Draft

Environmental Impact Statement /
Overseas Environmental Impact Statement

GUAM AND CNMI MILITARY RELOCATION

Relocating Marines from Okinawa, Visiting Aircraft Carrier Berthing, and Army Air and Missile Defense Task Force

Volume 6: Related Actions – Utilities and Roadway Projects

November 2009

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Guam and CNMI Military Relocation EIS/OEIS

Volume 6: Related Actions – Utilities and Roadway Projects (Guam)

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CHAPTER 1.
PURPOSE OF AND NEED FOR ACTION

Volume 6 of the Guam and Commonwealth of the Northern Mariana Islands (CNMI) Military Relocation Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) evaluates proposed utilities and roadway improvements on Guam.

The proposed military buildup on Guam associated with the relocation of the United States (U.S.) Marine Corps (Marine Corps), the Navy aircraft carrier berthing, and the Army Air and Missile Defense Task Force (AMDTF) would increase the demand for power, potable water, and wastewater utilities. The buildup would also affect the remaining life of existing solid waste facilities and the demand for the new Government of Guam (GovGuam) Layon Landfill in Dandan. The proposed actions would also require roadway improvements.

For utilities, the Navy conducted several studies to identify the Guam utility improvements required to accommodate the proposed action. These included a study for power, potable water, wastewater, and solid waste. The utility studies sought to quantify the increased Department of Defense (DoD) demand that would result from the military buildup, and to develop utility solutions to meet those projected demands. The populations on which these utility studies were based are summarized in the individual utility studies (HDR|Hawaii Pacific Engineers 2008; NAVFAC Pacific 2008b, c). These studies accounted for projected increases in DoD personnel, increases in the on-base civilian workforce required to support the military buildup, and construction worker demands while working on base that were known at the time. Subsequent supplementary analysis letter reports (NAVFAC Pacific 2009a, b, c) were prepared to document the changes between the power, potable water, and wastewater utility discussions presented in this Draft Environmental Impact Statement (DEIS) and the original studies.

The roadway improvements sections have been prepared jointly by the Federal Highway Administration (FHWA) as a federal cooperating agency, the Navy's Joint Guam Program Office as the federal lead agency for the Guam and CNMI military relocation, and the Guam Department of Public Works (DPW) as a participating agency.

The utilities and off-base roadway improvements are considered "related actions," in that they would be implemented only to satisfy the increased demand directly caused by the overall proposed actions. Therefore, the purpose of and need for the utilities and roadway improvements support the purpose of and need for each of the three major action components described in the following volumes:

- Volume 2 (Marine Corps Relocation Guam)
- Volume 4 (Aircraft Carrier Berthing)
- Volume 5 (Army AMDTF)

The purpose of and need for each major action component is described in Chapter 1 of each of those volumes. The purpose of and need for the utilities are to provide for the essential increased utility demands from the DoD buildup and induced growth. The purpose of and need for roadway improvements is described later in this chapter.

1.1 PURPOSE OF AND NEED FOR ROADWAY IMPROVEMENTS

1.1.1 Introduction

The Guam Road Network (GRN) is proposed to become Guam's nonmilitary roadway system. Construction of the GRN is required to provide mission-critical transportation infrastructure as part of the planned construction, training, and operations associated with the three proposed military actions (Figure 1.1-1). First, the GRN must accommodate increased traffic from the island's military buildup associated with relocating approximately 8,600 Marines of the III Marine Expeditionary Force and their dependents from Okinawa by 2014. Aviation and waterfront operations; training; construction of the main cantonment, family housing, and associated utilities; and infrastructure improvements represent the scope of activities to be conducted in support of Marine Corps projects on the island. Roadway improvements are needed to support both construction of the facilities and the ensuing traffic related to the military buildup on Guam. Roadway improvements are also related to construction of operational facilities, the main cantonment, and family housing on Guam, and training to support the Marine Corps' defensive mission.

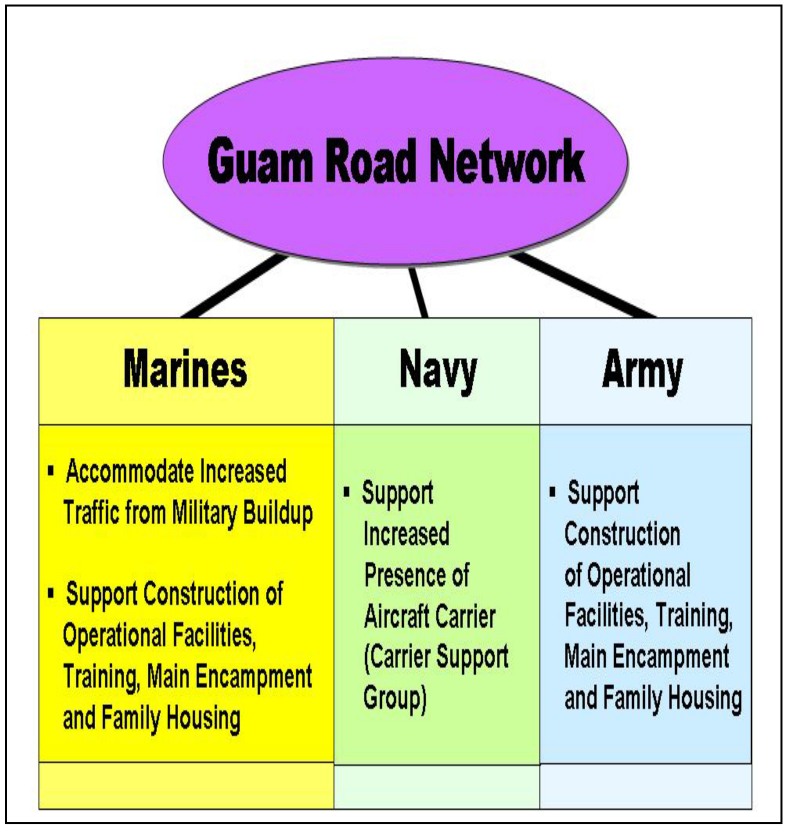

Figure 1.1-1. Connectivity of the Guam Road Network

Second, the roadway improvements are related to Navy initiatives associated with an increase in aircraft carrier presence to support engagement and deterrence consistent with the global shift of trade and transport. A new deep-water wharf at Apra Harbor is needed to support the increased Navy presence and port visits associated with a carrier support group.

Third, the roadway improvements are related to construction of operational facilities, training, and construction of the main cantonment and family housing on Guam, and training to support the AMDTF and its defensive mission.

1.1.2 Project Purpose

The purpose of the proposed construction of the GRN is to improve the existing network through the Defense Access Road Program and provide mission-critical transportation infrastructure as part of the planned military buildup. The improvements proposed for the GRN would result in strengthened roadways, bridge replacement, increased roadway capacity, roadway realignment (Route 15), new access, and enhanced roadway safety on Guam as a response to construction for military buildup and growth.

1.1.3 Project Need

An improved network of roads on Guam is needed as part of the mission-critical infrastructure to support planned relocation of Marines and their dependents, as well as to accommodate ongoing growth on the island. The island of Guam is experiencing a variety of roadway problems: inadequate bridges; flooding roads; poor lane visibility as a result of tight corners; poor lane striping, lighting, and lane geometry; locations with a large number of accidents; landslides; eroding embankments; and inadequate intersections because of the absence of traffic signals. The existing roadways connecting the population centers and DoD lands on Guam are shown in Figure 1.1-2.

Without improved roads and bridges, the movement of people, materials, equipment, and waste associated with construction and operations would result in congestion. The resultant wear and tear on existing roads could severely limit the construction schedule if these roadway and bridge projects were not implemented.

To meet these needs, the proposed GRN improvements would include roadway widening, intersection improvements, bridge replacements, and pavement strengthening at specific locations islandwide, as well as the realignment of Route 15. These improvements are needed to resolve traffic congestion during the construction period from 2010 through 2016, with peak construction and peak population in 2014, and the ensuing traffic increase from full military buildup combined with projected organic growth. The transportation network would become an integral component for fulfilling the U.S. defense strategy and alliance requirements; the network would also enhance the ability of the AMDTF to defend critical military assets on Guam. The need for the proposed action is explained in further detail in Section 2.5.1.

1.1.4 Project Location, Funding, and Setting

The project may be funded by FHWA through annual allocations for calendar years 2010 through 2016 and funding requested under the Defense Access Road Program. The Defense Access Road Program provides the means for DoD to pay a fair share for public highway improvements required as a result of a sudden or unusual defense-generated traffic impact or unique defense-related public highway requirement.

The setting for the project encompasses the primary roadway network for the entire island of Guam, composed of 20 federal-aid roadways and one local road totaling approximately 66 miles (106 kilometers) in length.

Projects may be eligible for funding based on any of the following five criteria:

- A new access road to a facility is needed.
- A defense action would cause traffic to double.
- A new or improved access road is needed to accommodate a temporary surge in traffic associated with a defense action.
- A new or improved road is needed to accommodate special military vehicles.
- A road is needed to replace one closed for defense needs.

Figure 1.1-2
Roadways Connecting Military Lands on Guam

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1.1.5 Governing Laws, Regulations, and Standards

Governing laws, regulations, and standards include the Council on Environmental Quality's *Regulations for Implementing NEPA* (40 Code of Federal Regulations [CFR] 1500-1508); FHWA environmental regulations (23 CFR 771); FHWA Technical Advisory T6640.8A (*Guidance for Preparing and Processing Environmental and Section 4(f) Documents*); FHWA Section 4(f) Regulations (23 CFR 774—Parks, Recreation Areas, Wildlife and Waterfowl Refuges, and Historic Sites (Section 4(f)); and the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) (23 United States Code [USC] 139).

1.1.5.1 Least Environmentally Damaging Practicable Alternative (LEDPA)

Chapter 4 of this volume contains an analysis of the least environmentally damaging practicable alternative (LEDPA), which is required under the Section 404(b)(1) guidelines of the Clean Water Act (CWA). Specifically, Section 404(b)(1) of the CWA stipulates that no discharge of dredged or fill material into waters of the U.S., which include wetlands, shall be permitted if there is a practicable alternative (LEDPA) which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant environmental consequences. Furthermore, an alternative is considered practicable if it is available and capable of being implemented after taking into consideration cost, existing technology, and logistics in light of overall project purposes. The Section 404 (b)(1) guidelines are applicable to proposed actions that are analyzed in this volume.

1.2 NON-DECISION POINT ACTIONS

DoD's proposed action to relocate about 8,600 Marines to Guam and the Navy and Army actions covered by this DEIS would create ripple impacts affecting Guam. Impacts can be identified as direct impacts and indirect or induced impacts. In various cases, effects on resource areas could occur but may not be discernable as direct and indirect impacts. This section discusses areas and/or facilities that are related to the proposed action, but are not in DoD's control .

1.2.1 Port of Guam

The Jose D. Leon Guerrero Commercial Port (also known as the Port of Guam [Port]) is located in the northern portion of Apra Harbor. It is the only port on Guam, and more than 90% of all imported goods and materials come through the Port. This makes the Port an essential facility that supports the entire population of Guam. The proposed military buildup on Guam would create an increased demand for imported goods and materials (especially construction supplies, equipment, and materials) that would be shipped to Guam. Also, during the peak years of construction, goods and other supplies would be required to support the estimated off-island construction workers and induced population. Long-term operational impacts include the importation of supplies, goods, and materials that would support the additional permanent population created by the proposed action.

The Port is administered by the Port Authority. The Port Authority is part of GovGuam and operates as a semipublic organization.

Since its construction in 1969 the Port has remained largely unchanged. With many areas near capacity or unusable, expanding the Port's facilities and equipment upgrades would create operational efficiencies and maximize Port capacity. Before the news of the proposed military relocation, Port improvements and expansion were under consideration; however, the military relocation created an additional impetus to implement planning studies and improvements to service the anticipated construction work and additional population.

In August 2007, work began to update the Port's master plan. The recommendations and updates address future expansion and development based on typical commercial growth, as well as the impending military buildup. Needs assessments for the proposed military buildup on Guam were based on preliminary information about cargo volumes and personnel relocation provided by the Joint Guam Program Office. A final draft Port master plan was completed in April 2008 which updated master plan and set the road map for upgrading the facilities. The master plan for the Port calls for nearly $200 million in capital improvement upgrades to the Port facilities to support the military buildup. The modernization program, which was granted conditional approval from the Guam Legislature in December 2008, would address both Guam's expected growth without the proposed action and the anticipated increase in cargo volume resulting from the proposed action.

The following are some of the key modernization initiatives for the Port:

- Upgrade of the terminal operating system to allow for automated invoicing, cargo and container tracking, financial management, and maintenance management
- Expansion of wharf space to accommodate larger vessels and increase overall vessel handling capacity
- Acquisition of additional gantry cranes to allow increased cargo movement through the Port and enhance overall productivity and efficiency
- Expansion of existing facilities to support the fishing and cruise line industries

The upgrades to the Port are scheduled to occur between 2009 and 2012 and would comply with both Guam's environmental regulations and the National Environmental Policy Act (assuming that funding from the United States through federal agencies is involved). The modernization plan would increase demand capacity to ensure that Guam's only commercial port is developed and managed to adequately accommodate and capitalize on the expansion (including the military relocation) expected to occur over the next few decades.

At the time of this writing, Port personnel continue to evaluate the Port master plan and study the key modernization initiatives identified above.

Funding for the Port's improvements (modernization) and expansion is anticipated to come from various federal agencies, GovGuam, and private sources. The funds for capital improvements would likely be repaid through user fees that would then be passed on to consumers, businesses, and other entities (i.e., DoD). DoD is not funding Port improvements, nor is it directing or requesting Port improvements.

1.2.2 Related Action

Related actions, as defined in 40 CFR 1508.25, are actions that are closely related. Such actions automatically trigger other actions that have environmental impacts, cannot or would not proceed unless other actions have been taken previously or simultaneously, or are interdependent parts of a larger action and/or depend on the larger action for their justification. If not for the proposed actions, then the related action would not occur.

Workforce housing to support the proposed actions would be a related action.

Workforce housing would be provided by the contractors as described in Volume 2, Chapter 16, "Socioeconomics and General Services." DoD would not provide workforce housing, but design-build contracts would require the contractor to accommodate the workforce in accordance with specified health and safety standards. Various proposals are being developed by potential contractors in anticipation of winning a contract. The timing and location are unknown for construction and/or renovation of housing to accommodate the construction workforce, but it is likely that some of the workforce housing projects would begin in advance of the record of decision. DoD has no decision-making authority on current proposals for construction workforce housing, and the record of decision would not endorse specific proposals for workforce housing.

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CHAPTER 2.
PROPOSED ACTION AND ALTERNATIVES

The proposed military buildup on Guam associated with the relocation of the United States Marine Corps (Marine Corps), the Navy aircraft carrier berthing, and the Army Air and Missile Defense Task Force (AMDTF) would increase the demand for power, potable water, and wastewater utilities. It would also affect the remaining life of existing solid waste facilities and the demand for the new Government of Guam (GovGuam) Layon Landfill in Dandan. The proposed actions would also require roadway improvements. To support the proposed military buildup, utility and roadway alternatives were developed.

For utilities, interim, basic, and long-term alternatives have been developed.

Interim alternatives would meet the demand for utilities to support the military buildup on Guam and are evaluated in this Draft Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) in a project-specific manner. For interim alternatives, no additional National Environmental Policy Act (NEPA) analysis, other than what is included in this Draft EIS/OEIS, would be conducted.

Basic alternatives would meet the demand for utilities to support the military buildup on Guam for both the near-term and long-term, and are evaluated in this DEIS in a project-specific manner. For basic alternatives, no additional National Environmental Policy Act (NEPA) analysis, other than what is included in this DEIS, would be conducted.

Long-term alternatives would meet the demand for utilities over the long term, in the event that interim alternatives are found to be insufficient in the future. Long-term alternatives are presented conceptually, as much of the detail related to them is yet unknown and would require substantial study, planning coordination, and budgeting. Because long-term alternatives are not ripe for detailed, project-specific environmental impact evaluation at this time, they would require additional NEPA analysis in the future should they be pursued.

Interim and Basic Alternatives

The following interim and basic alternatives for utilities are analyzed in a project-specific manner. They are described in more detail later in this volume and are graphically presented in Figure 2.0-1.

