scheduled during the rainy season and activities with a low potential to start fires could occur during times of high fire danger.

Fire Suppression

All fires that start within the forested environment must be suppressed. The best way to avoid a fire start is through proper prevention during periods of high fire danger. The Camp Santiago Operating Plan describes the process for shutting down operations and extinguishing fires immediately on Ranges 22 and 27 as well as Training Areas N, M, and L. In the current Operating Plan, the Company that is using the area is responsible for extinguishing any fires that start in an area in which they are training.

When fires occur in the forested areas, it would be advantageous for Camp Santiago to have its own wildfire engine and group of trained firefighters that would respond to the fires in these areas. Fire suppression initiatives included in the Camp Santiago INRMP are:

- Acquisition of Two 1-Ton Wildland Fire Trucks - To meet National Wildland Fire Standards, each truck is to be equipped with 200 to 400 gallon water tanks, pumps with a minimum capacity of 50 gallons per minute, 300 feet of 114-inch hose, 300 feet of 1-inch hose, and

6 hand-tools per truck. Each truck is to be staffed with three qualified firefighters (see **Figure 8-11**).

- Development and Maintenance of Fuelbreaks Around All New Plantations at Camp Santiago - These fuelbreaks would include the removal of all fuels and vegetation covering a 5-foot wide zone, at a minimum, along the area to be protected. It would be beneficial for Camp Santiago to have its own wildland fire engine and crew of wildland firefighters to assure that any new fire will be contained prior to reaching the plantation.

Proposed fuelbreaks would use the lateral prism of existing roads, and extent 10 to 15 feet on each side with a fuel-free or reduced fuel area. These reduced fuel zones could be mowed and maintained with conventional mechanized machinery from the road and would create a fuelbreak, in conjunction with the existing road width of 40 to 50 inches. During a fire event, a wet line would be created by an engine, sprinkler system, and/or other method on one or both sides of the road, creating an effective fuelbreak. Wet lines can be used anywhere the savannah grass fuel exists and are generally effective for approximately one hour.

Fuelbreaks Adjacent to Plantations

The proposed construction of 300 meters of fuelbreaks along existing and proposed plantations would enable initial attack forces to rapidly deploy along pre-determined containment lines. It is recommended that fuelbreaks on existing plantations be constructed first.

As described above, these fuelbreaks may not stop fire in the average worst case scenario without fire personnel and equipment to support them. They would, however, function as anchor points for prescribed fire treatments if prescribed fire were to become an available tool for fuel maintenance and reduction within Camp Santiago. Fuelbreaks would be most effective if proposed hydrants are integrated along proposed locations. These hydrants would also be used in plantation maintenance.

Fuelbreaks Adjacent to Ranges

It is recommended to assess the need and feasibility of the construction of fuelbreaks adjacent to firing ranges in order to contain potential wildland fire events.

Fuelbreaks around existing and proposed ranges would enable initial attack forces to rapidly deploy along predetermined containment lines. These fuelbreaks may not stop fire in the average worst case scenario without fire personnel and equipment to support them. These fuelbreaks would be most effective if proposed hydrants are integrated along proposed locations.

It is recommended that hydrants, or other portable sources of water (such as porta-tanks), be available at all ranges during fire season for rapid response and refill capability in the event of a fire in the vicinity of the range. It is also recommended that this strategy be incorporated into all training plans that occur during fire season.

Fuelbreaks Adjacent to the Ammo Area

It is recommended to access the need and feasibility of the construction of fuelbreaks adjacent to the Ammo Area in order to protect the facility from a potential range fire.

Sprinklers

It is recommended to install a sprinkler system for use in suppressing fires. Sprinklers are an effective and economical method of creating wet lines in advance of a wildland fire event and have been proven to work well with the fuel type common at Camp Santiago. These systems may be as simple as sprinkler heads fabricated onto a standpipe of suitable height, separated by an appropriate distance of sufficient diameter hose, or hard line connected to an adequate water source.

These systems can be installed prior to fire season adjacent to high value resources, such as a tree plantation, and left in place. They are then charged during a fire event and can be left alone or serve as a safe zone for personnel or equipment during the fire event. They should be tested throughout the season and maintained during the fire event. The domestic water capacity at Camp Santiago as well as the age and capacity of existing water storage tanks should be considered in order to adequately charge and sustain such a system.

Sprinklers can also be pre-loaded on a trailer or vehicle to be rapidly deployed in the event of a wildland fire. These units can be purchased or fabricated by on-site personnel.

Portable Water Sources

It is recommended to acquire portable water source devices for use during the initial attack of a wildland fire. Portable water sources, such as folda-tanks, can be prepositioned on site for use in refilling engines and backpack pumps. It is recommended that in lieu of, or in addition to, hydrants at each firing range, a source of water is made available at strategic points for rapid response to wildland fire. A larger porta tank, or pumpkin, either pre-positioned or brought to the fire site, would allow for helicopter dip operations and initial attack ability into rough terrain not accessible by vehicles.

Other Equipment / Supplies

It is recommended to acquire other equipment and supplies for use in fire suppression activities including the following:

- No-Mex Clothing – All wildland firefighters are required to wear approved fire-resistant clothing and fire shelters. Camp Santiago should have an adequate inventory of approved firefighting clothing, gloves, hardhats, fire shelters, etc. for all qualified personnel.
- Fire Hose – Camp Santiago's fire cache should have an adequate supply of wildland fire hose in increments of ¾ inches, 1 inch and 1½ inches. Thread specifications should be considered if it is likely that other hose, with dissimilar thread, would be connected. Appropriate valves, nozzles, and connectors should also be considered.
- Belt Weather Kits – These portable weather kits allow on site weather information, such as ambient temperature, relative humidity, and wind speed, to be readily available. There are also small digital instruments capable of retrieving and storing this data.

Hydrant(s) and Hydrant Lines

It is recommended to install additional hydrant and hydrant lines. This initiative would provide better on-site water sources to assist in an initial attack during range fire suppression operations. This additional water source would also provide support for the maintenance of the Camp Santiago plantations.

Other Alternative Fuel Reduction Methods

It is recommended to assess the effectiveness of alternative fuel reduction methods including:

- Grazing – Evidence indicates that part of the reason there is more wildland fire incidence is the cessation of grazing at Camp Santiago. Range cattle consume fine fuels which, when cured during fire season, are the main component of wildland fire spread at Camp Santiago. Selected areas could be fenced, either electrically or barbed, and allowed to be grazed, reducing hazardous fuels. Effective management of grazing activities would ensure that grazing does not destabilize soils.
- Herbicide – Herbicides, when applied properly and during the right time of the year, are also effective at reducing fine fuel accumulation.

Other Initiatives

It is recommended to continue to develop and maintain weather and wildfire data in the geographic information system (GIS) database and other formats, such as excel spreadsheet, to enable users to query historical data.

Permanent vegetation response plots should be established in all burned areas over 10 acres (as per recommendation of USFWS letter dated June 19, 2001) to measure post-fire plant succession.

Additional surveys should be conducted in the area in order to provide further documentation of the areas of flora.

Fire suppression training is recommended. All firefighters on federal lands, or under the auspices of a federal agency, need to be qualified under the National Fire Training Qualifications System. Some of the basic courses every firefighter must have are:

- S-260 Fire Business Management,
- S-131 Advanced Firefighter,
- S-132 Standards for Survival,
- S-133 Look up, Look down,
- I-200 Intro to ICS,
- S-215 Urban Interface,
- S-234 Ignition Operations, and
- S-290 Fire Behavior.

These courses could be taught by a small cadre of trainers. For example, these courses are taught, along with many others, at the training academy on the Flathead National Forest every year for minimal cost per student. To keep costs down, materials are produced in-house and government facilities are used. It is recommended to establish a Fire Danger Rating (FDR) System at Camp Santiago to be monitored and implemented by a qualified individual during fire season. According to weather data, fires burn readily during fire season when the following conditions occur:

Temperature	>65°
RH	<60%
Wind	>12 mph
Wind Gusts	>20 mph

It is recommended that an FDR of "HIGH" be implemented when the above parameters are reached or forecasted. Wind is the driving factor for most fires at Camp Santiago. When wind gusts are forecasted at greater than 20 mph, a "Red Flag" alert should be issued. This strategy needs to be coordinated with the Bomberos de Estatal and other adjacent cooperators and posted at central places within Camp Santiago and the surrounding communities. Training managers at Camp Santiago need to determine what activities are appropriate, if any, and in what locations they are appropriate when fire danger is "HIGH".

8.17.2.3 Expected Benefits

Camp Santiago currently has an Operating Plan for fire prevention and suppression, though this alternative would add a wildland fire suppression organization to their existing plan and ensure trained personnel were responsible for fire suppression.

There would be a better chance of extinguishing wildland fires while they are small, which would lessen the risk of fire encroachment into forested areas, plantations, and riparian areas. Over time, there would be an overall increase in acres of secondary forest types and a decrease in acres of grassland types.

Fuelbreaks will prevent fires from burning into the plantation areas.

The threat from wildfire to facilities at Camp Santiago and to the local community will be reduced.

The amount of lost training time due to disruptions caused by wildland fires would be reduced.

8.18 SPECIAL INTEREST AREA PROTECTION

8.18.1 UPLAND FOREST VEGETATION AND RIPARIAN AREAS

Training Areas M and L include valuable forest habitat for wildlife. Riparian areas along watercourses in other areas provide special values for wildlife and habitat diversity. The emphasis on protecting these areas from deforestation allows forest succession to expand. In the case of stream course riparian areas, it is desirable to have wide forest tree cover.

The fire management and fencing initiatives are the most effective tools for protecting and allowing succession of forest growth. These initiatives integrate the need for protecting forested wildlife habitats to the extent feasible with conducting training operations. Streamside and river improvements with reforestation and other plantings will be compatible with wildlife habitat needs.

Training exercises that integrate operations for limiting physical impacts to the forest vegetation and streamside vegetation during maneuvers, bivouacs, and firings would meet the needs for wildlife habitat protection.

8.19 OUTDOOR RECREATION

8.19.1 MILITARY MISSION CONSIDERATIONS

Recreation activities are prohibited in the Impact Area. Other designated areas, such as the ASP, are designated as off limits or restricted. Range control may also close active training areas for public use. The installation can be closed at the discretion of the Installation Commander when deemed necessary.

8.19.2 PUBLIC ACCESS

The public is only allowed access for recreation purposes within the Cantonment Area where activities are limited to social events for Camp Santiago users, their families, and local civic groups such as the Girl/Boy Scouts.

Civilians trespass onto the training facility for purposes of recreation.

8.19.3 HUNTING, FISHING AND TRAPPING PROGRAMS

There is no hunting, trapping, or fishing allowed at Camp Santiago.

8.19.4 RECREATION AND ECOSYSTEM MANAGEMENT

Human uses and their social needs are an integral part of ecosystem management. The outdoor recreation program is based on providing quality experiences while sustaining ecosystem integrity. Special considerations will be given to protecting critical areas (e.g., cultural resource sites) from negative impacts due to outdoor recreation.

8.20 TRAINING REQUIREMENTS INTEGRATION

An RCMP for Camp Santiago is currently being prepared through coordination between PRARNG, U.S. Army Engineering and Support Center, and Nakata Planning Group, LLC. A preliminary draft of this RTLP was published in August 2000.

The ITAM program is currently being developed for Camp Santiago. The TRI component of the ITAM program will identify Camp Santiago's training requirements and determine the areas that can best support various training activities. TRI is a major land protection phase of ITAM. It uses information from the Land Condition Trend Analysis (LCTA) and GIS to determine viable training load carrying capacities and to locate military training exercises accordingly. Load carrying capacity considers the status of the natural and cultural environment of training areas at the time the training events take place.

8.21 OBJECTIVES

The objectives of the inventory and monitoring initiatives are to:

- Document the existing condition of natural resources at Camp Santiago;
- Determine the effectiveness of the INRMP initiatives to protect, restore, and enhance natural resources;

- Monitor changes and predict trends for natural resources; and
- Identify additional management actions that are required for the protection and preservation of natural resources.

8.22 GENERAL

This chapter describes the inventory and monitoring initiatives that are required to make determinations about the effectiveness of the Camp Santiago INRMP. Natural resources to be inventoried and monitored include flora, fauna, and water quality. Additionally, weather data and information on wildland fire starts will be gathered.

The inventory and monitoring protocols provided for each resource to be evaluated include:

What	Specifically, what is to be monitored.
When	The area or location where the inventory and monitoring will be conducted.
Where	The timeframes and/or frequency of the inventory and monitoring.
Why	The purpose for conducting the inventory and monitoring.
Expected Results and Uses	Describes how the inventory/monitoring information will be used.

The inventory/monitoring protocols provided do not include:

How	The methods used to conduct the inventory and monitoring.
Who	Organization/individuals who will conduct the inventory and monitoring.

The *"how"* and *"who"* of the inventory and monitoring protocols must be developed through a collaborative effort with partners who have expressed interest in participating with PRARNG in the Camp Santiago INRMP inventory and monitoring including:

- University of Puerto Rico (Ponce),
- Puerto Rico Department of Natural Resources and Environment,
- USDA Forest Service, Caribbean National Forest,
- USDA National Resources Conservation Service,
- U.S. Fish and Wildlife Service, and
- U.S. Geological Service.

The ITAM for Camp Santiago includes a LCTA program which includes monitoring of Camp Santiago usage, potential usage, and trends. The results of the LCTA will provide useful information in evaluating the results of the INRMP inventories and monitoring projects.

8.23 FLORA INVENTORY AND MONITORING

Flora inventory and monitoring initiatives include:

- Vegetation cover monitoring surveys of all Camp Santiago lands on a five-year cycle to determine overall forest recovery within areas currently dominated by invasive grasses. The surveys will also allow continual assessments of vegetation conditions and wildlife habitat and assist in predicting trends. This inventory meets the intent of AR 200-1 to complete an inventory of all of Camp Santiago on a ten-year cycle.

- Monitoring the effectiveness of the forest and riparian planting initiatives and to determine if additional planting or thinning is required. These inventories are to be conducted yearly for five years from the date of the planting.
- Bi-annual inventory of urban forest conditions to identify safety hazards and monitor overall forest health.

8.24 FAUNA INVENTORY AND MONITORING

Fauna inventory and monitoring initiatives include:

- Bird Surveys - Bird surveys will be conducted to determine the presence of threatened or endangered species and neo-tropical migratory birds and to monitor the local resident bird community. Depending on available funding, these surveys are to be conducted on either a one-, three- or five-year cycle. Annual monitoring for the occurrence of the black-faced grassquit (*Tiaris bicolor*) will be conducted at Camp Santiago. The monitoring protocol includes evening 50-meter bird call point counts conducted for three days during late spring. The findings from this monitoring will provide information on native bird species composition, assist in predicting trends, and help to evaluate the effectiveness of management initiatives designed to protect and improve forest and riparian area habitat values.
- Native Aquatic Species Monitoring - Annual monitoring of populations of river point counts will be conducted for three days during late spring. Monitoring of shrimp (*Atya lanipes*), rosy barb (*Barbus conchonius*), and tilapia (*Tilapia mossambica*) in the Rio Nigua will be conducted during the wet season (August - September) and include electrofishing at long-term reaches. The findings from this monitoring will provide a long-term data of the river's native aquatic species composition, assist in predicting trends, and help in evaluating the effectiveness of management initiatives designed to protect and improve water quality and aquatic habitat values.
- Native Amphibian Species Monitoring - Annual monitoring of populations of the common coqui (*Eleutheryldactyl us coqu*) will be conducted for three nights during late spring and include evening 50-meter coqui call point counts. The findings from this monitoring will provide a long-term data of the occurrence of native amphibians (coqui and possible species presence) at Camp Santiago, assist in predicting trends, and help in evaluating the effectiveness of management initiatives designed to protect and improve forest and riparian area habitat values.
- Pest Monitoring - Annual monitoring of populations of mongoose (*Herpestes auropunctatus*), feral dogs (*Canis familiaris*), feral cats (*Felis domesticus*), and rats (*Rattus spp*) will be conducted at Camp Santiago. The monitoring protocol includes live trapping (20 live traps and 20 bait stations) for an estimated 40 days during each fiscal year. After trapping, captured animals are sent to a refuge. The findings from the monitoring will provide a population estimate and distribution of pests within Camp Santiago and will be used to correlate the number of human-species interactions.