- Power:
  - Interim Alternative 1—recondition up to four existing Guam Power Authority (GPA) generating facilities and continue to operate within existing permitted capacity and upgrade transmission and distribution (T&D) systems
  - Interim Alternative 2—recondition up to three existing GPA generating facilities and increase permitted capacity and upgrade T&D systems
  - Interim Alternative 3—recondition up to three existing GPA generating facilities, upgrade one DoD generating facility, increase permitted capacity, and upgrade T&D systems
- Potable Water:
  - Basic Alternative 1—develop new water system for Marine Corps relocation assuming Cantonment Alternatives 1 and 2, and install up to 22 new wells on DoD property
  - Basic Alternative 2—develop new water system for Marine Corps relocation assuming Cantonment Alternatives 3 and 8, and install up to 31 new wells on DoD property

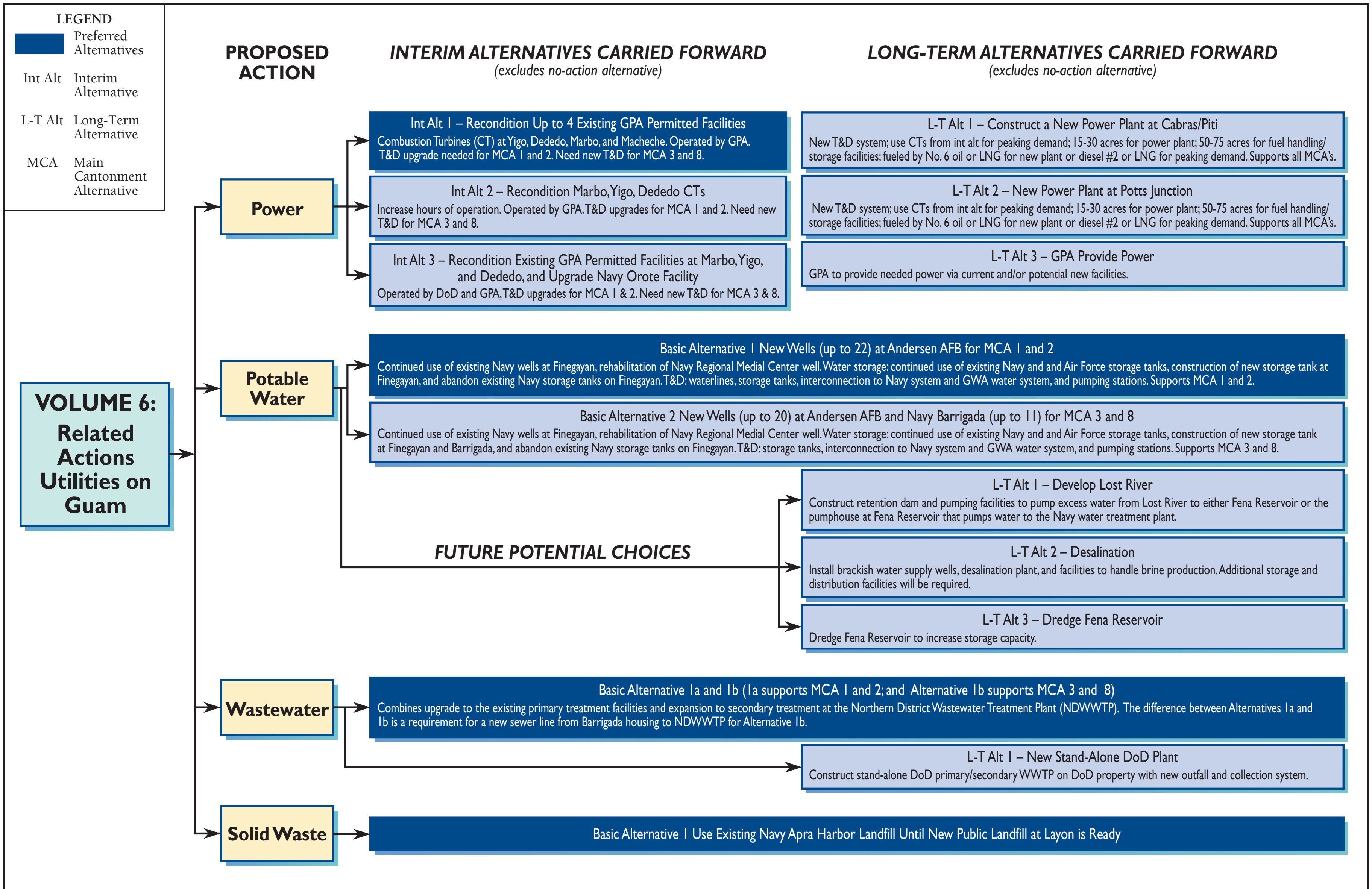

Figure 2.0-1
Summary of Proposed Action and Alternatives Carried Forward for Utilities, Guam

- Wastewater:
  - o Basic Alternative 1 (1a supports Main Cantonment Alternatives 1 and 2; and 1b supports Main Cantonment Alternatives 3 & 8) combines upgrade to the existing primary treatment facilities and expansion to secondary treatment at the Northern District Wastewater Treatment Plant (NDWWTP). The difference between Basic Alternatives 1a & 1b is a requirement for a new sewer line from Barrigada housing to NDWWTP for 1b.
- Solid Waste:
  - o Basic Alternative 1—continue to use the Navy landfill until the new GovGuam Layon Landfill at DanDan is available for use

For roadways, the alternatives listed below were developed in conjunction with each cantonment alternative configuration and are analyzed in a project-specific manner. Each alternative consists of a set of GRN projects, the majority of which are common to all four alternatives. Each project may consist of one or more of six types of roadway improvements (intersection improvements [including military access points (MAP)], bridge replacements, pavement strengthening, roadway widening, roadway relocation, and new road). They are described in more detail later in this volume and presented in Table 2.5-3.

Alternative 1— There are 49 GRN projects that would be required for Alternative 1. They are listed in Table 2.5-3, with the exception of GRN #38, 39, 41, 47, 48, 49, 49A, 63, and 74. These projects consist of 29 pavement strengthening, 8 roadway widening, 14 intersection improvements (includes 8 MAPs), 5 bridge replacements, 1 road relocation, and 1 new road.

Alternative 2— There are 49 GRN projects that would be required for Alternative 2. They are listed in Table 2.5-3, with the exception of GRN #38A, 39A, 41A, 47, 48, 49, 49A, 63, and 74. These projects consist of 29 pavement strengthening, 8 roadway widening, 14 intersection improvements (includes 8 MAPs), 5 bridge replacements, 1 road relocation, and 1 new road.

Alternative 3— There are 51 GRN projects that would be required for Alternative 3. They are listed in Table 2.5-3, with the exception of GRN #20, 31, 38A, 39A, 41, 41A, and 124. These projects consist of 29 pavement strengthening, 10 roadway widening, 17 intersection improvements (includes 11 MAPs), 5 bridge replacements, and 1 road relocation.

Alternative 8— There are 51 GRN projects that would be required for Alternative 8. They are listed in Table 2.5-3, with the exception of GRN #38, 39, 41, 47, 48, 49, 63, and 74. These projects consist of 28 pavement strengthening, 8 roadway widening, 15 intersection improvements (includes 9 MAPs), 5 bridge replacements, 1 road relocation, and 1 new road.

Long-Term Alternatives

As mentioned previously, a programmatic approach is taken in this DEIS for long-term alternatives. Based on available information, the potential environmental effects associated with the long-term utility projects are analyzed for impacts to the utilities themselves but impacts of the long-term utilities alternatives to other resource areas are not analyzed in this DEIS. If such projects were to be pursued, additional NEPA documentation and resource surveys would be completed in the future when project-specific information and funding becomes available for these long-term projects.

Some long-term solutions have not been finalized because it is anticipated that special purpose entities will be formed to operate, manage, upgrade or develop utility plants and associated infrastructure such as collection or distribution systems. The precise manner in which these private business entities would operate is not known but the Navy anticipates they will receive financing from the Government of Japan under the agreement reached between the U.S.. and Japan regarding relocation of Marines from Okinawa to Guam. The Navy will not exercise any authority or control over the SPEs but is committed to facilitate discussions between GOJ, the SPE and Guam to focus SPE efforts on addressing utility impacts associated with the short-term construction work force and long term population growth. For example, private entities might develop, construct, and manage a power plant or a wastewater treatment plant. The U.S. government would then agree to purchase utilities from that plant as a fee that provides payback to the SPE on its investment. Given that these SPEs have yet to be formed, these long-term alternatives are not currently defined in detail.

The following long-term utilities alternatives are analyzed in a programmatic manner. They are described in more detail later in this volume.

- **Power:**
    - Long-Term Alternative 1—New Power Plant at Cabras/Piti Location
    - Long-Term Alternative 2—New Power Plant at Potts Junction Location
    - Long-Term Alternative 3—Power supplied by GPA
- **Potable Water (to augment basic alternative chosen if required):**
    - Long-Term Alternative 1—Development of Lost River
    - Long-Term Alternative 2—Desalination of Brackish Water
    - Long-Term Alternative 3—Dredge Sediment from the Navy Reservoir to Increase Storage Capacity
- **Wastewater:**
    - Long-Term Alternative 1—New DoD Only Stand Alone Primary/Secondary Treatment Facility on DoD land at Finegayan including a New Outfall in Support of all Main Cantonment Alternatives

The utility studies assumed that the construction workforce would reside off base and would be served by Guam public utilities at their places of residence. Breakpoints (when utility demand would exceed capacity) were estimated to assess the potential effect on Guam public utilities of the combined DoD population increases and construction workforce increases, with specific discussion of impacts on the NDWWTP, the Guam Waterworks Authority (GWA) water system, and the Guam Power Authority (GPA) Island-Wide Power System (IWPS).

A socioeconomic analysis performed in support of this EIS projected that in addition to direct increases in DoD personnel, the on-base civilian workforce, and the temporary construction workforce, the proposed military buildup would likely affect civilian population growth. The population loadings developed by the socioeconomics team and assumed for analysis in this DEIS are summarized in Volume 1, Table 2.1-2. The population loading assumptions for direct DoD personnel, the on-base civilian workforce, and the construction workforce do vary somewhat from what was assumed in the utility reports. Specifically, the following differences are noted:

- Personnel by service is changed (fewer permanent Air Force and Navy personnel).
- Transient personnel not previously identified were added (Navy and Marine Corps).
- The construction workforce numbers are slightly higher.
- The population flow was revised.

A qualitative assessment of the population changes determined that increases in Marine Corps transient personnel would be offset by reductions in the permanent contingent of Air Force and Navy personnel. The Navy transient personnel are all shipboard, and the ships would not require support services during the interim period (i.e., would not initially contribute to demands on public utilities), with the exception of wastewater. The wastewater flows generated from the Navy's transient population would be sent to the Navy's Apra Harbor WWTP. With consideration for these additions and reductions, a determination was made that the on-base demand for the population described in Table 2.1-2 below would not differ substantially from the demand calculated in the utility studies, and the general conclusions and recommendations made in the utility studies would still be valid for the current population being considered in this EIS/OEIS.

The utility studies did not consider the potential impact associated with civilian growth. The socioeconomic analysis projected that induced civilian growth as a result of the military buildup could increase the island-wide population of Guam by approximately 40,000 in the peak year of 2014. The increased demand associated with this induced civilian growth was estimated by extrapolating the results and methodology used in the utility studies. However, these revised demands have not been confirmed by a detailed utility study. These demand increases would affect GovGuam utilities more than the DoD utilities.

In addition, non-project population increases for the Air Force, Navy, and Coast Guard are considered in the utilities analyses in order to ensure adequate services and capture the entire impact for the foreseeable future.

Other differences between the original utility studies and this DEIS include:

- The elimination of the growth factor from the Uniform Facilities Criteria (UFC) during the interim period for power and potable water. It is not reasonable to assume a growth factor during the buildup period since growth would already be integral to the buildup.
- Consideration for energy and water conservation as required by numerous executive orders.
- Leadership in Energy and Environmental Design (LEED) and sustainability initiatives being pursued during the planning and design for this buildup, which will reduce power and water demand.
- Local Guam factors that reduce utility demand from that prescribed by the UFCs, such as natural precipitation being adequate for properly designed landscaping, thus eliminating irrigation.
- More accurate current wastewater flow data from both Andersen AFB and GWA for NDWWTP was received in February 2009 due to erroneous flow measurements.
- More accurate power requirements for the future "Ford" class of aircraft carrier became available. This reduced the power demand for this transient condition.

All of these differences between the original utility studies and are discussed in supplementary analysis letter reports for power, water, and wastewater. The reasons for differences in the proposed alternatives in this DEIS and the studies are also discussed in the supplementary analysis letter reports.

2.1 POWER

2.1.1 Overview

The proposed actions on Guam would create an increased power demand. Table 2.1-1 lists the anticipated demand for each component of the proposed military buildup, including the AMDTF. The estimated total Marine Corps demand is 20.94 megawatts (MW) and total DoD demand is 123.63 MW (existing, transient, and future). The total demand is anticipated to occur as early as 2015, when all planned facilities would be in service and operational. Each of the demand values in Table 2.1-1 is based on the UFC planning criteria, but does not include additional capacity for future growth, which will be used for the long-term power generation planning. .

Table 2.1-1. Estimated Department of Defense Power Demand for Guam

Demand Description	*Demand (MW)*			
	Existing DoD Demand	*Other Planned DoD Demand Increases*	*Marine Corps Demand Increases*	*Total DoD Future Planned Demand*
Andersen AFB	18.10	8.64	0.46	27.20
Northwest Field	0.50	1.08	0.00	1.58
Andy South	1.00	0.00	0.00	1.00
NCTS Finegayan (plus utilities)	1.20	2.82	14.47	18.50
South Finegayan Housing Area	1.50	0.00	5.87	7.37
Barrigada	1.30	0.00	0.00	1.30
Naval Hospital	3.20	1.66	0.00	4.86
Naval Base Guam	20.75	1.12	0.14	22.01
Total Demand (excludes transient)	**47.55**	**15.32**	**20.94**	**83.81**
Naval Base Guam (max. transient demand) [a]				39.82
Total Electrical Demand (MW) [b]				**123.63**

Legend: AFB = Air Force Base; DoD = Department of Defense; MW = megawatts; NCTS = Naval Computer and Telecommunications Station.
[a] Represents maximum demand on any given day for aircraft carrier and associated escort ships (Navy), or Expeditionary Strike Group (ESG) (Marine Corps) (not in port on the same days) .
[b] For 19 service locations.
Source: NAVFAC Pacific 2008b.

Power requirements presented are based on planned facilities to meet the needs of the projected population. Different Main Cantonments will require different transmission and distribution upgrades, but the basic facility demands would be the same as presented in Table 2.1-1. Proposed generation facilities are expected to remain the same in both capacity and location.

DoD estimates a future peak demand of 123.63 MW. This includes 47.55 MW of current DoD demand at existing DoD facilities on Guam, a total of 15.32 MW from other planned non-project DoD actions, a total of 20.94 MW from the proposed Marine Corps relocation, and a net total of 39.82 MW of transient demand.

A transient power demand will occur when either the proposed berthing and embarkation of a transient aircraft carrier and escorts or the ships that make up an Expeditionary Strike Group (ESG) are in port. The demand from the transient aircraft carrier and associated escort ships is estimated at 39.82 MW. The ESG demand is estimated at 16.78 MW. The transient aircraft carrier and its associated escort ships would not be in port at the same time as an ESG; therefore, the power demand for the transient aircraft carrier and an ESG is not combined. The higher demand number related to the transient aircraft carrier was considered in demand projections and is part of the total estimated future demand of 123.63 MW.

Current planning for the transient demand includes a dedicated transmission line between the planned transient aircraft carrier berthing at Polaris Point and Piti Substation, located near Cabras Power Plant. Under the proposed action for a transient aircraft carrier wharf, there would be a cumulative total of up to 63 visit days per year, with an anticipated length of 21 days or less per visit. Because of the short length of the transient visits, such visits are categorized as a peaking type load, and planned power for transient ships would be provided by peaking-power facilities instead of a base load power generation facility.

A peaking-power facility is operated for relatively short periods of time and often has a lower installed cost per MW of capacity because of the type of facility and expected operating requirements. Base load power generation is expected to operate continuously except for periods of maintenance or equipment failure and typically has a higher cost per MW of installed capacity as the facility is expected to operate more than 85% of the time in any given year. Also using peaking power units for short time periods is more economical than operating a larger base load generation facility.

The non-transient DoD demand increase is estimated to be 36.26 MW (123.63 MW – 39.82 MW – 47.55 MW). Power usage at existing DoD facilities was evaluated to determine their ratio of minimum power demand to maximum power demand so the power demand could be segregated into base and peaking type power demands. Thirty-one days of data from 17 DoD utility meters were reviewed and resulted in an approximate ratio of 90/10. That is, 90% of the peak load is the minimum load in a day and generally represents the base load percentage typically needed to serve DoD demand.

The minimum continuous demand from the existing DoD system is approximately 90% of the peak demand. Applying the 90/10 ratio of base demand to peak demand to the anticipated future DoD demand results in a required increased base demand of 32.63 MW, with 3.63 MW plus the transient load of 39.82 MW resulting in a new peaking demand of 43.45 MW.