8.25 WATER QUALITY MONITORING

Water quality monitoring initiatives include:

- Conducting sediment source surveys on roads to determine effectiveness of road drainage structures and to identify sites where structures need to be added and/or improved. These surveys are to be conducted annually and after any severe tropical storm.
- Conducting stream channel surveys to determine the effectiveness of stream channel and riparian restoration initiatives. These surveys are to be conducted twice annually, once during the expected high stream flow in October and once during the expected low stream flow in February.
- Establishing permanent stream cross-sections above and below areas where gravel is currently being extracted or is planned to be extracted from areas in or adjacent to stream channels. Monitoring of the cross-sections will identify major shifts in stream channel stability, water quality, and impact on riparian habitat and associated wildlife and aquatic species. These surveys are to be conducted twice annually, once during the expected high stream flow in October and once during the expected low stream flow in February.

8.26 WILDLAND FIRE MONITORING

Wildland fire monitoring initiatives include:

- Establishing and maintaining a database to record all fire starts by cause, size, location, temperature, relative humidity, and wind speed. This monitoring will provide a means for predicting hazard level of potential fire ignitions and predict fire behavior trends.
- Establishing a remote automated weather station to monitor daily weather conditions.

8.27 DATA STORAGE, RETRIEVAL, AND ANALYSIS

Survey data will be stored in GIS format and referenced in GPS, as possible, with applicable points, lines, and polygons. Existing paper files of survey information should be converted to GIS format. Digital orthophotos, digital raster graphic maps, and digital photo images will be used to reference actual Camp Santiago vegetation conditions to compare with future conditions.

The data collected through the inventory and monitoring plan will be kept at Camp Santiago. This information will be made available, upon request, to interagency resource specialists who would assist the Camp Santiago commander in the managing Camp Santiago natural resources in the future.

8.28 INVENTORY AND MONITORING PLAN

Tables 8-2 to **8-5** below provide a summary of the INRMP inventory and monitoring initiatives.

Table 8-2. Five-Year Inventory and Monitoring Plan (2021-2025 INRMP for Camp Santiago) Flora Resources

What	How	Where	When/ Duration	Why	Who	Expected Results and Uses
Vegetation Cover Surveys	Re-measurement of permanent plot clusters and walk-through inventories.	All Camp Santiago lands	Conducted once during each 5-year cycle starting in 2006. May need to complete a portion (20%) each year.	To determine overall forest recovery within areas currently dominated by invasive grasses. Provide for periodic assessments of vegetation conditions and wildlife habitat.	Puerto Rico Army National Guard (PRARNG) and partnership with local universities and/or other government agencies	Evaluate the effectiveness of initiatives designed to protect and enhance forest and riparian vegetation and wildlife habitat. Document changes and predict trends.
Plantation Surveys	Survey methods to be determined (TBD).	Within plantations	Conducted yearly	To assess seedling survival rates and to determine if additional planting or thinning is required. Document changes and predict trends.	PRARNG and partnership with local universities and/or other government agencies	Evaluate the effectiveness of the plantations (site preparation & planting methods and irrigation systems); verify that the planting stock used adapted to the site; determine if additional areas should be planted.
Urban Forest Conditions	Walk through	Cantonment Area and adjacent to roads and convoy routes	Conducted yearly	To identify and eliminate safety hazards and to monitor overall urban forest health.	PRARNG and partnership with local universities and/or other government agencies	Identify and eliminate safety hazards. Determine the effectiveness urban plantations.

Table 8-3. Five-Year Inventory and Monitoring Plan (2021-2025 INRMP for Camp Santiago) Fauna Resources

What	How	Where	When/ Duration	Why	Who	Expected Results and Uses
Bird surveys to document presence of threatened or endangered species; neo-tropical migratory bird community	To be determined (TBD)	Selected points at Camp Santiago points TBD	December through breeding season of native species. Depending on availability of funding, conduct, yearly, 3-year, or 5-year cycle surveys.	Determine the bird presence and usage of the Camp Santiago forest and riparian habitat. Establish baseline for future comparison and analysis.	Puerto Rico Army National Guard (PRARNG) and partnership with others (TBD).	Compliance with Endangered Species Act and to conduct further dialogue with U.S. Fish and Wildlife Service (USFWS) on future resource management of Camp Santiago. Surveys will provide base-line information to be used for future comparison analysis, INRMP revisions, and predicting trends.
Evening 50-meter bird call point counts	Selected points at Camp Santiago points TBD	During three days within the late spring timeframe.	Provide information native bird species composition.		PRARNG and partnership with others (TBD)	Provide long-term data of the river's native aquatic species composition. Assist in predicting trends. Help in evaluating the effectiveness of management initiatives designed to protect and improve forest and riparian area habitat values.
Bat surveys (Pallas' Mastiff bat [*Molossus molossus*])	Monitoring bat boxes for occupation; bat	Bat box locations	Monthly evening bat netting during three nights during the	Provide information on bat population	PRARNG and partnership with others (TBD)	Assist in predicting trends and in evaluating the effectiveness of

What	How	Where	When/ Duration	Why	Who	Expected Results and Uses
	population monitoring	Location points TBD	summer timeframe	and occurrence.		management initiatives designed to maintain and improve wildlife habitat.
Native aquatic species monitoring emphasis on the river shrimp (*Atya lanipes*), rosy barb (*Barbus conchonius*), and Tilapia (*Tilapia mossambica*).	Electrofishing at long-term reaches	Selected sites along the Rio Nigua (locations TBD)	Annually during the wet season (Aug-Sep)	Provide information on native aquatic species population and occurrence.	PRARNG and partnership with others (TBD)	Provide long-term data of the river's native aquatic species composition. Assist in predicting trends. Help in evaluating the effectiveness of management initiatives designed to protect and improve water quality and aquatic habitat values.
Native amphibian species monitoring emphasis on the common coqui (*Eleutheryldactyt us coqu*).	Establishment of 50-meter coqui call point counts	Selected sites (locations TBD)	Annually during three nights during the late spring timeframe	Provide information on native amphibian species population and occurrence	PRARNG and partnership with others (TBD)	Provide long-term data of the occurrence of native amphibians. Assist in predicting trends. Help in evaluating the effectiveness of management initiatives designed to protect and improve water quality and aquatic habitat values.

What	How	Where	When/ Duration	Why	Who	Expected Results and Uses
Pest Monitoring emphasis on Mongoose (*Herpestes auropunctatus*), Feral Dogs (*Canis familiaris),* Feral Cats (*Felis domesticus*), and Rats (*Rattus spp*).	Live trapping (20 live trap and 20 bait stations)	Selected sites (locations TBD)	Annually during an estimated 40 days within each year	Provide information on pest population and occurrence	PRARNG and partnership with others (TBD) There is a need for the assistance from the USDA Animal Plant & Health Inspection Service (APHIS) to train present technicians in deploying livetraps and bait stations.	Findings from the monitoring would provide a population estimate and distribution of pests within Camp Santiago. Information within Camp Santiago would be used to correlate the number of human-species interactions.

Table 8-4. Five-Year Inventory and Monitoring Plan (2021-2025 INRMP for Camp Santiago) Water Quality Resources

What	How	Where	When/ Duration	Why	Who	Expected Results and Uses
Sediment source surveys	To be determined (TBD)	Camp Santiago road network, focus on improved roads	Conducted annually and after any severe tropical storm	Determine the effectiveness of road drainage designs. Identify sites where structures need to be added or improved to reduce erosion from roads.	Puerto Rico Army National Guard (PRARNG) and partnership with others (TBD)	Develop a prioritized listing of road drainage structure maintenance / repair projects. Improved road designs will eliminate sediment source and thereby improve water quality.
Stream channel stability surveys	TBD	All Camp Santiago stream channels	Conducted twice annually (October & February)	Determine current stream channel and stream bank conditions and to monitor changes over time. Monitor the establishment and growth of seedlings planted within the riparian areas.	PRARNG and partnership with others (TBD)	Determine effectiveness of INRMP initiatives to improve stream channel stability and restore/ enhance riparian vegetation.
Establish permanent stream cross sections	TBD	Above and below stream segments where gravel has been/is being extracted and where channel cleaning operations are routinely conducted.	Conducted twice annually (October & February)	Determine current conditions and establish baseline for future analysis. Monitor to identify changes in stream channel stability, water quality, and impact on riparian habitat and associated wildlife and aquatic species.	PRARNG and partnership with others (TBD)	The surveys are expected to show an obvious difference in the amount of channel shifting caused by extreme rain events at cross-sections established below the operations when compared to “reference sites” above the extraction sites. These differences will diminish in magnitude when extraction ceases and riparian areas are replanted with deeply rooted vegetation.

What	How	Where	When/ Duration	Why	Who	Expected Results and Uses
						Determine effectiveness of INRMP initiatives to improve stream channel stability and restore/ enhance riparian vegetation.

Table 8-5. Five-Year Inventory and Monitoring Plan (2021-2025 INRMP for the Camp Santiago) Range Fire Condition Monitoring

What	How	Where	When/ Duration	Why	Who	Expected Results and Uses
Maintain a remote automated weather station; record all fire starts by date, cause, size, location, and temperature, relative humidity, and wind speed.	TBD	Located near the Range Control building	Conducted year-round whenever weather data is needed particularly during the fire season	To determine current and forecasted fire danger rating	Puerto Rico Army National Guard (PRARNG) and U.S. Department of Agriculture (USDA) Forest Service	Consistent method of monitoring and forecasting fire weather data. Information can be used in cooperation with Bomberos de Estatal to determine wildland fire risk. Information can also be used to calibrate weapon systems and in the preparation of the commander's risk assessment.

9 ENFORCEMENT

9.1 NATURAL RESOURCES LAW ENFORCEMENT

A natural resources law enforcement program does not exist at Camp Santiago for the purpose of enforcing hunting and fishing activities as hunting and fishing is prohibited at Camp Santiago.

The Camp Santiago security program includes patrol of the Camp by military police, other designated military personnel, and local animal wardens. These patrols provide protection to natural resources by:

- Limiting civilian trespass and unauthorized extraction of commodities such as vegetation and minerals and the dumping of trash;
- Limiting the trespass of livestock and associated natural resource damage; and
- Limiting the presence of domestic pets and stray dogs and associated natural resource damage.

10 ENVIRONMENTAL AWARENESS

10.1 GENERAL

Camp Santiago's commanders have consistently placed an emphasis on sound land stewardship practices and promoting the protection of natural resources at Camp Santiago. Range Control is currently updating its 2000 Standing Operating Procedures.

Camp Santiago has an effective environmental awareness program in place. Therefore, it is not necessary to address the issue of environmental awareness.

10.2 OBJECTIVES

To protect natural resources, Camp Santiago's commanders have placed strong emphasis on promoting environmental education and awareness of the Camp Santiago users. The environmental awareness component of the ITAM Program provides a means to develop and conduct environmental awareness at Camp Santiago.

Environmental awareness is a people-oriented, educational, and consciousness-raising program to encourage environmental stewardship and responsible use of Camp Santiago natural resources. The purpose of environmental awareness is to prevent unnecessary damage to the environment and, in particular, training lands by providing information to all Camp Santiago users. It has a two-fold thrust, one for unit leaders and one for nonmilitary Camp Santiago users. Environmental awareness is designed to improve their understanding of the effects of their mission, training, and activities on the natural resources of Camp Santiago.

10.3 MILITARY PERSONNEL AND PUBLIC AWARENESS

Environmental awareness also serves to educate the public and gain their support by effectively communicating the nature of the military mission and level of success of natural resources management at Camp Santiago. When military users and the public are informed and educated about management practices, they tend to give their support rather than opposition to the practices.

PRARNG has an aggressive and progressive command climate in which existing and potential environmental stewardship conditions, issues, and constraints are fully integrated into all mission training support and installation planning activities.

The following vision statement for Camp Santiago by the training site commander reflects his emphasis on ecosystem management and good land stewardship:

> *"...to be clean, well-organized, free of vandalism, secure, respectful, available, warm, peaceful, and appealing to the senses".*

Goals for military personnel and public environmental awareness include:

- Develop and distribute to the Camp Santiago users range standard operating procedures and training bulletins that identify environmental requirements, considerations, and guidelines for military tenants using the facilities and resources. Develop other troop environmental awareness materials for use at Camp Santiago.

- Provide public service announcements and news releases to inform the public of events occurring at Camp Santiago.

11 NATIONAL ENVIRONMENTAL POLICY ACT

11.1 INTRODUCTION

32 CFR Part 651, Environmental Effects of Army Actions, implements NEPA, setting forth the Army's policies and responsibilities for the early integration of environmental considerations into planning and decision-making. The purpose of NEPA is to identify environmental problems and attempt to resolve them using planning at early stages of project development.

11.2 OBJECTIVES

The objectives for NEPA include:

- Identifying projects and activities on the installation that might impact natural resources,
- Working with project planners to resolve issues early in the planning process, and
- Ensuring that this INRMP is documented according to guidance in 32 CFR Part 651.

11.3 NEPA RESPONSIBILITIES AND IMPLEMENTATION

The Deputy Director of the Army National Guard Bureau is responsible for signing all Findings of No Significant Impact (FONSI) for Environmental Assessments (EA) prepared for ARNG actions across the country. The Camp Santiago commander is the responsible official for the NEPA supporting the implementation of the INRMP. The Adjudicate General (TAG) of PRARNG is directly responsible for ensuring coordination of INRMP initiatives between his environmental, training, and engineering staffs. The Environmental Engineer, ECA Environmental Manager, and Hazardous Waste Specialist are responsible for advising the Camp Santiago Facilities Manager Officer on the best ways to comply with federal and state environmental laws and regulations.

11.4 NEPA AND NATURAL RESOURCE MANAGEMENT

11.4.1 2001-2005 INRMP

In accordance with NEPA, an EA and FONSI support the 2001-2005 Camp Santiago INRMP.

Scoping and coordination associated with the preparation and review of the proposed action is described in Chapter 2 of the Final EA and scoping records are described in the Administrative Record, tabs C and D.

In accordance with the *Sikes Act*, the development of the EA supporting this INRMP was a cooperative effort with USFWS and the Puerto Rico Department of Natural Resources and Environment. Appendices A and E of the Final EA define the role of the natural resource specialists and other agencies respectively, who participated in the development of the 2001-2005 INRMP.

As required by the *Sikes Act*, PRARNG has completed a formal review of the 2001-2005 INRMP for Camp Santiago. This review was conducted in accordance with DoD memo dated November 01, 2004, from the Assistant Deputy Under Secretary of Defense (Environmental, Safety, and Occupational Health), Subject: *Implementation of the Sikes Act Improvement Amendments: Supplemental Guidance concerning INRMP Reviews*.

The review validated that the development and implementation of the 2001-2005 INRMP is consistent with the NGB-JA (Judge Advocate) Legal Opinion, "Appropriate Environmental Analysis for Integrated Natural Resources Management Plans Prepared Pursuant to the Sikes Act Implementation Act," dated 14 March 2000. The review was completed in February 2005 and the findings are included in Appendix G of the 2006-2010 Camp Santiago INRMP.

11.4.2 2006-2010 INRMP

In accordance with the terms and conditions of a Memorandum of Agreement between PRARNG and the USDA Forest Service, Caribbean National Forest, an Interdisciplinary Team (IDT) of natural resource specialists updated the Camp Santiago INRMP for the 2006-2010 timeframe.

A Record of Environmental Review (RER) was conducted in accordance with direction provided by the NGB NEPA Handbook *Guidance on Preparing Environmental Documentation for Army National Guard Actions in Compliance with the National Environmental Policy Act of 1969*. The findings of the RER indicate that a new environmental document is not necessary, and that implementation of the Camp Santiago INRMP, as supplemented, should continue for the 2006-2010 timeframe.

The NEPA documentation to support this INRMP is consistent with the Council on Environmental Quality requirements and guidance contained in AR 200-2.

The NEPA process ensures that consequences of potential natural resources impacts resulting from the proposed actions are identified, analyzed, and disclosed. The EA provides an evaluation of various management activities of Camp Santiago's natural resources. If future natural resource projects fall outside the scope of significance criteria established in the EA, the projects will be individually reviewed to determine whether additional NEPA review (according to AR 200-1, 32 CFR part 651) is required. As a minimum, both the INRMP and its EA can be referenced with regard to describing the affected environment to reduce verbiage in future NEPA documentation.

The NEPA process ensures compliance with the 27 October 1999 Annotated Department of Defense American Indian and Alaska Native Policy and with Executive Order 12892, Environmental Justice.

In accordance with the *Sikes Act*, the development of the EA supporting this INRMP was a cooperative effort with USFWS and the Puerto Rico Department of Natural Resources and Environment.

11.4.3 2020-2024 INRMP

In accordance with the terms and conditions of a Memorandum of Agreement between PRARNG and the USACE, an IDT of natural resource specialists updated the Camp Santiago INRMP for the 2020-2024 timeframe.