Although the above analysis of power requirements does include power required for the transient ships, the interim alternatives presented do not include this power requirement. This is because the berthing of the transient ships would not include going cold iron (e.g. when ship provided power would be turned off and total power supply from shore would be required) before 2015 or when the long-term power solution would be in place.

Two other types of demand are expected to increase overall power demand on Guam. One is induced civilian growth and the other is construction workers. Power demand from induced civilian growth was considered to be similar to but less than existing per capita power demand because less additional infrastructure per person is expected to be required. In other words, the basic infrastructure is currently present on Guam and any additional power consuming infrastructure required to support the induced civilian growth would be less than existing per capita power demand. Given that consideration, the power demand for induced civilian growth was estimated at two-thirds of the current per capita demand for Guam, which is 1.1 kilowatt (kW). The construction worker load was assessed at a smaller demand because of the expectation that construction workers would be in a high-density living arrangement and have somewhat limited amenities in their housing (e.g. minimal yard lighting, minimal/shared kitchen and entertainment appliances). Thus, the power demand from this population was considered at one-third of current per capita civilian demand.

Power demand from induced civilian population growth caused by the planned DoD buildup on Guam would then be estimated at 0.74 kW average demand per person. Power demand from construction workers would be estimated at 0.36 kW per person. Table 2.1-2 shows the anticipated demand requirements for DoD, construction workers, general population growth projections, and population growth induced by the proposed DoD buildup on Guam.

Table 2.1-2. Power Supply and Demand on Guam (MW)

GPA Power System	*Demand (MW)*									
	Interim Period without 25% Growth Factor					*Long-Term without 25% Growth Factor*				
	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*
Islandwide, including DoD and GPA baseline projected growth										
Existing Guam	281	287	294	299	303	306	309	312	315	318
Guam Induced Civilian Increase (induced growth caused by military increase)	4.93	12.25	19.99	23.44	29.24	22.08	11.23	7.75	7.75	7.88
Construction Worker Increase	1.18	2.99	5.19	6.51	6.70	4.43	1.38	0.00	0.00	0.00
DoD Increase (less 39.82 MW load from transient aircraft carriers)	1.83	2.18	5.04	11.35	17.99	33.31	35.29	35.29	35.29	36.26
Total Demand	288.94	304.42	324.21	340.29	356.93	365.82	356.90	355.03	358.03	362.14
Total Available Supply	490.00	490.00	550.00	550.00	550.00	630.00	630.00	630.00	630.00	630.00
Future Supply Accounting for 1.52 Reliability Factor	322.37	322.37	361.84	361.84	361.84					
Future Supply Accounting for 1.52 Reliability Factor						414.47	414.47	414.47	414.47	414.47
Supply – Demand (net excess or shortfall without transient loads)	33.43	17.95	37.63	21.55	4.91	48.66	57.58	59.44	56.44	52.33
Transient Load Highest requirement with CVN group)						39.82	39.82	39.82	39.82	39.82
Supply – Demand (net excess or shortfall with transient loads)	33.43	17.95	37.63	21.55	4.91	8.84	17.76	19.62	16.62	12.51

Source: NAVFAC Pacific 2008d. Guam Power Authority Integrated Resource Planning (IRP 2008) for existing Guam growth projections.

The majority of the construction activities associated with the proposed Marine Corps relocation are expected to be completed between 2012 and 2015. The proposed military buildup on Guam coincides with Guam Power Authority (GPA) exceeding its "1 day in 4.5 years" reserve capacity to meet reliability goals. This capacity represents a statistical system capacity that would result in an outage of less than 1 day in 4.5 years. The Island-Wide Power System (IWPS) reserve analysis is based on the GPA *Reliability Manual* (1998). In general, the capacity used by GPA to meet its reserve capacity of "1 day outage in 4.5 years" requires a generation capacity in the installed system of approximately 1.52 times the peak demand level. That is, 1.52 MW of supply capacity is required for every 1.0 MW of demand (a simplification of the actual reliability requirements for the power system). GPA's interim system supply capacity is indicated in Table 2.1-2 as 322.37 MW and 361.84 MW and is based on a system generation capacity of 490 MW and 550 MW, respectively, for the years from 2010 to 2014.

GPA's supply forecast is based on an installed generation capacity of 550 MW. A review of 1 year of GPA's actual generation capacity indicates an average daily generation capacity of 490 MW, or nearly 15% less than its stated capacity. This appears to be largely related to units out of service for extended periods of time and units simply not available or not needed and are thus not included in the generation capacity for the daily report. The daily-capacity report is a document produced by GPA that was evaluated over a 1-year period to determine what GPA's typical unavailable capacity is on a regular basis. In this report, the existing combustion turbines (CTs) had been out of service with no specific return-to-service dates identified. A CT refers to a facility that includes a direct-fired turbine (i.e., one in which fuel is fed directly to the turbine) that is connected to and drives a generator for power production. The CT system includes fuel storage and handling, the turbine generator unit, exhaust handling system, cooling system, and related components.

Planning indicates that new power generation capacity would be available by approximately 2015 to support the additional demand and power supply required for long-term power consumption. This new power capacity would be approximately 80 MW. It is planned to have the reconditioned CTs used as peaking/standby capacity once the long-term generation facility is available. Generation of the base load by the new power plant would be expected to provide a lower energy cost than the CTs.

2.1.2 Screening Process

The following power generation alternatives were evaluated in the *Guam Power Generation Study Report for Proposed U.S. Marine Corps Relocation* (NAVFAC Pacific 2008b). These alternatives were evaluated for their ability to provide a long-term permanent solution to meet anticipated DoD energy demands.

The following alternative energy sources for producing base load power were considered:

- Ocean thermal energy conversion (OTEC)
- Wind power
- Solar energy conversion
- Biofuel power
- Waste-to-energy (WTE)
- Fuel cells
- Wave energy conversion
- Geothermal

In addition, the following conventional generation fuel options were considered:

- Heavy (Number [No.] 6) fuel oil
- Liquefied natural gas (LNG)
- Diesel No. 2
- Coal

These alternatives were evaluated based on a qualitative approach to identify the most viable alternatives, using the following criteria for base load and peak power generation:

- *Quality:* Stable frequency and voltage (affected by the balance of the IWPS)

- *Quantity:* Sufficiency to handle peak demand and unscheduled surge, coordinated with GPA generation
- *Fuel Source Availability:* Availability of fuel resources to supply generation plants with sufficient reserve storage for extended delivery schedule
- *Cost Effectiveness:* Analysis of cost-versus-benefit analysis
- *Reliability:* Infrequent outages and reliability in excess of 85% (includes planned outages for operation and maintenance)
- *Ability to Support Base Load:* Ability of the source or system to reliably generate powe to meet base load demand
- *Suitability of Site:* Reasonable availability of suitable site to construct plant

A summary of these alternatives and evaluation to the criteria is included in Table 2.1-3.

Table 2.1-3. Summary of Alternatives Evaluated for Power Systems

Power System Alternative	*Evaluation Considerations*	*Recommendation*
Ocean Thermal Energy Conversion	• Suitable for base load power • Not a reliable mature technology • Very high cost of generation capacity (potentially 20 times) when compared to steam or combustion turbine technologies	Eliminated (possible future consideration with technology improvement)
Wind Power Generation	• Marginal wind quality on Guam • Limited data (a study done at Andersen AFB concluded that wind quality was rated as a 2 on a scale of 1 of 5 with 5 being the best) • Few installed applications with similar typhoon exposure; therefore, not a reliable technology • Not suitable for base load power (wind is not consistent)	Eliminated
Solar Energy Conversion	• Not suitable for base load power (energy available only during daylight) • Relatively high cost for energy when compared to conventional technology • Large land area required (possibly not available) to meet demand requirements; therefore, not viable	Eliminated
Biofuel Power Generation	• No source of bioenergy (crops) on Guam • Fuel cost is higher than diesel fuel or heavy fuel oil currently used and conversion technology is similar to current generation (no technology advantage)	Eliminated
Waste-to-Energy Generation	• No available site on Guam • Possibly suitable for base load generation • Insufficient quantity of waste to support generation large enough to support planned loads	Eliminated
Fuel Cell Power Generation	• No current facility larger than 200-500 kW (would not support planned loads) • No site available suitable to support a fuel cell based facility	Eliminated

Table 2.1-3. Summary of Alternatives Evaluated for Power Systems

Power System Alternative	*Evaluation Considerations*	*Recommendation*
Wave-Energy Generation	• Insufficient wave energy/intensity to provide viable facility • Occurrence of typhoons limits ability to provide a suitable installation; therefore, not viable • Not commercially available in sufficient size to support planned demand	Eliminated
Geothermal	• Insufficient geothermal activity on Guam based on available data • Generally reliable with consistent energy source • No suitable site on Guam identified	Eliminated (possible future consideration with additional study)
Conventional Generation (Fuel Options)		
Heavy (No. 6) Fuel Oil	• High sulfur content results in excessive air emissions • Most used fuel for existing base load generation • Substantial fuel storage reserves on Guam to support generation needs	Retained
Liquefied Natural Gas	• Fuel not currently available on Guam in quantities to support generation • Supplier identified that would provide turnkey natural gas supply on Guam; therefore, could be a viable option because the desire is to go for cleaner fuels • Fuel can be transported in liquid form (smaller volume) and gasified at the generation site • Lower emissions than diesel or heavy fuel oil	Retained
Coal	• Fuel not currently available on Guam • Stable fuel cost and historically lower than oil to produce energy • High carbon dioxide emissions • Mercury emissions	Eliminated
Diesel No. 2	• Higher fuel cost than heavy fuel oil or coal • Lower sulfur emissions than heavy fuel oil • Available sources on Guam	Retained
Interconnection Options		
Construct a New SPE-Owned/Operated Base load Power Plant on DoD-Provided Land with the Ability to Sell Excess Power to GPA	• Unlikely that GPA would purchase power during low DoD use periods (GPA does not currently have a shortage of power) • Additional cost of backup capacity from GPA could increase energy costs another 10% to 20% • The SPE would not be able to increase the size of the facility to serve loads outside of Finegayan (and thus reduce the per-MW capital cost)	Eliminated

Table 2.1-3. Summary of Alternatives Evaluated for Power Systems

Power System Alternative	*Evaluation Considerations*	*Recommendation*
Construct a New SPE-Owned/Operated Base Load Power Plant for Load on North Finegayan with No Connection to the GPA	• A separate system would require the power producer to provide the necessary system backup and spinning reserve capacity to meet system demands and reliability requirements • The system would require privately owned transmission lines to deliver power to remote load locations for loads associated with the Marine Corps relocation, and would require the associated rights-of-way for these transmission line routes • The facility design requirements would include additional standby generation units to address reliability criteria required by the DoD facilities	Eliminated
Construct a New Power Plant at Cabras/Piti—Combination of Repowering Existing Generation Units and New Power Plant and Distribution System, with Base Load Generation Fueled by Coal and Peaking Generation Fueled by Diesel No. 2	• Coal was dismissed as a viable fuel alternative because of the investment in infrastructure, air quality concerns, and inability of coal to benefit the current generating units on Guam • Land is available near the existing generation facilities in Cabras/Piti that is suitable for development of additional generation capacity • The current nonattainment area near Cabras/Piti would require an agreement with GEPA before any progress could be made to site a facility or increase generation capacity in the Cabras area • Fuel storage/availability is convenient because of proximity to the harbor and existing storage (in the case of diesel and No. 6 fuel oil)	Eliminated
Construct a New Power Plant at Cabras/Piti and Related Distribution System Improvements, and Repower Existing Generation Units, with Base Load Generation Fueled by No. 6 Oil or LNG, and Peaking Generation Fueled by Diesel No. 2 or LNG.	• Use of low-sulfur fuel oil or LNG offers the potential to operate within air quality limits for the area • Land is available near existing generation facilities and T&D systems for interconnection with the IWPS • Close proximity to the harbor allows limited overland transportation of fuel or minimal new pipelines to deliver fuel	Retained
Construct a New Power Plant at Potts Junction and Associated Distribution System Improvements to Deliver the Power, and Repower Existing Generation Units, with Base Load Generation Fueled by No. 6 Oil or LNG, and Peaking Generation Fueled by Diesel No. 2 or LNG	• The site area would be less impacted by existing air pollution concerns than the Piti/Cabras location • The area is owned by DoD • Either fuel would need to be trucked in or a new fuel line would need to be built for delivery • A new electrical substation adjacent to the new power plant would be required instead of potential upgrades to an existing substation	Retained

Table 2.1-3. Summary of Alternatives Evaluated for Power Systems

Power System Alternative	*Evaluation Considerations*	*Recommendation*
Place All Generation Planning, Sizing, and Implementation Responsibility with GPA, Possibly by Using Current Generation Capacity (Including Long-Term Higher Use of Combustion Turbine Site Fueled with Diesel) to Meet Power Needs beyond 2015 and Delay New Generation	• GPA would have final decision regarding use of new generation or longer term operation of existing assets. Existing diesel combustion turbines would have higher energy costs because of higher fuel costs. • Current system performance managed by consolidated commission on utilities would be maintained. • Higher energy costs of combustion turbine operation would be passed on to DoD based on input from GPA.	Retained

Source: NAVFAC Pacific 2008b, letter report update to July 2008 study.

2.1.3 Alternatives Dismissed

The long-term alternatives that were evaluated but dismissed and the rationale for their dismissal are summarized below.

2.1.3.1 Construct a New Special Purpose Entity-Owned/Operated Base load Power Plant on DoD-Provided Land with the Ability to Sell Excess Power to GPA

This alternative anticipates that an SPE would construct a new power-generating facility (on DoD-provided land) to meet the anticipated load requirements for the Marine Corps relocation to Guam. The facility would be configured primarily to provide energy to support DoD loads and would include the ability to sell excess power to GPA. The facility would rely on GPA for backup power requirements.

This alternative was dismissed because of the following primary issues:

- It is unlikely that GPA would purchase power during low DoD use periods. (GPA does not currently have a shortage of power generation that would require such a purchase and needs to maximize use of current assets to cover the cost of the facilities.)
- The additional cost of backup capacity from the GPA could increase energy costs by another 10% to 20%.
    - The SPE would not be able to increase the size of the facility to serve loads outside of Finegayan (and thus reduce the per-MW capital cost). The customer base would be limited to Finegayan and the amount of power that the GPA would agree to purchase. (Although the system would be sized to meet peak requirements, it would operate at that level for only a small percentage of the time and thus would not maximize output and minimize cost.)

2.1.3.2 Construct a New Special Purpose Entity-Owned/Operated Base load Power Plant for Load on North Finegayan with No Connection to the GPA

This alternative would establish a separate grid system for planned loads. One of the main issues associated with this approach is backup power and system reliability. In general, a power facility with a firm capacity of 60 MW (e.g., three 20-MW units) would require installation of two additional 20-MW units so that one unit could be removed from service, a second unit could fail, and the 60-MW firm capacity rating could still be met. This would enable the system to provide sufficient capacity for standalone power with standby capacity, allowing for maintenance of duty units and continued operation should a duty unit fail unexpectedly. The system's reliability would also be affected by the distribution system design. Most distribution systems provide multiple paths to provide power to a location. The number of paths would depend on the voltage level and type of equipment located at the point in question.

Either of these two issues (generation and distribution) would have a tremendous effect on the installed cost for this alternative. The generation impact could require installation of twice the firm capacity to meet expectations for reliability. Moreover, to maintain an equivalent level of redundancy with the existing GPA transmission system, the distribution system would need to be designed with alternate feeders to be used should the primary feeder fail.

Several other major considerations make this alternative undesirable:

- A separate system would require the power producer to provide the necessary system backup and spinning reserve capacity to meet system demands and reliability requirements.
- The system would require privately owned lines to deliver power to the Finegayan load locations associated with the Marine Corps relocation, and would require the associated rights-of-way for these routes if not on DoD land.
- The facility design requirements would include additional standby generation units to address reliability criteria required by the DoD facilities.

These issues would result in a cost basis that cannot be supported with a competitive cost for electricity to the new customers associated with the Marine Corps relocation. This option was therefore eliminated from further consideration.

2.1.3.3 Construct a New Power Plant at Cabras/Piti—Combination of Reconditioning Existing Generation Units (20-40 MW) and New Power Plant and Distribution System, with Base Load Generation Fueled by Coal and Peaking Generation Fueled by Diesel No. 2

Coal is a cheaper fuel option than oil, but carries with it some other burdens. Coal use would require a large investment in material handling infrastructure to transport, unload, transfer, and store coal near the new power plant. These activities would require a substantial amount of space. Because this location is currently considered a nonattainment area with regard to air pollution, implementation of this alternative would likely require state-of-the-art combustion such as a fluidized bed that refers to the combustion chamber/process for a boiler system, in combination with exhaust cleanup technologies such as electrostatic precipitators and wet scrubbers. Even with these features, exhaust from the existing oil-fired generators would likely need to be cleaned up to prevent degradation in the region's air quality.