An RER was conducted in accordance with direction provided by the NGB NEPA Handbook *Guidance on Preparing Environmental Documentation for Army National Guard Actions in Compliance with the National Environmental Policy Act of 1969*. The findings of the RER indicate that a new environmental document is not necessary, and that implementation of the Camp Santiago INRMP, as supplemented, should continue for the 2020-2024 timeframe.

The NEPA documentation to support this INRMP is consistent with the Council on Environmental Quality requirements and guidance contained in 32 CFR part 651.

The EA provides an evaluation of various management activities of Camp Santiago's natural resources. If future natural resource projects fall outside the scope of significance criteria established in the EA, the projects will be individually reviewed to determine whether additional NEPA review (according to 32 CFR part 651) is required. As a minimum, both the INRMP and its EA can be referenced with regard to describing the affected environment to reduce verbiage in future NEPA documentation.

The NEPA process ensures compliance with the 27 October 1999 Annotated Department of Defense American Indian and Alaska Native Policy and with Executive Order 12892, Environmental Justice.

In accordance with the *Sikes Act*, the development of the EA supporting this INRMP was a cooperative effort with USFWS and the Puerto Rico Department of Natural Resources and Environment.

12 BIOPOLITICAL ISSUE RESOLUTION

12.1 BIOPOLITICAL ISSUE RESOLUTION

One of the main issues at Camp Santiago relates to the use of Camp lands by civilians from the surrounding communities. Because the post is open, civilians can enter Camp Santiago from various locations. The boundary is not well defined or recognized by the public.

There is concern expressed by PRARNG personnel about the following issues:

- Illegal dumping of refuse,
- Continual trespass of horses and cattle, and
- Random entry of civilians gathering livestock or collecting materials.

Since trespassing at Camp Santiago has become, over time, a perceived right for the community, regaining control of the boundary will provide a difficult challenge. The concerns for safety will only increase with the opening of new firing ranges.

The key to the future existence of Camp Santiago as a viable training area is controlling public access. Surveying and fencing are only one component to the solution. Further restrictions in uncontrolled public access will strain friendly relationships that currently exist with the status quo. Resolving this issue in short order to the satisfaction of both PRARNG and the local community may be unrealistic. Animosity towards the military can be quickly and easily elevated as evidenced in recent events at nearby military installations.

The resolution of this issue will need to be pursued through a combination of political and legal avenues. PRARNG and the Camp Santiago Commander will work with local community officials and law enforcement to seek common resolution of this issue.

13 IMPLEMENTATION

Implementation is the final step in the planning process, marking the end of the planning and the beginning of the action. Monitoring is an integral part of the implementation phase. **Chapter 9** provides a detailed summary of the monitoring initiatives included in the INRMP.

13.1 MANPOWER

A balanced team of trained professional and technical staff is essential for the successful implementation of the Camp Santiago INRMP. Staffing sources for implementation of the Camp Santiago INRMP include:

- Permanent Staff:
  - Camp Santiago Commander and Staff
  - Local Commonwealth-funded maintenance and security workers
- Traditional National Guard Soldiers
- Special Contractors (as described in **Chapter 5**)
- Assistance from and collaboration with the following agencies/organizations:
  - Local universities (initial coordination has been made with the University of Puerto Rico in Ponce)
  - Puerto Rico Department of Natural Resources and Environment
  - USDA Forest Service, Caribbean National Forest
  - USDA Forest Service, International Institute of Tropical Forestry
  - USDA National Resources Conservation Service
  - U.S. Fish and Wildlife Service
  - U.S. Geological Service

13.2 ORGANIZATION, ROLES, AND RESPONSIBILITIES

Chapter 5 summarizes the parties, roles, and responsibilities for implementation of the INRMP.

13.3 PROJECT/PROGRAM PRIORITIES

Table 8-1 provides a summary of initiatives described in this INRMP, and **Tables 8-2** through **8-5** provide a summary of inventory and monitoring initiatives identified in the INRMP.

13.4 IMPLEMENTATION FUNDING OPTIONS

Table 13-1 lists the projects that will be implemented because of this plan. How the project would be accomplished and the project schedule (by fiscal year [FY]) are also shown. Estimated project costs are not subject to public disclosure but are available from PRARNG to authorized persons. Projects will be established in the NGB Status Tool for Environmental Program (STEP) or ITAM Workplan and undertaken as funding becomes available. Inclusion of projects on this list does not obligate PRARNG to complete required actions if funding is not available from federal sources.

13.5 COMMAND SUPPORT

The Camp Santiago commander is responsible for and committed to the successful implementation of the INRMP. His leadership in the integration of the INRMP with training activities will result in sound land stewardship and the preservation of natural resources at Camp Santiago.

13.6 CONSULTATION WITH OTHER AGENCIES

In compliance with 16 U.S.C., Section 670a(a)(2), PRARNG has prepared this INRMP and supporting NEPA documentation in cooperation with USFWS and the Puerto Rico Department of Resources and Environment. **Appendix C** contains copies of correspondence with both of the above-mentioned agencies that document their comments and input towards the development of the Camp Santiago INRMP.

Table 13-1. Initiative Implementation Matrix (2021-2025 INRMP for Camp Santiago)

Initiative Description	Implementation Year	Materials and Work Provided by	Remarks/Comments
Security and Public/Soldier Safety with Camp Santiago			
Continue installing approximately 3.0 miles of cyclone and 11 miles of barbed-wire fence along portions of the training boundary *(see to **Figure 8-1**)*.	FY 23 – FY 25	PRARNG in coordination with U.S. Army Corps of Engineers and/or private contractor	
Restrict livestock from grazing in riparian areas within Camp Santiago.	FY 21 – FY 25	PRARNG	
Restore and Protect Forest Vegetation			
Vegetation cover surveys: Inventory all of Camp Santiago lands on 5-year cycle (re-measure permanent plot clusters, which have been established in all vegetation classification types, Conduct walk-through inventories).	FY 21 – FY 25	PRARNG personnel, contractor, MOU with local universities and/or other government agencies	Inventory/monitoring initiative Information collected will also allow the periodic assessment of wildlife habitat.
Perform floristic planning level surveys to collect baseline data on the occurrence and distribution of TESS plant species in support of natural resource management planning on Camp Santiago and Fort Allen.	FY22	PRARNG	
Eliminate Sediment Sources, Improve Stream Crossings, and Eliminate Safety Hazards Associated with Camp Santiago Convoy Routes			
Work on primary convoy routes: • Improve surface drainage and reduce surface erosion and sediment sources by implementing water quality Best Management Practices on convoy routes. • Improve stream crossings by repairing and/or replacing existing drainage structures.	FY 21 – FY 25	PRARNG	This is the #1 priority identified in the 2006 - 2010 INRMP. Part of this will be addressed by the ITAM program. ***The stream crossing repair/replacement and elimination of sediment sources is responsive to troop safety and protection of natural resources values.***

Initiative Description	Implementation Year	Materials and Work Provided by	Remarks/Comments
• Perform road maintenance to eliminate sediment sources and associated safety hazards. Note: Work includes design/construction of both general surface drainage sediment sources and site- specific sediment sources.			
Design and construction on entrance bridges: • Repair and stabilize old entrance approaches and protect channel banks and bed from erosive channel flows. • Protect eroding channel banks at new entrance bridge. Note: Work includes design/construction of old entrance crossing and bank stabilization of new entrance.	FY 24	PRARNG	This is a high priority initiative. This will be done by CFMO and ITAM. ***And is responsive to troop safety and protection/ enhancement of water quality***
Design and construction of firing ranges and Ammo Area: • Improve surface drainage and reduce surface erosion associated with Firing Range 22 and Ammo Area. Note: Work includes design/ construction of firing range and Ammo Area drainage improvements.	FY 24	PRARNG	This will be done by CFMO. USACE has already designed the project and it is expected to have the exclusion by FY 23 or FY 24. ***This is responsive to addressing overland drainage and erosion problems and is responsive to troop safety and protection/ enhancement of wafer quality.***
Restore and Protect Riparian Areas			
Fill-dirt extraction within the Rio Nigua stream channel and adjacent riparian areas.	FY 21 – FY 25	PRARNG in partnership with the Puerto Rico Department of Natural Resources (PR DNRE).	***This is a high priority initiative***. The past gravel and fill-dirt extraction is resulting in negative impacts on water quality, aquatic habitat, and riparian area habitat.

Initiative Description	Implementation Year	Materials and Work Provided by	Remarks/Comments
Ensure future extraction operations meet applicable environmental laws and standards.		Note: The current extraction operation is permitted and administered by the PR DNRE.	
Plant approximately 200 acres of riparian areas. *(See **Figure 8-3**)*	FY 21 – FY 25	Nursery stock provided by PR Conservation Trust and DNRE	Plant 40 acres per year; approximately 400 seedlings per acre.
Restrict cross-country vehicle maneuver with riparian areas. Modify Camp Santiago Map to show sensitive riparian areas as "restricted, off-limit areas".	Continuous	Camp Santiago personnel	
Identify Sediment Sources			
Conduct sediment surveys; emphasis is on **secondary convoy routes** and assembly areas. Note: During year 1, focus surveys on secondary convoy routes; during the 2nd to 5th year focus in on monitoring the secondary and secondary convoy routes and road system.	Continuous	PRARNG	The identification of sediment sources and subsequent elimination of these sediment sources is responsive to troop safety and protection/ enhancement of natural resources values.
Inspect primary convoy routes during rainstorms, clearing debris from above, within, and below culverts.	FY 21 – FY 25	PRARNG	
Conduct Stream Channel Surveys/Monitoring			
Conduct stream channel surveys to determine current stream channel and bank conditions and to monitor changes over time.	FY 21 – FY 25	PRARNG	**Surveys would identify restoration opportunities.** To be conducted every other year.
Stream monitoring: • Establish permanent stream cross-sections	FY 23 – FY 25	PRARNG	

Initiative Description	Implementation Year	Materials and Work Provided by	Remarks/Comments
Protect and Enhance Wildlife Habitat			
Wildlife monitoring: Monitoring for the presence of species requiring special habitats and ecological indicator species on an every other year basis. *(See **Chapter 8** for a detailed description of wildlife and pest monitoring initiative. See **Chapter 9** for a detailed description of the proposed monitoring protocols.)*	FY 21 – FY 25	PRARNG in coordination with the contractor and local universities	**Information collected will assist in assessing the effectiveness of management initiatives designed to maintain and/or enhance forest and riparian habitat and to achieve desired conditions of local fauna populations.**
Wildland (Range) Fire Suppression			
Train fire personnel wildfire suppression techniques.	FY 21 – FY 25	PRARNG	***This is a high priority initiative*** and is responsive to troop safety, maximizing training opportunities, and protection/enhancement of natural resources.
Upgrade Fire Suppression Capabilities			
Construction and subsequent maintenance of approximately 300 meters of fuelbreaks to prevent potential range fires from encroaching into the plantation areas. *(See **Figure 8-11**)*	FY 21 – FY 25	PRARNG	
Install hydrant(s) and hydrant lines.	Continuous	PRARNG	
Implement Fire Danger/Awareness Rating System.	FY 21 – FY 25	PRARNG	
Continue to develop and maintain a GIS data base for Camp Santiago. Note: This initiative would provide support to the collective management of the natural resource values at Camp Santiago.	FY 21 – FY 25	PRARNG	

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APPENDICES

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APPENDIX A

Biological Resources Assessment for

Puerto Rico National Guard

Camp Salinas Training Site

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Biological Resources Assessment for
Puerto Rico National Guard
Camp Salinas Training Site

July 30, 2013

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Table of Content

EXECUTIVE SUMMARY

In an agreement accordance between the Puerto Rico Army National Guard and El Yunque National Forest (EYNF), there is need to be in compliance with the Sikes Act and Army Regulation 200-3. The EYNF provides professional natural resource management to meet these important regulations. In 2013 The EYNF surveyed for a rapid assessment of the vertebrate wildlife and fisheries species on the Camp Santiago Training Site (CSTS) using the best available science. There were no Federally endangered, threatened, proposed or candidate wildlife or fisheries species found on the CSTS. In other years of presence/absence surveys there are some noticeable differences in the observed wildlife and fisheries, but the scope of this report is to inform and not dwell into more costly metrics. The CSTS has area-level management goals and we briefly quote them to provide a structure for the administration to mitigate or monitor future challenges to their mandate such as climate change and invasive species to provide habitat for native wildlife and aqua fauna. This information can be used for future species specific needs for sustainable natural resources management.

INTRODUCTION

On February 11, 2013 the Forest Biologist and biological technicians of the El Yunque National Forest (EYNF) began a series of absence/presence surveys for all of the vertebrate wildlife and fisheries species on the Puerto Rico National Guard's Camp Santiago Training Site (CSTS). The purpose for this rapid assessment stems from the need to meet the Sikes Act (16 U.S.C. 670a et seq) and Army Regulations 200-3. To assist the CSTS to maintain their mission mandate and be in compliance with natural resources laws the EYNF collaborates to give CSTS staff a comprehensive report of what wildlife and fisheries resources they directly or indirectly manages.

The question the EYNF is asking is what is occurring on the CSTS in a rapid assessment. In this scenario, we define a rapid assessment as an assessment is the identification and evaluation of existing information to support land management planning. Assessments are not decision making documents, but provide current information on select topics relevant to the plan area, in the context of the broader landscape.

Fundamental goals of the natural resources management within the CSTS area is to achieve optimum, sustainable use of training lands by protecting natural and cultural resources and providing for multiple use (PRANG, 2001). The specific goals for the management encompassed for the Integrated Natural Resources Management Plan are stated in the table below:

Table 1: Specific goals of the management plan

Emphasis/Issue	Management Goal
Training	Maximize military training opportunities with no loss of training capabilities and support to the Puerto Rico National Guard
Safety	Increase and protect cultural resources that may be affected by natural resources initiatives.
Cultural Resources	Inventory and protect cultural resources that may be affected by natural resources initiative
Scenery	Improve the visual qualities of the training site
Stray Animals	Prevent stray domestic animals and livestock from entering the training area
Forest Vegetation	Minimize impacts on forest vegetation and implement restoration/reforestation projects
Riparian Areas	Reduce human, domestic animal, and livestock activity within the riparian areas and implement riparian area restoration projects
Stream Channels	Restore and protect stream channel and stream bank stability
Water Quality	Reduce sediment and pollution sources
Wildlife and Aquatic Species	Minimize wildlife and aquatic species displacement and impacts on their habitat
Wildfire Management	Improve wildfire prevention and suppression capabilities

In 2003 and 2006 the EYNF had conducted general surveys for both terrestrial and aquatic species. These past reports will be integrated to give an idea of the presence/absence to these species.

This report is separated into the type of wildlife that was found in surveys: avian, coqui, lizards, mammals, and aquafauna.

Location
The CSTS is located on the south central portion of Puerto Rico and is characterized as a tropical dry forest. Annual rainfall is highly variable and averages 860 mm yr_1 with two wet seasons: a major one from August through November and a minor one from April through May (Murphy and Lugo, 1986b). Temperatures fluctuate little throughout the year and average 25.1 _C. Soils are generally shallow, alkaline, and derived from calcareous substrates (USDA, 2008). The CSTS has a total of 12,489acres within its boundaries, of its total 2,693 acres are unavailable for training. The approximate net usable maneuver area is 9,796 acres, all of which is classified as light maneuver land (PRANG, 2001).

METHODS

The EYNF practices scientific based natural resources management and this rapid assessment uses the best available science in providing results with the limited personnel resources. Monitoring in this scenario is known as presence/absence methodology, but a more correct term would be detection/non-detection.
Results will represent the surveyor's ability to find the species in the landscape, not where the species is in the landscape. As an example, probability of detecting the species in an occupied location as .6 there is .4 (1-.6) probability of false absence. Thus in two surveys then the probability of non-detecting the species at either survey will be $(1-6)^2 = .016$. Continuing, with three surveys this will further change the probability of non-detection to $(1-.6)^3 = .064$. In general it is better to conduct multiple surveys in the time allotted in the same area. Generally, Abundance-related measures tend to be more costly, followed by occupancy and species richness-related metrics.

The bird surveys were conducted according to (USFS, 1996) where technicians were sent on transects and performs 10-minute spot counts and recorded the bird species observed through bird songs and visual identification. There were two transects used, western and eastern portion of CSTS.

The coqui surveys were performed in a modified approach based on (USFS, 1996). There were two transects, western and eastern portion of CSTS

Lizard surveys were conducted according to transect techniques found in wunderle (1994) where technicians would walk a transect in different habitat types and then document the number and species of lizards observed. There were two transects, western and eastern portion of CSTS

The mammals survey were conducted according to (Oberg, 2009), but instead of plastic tubes we modified a square plot that is covered in paper with bait in the center and instead of using ink we used black chalk to make the footprints of the mammal be shown reaching the bait in the center. The EYNF utilized three (3) transects with the first one with six (6) trap points, the second and third transect each with three (3). The total is 12 points and the survey was repeated three times.