In considering potential new fuel sources, coal offers a viable new and more economical source for only the new power plant. Diesel generators cannot be converted to coal use except through coal liquefaction or gasification, which are both more expensive than oil.

Coal was dismissed as a viable fuel alternative because of the cost of the infrastructure, air quality concerns, and the inability of coal to benefit the current generating units on Guam.

2.1.3.4 Wind Power

Wind turbines for electrical generation are commercially available in sizes from 25 kW to 3,000 kW. Based on review of the available wind studies for Guam, the best areas for wind development for the military are Andersen AFB in northern Guam, the ridgeline at the Naval Munitions Site, and the Orote Peninsula at Naval Base Guam in central Guam. Long-term historical wind data are not available for Andersen AFB. Data are available for the Guam Airport: however, winds there average 11 miles per hour (mph) (18 kilometers per hour [kph]) at 164 feet [ft] [50 meters (m) above ground]). Based on a wind-speed scale of Class 1 to Class 5 (with 5 being the best), these speeds achieve only a Class 2 rating. A minimum wind-speed rating of Class 3 (average wind speed of approximately 15 mph [24 pH.]) is generally considered necessary to prove cost effective based on current capital costs.

Because a unit of power varies proportionally with the cube of the wind speed, a 12-mph (19-kph) wind-speed site would have only one-half the potential wind power output of a 15-mph (24-kph) wind-speed site. However, because electrical costs on Guam are much higher than those in the United States, 12-mph (19-kph) wind speeds may be adequate to make this wind development viable. This fact was also weighed against the much higher construction costs for Guam, compared with average costs in the United States.

Consideration was also given to typhoon wind requirements. Facility design for Guam requires the ability to withstand 180-mph (290-kph) winds. Although some wind-power towers have been developed in Japan for typhoon conditions, few have withstood typhoon winds to provide a basis for a proven tower design.

Wind energy provides the benefit of being a renewable and sustainable energy source that is nonpolluting. However, visual aesthetics and the large land area required for siting the wind turbines are major considerations. In addition, this energy source is intermittent depending on the actual wind speeds present at the site, and cannot be used as a reliable means of power generation to serve as a continuous-duty or even backup source of power. For these reasons, wind power generation was eliminated from further consideration for base load power generation. However, wind energy could be used to supplement the base load power generation.

2.1.3.5 Photovoltaic Energy (Solar)

The majority of photovoltaic panels for electrical generation are commercially available in crystalline, polycrystalline, and amorphous silicon panels. A residential system is typically 2 kW and commercial applications are typically 50 kW or larger. Inverters are used to convert the direct-current power output from the panels into alternating-current power. Most of these systems are installed on houses or buildings, and supply the power at 120 or 220 volts.

Based on the available solar insulation data for Guam made available by National Renewable Energy Laboratory, a majority of the United States military lands on Guam are in areas with an average of 5.08 kilowatt hours per square meter (m^2) per day (or the amount of solar energy that strikes a square meter of the earth's surface in a single day). However, large land or large rooftop areas are required for panel installation. As a rule of thumb, 1 kW of power output requires 100 square feet (ft^2) (9 m^2) of roof area. A 5-MW system would thus require 500,000 ft^2 (152,400 m^2) of area; a 50-MW system, 5,000,000 ft^2 (465,000 m^2). In addition, this energy source is available only during sunlight hours, and is intermittent depending on the weather.

Consideration was given to the wind design requirements associated with typhoon regions. Facility design for Guam requires the ability to withstand 180-mph (290-kph) winds. Photovoltaic systems can be installed with mechanisms that rotate panels and minimize exposure to wind but damage from wind driven objects would be likely during a typhoon.

Consequently, photovoltaic energy cannot be used as a reliable means of continuous-duty or even backup power generation; therefore, solar energy generation was eliminated from further consideration for base load power generation. However, photovoltaic energy could be used to supplement the base load power generation.

Although photovoltaic power generation would not be used for baseline power needs, it may be used for incremental usage. Solar hot water heaters and photovoltaics are being considered for individual buildings including housing and office buildings.

2.1.3.6 Biofuel (Biodiesel) Power

Biofuels, ethanol, and hydrogen can be burned in power-generating turbines or engines principally designed to use fossil fuels. Combustion turbines can operate on ethanol or biodiesel, gas engines can operate on ethanol, and diesel engines can operate on biodiesel fuels. Examples include a simple or combined Brayton cycle combustion turbine (originally developed for aircraft jet engine technology); reciprocating gas or diesel engine technology can also be employed.

Air emissions from biofuel power plants would be lower than from power plants burning conventional fossil fuels. Improvements in air emission control technology such as low-nitrogen-oxide control burners would further reduce emissions of nitrogen oxides. Further reduction in air emissions is possible with the use of water or steam injection, or with the use of selective catalytic reduction technology. However, these additional emission controls add substantial capital and operational maintenance costs.

Currently, no agricultural business on Guam is developing crops for the biofuel market, and no producers of biofuel are present on Guam. At present, 20% of the land on Guam is used for agriculture, and another 15% is used for pastureland. Although some potential exists for further development, the implementation of biofuel power on a sustainable basis is not realistic at this time. In addition, there are no current biofuel importers on Guam. Thus, biofuels would need to be imported to Guam if they are to be used in the immediate future; therefore, biofuel power generation was eliminated from further consideration.

2.1.3.7 Fuel Cell Power

Fuel cells operate on the chemical reaction between hydrogen and oxygen that produces electricity, and water as a byproduct. Although a few DoD lands are in operation, the technology is still in commercial development. Although they are also nonpolluting, fuel cells rely on hydrogen as their fuel source. The potential of fuel cell technology to provide reliable power is limited because of the high cost and lack of applications for systems other than small (less than 500-kW) system capacity.

Hydrogen is not commercially available as a fuel source, and extracting hydrogen from water and/or the reducing gas or other fuels into hydrogen requires additional equipment and is energy intensive. Natural gas is often used as a fuel stock for the fuel cells. However, because Guam lacks natural gas resources, the natural gas would need to be imported if it is to be used.

Because this technology is not yet commercially available, and because sustainable sources for the production of hydrogen fuel have not yet been developed and the quantity that could be produced would be limited, the use of fuel cell generators is not recommended at this time; therefore, fuel cell power generation was eliminated from further consideration.

2.1.3.8 Wave-Energy Generation

Wave-energy generators extract the energy carried in ocean waves that flow across the coastline, principally through mechanical action. Wave-energy generators are not commercially available; however, a wave-energy demonstration project sponsored by DoD is being constructed offshore from Marine Corps Base Hawaii. Although wave-energy generators are nonpolluting and renewable, the amount of power extracted from these units would be intermittent and dependent on the strength of the ocean waves. These units cannot be used to provide a reliable means of power for continuous-duty, peak shaving, or emergency power generation; therefore, wave-energy generation was eliminated from further consideration.

2.1.3.9 Waste-to-Energy Conversion

Conventional WTE power plants are steam power plants that sort and burn solid wastes. Because the wastes are normally burned to generate steam (which drives a turbine generator), air emissions are a primary issue. The typical needs for combustion air-emission controls and scrubbing of the waste-exhaust air stream add to the complexity and operating costs for this type of system.

Alternative technologies to conventional WTE steam power plants include gasification, smelting, and plasma-arc technologies. However, none of these competing technologies are yet available in the commercial market.

This alternative was dismissed because under Guam Public Law 25-175, it is unlawful for any person to construct or operate a municipal solid waste incinerator or WTE facility on Guam, as defined by the rules and regulations of the U.S. Environmental Protection Agency (USEPA) or U.S. laws. However, this alternative would still be considered as a supplemental energy source if the law prohibiting operation of a WTE facility were to change to support this technology.

2.1.3.10 Long-Term Renewable-Energy Concepts

Implementation of the renewable-energy concepts discussed below would require additional studies. However, these sources of renewable energy have the potential to provide supplemental power for long-term solutions, given Guam's available resources and available technology. Because these energy concepts may be considered viable as the technology matures, they are being carried as notional options for renewable alternative-energy sources for long-term power solutions. Either way, neither the aircraft carrier nor ESG requirements are included in short-term solutions, but rather are addressed among the options for long-term solutions.

<u>Ocean Thermal Energy Conversion</u>

OTEC is a method for generating electricity that uses the temperature difference between deep and shallow waters to run a heat engine. As with any heat engine, the greatest efficiency and power is produced with the largest temperature difference. This temperature difference generally increases with decreasing latitude (i.e., near the equator, in the tropics). OTEC systems utilize this temperature gradient between warm surface-ocean waters and cold deep-ocean waters to drive either an ammonia-closed cycle, an open cycle, or a combined-cycle power plant. Although none of these systems are in commercial production, the technology has been proven several times. In 1979, a 50-kW demonstration plant was operated at the National Energy Laboratory of Hawaii Authority. This plant generated 50 kW of gross power and a net power of 10 kW, with about 40 kW required for pumping. Although this plant is not currently operating, the Navy is examining a barge-mounted OTEC facility for its Diego Garcia base. A 1-MW net power output production plant is being built at the National Energy Laboratory of Hawaii Authority.

Guam is an ideal location for OTEC because its western coastline fringes on cold deep-ocean water from the Mariana Trench. In fact, a difference of 40 degrees Fahrenheit (22.2 degrees Celsius) can be found between sea level and 3,281 ft (1,000 m) below sea level at a location less than 0.6 mile (1 kilometer [km]) from Guam's shore. This cold ocean water, in conjunction with Guam's warm coastal surface waters, can provide a renewable and sustainable energy source that is nonpolluting. Cold water pumped from the deep ocean can also be used for aquaculture, as a direct cooling source for central chilled-water air conditioning systems, and as a source of freshwater that is generated as a byproduct in open OTEC cycles. Because the supply of deep cold water and warm surface water is available daily throughout the year, OTEC systems could provide a reliable source of power for either continuous-duty or even backup or supplemental power generation.

Geothermal Power Generation

Geothermal power is energy generated from heat stored in the earth, or the collection of absorbed heat derived from underground. Guam is situated several miles east of the southern projection of a historically active line of volcanoes that compose the Mariana volcanic arc. The area is still subject to volcanic activity, with the nearest known active volcanism being an underwater eruption that occurred 100 miles (161 km) north, just south of Saipan. Because the Mariana island chain is at the edge of the subduction zone between the Philippine and Pacific Plates, Guam is subject to frequent earthquakes and tectonic plate movements that make Guam a likely candidate for subterranean volcanic activity and possible geothermal development.

However, there are no known detailed studies or assessment of the geothermal potential for Guam other than a report from the Colorado School of Mines, published in 1975, that provided an overview of the potential for geothermal energy in the Pacific region (Colorado School of Mines 1975). Additional geological studies and drilling are needed to quantify and determine the potential for geothermal development on Guam.

2.1.4 Interim Alternatives

It is assumed that new interim power generation facilities would consist of the same system capacity and upgrades for all four Main Cantonment alternatives, and only the cantonment locations of the planned DoD facilities would be different. Main Cantonment Alternatives 1, 2, 3, and 8 would require different transmission and distribution (T&D) upgrades to support substantially different load locations. The locations of the currently proposed interim power generation alternatives are shown in Figure 2.1-1.

2.1.4.1 Interim Alternative 1 (Preferred Alternative)

This alternative would recondition up to four existing permitted GPA combustion turbines to restore the system to its original design capacity and support interim-load demands with no modifications to air permits. This alternative would recondition up to four existing combustion turbines that are not current in their maintenance requirements and cannot be reliably used to their permit limits. Units to be reconditioned would include the combustion turbines at Yigo, Dededo Unit No. 1, Marbo, and Macheche. An additional combustion turbine (Dededo Unit No. 2) was recently reconditioned by GPA and would also be utilized under this alternative.

This alternative supports Main Cantonment Alternatives 1 and 2. For Main Cantonment Alternatives 3 and 8, the reconditioned combustion turbines selected would remain the same but require additional upgrades to the T&D system to support these Main Cantonment locations.

The evaluation of power generation considered islandwide power capacity and requirements. The DoD load calculations include DoD facilities only and do not consider construction workers or induced growth directly. However, the effects of construction workers and induced civilian growth were considered when evaluating the IWPS demands as shown in Table 2.1-2 and also in Chapter 3 of this volume. The estimated time that increased capacity would be required includes a power demand estimate for the construction workforce. This additional power capacity would be available to the IWPS at that time. The location of this housing is currently unknown and the necessary localized T&D upgrades to support the housing should be coordinated by the contractor with GPA.

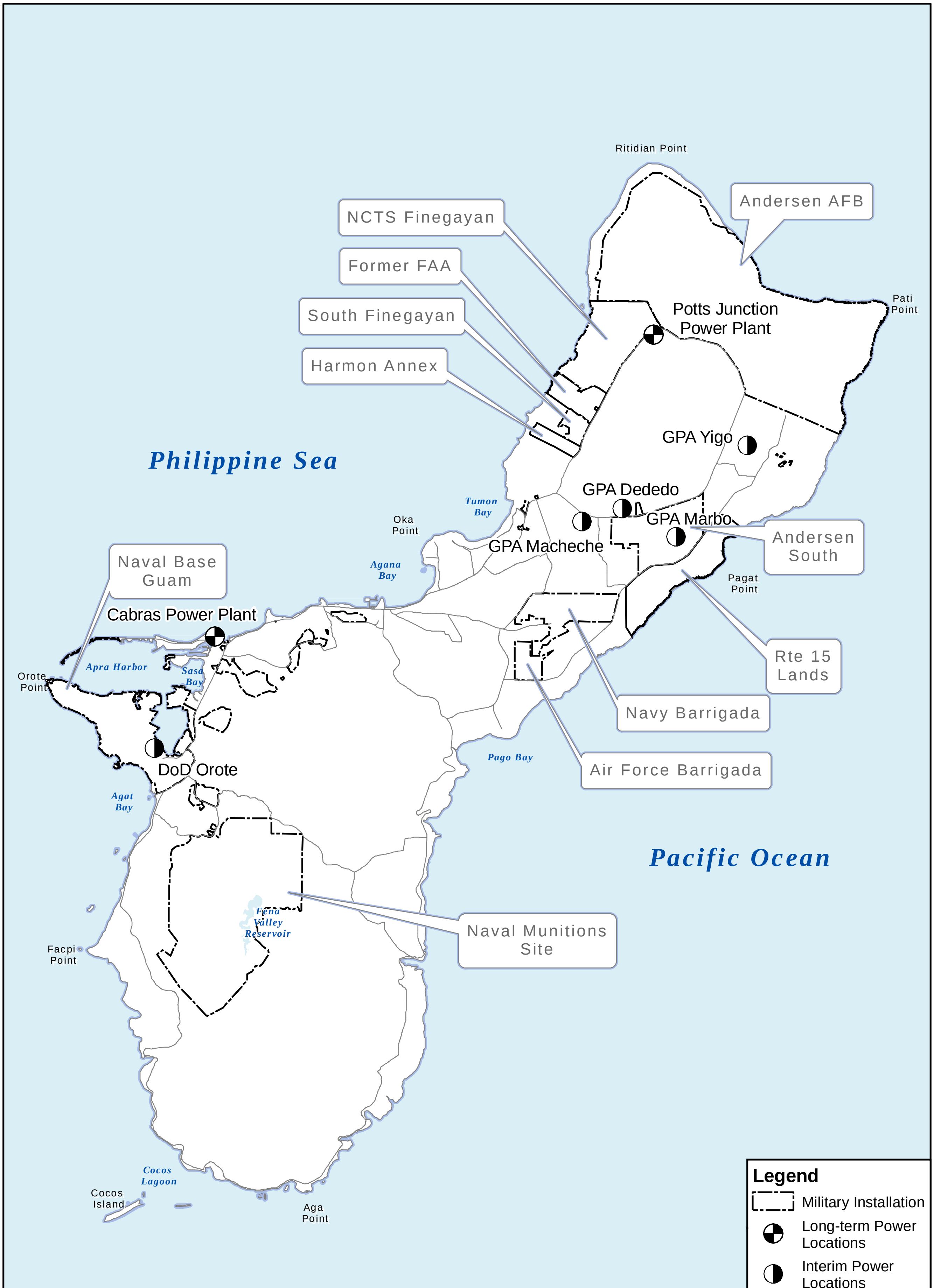

Figure 2.1-1
Proposed Power Alternative Locations

Miles 0 2 4
0 3 6 Kilometers
N W E S

Printing Date: Jun 18, 2009; M:\projects\GIS\8806_Guam_Buildup_EIS\figures\Current_Deliverable\Vol_6\2.1-1.mxd

Present requirements for T&D upgrades required during the interim period of construction associated with the military buildup on Guam for the Main Cantonment Alternatives 1 and 2, in addition to elements required for the Main Cantonment Alternatives 3 and 8, are listed in Table 2.1-4. The interim facilities are expected to support the USMC relocation by 2015 and include the following major components identified as part of Cantonment Alternatives 1 and 2:

- North Finegayan USMC facilities
- South Finegayan USMC facilities
- ESG facilities at Main Base Navy

The interim period includes direct and indirect impacts to the island wide power system (IWPS). The demand increases require a series of T&D upgrades to support transmission of the increased power. Those T&D upgrades are summarized in Table 2.1-4 and include capacity for interim and long-term loads.