Fisheries surveys are derived from a modified basinwide visual estimation technique (Roghair et al, 2001) which uses both a snorkeling survey with an additional electrofishing canvass of the water unit (pool or riffle). There were two rivers surveyed: Rio Nigua and Rio Jueyes.

RESULTS

Table 2. Avian Survey results

Species (common name)	**Scientific name**	**Number observed**
White-winged dove	*Zenaida asiatica*	10
Grey King bird	*Tyrannus dominicensis*	97
Northern Mockingbird	*Mimus polyglottos*	24
Zenaida dove	*Zenaida aurita*	4
Smooth-billed ani	*Crotophaga ani*	75
Mourning dove	*Zenaida macroura*	34

Puerto Rican Woodpecker	*Melanerpes portoricensis*	5
Puerto Rican Flycatcher	*Myiarchus antillarum*	15
Species (common name)	**Scientific name**	**Number observed**
Yellow-faced grassquit	*Tiaris olivacea*	5
Turkey Vulture	*Cathartes aura*	11
Domestic chicken (rooster)	*Gallus gallus domesticus*	6
Black-faced Grassquit	*Tiaris bicolor*	44
Banaquit	*Coereba flaveola*	67
Puerto Rican Emerald	*Chlorostilbon*	8
Common ground dove	*Columbina passerine*	9
Puerto Rican Tody	*Todus mexicanus*	14
Grass Sparrow	*Ammodramus savannarum*	2
Adelaide's Warbler	*Dendroica adelaidae*	59
American kestrel	*Falco sparverius*	9
Merlin	*Falco columarius*	8
Red-tailed Hawk	*Buteo jamaicensis*	11
Swallow species	*Not identified*	2
Cape May Warbler	*Dendroica tigrina*	6
Hummingbird species	*Not identified*	1
Snowy Egret	*Egretta thula*	60
Great antillean grackle	*Quiscalus niger*	22
Shiny cowbird	*Molthrus bonariensis*	1
Puerto Rican Spindalis	*Spindalis portoricensis*	1
Puerto Rican Bullfinch	*Loxigilla portoricensis*	1

Table 3. Coquies (amphibians) 

Species (Common name)	**Scientific name**	**Number observed**
Bullfrog	*Rana cathebarius*	1
White-lipped frog	*Leptodactylus albilabris*	61 and a site having over 50 individuals
Antillean coqui	*Eleutherodactylus antillensis*	18
Common coqui	*Eleutherodactylus coqui*	22
Cane toad	*Bufo marinus*	

Table 4. Lizards 

Species (common name)	**Scientific name**	**Number observed**
Sharp-mouthed lizard	*Anolis pulchellus*	58
Puerto Rican crested anole	*Anolis cristatelus*	23
Barred anole	*Anolis stratulus*	1
Upland grass anole	*Anolis krugi*	1
Gecko (unknown)	*Sphaerodactylus spp*	1

Table 5. Mammals 

Species (common name)	**Scientific name**
Small indian mongoose	*Herpestes aurepunctatus*
Black roof rat	*Rattus rattus*

Feral cat	*Felis catus*

Table 6. Fisheries

Species	**Scientific name**
River shrimp (prawn)	*Macrobrachium faustinum*
River shrimp (prawn)	*Macrobrachium carcinus*
Green swordtail	*Xiphorus hellerii*
Caribbean dwarf filter shrimp	*Micratya poeyi*
Green swordtail	*Xiphocaris elongata*
A filter shrimp	*Atya lanipes*
Jonga shrimp	*Atya scabra*
A filter shrimp (unidentified)	*Atya species*
Puerto Rican Land crab	*Epilobocera sinuatifrons*

DISCUSSION

This rapid assessment is designed to give a general knowledge of what type of wildlife and fisheries species are occurring on the CSJMTC at this time. We have the benefit to compare what was seen in the past but the surveys were not done in the same manner to use the past surveys as baseline data. As an important note, there were no Federally endangered, threatened, proposed or candidate species found in this year's survey.

Birds

There are different bird species observed in comparison with prior surveys (Cano, 2006). This year includes: *Cathartes aura, Gallus gallus domesticus, Falco sparverius, and Falco columarius.* This report will not elaborate on survey limitations, time of survey, or biases, but simply show the differences between years for any further studies that may be of interest to the PRANG. In 2006 the report documents more species: *Pandion haleaetus, Ceryle alcyon, Dendroica discolor, Charadrius vociferus, Ardea alba, Icterus icterus, Bubulcus ibis, Vireo altiloquus, Saurothera vielloti, Ardea Herodias, and Caprimulgus noctitherus.*

Amphibians

There is an increase of the number of amphibian species observed in this year compared with (Cano, 2006). The arrival of *Rana cathebarius* and *Eleutherodactylus antillensis* adds an interesting component for the possible effects with more species over the long-term.

Lizards

From the survey conducted in (2006) there are more lizards that were observed in the past that included: *Anolis gundlachi, Anolis evermanni, and Anolis stratulus*. There may be many reasons for these absences that will not be addressed her, but an interesting result in this survey is the presence of an unidentified *Sphaerodactylus* species. This individual Sphaerodactylus specimen was very small and young that in our reference books we couldn't identified it.

*Mamma*ls

Through the three night survey with a total of 36 points: Rats were documented in 8 points; Cats were in 2 points; Mongoose in 19 points. Large percentages of the mammals in the area of interest are the species that are not seen, on the CSJMTC it is the mongoose.

Fisheries

This survey found no *Sicydium plumieri, Atya lanipes, or Macrobrachium faustinum* that were found in (Cano, 2003) surveys. The conditions of the rivers are of concern due to vast conversion of the aquatic habitats that exerts immense population growth pressure against native fish and shrimp species. As a note, there was a pool that was observed with Tilapia.

Threat to natural resources and mission mandate
Climate change will be a major threat to the mission mandate of the CSJMTC where the specific response of the vegetation and biological resources is unknown. The scientific literature has been clear that changes are expected to occur and are proceeding within the Caribbean region. A long term study of climate in the Caribbean (1950-2000) found that trade winds in the early rainfall season have increased in magnitude and shifted to a more easterly or south-easterly flow, with global climate change playing an important role in the trend"(Comarazamy & Gonzalez, 2011). Personnel and animal species will be facing more changes to area in the changing conditions of air quality. "Observed sensitivities of African dust to changes in climate mean that future climate change could drastically change the amount of African dust reaching the Caribbean"(Prospero & Lamb, 2003).

Table 7. Identified threats to present wildlife and fisheries species and personnel

Threats	**Possible monitoring items or mitigations**
Increased African dust	Observe for any reactions from personnel in the form of increased allergies.
Increased fire occurrences	Keep track of the length of the burning season to notice an increase or decrease. Plant more vegetation that may be more resistant to drying conditions
Spreading of mongoose	Keep track of rabid mongoose and time of year to anticipate the spread of diseases, such as rabies. Provide trapping throughout the CSTS.
Increase of domestic animals	Observe where they occur and notice any changes in vegetation response. Repair fences of known access sites.
Increase change to aquatic habitats	Observe the amount of water in river waterways. Create more diverse pool habitats

Although different environments will have different effects many studies have provided a general representation of the overall conditions. Historic periods of drought in Puerto Rico, such as the extreme drought experienced in 1993-1995, provide a glimpse into future dry periods, which may increase as annual rainfall decreases over time in the Caribbean region (Larsen, 2000). The PRANG as a whole is well-positioned through installation such as CSJMTC to anticipate and better adapt to climate change. Tropical forest fire frequency has increased over recent decades, with the 1997-1998 El Niño Southern oscillation (ENSO) event leading to widespread fires in the tropics (Lewis, 2006). If climate change leads to more intense ENSO events as predicted (see: Yeh et al. 2006, 2009) the incidence, magnitude, and duration of fires in the tropics will continue to increase (Brodie et al. 2011).