Table 2.1-4. T&D Upgrades

Item	*Project Description*	*System Overhead/Underground*	*Voltage*	*Interim*
1	Upgrade Piti X20 to Orote X35 line (currently overhead)	Underground	34.5kV	Y
2	Upgrade Harmon X87 to Andersen X73 line (currently overhead)	Underground	34.5kV	Y
3	Upgrade Piti X21 to Orote X31line Double Circuit (currently overhead)	Underground	34.5kV	Y
4	Upgrade Dededo CT X150/155 to Andersen X71line Double Circuit (currently underground)	Underground	34.5kV	Y
5	Upgrade Harmon X88 to Dededo X151/154 line Double Circuit (currently overhead)	Underground	34.5kv	Y
6	Upgrade Harmon X82 to Yigo X160 line and Yigo X161 to Andersen X (currently overhead)	Underground	34.5kv	Y
7	New 24 MVAR Capacitor Bank at Orote 13.8kV	N/A	13.8kv	Y
8	New 3 MVAR Capacitor Bank at SRF 13.8kV	N/A	13.8kV	Y
9	New 24 MVAR Capacitor Bank at Andersen 13.8kV	N/A	13.8kV	Y
10	New 18 MVAR Capacitor Bank at NCTS	N/A	13.8kV	Y
11	New Harmon to Andersen line	Overhead	115kV	N
12	New Andersen Substation With 112 MVA Power Transformer	Overhead	115kV	Y
13	New Piti Orote line	Overhead	115kV	N
14	New Orote Substation With 112 MVA Power Transformer	Overhead	115kV	Y
15	Upgrade Harmon X87 to Andersen X73	Overhead	115kV	Y
16	Piti X20 to Orote X35 line	Overhead	115kV	Y
17	New 24 MVAR Capacitor Bank at Orote 13.8kV	N/A	13.8kv	Y
18	New 3 MVAR Capacitor Bank at SRF 13.8kV	N/A	13.8kV	Y
19	New 24 MVAR Capacitor Bank at Andersen 13.8kV	N/A	13.8kV	Y
20	New 18 MVAR Capacitor Bank at NCTS	N/A	13.8kV	Y
Additional Electrical Distribution Upgrades to Support Cantonment Alternatives 3 and 8				
Item	*Project Description*	*System Overhead/Underground*	*Voltage (kV)*	*Interim*
1	AF Barrigada (Eagle Field) Substation located at AF Barrigada	N/A	34.5	Y
2	Line from Barrigada to AF Barrigada (Eagle Field)	Overhead	34.5	Y
3	Line from AF Barrigada (Eagle Field) to Pulantat	Overhead	34.5	Y

Item	*Project Description*	*System Overhead/Underground*	*Voltage*	*Interim*
	(essentially re-routing Barrigada to Pulantat 34.5 kV line to go through Eagle Field Substation first)			
4	Apra to Talofofo Line	Overhead	34.5	Y
5	12 MVAR capacitor bank at AF Barrigada (Eagle Field) for voltage support.	N/A	13.8	Y
6	6 MVAR capacitor bank at Navy Barrigada for voltage support	N/A	13.8	Y

Each of the listed upgrades was identified while coordinating between GPA during preparation of the Power System Study Report (July 2008, revision 1). These upgrades were identified as necessary to meet system requirements for voltage and capacity while maintaining two sources of power to each area. The items identified as required for interim power would upgrade T&D for northern Guam circuits north of the existing Harmon Substation that impact Dededo, Yigo, Andersen, Pott's Junction and NCTS. These upgrades would be sized to support all future projected loads for both Finegayan and Andersen to avoid upgrading the same lines twice within a short period of time. The lines follow existing utility distribution and will require underground trenching.

The 115kV lines are expected to be installed overhead while 34.5kV lines would be installed underground to improve resistance to typhoons. The capacitor banks will be installed at existing facility locations (substations, switchgear or similar locations) and connected to the circuits to improve system voltage regulation. The existing GPA T&D system for Guam is shown in Figure 2.1.-2

The interim generation reconditioning would be at existing facilities and would not require new generating units; however, reconditioning would ensure reliability for longer periods of operation to meet the increased demand.

2.1.4.2 Interim Alternative 2

This alternative would be an action for GPA and consists of a phased reconditioning of existing generating units to improve existing permitted facilities. The intent of this interim power solution would be to provide additional capacity for 24-30 months plus use of GPA's currently available interruptible supply capacity to meet the anticipated phased interim power needs before the long-term alternative would be available.

It is anticipated that the power would be from reconditioned existing permitted facilities at Marbo, Yigo, and Dededo Unit No. 1. These combustion turbine sites are 15-20 years old and have an anticipated combined capacity of approximately 60 MW, but are not identified as available for service in the daily GPA capacity report. These units would require general reconditioning, capabilities testing, and controlled startup, which together would take an estimated 12 months. An additional combustion turbine (Dededo Unit No. 2) was recently reconditioned and would also be utilized under this alternative. The anticipated implementation timeline for this option would be a 12-month period for each unit for reconditioning to support base load or intermediate-load generation requirements. The final timeline would be coordinated with GPA, but it is anticipated that Dededo Unit No. 1 would be first, followed by Yigo and then Marbo. Distribution system upgrades would be required, consisting of new 34.5-kilovolt (kV) lines for Yigo to Harmon and Dededo to Andersen and Harmon. Construction of the above T&D upgrades would take an estimated 18 months with a crew of approximately 25 workers.

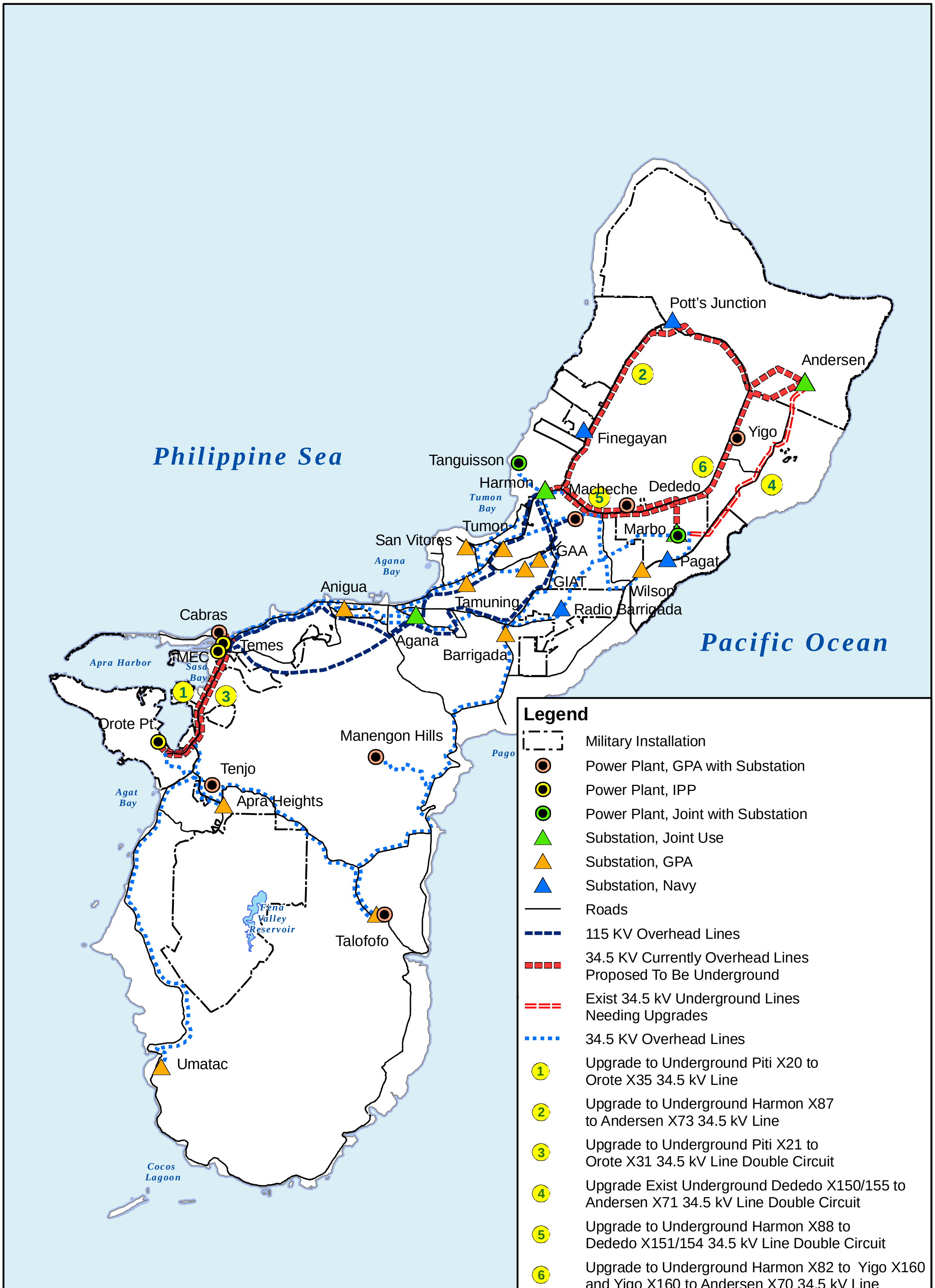

Figure 2.1-2
Proposed Upgrades to Existing GPA T&D System

This alternative would increase operational hours for existing combustion turbines and is expected to require a permit modification for Yigo (currently permitted at 4,280 hours per year).

This alternative supports total power requirements for all four Main Cantonment alternatives because the power would be available to the islandwide grid. Table 2.1-4 present requirements for T&D elements required during the interim period of construction associated with the military buildup on Guam for the Main Cantonment Alternatives 1 and 2, in addition to elements required for the Main Cantonment Alternatives 3 and 8.

Additionally, this alternative provides most of the increased power requirements for the construction workforce within the appropriate timeline. The electrical demand for the construction workforce and induced civilian growth is discussed in Chapter 3 of this volume.

2.1.4.3 Interim Alternative 3

This alternative would be a combined effort by DoD and GPA to implement a phased combination of reconditioning existing GPA permitted generation facilities and upgrading the DoD facility at Orote. The intent of this interim power solution would be to provide additional capacity for 24-30 months to meet the anticipated phased interim power needs before the operation of the final long term power solutions.

The main source of power generation would be from reconditioning of existing GPA-permitted facilities at Marbo, Yigo, and Dededo Unit No. 1. An additional combustion turbine (Dededo Unit No. 2) was recently reconditioned and would also be utilized under this alternative. Additionally the Navy-permitted Orote generation facility located on the Navy base will serve as a backup. These units have not been historically identified as available for service in the GPA daily-capacity report. As such, the three GPA combustion turbines sites are not currently viable for base load power generation. However, these units are 15-20 years old and have a combined rated capacity of approximately 59 MW that would become available for the interim period after reconditioning. It is anticipated that they would require general reconditioning, capabilities testing, and controlled startup, a process that could take up to 1 year for each systems; the systems could be worked on concurrently or sequentially. The extent of reconditioning necessary to provide base load or intermediate-load power generation would not be fully known until the units had been inspected and tested.

The anticipated timeline for this option would be a 12-month period to recondition each of the GPA generating units, and approximately 12 months for Orote to support base load or intermediate-load generation requirements. Orote would require a new fuel storage tank to enable longer run time between fuel deliveries. The final timeline would be coordinated between GPA and the Navy. It is anticipated that Dededo would be first, then Yigo, Orote, and Marbo. Upgrades to the latter three units would be scheduled concurrently to shorten the overall duration while allowing time to address permitting issues.

Upgrades would be required to the distribution system consisting of a new 34.5-kV line for Yigo to Harmon, and for Dededo to Andersen and Harmon. For Orote, distribution upgrades would consist of a 34.5-kV line and a 115-kV line to Piti, a new capacitor bank at the Orote substation (13.8 kV), and a new Orote substation with a 112-megavolt ampere power transformer. Construction of the above improvements would take an estimated 18 months with a crew of approximately 30 workers.

This alternative would increase operational hours of use for the existing combustion turbines and is expected to require a permit modification for Yigo (currently permitted at 4,280 hours per year) and Orote power plant (permitted for 450 hours per year per unit).

The Orote Power Plant is in an attainment area but may require mitigation of current and new air pollutant emissions. Air quality modeling for this alternative has been performed and is discussed in Volume 6, Chapter 7 and Volume 9, Appendix I.

This alternative supports the total power requirements for all Main Cantonment alternatives because the power would be available to the IWPS and would be the same for each alternative. Table 2.1-4 present requirements for T&D elements required during the interim period of construction associated with the military buildup on Guam for the Main Cantonment Alternatives 1 and 2, in addition to elements required for the Main Cantonment Alternatives 3 and 8.

Additionally, this alternative provides most of the increased power requirements for the construction workforce and induced civilian growth within the appropriate timeline. The projected electrical demand for the construction workforce and the induced civilian growth are discussed in Chapter 3 of this volume. Local T&D improvements may be needed depending on where the imported construction workforce would be housed. It is expected that the developer will coordinate with directly with GPA.

2.1.5 Long-Term Alternatives

Numerous alternatives to meet the power demand associated with the proposed military buildup on Guam were evaluated. However, nine of the alternatives evaluated were dismissed for the reasons provided in Section 2.1.3. Most of the dismissed alternatives are based on alternative energy sources and are not suitable for providing on-demand generation required by the electrical system on Guam. After careful evaluation, three long-term alternatives for power solutions were identified and are being considered. Two of the long-term power solution alternatives are relatively the same concept (building a new power plant), but at either different proposed site locations or supported by different types of fuels; the third alternative is to eliminate the SPE and make GPA responsible for the process and decisions related to providing additional generation for the IWPS.

The long-term power alternatives include using OTEC or geothermal power as a potential option for baseload renewable alternative energy sources. These are sustainable sources of energy and would lessen reliance on fossil fuels. A brief description of the renewable-energy options are provided above in Section 2.1.3.10. These nonfossil-fuel-alternative power sources would also assist the Marine Corps in meeting the energy requirements mandated by the Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007, and in compliance with Navy/DoD policies.

The first two long-term alternatives, as described below, are similar concepts that would recapitalize and modify the existing GPA system to support part of the proposed base load and peak load from the GPA grid, and provide a new generating facility to support the remainder of the required loads. The added generation would be provided by a private entity in the form of an SPE. The long-term power solutions would involve GPA and may possibly be undertaken as joint ventures. These long-term solutions would require close coordination between DoD and GovGuam to ensure that planned facilities would provide capacity for total projected power demands from both military and civilian sources. The third long-term alternative would place the responsibility for an SPE or power purchase agreement with GPA and eliminate DoD involvement.

The long-term alternatives would require follow-on analysis and tiered NEPA documentation. DoD and GPA are currently discussing the use of alternative energy sources. This may substantially change which long-term alternatives are pursued. Therefore, while a preliminary description of the long-term alternatives are presented in the following subsections, impacts related to these long-term alternatives are not assessed in this DEIS because they are not ripe for analysis.

2.1.5.1 Long-Term Alternative 1

This alternative would involve constructing a new power plant at Cabras/Piti and a distribution system, and recondition the existing Dededo Unit No. 1 and Yigo generation units (20-40 MW), which would most likely have been accomplished during implementation of the interim alternative. The base load generation would be fueled by No. 6 oil or LNG, and peaking generation would be fueled by diesel No. 2 or LNG.

This long-term alternative offers the potential to use a different fuel source near the Cabras/Piti location. Investment in infrastructure would be required to receive, handle, and store the fuel (either No. 6 oil or LNG). Using LNG in an initial generation facility would establish a base of LNG usage that would result in lower fuel costs as the use of LNG expands to other generation units.

Water use for this power plant would be independent of the fuel source used. The freshwater demand would be approximately 225 gallons per minute (gpm) (851 liters per minute [lpm]) using a closed-loop system with water tower coolers. The water demand would be driven by evaporation and losses in the system. Trucks and heavy equipment would not be anticipated to leave the site because the fuel (whether No. 6 oil or LNG) would be delivered via ship to fuel storage facilities (including a vaporization facility for LNG, if chosen) and transported through piping systems. Other chemicals and materials would not require heavy equipment or large trucks (limited chemical delivery in vehicles smaller than tractor/trailer units).