Meeting the needs of the natural resources and the training mandate will require large-scale environmental planning due to the fact there are many species that are living in tedious conditions. Tropical vertebrate ectotherms (fish, amphibians, and reptiles will reach their critical maximum temperature proportionally faster than similar high-latitude species, despite the tropic's lower absolute rates of warming (Deutsch et al, 2008). This is because tropical species often have narrow thermal tolerances, and are already living close to their upper thermal limits (Laurance et al, 2011; Huey et al, 2009; Gunderson & Leal, 2012); thus deleterious thermal performance changes are likely in tropical member of all four taxonomic groups (Deutsch et al, 2008)

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APPENDIX A – GIS Map

APPENDIX B

Species Recommended for Reforestation

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APPENDIX B – Species Recommended for Reforestation

Scientific Name	Common Name	Native (N) / Exotic (X)
Andira inermis	Moca	N
Bauhinia variagata	Palo de orquideas	X**
Bucida buceras	Ucar	N
Bursera simaruba	Almacigo	N
Byrsonima spicata	Maricao	N
Ceiba pentandra	Ceiba	N
Citharexylum fruticosum	Pendula	N
Citharexylum fruticosum	Pendula	N
Coccoioba venosa	Calambreha	N
Columbrina arborescens	Mabi	N
Cordia laevigata	Capa	N
*Cordia ricksecker*i	San Bartolome	N
Cresentia linearifolia	Higueriilo	N
Delonix regia	Flamboyan	X**
Guaiacum officinale	Guayacan	N
Guazuma ulmifolia	Guacima	N
Guetarda krugii	Cucubano	N
Lagerstroemia speciose	Reina de las Flores	X**
Leucaena leucocephaia	Zarcilla	N
Melicoccus bijugatus	Quenepa	X
Pictetia aculeate	Tachuelo	N
Pithecellobium dulce	Guama Americana	X
Poisetia florida	Retama	N
Polygala cowellii	Arbol de violeta	N
Pterocarpus macrocarpus	Terocarpus	X
Roystonea borinquena	Palma Real	N
S. mahagoni x macrophylla	Caoba hibrida	X
Samanea saman	Saman	X
Swietenia mahagoni	Caoba dominicana	X
Tabebuia haemantha	Roble bobo	N
Tabebuia heterophylla	Roble	N
Tamarindus indica	Tamarindo	X
Thouinia striata	Ceboruquillo	N
Zanthoxylum flavum	Aceitillo	N
Zanthoxylum martinicense	Espinosa	N
Zanthoxylum monophylum	Espino rubial	N

Note: All exotic species recommended are reported as naturalized in Puerto Rico and only Pelthophorum inerme, and Dalbergia sissoo are not reported as present at Camp Santiago. The native species Zanthoxylum flavum is not reported for Camp Santiago. AH these species are suitable for planting at Camp Santiago Site.

*** All of these species are suitable for planting at Camp Santiago Joint Training Center in the urban setting of the Cantonment Area for ornamental and landscaping purposes.*

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APPENDIX C

Consultation with Other Agencies

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Appendix C – Consultation with Other Agencies

Record of consultation with the U.S. Fish and Wildlife Service, Puerto Rico Department of Natural Resources and Environment, and State Historic Preservation Office:

C.1. Consultation with the U.S. Fish and Wildlife Service

C.2. Consultation with the PR Department of Natural Resources and Environment

C.3. Consultation with the State Historic Preservation Office

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APPENDIX D
Glossary

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APPENDIX D – Glossary

Aquatic Ecosystem – A natural system based on a body of water (such as a stream, lake, or estuary) with its aquatic organisms and non-living components.

Biological Diversity – The variety of life and its processes, including the variety in genes, species, ecosystems, and ecological processes.

Canopy Cover – The percentage of ground surface that is shaded by the live foliage of plants as seen from above. Used to describe how open or dense a stand of trees is.

Competition – An interaction that occurs when two or more individuals make demands of the same resources that are in short supply.

Composition (species) – The mix of different species that make up a plant or animal community, and their relative abundance.

Connectivity – The arrangement of habitats that allows organisms and ecological processes to move across the landscape.

Conserve – Planned management to prevent exploitation, destruction, or neglect. A conservation emphasis assumes that the ecosystem is functioning relatively well and is producing associated human needs and values within its inherent capabilities. The ecosystem is resilient and integrity is moderate to high.

Cover type – The present vegetation composition of an area.

Demographic – Related to the vital statistics of human populations (size, density, growth, distribution, etc.) and the effect of these on social and economic conditions.

Disturbance – Refers to events that alter the structure, composition, or function of terrestrial or aquatic habitats. Natural disturbances include, among others, drought, floods, wind, fires, wildlife grazing, insects, and pathogens. Human caused disturbances include actions such as timber harvest, livestock grazing, roads, and the introduction of exotic species.

Ecological processes – The flow and cycling of energy, materials, and organisms in an ecosystem.

Ecosystem – Any community of organisms along with its environment, forming an interacting system.

Ecosystem health – A condition where the parts and functions of an ecosystem are sustained over time and where the system's capacity for self-repair is maintained, such that goals for uses, values, and services of the ecosystem are met.

Ecosystem management – Scientifically based land and resource management that integrates ecological capabilities with social values and economic relationships, to produce, restore, or sustain ecosystem integrity and desired conditions, uses, products, values, and services over the long term.

Endangered Species – A plant or animal species which is in danger of extinction throughout all or a significant portion of its range. Endangered species are identified by the Secretary of the Interior in accordance with the 1973 Endangered Species Act.

Endangered Species Act – A law passed in 1973 for the purposes of conserving the ecosystems upon which endangered species and threatened species depend, and providing a program for the conservation of such species.

Epidemic (outbreak) – The rapid spread, growth, and development of pathogen or insect populations that affect large numbers of a host population throughout an area at the same time.

Fire Suppression – Any act taken to slow, stop, or extinguish a fire.

Forest Health – The condition in which forest ecosystems sustain their complexity, diversity, resiliency, and productivity while providing for human needs and values. It is a useful way to communicate about the current condition of the forest, especially with regard to the ability of the ecosystem to respond to disturbances.

Forest Structure – The mix and distribution of tree sizes, layers, and ages in a forest. Some stands are mostly one size (single-story), some are two-story, and some are a mix of trees of different ages and sizes (multi-story). Fuel (fire) Dry, dead parts of trees, shrubs, and other vegetation that can burn readily.

Game Species – Wildlife or fish that are harvested by hunters, trappers and fishermen for food and recreation according to prescribed seasons and limits.

Grazing – The foraging of livestock.

Habitat Type – The land area capable of supporting a single plant association. Provides a way to classify land area.

Lethal Fire – A fire that is intense enough to consume the entire vegetation community (grasses, shrubs, and trees).

Livestock – Domestic animals such as cattle, horses, goats, and sheep.

Monitoring and Evaluation – The periodic evaluation, on a sample basis, of Forest Plan management practices to determine how well objectives are being met, as well as the effects of those management practices on the land and environment.

Pests – Animals that detrimental to people and/or activities conducted by people, such as stray dogs, feral cats, rats, mice, and bats.

Restore – To bring back to a former, desirable condition, pattern, or process. Generally, refers to the process of enabling the system to resume its resiliency to disturbances. Restore strategies are normally applied to areas of moderate to low ecological integrity.

Riparian Area – Area with distinctive soil and vegetation between a stream or other body of water and the adjacent upland; includes wetlands and those portions of floodplains and valley bottoms that support riparian vegetation.

Riparian Ecosystem – An ecosystem that is a transition between terrestrial and aquatic ecosystems; includes streams, lakes, wet areas, and adjacent vegetation communities and their associated soils which have free water at or near the surface.

Scoping – The early stages of preparation of an environmental impact statement, used to solicit public opinion, receive comments and suggestions, and determine the issues to be considered in the development and analysis of a range of alternatives.

Silviculture – The practice of manipulating the establishment, composition, growth, and rate of succession of forests to accomplish specific objectives.

Species – A population or series of populations of organisms that can interbreed freely with each other but not with members of other species.

Succession – A predictable process of changes in structure and composition of plant and animal communities overtime. Conditions of the prior plant community or successional stage create conditions that are favorable for the establishment of the next stage. The different stages in succession are often referred to as "serai stages."

Successional Stages – The sequence of plant, animal, and microbial communities that successively occupy an area over a period of time.

Viability – The probability that a wildlife population of specified size will persist in an area for a specified time period.

Viable Population – A population which has adequate population size and distribution of reproductive individuals to ensure the continued existence and interaction of the species population in the planning area

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APPENDIX E
Planning Level Floristic Survey
Camp Santiago Joint Training Center, Salinas
And Fort Allen, Juana Diaz, Puerto Rico

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