The potential for hazardous waste is limited to typical industrial paints, solvents, oils/industrial lubricants, and similar compounds. Use of gaseous ammonia or chlorine is not anticipated.

Site security would be provided by one or more perimeter and internal cameras and perimeter fencing with security card access or on-site staff authorization.

Anticipated site area requirements would be 15-30 acres (ac) (6-12 hectares [ha]) for the generation facilities, not including new fuel handling and storage facilities that may require an additional 50-75 ac (20-30 ha). Securing an adequate land area for generation and storage/delivery/handling facilities within the Cabras/Piti area would be a concern. Some demolition of existing but abandoned facilities would be required to provide adequate space for these new facilities. Coastal areas would require coastal use permits and possible land reclamation to provide sufficient area.

Construction and operating permits would be required. The site would require minimal cut/fill because the facility would be at grade and the site is relatively flat. Subgrade construction would be limited to process piping, minimal subgrade structures, and utility distribution lines (electrical, communications, water, and wastewater).

Main exhaust stacks would be approximately 100-150 ft (30-46 m) tall and 4-8 ft (1-2 m) in diameter, depending on detailed design and fuel choice. A distribution interconnection to GPA's transmission system would be required between the power generation facility and the Cabras/Piti Substation. This alternative would require construction or upgrade of the existing GPA electrical substation at Cabras/Piti.

2.1.5.2 Long-Term Alternative 2

This alternative would involve constructing a new power plant at Potts Junction and associated distribution system improvements to deliver the power, and recondition existing generation units (20-40 MW). The base load power generation would be fueled by No. 6 oil or LNG, and peaking generation would be fueled by diesel No. 2 or LNG. This alternative would not have the same air pollutant emission concerns as Long-Term Alternative 1 because it would not be located in an area with current air pollution compliance issues. This alternative would likely still require the use of advanced emission control technology for oil-based generators. The location would create a need to transfer fuel oil from the harbor to the power plant site via tanker truck or new and lengthy pipeline. Other attributes would be similar to those of Long-Term Alternative 1, except for the following:

- The site area would be less constrained by existing air pollution concerns.
- A new electrical substation adjacent to the new power plant would be required instead of potential upgrades to an existing substation.

2.1.5.3 Long-Term Alternative 3

This alternative would involve GPA providing the financing and planning for the power generation required to serve planned loads and meet system reliability requirements. GPA would be responsible for planning and implementing the necessary generation expansion to support DoD planned loads based on the proposed implementation schedule.

2.1.5.4 Transmission and Distribution Upgrades for Long-Term Alternatives 1, 2, and 3

Each of the long-term alternatives described in Sections 2.1.5.1, 2.1.5.2, and 2.1.5.3 would require and include T&D upgrades as shown in Table 2.1-5. Note that some of these T&D upgrades would have already been completed during the chosen interim alternative as shown in Table 2.1-4.

Table 2.1-5. Electrical Distribution Upgrades to Support DoD Planned Facilities

Project Description	*System Overhead/Underground*	*Voltage (kV)*
New Harmon-to-Andersen line	Overhead	115
New Andersen substation with 112-MVA power transformer	Overhead	115
New Piti-to-Orote line	Underground	115
New Orote substation with 112-MVA power transformer	Overhead	115
Upgrade to Harmon-to-Andersen line	Underground	115
Upgrade to Piti-to-Orote line	Underground	115
New 24-MVAR capacitor bank at Orote 13.8 kV	NA	13.8
New 3-MVAR capacitor bank at SRF 13.8 kV	NA	13.8
New 24-MVAR capacitor bank at Andersen 13.8 kV	NA	13.8
New 18-MVAR capacitor bank at NCTS	NA	13.8
NCTS substation, Barrigada substation, Marbo substation, Yigo line upgrades	NA	34.5/13.8 (primary/secondary)
Additional Electrical Distribution Upgrades to Support Cantonment Alternatives 3 and 8		
Project Description	*System Overhead/Underground*	*Voltage (kV)*
AF Barrigada (Eagle Field) Substation located at AF Barrigada	NA	34.5
Line from Barrigada to AF Barrigada (Eagle Field)	Overhead	34.5
Line from AF Barrigada (Eagle Field) to Pulantat (essentially re-routing Barrigada to Pulantat 34.5 kV line to go through Eagle Field Substation first)	Overhead	34.5
Apra to Talofofo Line	Overhead	34.5
12 MVAR capacitor bank at AF Barrigada (Eagle Field) for voltage support.	NA	13.8
6 MVAR capacitor bank at Navy Barrigada for voltage support	NA	13.8

Source: NAVFAC Pacific 2008b.

Both long-term alternatives support Main Cantonment Alternatives 1, 2, 3, and 8 in terms of total power generation. Main Cantonment Alternatives 3 and 8 may require more or different T&D upgrades than those indicated in Table 2.1-5. Those upgrades would be determined before the follow-on NEPA documentation.

2.2 POTABLE WATER

2.2.1 Overview

The proposed military buildup on Guam would be located at Andersen AFB, Naval Computer and Telecommunications Station (NCTS) Finegayan, South Finegayan, Andersen South, Barrigada, and Naval Base Guam. These areas are currently served by the DoD potable water systems of Andersen AFB and Navy.

2.2.2 Anticipated Demand

2.2.2.1 On-Base Water Demand

On-Base Water Demand with Current DoD Criteria Demand Calculation

The demand calculations presented in *Water, Wastewater, and Solid Waste Management Impact Assessment for GJMMP, Guam* (HPE 2006) are the basis for the calculation of anticipated on-base water demand below, with modifications as necessary.

The water demand for the Marine Corps relocation was calculated using the UFC 3-230-19N report, *Unified Facilities Criteria (UFC) Design: Water Supply Systems* (DoD 2005). Demand calculations include total requirements for domestic, industrial, fire protection, and unaccounted-for water (UFW) demands for the Marine Corps relocation population in year 2019. UFW is water that is not metered (such as that lost in leaks or unmetered usage) and is not accounted for in billing by the water utility. UFW is derived by subtracting the amount of water measured by meters and billed to customers from the water that is supplied by the treatment plants and wells, and also accounting for net changes in water storage tank inventories. The current UFW estimates for the Navy from the 2005 utility technical study report (NAVFAC Pacific 2005) are used in calculating baseline demand. Demand for additional population on the Navy bases is calculated using 15% UFW. It is assumed that the current UFW for Andersen AFB is 15%. Based on state standards summarized in the 2005 utility technical study report (NAVFAC Pacific 2005), a UFW of 15% is assumed for the current design. For the Marine Corp base at Finegayan, the UFW is estimated at 5% because the majority of the system will be newly constructed and water meters will be installed to identify and repair leaks as the system ages.

Population loadings used to calculate the projected future demand included active duty personnel and their dependents, transient personnel associated with the aircraft carrier group and the ESG (non-concurrent transient demand), and demands associated with on-base civilian support workers. Table 2.2-1 lists the DoD populations for the military buildup. The future induced civilian population and construction workers are not included in the DoD populations. The induced population and construction workers are expected to be housed off base. The estimated impact to the GWA water system is examined and discussed in Volume 6 Chapter 3.

Table 2.2-1. Department of Defense Population Increases

Population Type	*Baseline*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*
Project-Related Cantonment Alternatives 1 and 2											
Active duty	33	535	1,220	1,220	1,220	8,602	9,182	9,182	9,182	9,182	9,182
Dependents	52	537	1,231	1,231	1,231	9,000	9,950	9,950	9,950	9,950	9,950
Transient	0	0	400	400	400	2,000	2,000	2,000	2,000	2,000	2,000
Civilian Work Force	12	102	244	244	244	1,720	1,836	1,836	1,836	1,836	1,836
Finegayan Total	97	1,174	3,095	3,095	3,095	21,323	22,968	22,968	22,968	22,968	22,968
Project-Related Cantonment Alternatives 3 and 8											
Active duty	33	395	884	884	884	6,239	6,659	6,659	6,659	6,659	6,659
Dependents	52	179	410	410	410	3,000	3,317	3,317	3,317	3,317	3,317
Commuters from Barrigada	0	140	335	335	335	2,364	2,523	2,523	2,523	2,523	2,523
Transient	0	0	0	400	400	400	2,000	2,000	2,000	2,000	2.000
Civilian Work Force	12	92	220	220	220	1,548	1,653	1,653	1,653	1,653	1,653
Finegayan Total	**97**	**806**	**1,850**	**2,250**	**2,250**	**13,551**	**16,152**	**16,152**	**16,152**	**16,152**	**16,152**
Active duty	0	140	335	335	335	2,364	2,523	2,523	2,523	2,523	2,523
Dependents	0	358	821	821	821	6,000	6,633	6,633	6,633	6,633	6,633
Transient	0	0	0	0	0	0	0	0	0	0	0
Civilian Work Force	0	10	24	24	24	172	184	184	184	184	184
Barrigada Total	**0**	**508**	**1,180**	**1,180**	**1,180**	**8,535**	**9,340**	**9,340**	**9,340**	**9,340**	**9,340**

Table 2.2-1. Department of Defense Population Increases

Population Type	*Baseline*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*
Nonproject-Related Cantonment Alternatives 1, 2, and 3 and 8											
Active duty	2,145	0	0	0	0	0	0	0	0	0	0
Dependents	2,950	0	0	0	0	0	0	0	0	0	0
Transient	0	900	900	1,256	1,256	1,256	1,256	1,256	1,256	1,256	1,780
Civilian Work Force	805	0	0	0	0	0	0	0	0	0	0
Andersen AFB Total	**5,900**	**900**	**900**	**1,256**	**1,256**	**1,256**	**1,256**	**1,256**	**1,256**	**1,256**	**1,780**
Active duty	4,490	80	80	80	130	170	250	250	250	250	450
Dependents	5,410	118	118	118	148	240	290	290	290	290	50
Transient	0	0	0	0	0	0	0	0	0	0	0
Civilian Work Force	1,684	17	17	17	27	35	38	38	38	38	45
Navy Bases Total	**11,584**	**215**	**215**	**215**	**305**	**445**	**578**	**578**	**578**	**578**	**785**

Notes:
1. 7,222 transients at Apra Harbor not included in water demand—they are housed on ships.
2. Civilian workforce does not include construction workers.

Per capita (person) requirements for domestic uses including drinking water, household uses, and household lawn irrigation are as follows for permanent and temporary installations (DoD 2005), with the per capita requirements for the tropics selected for Guam:

- Unaccompanied Personnel Housing, 155 gallons per capita per day (gpcd)
- Family Housing, 180 gpcd
- Transients and Workers (per shift), 45 gpcd

The average demand in gallons per day (gpd) is calculated by Equation 1:

Equation 1

Average daily domestic demand in gpd = gpcd x design population x growth factor

The following growth factors are used in Equation 1:

(a) Large systems (5,000 population or greater), 1.25.

(b) Small systems (populations less than 5,000), 1.50.

Total average demand is the sum of averages for unaccompanied personnel housing, family housing and workers. Other controlling demands are calculated by Equation 2:

Equation 2

Maximum Daily Domestic Demand = average daily domestic demand in gpd x K

Where K is 2.25 for populations $< 5,000$ and 2 for populations $> 5,000$.

The demand calculation for GWA is provided in Section 2.2.2.2. It is assumed that the water demands for the services would be addressed by the DoD water systems as follows:

- Marine Corps—Finegayan Base Complex water system
- Air Force—Andersen AFB water system
- Navy—Navy islandwide water system
- Army—Finegayan Base Complex water system
- U.S. Coast Guard—Navy islandwide water system
- Special Operations Force—Finegayan Base Complex water system, Navy islandwide water system, and Andersen AFB water system

It is assumed that housing for the Marine Corps would be either entirely within the Finegayan Base Complex (Main Cantonment Alternatives 1 and 2) or split between the Finegayan Base Complex, Navy Barrigada, and/or Air Force Barrigada (Main Cantonment Alternatives 3 and 8). Main Cantonment Alternative 2 was taken as representative for both Alternatives 1 and 2, and Alternative 3 was taken as representative for both Alternatives 3 and 8.

Industrial water uses include air conditioning, irrigation, swimming pools, shops, laundries, dining, processing, flushing, air conditioning, and boiler makeup water. Demands were assigned according to the values in UFC 3-230-19N (DoD 2005). Additionally, UFC 3-230-19N (DoD 2005) requires the use of water demand data from other activities with uses similar to those anticipated. The industrial demands for the facilities not covered by UFC 3-230-19N (DoD 2005) were assigned a demand based on the measured demands for similar to facilities within the existing Navy bases. The future estimated average daily industrial use is 1.4 million gallons per day (MGd) (5.3 mld) at the Finegayan Base Complex. The industrial demands for Main Cantonment Alternatives 3 and 8 are similar to the industrial demands estimated for Main Cantonment Alternatives 1 and 2. This demand includes 250 gpm (946 lpm) for use in a power generation. Aircraft carrier–related water demand of 0.14 MGd (0.53 mld) is included in the Navy demands. The water demand related to construction is not included in the DoD water demand estimates. The construction-related demand is relatively low and is assumed to be supplied by the contractor through the GWA water system. DoD may provide the construction-related demand through the DoD water system. The anticipated DoD water demands are summarized in Table 2.2-2.

Table 2.2-2. Projected Future DoD Water Demands

	Baseline	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*
Average Daily Demand (MGd)											
Cantonment Alternatives 1 and 2											
Finegayan	0.12	0.32	0.99	1.39	1.78	4.68	4.97	4.97	4.97	4.97	5.89
Andersen AFB	1.86	1.99	2.08	2.19	2.28	2.28	2.28	2.28	2.28	2.28	2.60
Navy	7.57	8.29	8.49	8.64	8.82	8.82	8.85	8.85	8.85	8.85	9.48
Total	9.56	10.60	11.56	12.22	12.87	15.78	16.10	16.10	16.10	16.10	17.97
Cantonment Alternatives 3 and 8											
Finegayan and Barrigada	1.08	1.28	2.06	2.56	3.05	6.04	6.33	6.33	6.33	6.33	7.28
Andersen AFB	1.86	1.99	2.08	2.19	2.28	2.28	2.28	2.28	2.28	2.28	2.60
Navy	6.61	7.32	7.52	7.68	7.85	7.86	7.89	7.89	7.89	7.89	8.52
Total	9.55	10.60	11.67	12.42	13.18	16.18	16.50	16.50	16.50	16.50	18.40
Maximum Daily Demand (MGd)											
Cantonment Alternatives 1 and 2											
Finegayan	0.14	0.59	1.60	2.00	2.39	8.07	8.64	8.64	8.64	8.64	10.48
Andersen AFB	2.85	3.10	3.19	3.32	3.41	3.41	3.41	3.41	3.41	3.41	4.05
Navy	9.41	10.63	10.76	10.96	11.20	11.28	11.32	11.31	11.31	11.31	12.58
Total	12.40	14.32	15.56	16.28	17.00	22.76	23.38	23.37	23.37	23.37	27.11
Cantonment Alternatives 3 and 8											
Finegayan and Barrigada	1.14	1.61	2.74	3.23	3.73	9.58	10.17	10.17	10.17	10.17	12.07
Andersen AFB	2.85	3.10	3.19	3.32	3.41	3.41	3.41	3.41	3.41	3.41	4.05
Navy	8.44	9.66	9.79	9.99	10.23	10.31	10.35	10.34	10.34	10.34	11.61
Total	12.43	14.37	15.73	16.55	17.37	23.30	23.93	23.93	23.93	23.93	27.72

Legend: MGd = million gallons per day

<u>Demand Adjusted to Reflect Federal Mandates to reduce consumption</u>

The potable water demand assumptions presented in Section 2.2.2.1 are based on UFC (UFC-3-230-19N dated 8 June 2005) that provides a conservative estimate to plan the potable water source demand for a standalone system to serve the long term needs of a generic military base located anywhere in the world. Construction on military bases is standardized and dictated by UFC documents that provide planning, design, construction, sustainment, restoration, and modernization criteria. They are applicable to Military Departments, Defense Agencies, and DoD Field Activities. They were relied upon in the development of project designs and would be incorporated into construction documents and permits, and operations and maintenance activities. The documents address issues such as design standards for water systems based primarily on installation population. There is little flexibility in minimal design standards, but there is flexibility in site planning. Congressional appropriations require the incorporation of all relevant UFCs in design.

Unfortunately UFC-3-230-19N addresses the criteria to be used to define the source of water, but does not account for the fact that several federal mandates (Executive Order (EO) 13423, EPAct 2005, EISA 2007, EO 13514) have been issued since the last release of UFC-3-230-19N. These federal mandates require the use of water conservation technology to achieve significant reductions in water usage. EO l3514 dated 5 October 2009 requires federal agencies to reduce their water consumption 26% by 2020 as compared to the federal agency's water consumption in 2007. The disconnect is that with the mandated reductions in usage, we are left with a UFC compliant water source in excess of the actual need. To address this situation, in advance of an update of UFC-3-230-19N and to factor in a more realistic scenario based on Guam, it was decided to incorporated sustainability and water conservation into the water demand calculation. This approach has been endorsed by the Navy Criteria team that is responsible for updating the UFCs and is considered consistent with the spirit and intent of the UFCs. It is essential to start with UFC-3-230-19N and apply sound engineering judgment to adjust requirements in order to preclude the construction of a more costly system that would constrain a limited water resource and ultimately be underutilized, potentially resulting in long term operating issues.

The reduction in on-base water demand for the new Marine Corps base is expected to be in the order of 22% on for the average daily demand, and 40% for the maximum daily demand if conservation measures, sustainability principles, and Guam site-specific conditions are applied. Modifications to the potable water demand estimates are still being finalized at the time of this DEIS publication; however, as discussed in more detail below, the reduced demand presented in this DEIS provides a realistic estimate of the expected demand currently being presented to the Guam Water Authority (GWA) for planning purposes.

<u>Sustainability Principles</u>

The following directives and guidance documents address water conservation:

- EO 12902, "Energy Efficiency and Water Conservation at Federal Facilities"
- EO 13423, "Strengthening Federal Environmental, Energy, and Transportation Management"
- Energy Policy Act of 2005Energy Independence and Security Act of 2007
- 10 United States Code (USC) 2866, " Water Conservation at Military Installations"
- 10 USC 2915, "New Construction: Use of Renewable Forms of Energy and Energy Efficient Products"
- Military Handbook 1165, *Water Conservation*, Mil-HDBK-1165 (1996)
- *Navy Water Conservation Guide For Shore Activities*
- EO 13514, "Federal Leadership In Environmental, Energy, And Economic Performance" (5 October 2009)

Additionally, the existing Navy and Air Force bases are subject to water conservation goals, such as those in EO 13423. Implementation of this order would require a reduction in water usage of 16% by 2015 on the existing bases, this percent reduction is included in the modified potable water demand estimates presented in this DEIS. The water conserved on the existing bases would either reduce the stress on the Northern Guam Lens Aquifer or be made available via interconnects to support off-base developments related to the buildup via a formal request by GWA to the Navy (Naval Facilities Engineering Command Marianas). For more information on sustainability policies and guidance, refer to Volume 8, Chapter 6.

DoD is in the process of developing and approving water conservation measures for the Marine Corps base through equipment selection and management practices. Water consumption at the Marine Corps base would differ from consumption at the existing bases because, as part of the proposed action, the design and construction of the new base at Finegayan would implement low-flow equipment and other improvements to the extent practical. Examples include the following:

- Low-flow faucets
- Ultra-low-consumption toilets/urinals with electric flush sensors
- Low-flow showerheads
- Lower flow commercial-type "Energy Star" washing machines in housing units
- Energy- and water-saving dishwashers (Energy Star)
- Use of water softeners only as needed
- Use of wastewater recycling in industrial washing and rinsing of aircrafts and vehicles
    - Water-efficient cooling systems
    - Minimal landscape irrigation
    - Rainwater collection and reuse

Water management practices would be implemented at the Marine Corps base to better control water consumption and prevent water loss. The amount of water used to water lawns and landscapes would be minimized or eliminated through sustainable design and use of native vegetation. Meters would be installed at all facilities and at key locations within the water distribution system significantly improving the ability to quickly identify leaks and take corrective action. Water management operation procedures would be reviewed periodically and revised as needed. Base residents would be educated with respect to living responsibly on a sustainable base in order to create a sustainable culture through responsible actions by residents. Education programs on proper use of water would include: watering lawns sparingly or not at all, installing low flow fixtures, water reuse, full load clothes washing, etc.. Metering will allow water users to have full awareness of their water usage. For housing residents meters will support billing of water usage directly to the residents. Water conservation will be a key program that will receive command level attention and follow-up.

<u>Site Specific Water Conservation Measures</u>

Because the proposed Marine Corps base is located on Guam, some of the assumptions behind the development of the UFC guidance are not relevant. Notably, the water needed for lawn irrigation would be minimal because of Guam's climate, particularly in the rainy season. As described above, the facility design is expected to implement water conservation equipment that is likely to produce at least a 22% water savings compared to conventional equipment. This water savings is mandated by regulation (EO 13514). No irrigation will be utilized for housing and will be used minimally elsewhere on the base. Landscaping throughout the base will be restricted to the use of native plants that can survive without watering. A common components manual to guide the development of the new Marine Corps base at Finegayan will address which local plants can be utilized in landscaping. Improved leak detection, extensive metering and management systems are expected to reduce the amount of unaccounted for water (UFW) to a rate of 5% based on engineering judgment. It is noted that the UFC-3-230-19N does not address the issue of UFW. The original water demand calculation used a 15% UFW based on current experience at the Navy base. The controlling demand factor used to estimate the maximum daily demand and to size water system components would be lower for Guam because there are limited climatic changes on Guam as compared the mainland and other locations.

The potential savings from water conservation measures for Main Cantonment Alternatives 1 and 2 at

Andersen AFB and Navy bases are shown below in Table 2.2-3.

Table 2.2-3.Water Demand Comparisons Using Conservation/Sustainability Measures

Water Demand Criteria(Existing and Proposed)	*Water Demand (in MGd)*			
	Marine Corps Finegayan	*Andersen AFB*	*Navy*	*Total*
Average Daily Demand using UFC Guidance	5.9	2.6	9.5	18
Average Daily Demand using Sustainability Principles	4.6	2.2	8.7	15.5
Potential Percent Reductions for Average Daily Demand	**22%**	**15%**	**8%**	**14%**
Maximum Daily Demand using UFC Guidance	10.5	4	12.6	27.1
Maximum Daily Demand using Sustainability Principles	6.3	2.8	10.1	19.2
Potential Percent Reductions for Maximum Daily Demand	**40%**	**30%**	**20%**	**29%**

Incorporating these assumptions, the daily demand for the Marine Corps base is estimated to be reduced by approximately 22% of the current estimated average daily demand and 40% of the maximum daily demand. Impacts of these potential water demand reductions is discussed in Chapter 3 of this volume.

2.2.2.2 Off-Base Water Demand

Off-base water demand would be met by GWA. Population estimates are provided in Table 2.2-4. The population consists of the baseline growth (the expected growth in the Guam population without military buildup) in the existing population, the population induced by the Marine relocation, and the construction workers. A separate estimate is provided for the population located in northern and central Guam, where the water demand is met through groundwater resources. The islandwide off-base population would peak in 2014 at 247,897.

Table 2.2-4. Off-Base Population Estimates

Year	*All of Guam*				*Portion Served by Wells (North and Central)*			
	Baseline	*Construction Workers*	*Induced*	*Total*	*Baseline*	*Construction Workers*	*Induced*	*Total*
2010	180,692	3,238	6,651	190,582	175,271	3,238	6,651	185,161
2011	183,081	8,202	16,538	207,820	177,589	8,202	16,538	202,328
2012	185,435	14,217	26,989	226,641	179,872	14,217	26,989	221,078
2013	187,754	17,834	31,646	237,234	182,121	17,834	31,646	231,601
2014	190,042	18,374	39,481	247,897	184,341	18,374	39,481	242,196
2015	192,302	12,140	29,809	234,251	186,533	12,140	29,809	228,482
2016	194,541	3,785	15,165	213,491	188,705	3,785	15,165	207,655
2017	196,757	-	10,462	207,219	190,854	-	10,462	201,317
2018	198,942	-	10,462	209,404	192,974	-	10,462	203,436
2019	201,095	-	10,639	211,734	195,062	-	10,639	205,701

The off-base water demand is estimated using Equation 1 assuming 125 gpd per person per day (473 mld), 50% UFW (e.g., leakage and unmetered usage), and a fixed industrial demand of 10 MGd (38 mld) islandwide. No other factors are included in the estimate (e.g., growth factor). The approach for estimating GWA's water demand is based on information in the GWA *Water Resources Master Plan* (WRMP) (GWA 2007). The off-base water demand estimate is provided in Table 2.2-5. Off-base water demand peaks in 2014 at 61 MGd (231 mld).

Table 2.2-5. Off-Base Water Demand

MGd	*All of Guam*				*Portion Served by Wells (North and Central)*			
Year	*Baseline*	*Construction Workers*	*Induced*	*Total*	*Baseline*	*Construction Workers*	*Induced*	*Total*
2010	49	0.6	1.2	51	47	0.6	1.2	49
2011	49	1.5	3.1	54	48	1.5	3.1	53
2012	50	2.7	5.1	58	48	2.7	5.1	56
2013	50	3.3	5.9	59	49	3.3	5.9	58
2014	51	3.4	7.4	62	49	3.4	7.4	60
2015	51	2.3	5.6	59	50	2.3	5.6	58
2016	51	0.7	2.8	55	50	0.7	2.8	54
2017	52	0.0	2.0	54	50	0.0	2.0	52
2018	52	0.0	2.0	54	51	0.0	2.0	53
2019	53	0.0	2.0	55	51	0.0	2.0	53

2.2.3 Water Supply Sources

Water supply sources considered to meet on-base and off-base water demands are described below. Development of groundwater resources would require coordination between DoD, GWA, and the Guam Environmental Protection Agency (GEPA). This coordination is a necessary part of the well permitting and construction process, and proper management of the Northern Guam Lens Aquifer (NGLA), a designated sole source aquifer. During use of the wells, coordination would continue between DoD and GWA. Groundwater monitoring for chloride content would continue to be measured as an indicator of saltwater intrusion in the NGLA subbasin. Modification of well usage would be evaluated jointly to maximize use of the resource.

The NGLA, located directly underneath northern Guam, is a sole-source aquifer. A sole-source aquifer is an underground water supply designated by USEPA as the "sole or principal" source of drinking water for an area because it supplies at least 50% of the drinking water consumed in the area overlying the aquifer. northern Guam is underlain by a karst limestone plateau with high water conductivity that results both in low retention times between injection wells and withdraw wells, and in a minimum of soil aquifer treatment.

2.2.3.1 DoD Water Supply Sources

The current water supply and additional supply required to meet future on-base DoD demands are summarized in Table 2.2-6. The existing DoD water supply is sufficient to meet current on-base DoD demands. Additional supply to meet future Marine Corps, Army, Air Force, and Navy demands would be required for the military buildup. The future Navy-required supply described in Table 2.2-6 includes up to 4 MGd (15 mld) transferred to GWA. However, due to GWA's planned system expansion, it is expected that less than the full 4 MGd (15 mld) available for transfer from the Navy will be required by GWA in 2019.

Table 2.2-6. Current and Future On-Base DoD Potable Water Supply and Demand

Site	*Current Maximum Demand (MGd)*	*Current Supply (MGd)*	*Current Supply Description*	*Future Maximum Demand (MGd)*	*Additional Supply Needed (MGd)*[a]
Main Cantonment Alternatives 1 & 2					
Finegayan	0.1	0	Navy Islandwide System including Wells on Finegayan	10.5	10.5
Andersen AFB	2.9	4.7	Marbo Wells in Andersen South Five Wells on Andersen AFB	4.0	-
Navy	9.4	10.1	Navy Islandwide System minus 4 MGd for GWA transfer	12.6	2.5
Total DoD	**12.4**	**14.8**		**27.1**	**13.0**
Cantonment Alternatives 3 and 8					
Finegayan and Barrigada	1.1	0	Navy Islandwide System including Wells on Finegayan	12.1	12.1
Andersen AFB	2.9	4.7	Marbo Wells in Andersen South Five Wells on Andersen AFB	4.0	-
Navy	8.4	10.1	Navy Islandwide System minus 4 MGd for GWA transfer	11.6	1.5
Total DoD	**12.4**	**14.80**		**27.7**	**13.6**

Notes: [a] additional required supply = (future maximum demand – current supply); [b] includes 4 MGd available for transfer to Guam Waterworks Authority. [c]The transfer amount to GWA is projected to be less in 2019 due to planned GWA system expansion and continuing improvement efforts.
Source: NAVFAC Pacific 2008c

The year when the anticipated water demand would exceed the current on-base DoD water supply was estimated, and is called the "breakpoint year." This analysis assumes no DoD-planned water supplies are put on line. The capacity of the existing water supply is compared to the required capacity of the water supply which is the maximum daily demand plus the size of the largest well for groundwater based systems. Table 2.2-7 shows two sets of breakpoint years. Both assume that construction workers would be housed off base. The first set shows the breakpoint years using current DoD UFC demand calculations as described previously. The second set shows the breakpoint year using the modified demand calculations once anticipated water conservation measures are implemented and sustainability principles are applied to the design of on-base buildings and facilities.

Table 2.2-7. Estimated Breakpoint Years for DoD Water System

Location	*Breakpoint Year (UFC demand estimate)*	*Breakpoint Year (modified demand estimate)*
Finegayan Base Complex	2013	2014
Andersen AFB	-	-
Navy Islandwide System (excluding water transferred to GWA)	2010 [a]	2019
DoD Combined Resources	2011	2014

If the Preferred Alternative is selected, and water conservation measures and sustainability principles are not implemented (i.e.: what is assumed by the current DoD UFC Demand calculations), then on-base water demand at Finegayan would exceed the available water supply in 2013. This coincides with the start of construction of the proposed water system. Although the maximum daily demand is not met by the existing supply on Finegayan in 2013, with the installation of a subset of the DoD-planned wells there will be sufficient capacity to meet the estimated average daily demand, though not the required maximum daily demand of the water system (assuming water conservation and sustainability measures are applied). If there is a shortfall, then adaptive management principals will be implemented such as reducing the pace of construction activity. For more information on adaptive management, see Volume 7.

2.2.3.2 Non-DoD Water Supply Sources

Non-DoD water supply sources consist of groundwater and surface water supplies throughout Guam. The GWA water supply sources are presented in Table 2.2-8. Potable water is mainly supplied to the northern system by 119 deep wells. Collectively, these wells have a daily average production rate of approximately 41.8 MGd (158 mld). The current production rates are approximately equal to the design and permitted rates, indicating that the wells are running at full capacity. The GWA WRMP also assumed that the active wells were running 24 hours per day.. In addition to the deep wells, the northern system also receives approximately 3.6 MGd (13.6 mld) from the Navy Water Treatment Plant (WTP) in southern Guam, which is supplied by surface water from Fena Reservoir. According to the current memorandum of understanding, GWA can receive up to 4 MGd (15 mld) of supply from the Fena Reservoir.

The GWA WRMP discusses options for expanding the well system in the Agana subbasin to produce an additional 2.7 MGd (10.2 mld) and the system in the Agafa-Gumas subbasin to produce an additional 2.9 MGd (11.0 mld). These expansions are identified as being in areas that are outside of DoD boundaries and available to GWA. During the ongoing meetings between DoD and GWA, installation of 30 wells was proposed by GWA (GWA 2008), bringing the proposed well expansion throughout the NGLA for non-DoD use to 16.9 MGd (64.0 mld). The total future water supply for GWA is 63.2 MGd (239 mld) including the water transferred from Fena Reservoir. Between the existing non-DoD water supply sources and GWA's rehabilitation and expansion plans, there is sufficient water supply to meet the anticipated non-DoD water demand, provided that the proposed system expansion is operational in time to meet increased demand.

Table 2.2-8. Guam Waterworks Authority Water Supplies

	Current Production Rate (MGd)	*Future Expansions (MGd)*	*Total (MGd)*
North			
Deep Wells	41.8	13.1	54.9
Navy GWA Transfer (purchased)	4		4
South			
Ugum Water Treatment Plant	2.2	1.8	4.0
Santa Rita Spring	0.2		0.2
Nonpotable Deep Wells	0.1		0.1
Total	**48.4**	**14.9**	**63.2**

2.2.3.3 Development of Alternatives to Increase DoD Water Supply Sources

As shown in Table 2.2-6, 13.0 MGd (49.2 mld) of additional water supply would be required to meet future on-base DoD demands projected for the military buildup for Main Cantonment Alternatives 1 and 2 utilizing UFC requirements.

Several alternatives for increasing DoD water supply sources are carried forward for analysis in this DEIS, which are discussed in detail in Section 2.2.4 below. These alternatives were developed based on an assessment of nine primary water system improvement options. These water system improvement options were evaluated in the *Guam Water Utility Study Report for Proposed U.S. Marine Corps*

Relocation (NAVFAC Pacific 2008c) and are listed below.

- *Option 1:* Optimize groundwater resource development within DoD land and add additional supply wells
- *Option 2:* Rehabilitate, replace, or treat well water from existing wells that are not currently in production due to contamination, structural, and/or mechanical problems
- *Option 3:* Coordinate with GWA to establish the quantity of potable water that GWA would be agreeable to selling to DoD, and purchase water from GWA
- *Option 4:* Dredge sediment from the Navy Reservoir to increase storage capacity
- *Option 5:* Expand storage capacity of the Navy Reservoir by raising the dam crest
- *Option 6:* Reclaim potable water through effluent reuse
- *Option 7:* Indirectly reclaim potable water through groundwater recharge
- *Option 8:* Perform desalination
- *Option 9:* Develop a new surface water source (e.g., the "Lost River").

Each of the nine options identified above was evaluated with regard to several factors: feasibility, technical complexity, reliability, regulatory acceptance, environmental impacts, overall cost, time to implement, and the quantity of water that would potentially be obtained. This screening process is included in the *Guam Water Utility Study Report for Proposed U.S. Marine Corps Relocation* (NAVFAC Pacific 2008c). Options 5, 6, and 7 were dismissed from further consideration. Combinations of the remaining options were used to build the alternatives that are carried forward for analysis in this DEIS/OEIS, as discussed in Section 2.2.4. Table 2.2-8, shown in Section 2.2.4 below, summarizes the various options listed above that were retained and that were used to build the alternatives.

For potable water, no distinction is made between interim and long-term alternatives for the first two basic alternatives. These alternatives would be pursued in a phased implementation approach, which reduces costs and the time needed to implement. Should there be a need for additional water supply sources, three long-term alternatives have been identified and carried forward on a programmatic basis.

2.2.3.4 Water Supply Options Considered to Build Alternatives

The following is a brief discussion of the water supply options that were retained for further consideration and are used to build the alternatives carried forward for analysis in this EIS/OEIS.

<u>Option 1: Optimize Groundwater Resource Development within DoD Land and Add Additional Supply Wells</u>

This option includes the development of groundwater wells drawing water from the NGLA in the Navy water system and the Andersen AFB water system. Because they and the GWA water system in northern Guam draw water from the same sole source aquifer with a limited sustainable yield, the development of this option to include new production wells must consider the effects of wells pumping in adjacent areas and proposed additional well production from GWA. The effects include potential saltwater intrusion problems, excessive drawdown in the aquifer, and other related water quality problems. This option includes use of the existing Navy wells at Finegayan that produce up to 2.3 MGd (8.7 mld). The Marine Corps water system would be connected with both the Air Force and Navy islandwide systems to allow the flexibility needed to meet water demands on the DoD bases in northern Guam if housing were to be shifted away from the Finegayan Base Complex and in emergencies.

The development and implementation of this option would be managed by DoD, avoiding uncertainties in timely implementation through direct management. Coordination with GWA is important in the development of new production wells in the DoD areas to avoid negative effects caused by overpumping of the aquifer.

The freshwater lens aquifer is segregated into six distinct and hydrologically separate subbasins on the northern portion of the island. The primary subbasin used for groundwater extraction by the Navy, Finegayan Subbasin, is near its maximum sustainable yield. The subbasin being utilized by Andersen AFB still appears to have sustainable yield available before reaching capacity. Based on review of the sustainable yield and current pumping capacity for existing wells, the water supply obtained from within DoD lands can meet the projected Marine Corps demand.

<u>Option 2: Rehabilitate, Replace, or Treat Well Water from Existing Wells that Are Not Currently in Production Due to Contamination, Structural, and/or Mechanical Problems</u>

This option includes the development of nonoperational and underperforming existing groundwater wells drawing water from the NGLA in the Navy water system and the Andersen AFB water system. Because DoD and the GWA water system in northern Guam draw water from the same aquifer with a limited sustainable yield, the development of this option to include rehabilitation or replacement of existing production wells also considers the effects of wells pumping in adjacent areas. These impacts would include potential saltwater intrusion problems, excessive drawdown in the aquifer, and other related water quality problems. Successful rehabilitation or replacement of the inactive wells would result in approximately an additional 4 MGd (15 mld) if adequate yield in the aquifers were available. Preliminary review indicates that there is adequate available yield in the subbasins.

This option has the potential to add to the reliability of a DoD water supply. The development and implementation of this option would be managed by DoD, avoiding uncertainties in timely implementation through direct and proper management. Coordination with GWA is important in the development of new production wells in the DoD areas to avoid negative effects caused by over pumping.

<u>Option 3: Coordinate with GWA to Establish the Quantity of Potable Water that GWA Would Be Agreeable to Sell to DoD, and Purchase Water from GWA</u>

This option includes obtaining water from GWA by either purchasing water or exchanging water through metered interconnections between the GWA and DoD water systems. There are several existing connections between the GWA and Navy water systems, although given the information currently available, none of these connections would be sufficient to meet a substantial portion of the demand in the northern region without well development, water facilities improvements, and other construction. The implementation of this option would include establishing or upgrading metered connections between the GWA and DoD water systems.

Because the Northern Public Water System operated by GWA is an elaborate water supply system in northern Guam with 119 wells that draw water from the NGLA, this option could supplement DoD's groundwater supply. This option could potentially result in energy cost savings by reducing the cross-island pumping of large quantities of water through the existing parallel water mains running from the north to the south. However, little or no water is available for purchase from GWA in the north that is not already required for GWA customers in that region. The Navy currently transfers up to 4 MGd (15 mld) of water to GWA for use in central Guam. In the future, the water purchase option may become available if the GWA system is improved to reduce the loss rate, and if expansion of the GWA northern well systems is implemented (GWA 2007).

Option 4: Dredge Sediment from the Navy Reservoir to Increase Storage Capacity

The Navy Reservoir (also known as Fena Reservoir), located in southern Guam, is a primary source of potable water for the island and was created through the impoundment of the Fena River Valley by a dam (Navy Reservoir Dam). The Navy Reservoir Dam, constructed by the Navy and completed in 1951, is a zoned earth and rockfill embankment with a maximum height of 85 ft (26 m) above original grade. The entire watershed impounded by the dam covers an area of 5.88 square miles (15.23 square km) of moderately to steeply sloped lands, and soil within the watershed is predominantly clay of volcanic origin. The slopes and soil type both contribute to rapid runoff rates and substantial erosion, particularly in areas where the native vegetation has been removed. Eroded soil is ultimately transported to the reservoir itself by the runoff, and resulting sedimentation contributes to ongoing reduction of reservoir capacity.

The increased water supply from implementation of this option would serve DoD demands in southern Guam. It is assumed that the water supply would increase by approximately 2.5 MGd (9.5 mld) if the reservoir were dredged to the original design elevations. If water were supplied from the Northern Aquifer near the Finegayan Base Complex, water supply from implementation of this option would not support the Marines relocation, but would provide additional supply in the south that could be transported to northern Guam if necessary.

Potential benefits of the proposed dredging are several. First, the proposed work is relatively simple and would not present a great demand for skilled labor that may be difficult to procure from the limited labor pool on Guam. Secondly, the dredging would not result in the creation of new capital structures that must be operated and maintained indefinitely. Dredging would maintain the existing hydrology of the reservoir system and would not require inundation of additional land. Finally, this option would not require changes to the existing water distribution network, in that the existing discharge and bypass points would be maintained in place.

Potential obstacles and drawbacks exist as well. In particular, the potential difficulty in mobilizing a dredge to the project site because of its remote location and the large mobilization distances for dredges would cause actual project costs to be uncertain. In addition, there are substantial logistical difficulties in managing dredged material on Guam. The lack of sufficient land area may complicate implementation.

Although dredging is a viable option, it cannot be sustained as a stand-alone alternative for Marine Corps relocation. Water supplied by this option to the Marine Corps base would require additional funds for transportation. The option is retained as part of ongoing maintenance for the Navy Reservoir as a long term alternative, which supplies water to DoD facilities in southern Guam.

Option 8: Desalination

Desalination is a process that removes dissolved minerals from seawater, brackish water, or treated wastewater. The water supply provided by implementation of desalination would support the Marine Corps relocation.

Several technologies have been developed for desalination, including reverse osmosis, electrodialysis reversal, and distillation. In reverse osmosis, feedwater is pumped at high pressure through permeable membranes, separating salts from the water. In electrodialysis reversal, ions are transferred through the membranes by means of direct current voltage and are removed from the feedwater as the current drives the ions through the membranes. In the distillation process, feedwater is heated and then evaporated to separate out dissolved minerals.

It is assumed that the brackish water would have a total dissolved solids (TDS) level ranging from about 3,000 milligrams per liter (mg/L) to 4,000 mg/L. Within this TDS range, reverse osmosis is the preferred technology. Brackish water generally requires less energy to desalinate than seawater because of its lower concentration of dissolved solids. Therefore, the desalination of brackish water is generally less expensive than desalination of seawater. Energy costs represent about one-third to one-half of the cost of desalination, and as a result, desalination costs are relatively sensitive to the cost of energy.

For this option, the lowest salinity water available outside of the NGLA would be considered. Brackish-water wells would be located within 1,000 ft (305 m) of the shoreline to avoid effects on the NGLA and existing wells. Sufficient brackish water would be collected from a series of wells to generate 12 MGd (45 mld) of potable water. The desalination plant would be located near the Finegayan Base Complex on Andersen AFB to be close to the location of the source and the demand. The plant would include units for pretreatment (filtration and disinfection), desalination, and post-treatment (corrosion control, remineralization, and disinfection), resulting in a product of drinking water quality with TDS less than 500 mg/L. If desalination of brackish water were to be implemented, untreated brackish water may be used to meet fire demands, requiring a separate set of nonpotable waterlines and storage.

Desalination plants produce liquid wastes that may contain some or all of the following constituents: high salt concentrations, chemicals used during defouling of plant equipment, and pretreatment residues. Liquid wastes may be discharged directly into the ocean, combined with other discharges (e.g., power plant cooling water or sewage treatment plant effluent) before ocean discharge, discharged into a sewer for treatment in a sewage treatment plant, or dried and disposed in a landfill.

Desalination is a viable option that results in very pure water, excellent pathogen removal, and flexible operations. The costs for this option are likely to be high relative to the water supplied by freshwater wells. The high power demand for desalination would need to be considered in the utility planning for electricity. The cost for desalination would also be sensitive to the TDS level in the brackish water supply. The quantity of brine requiring disposal would be substantial if used as the primary water supply. If water demands eventually exceed the capacity of the freshwater aquifer in the north, desalination could potentially provide a source of potable water for DoD. Therefore, this option is retained as a long-term alternative.

Option 9: Develop a New Surface Water Source (e.g., the "Lost River")

Development of a new surface water source on Guam would require identifying a new water source; conceptualizing and designing the water source area, the treatment process, and transmission and distribution infrastructure; and constructing the complete system to supplement the existing water systems. Such a system preferably would have to be sited within DoD lands, and finding an alternate surface water source with substantial capacity would likely be a major and costly initiative.

A possible new surface water source is the Lost River. The increased water supply from implementation of the Lost River would serve DoD demands in southern Guam. If water were supplied from the Northern Aquifer near the Finegayan Base Complex, water supply from implementation of this option would not support the Marine Corps relocation. However, this option is carried forward as a long-term alternative to supplement water supply to DoD in southern Guam.

2.2.3.5 Options Eliminated from Further Analysis

Following is a brief discussion of the options that were eliminated from further consideration, and are not used to build the alternatives carried forward in this DEIS/OEIS.

Option 5: Expand Naval Reservoir Storage Capacity by Raising Dam Crest

This option would involve raising the dam crest of the Navy Reservoir to increase capacity. Based on a review of topographic maps depicting the immediate vicinity of the Navy Reservoir, the topography is such that raising the elevation of the dam crest by 20 ft (6 m) would increase total reservoir capacity by 3,940 acre-feet (4.86 million cubic meters), or 1.28 billion gallons. Assuming that the watershed would generate sufficient runoff to ensure the reliability of this supply, the safe yield of the reservoir would increase by 35%, from 11.4 MGd to 15.4 MGd (43.1 mld to 58.3 mld).

This option would have the advantage of improving DoD's water supply by increasing its storage capacity in the Navy Reservoir. However, the disadvantages and uncertainties are substantial and include the following:

- Technical complexity of design and implementation
- Potential adverse environmental impacts (wetlands, endangered species)
- Uncertainties with respect to relative advantages compared to other viable options
- Studies (hydraulic, geotechnical, seismic) required
- Potential difficulties during construction limiting use of the reservoir
- Uncertainties regarding construction and operations and maintenance costs

Because of uncertainties regarding its viability, this option was eliminated from further evaluation.

Option 6: Reclaim Potable Water through Effluent Reuse

This option would include construction of a new tertiary wastewater treatment plant near the Marine Corps base on DoD land at Finegayan. The plant would provide primary treatment, secondary biological treatment, and advanced tertiary treatment. It would treat the DoD wastewater from existing sources and proposed future expansions in the northern Guam region to drinking water standards.

This treatment application is categorized as direct potable reuse of reclaimed water. Normal treatment practice consists of primary settlement, submersible membrane bioreactor, disinfection, reverse osmosis, and advanced oxidation. The treated, potable water would be returned to the main water supply for reuse.

Although much research has been conducted on the direct potable reuse of reclaimed water, this is not a practice that is in widespread use. Only a few direct potable-reuse applications have been reported worldwide. Even without factoring in its extremely high capital investment cost and sophisticated process operation, it might be difficult to gain regulatory acceptance of this approach. Because of the negative connotations and public perceptions surrounding the use of reclaimed water as a potable water source, it is expected that community acceptance of this approach would also be difficult to achieve. Currently, there are no direct potable-reuse applications in the United States. All reclaimed water that is treated by wastewater treatment plants has been used as potable water in an indirect way, with a natural buffer (e.g., either a stretch of river or a groundwater aquifer) between the reclaimed water introduction and its distribution to the potable-water treatment plant.

This option would require permission from either USEPA or GWA. Because no regulations exist for the reclaimed-water potable-reuse application, treatment requirements and performance monitoring standards for this option would need to be established, adding time and cost to its implementation. Therefore, this option was dismissed.

Option 7: Indirectly Reclaim Potable Water through Groundwater Recharge

This option would include construction of a new tertiary treatment plant on DoD land. The plant would treat the DoD wastewater from existing sources and future proposed military buildup in northern Guam. Treated effluent would be injected into the underground aquifer (i.e., the freshwater lens) for groundwater recharge or to limit salt water intrusion.

Due to the NGLA being a sole source aquifer as discussed above, additional precautions must be taken in managing recharge with reclaimed water. At the selected effluent injection point, the recommended 9- to 12-month detention time in the aquifer before removal could not be met because of the high hydraulic conductivity in the aquifer. Under these conditions, a very high degree of treatment (normally beyond USEPA primary drinking water standards) would have to be achieved.

In practice, even if tertiary treatment of effluent were applied for this kind of indirect potable reuse of reclaimed water, it is expected that this option would not be readily accepted by regulatory agencies. Underground injection control regulations established by GEPA categorize recharge wells discharging effluent from sewage treatment plants as Class V wells. GEPA does not specify the treatment standards and criteria for underground injection of this type of effluent to recharge the aquifer. The process of establishing treatment requirements and performance monitoring standards for this option would increase the cost and time to implement the project. Also public acceptance of recharging the NGLA with WWTP effluent would likely be controversial. Therefore, this option was dismissed.

2.2.4 Alternatives Developed Forward for Potable Water

Using the options carried forward that are outlined in Section 2.2.3, two basic alternatives were developed to meet the water demand resulting from the Marine Corps relocation. Should the supply provided by the chosen alternative need future augmentation, three additional long-term alternatives have also been carried forward. Basic alternative 1 supports Main Cantonment Alternatives 1 and 2 (use of Finegayan) and basic alternative 2 supports Main Cantonment Alternatives 3 and 8 (use of Finegayan and Barrigada). These alternatives are summarized below. A summary of the components for the alternatives is provided in Table 2.2-9.

Table 2.2-9. Summary of Potable Water Alternatives

Alternative	*Components*				*Comments*
	Water Supply	*Water Treatment*	*Water Storage*	*Distribution System*	
Basic Alternative 1	• Up to 22 new water supply wells on Andersen AFB • Continued use of existing Navy wells on Finegayan • Rehabilitation of a well at the Naval Hospital	• Disinfection and fluorination at the wellhead	• Construction of new storage tank on Finegayan • Abandonment of existing Navy storage tanks on Finegayan	• Waterlines: transport of water to storage tanks, and distribution of water throughout Finegayan • Improvements and interconnect Andersen AFB water system with Navy islandwide system • Connection to GWA water system	• Supports Main Cantonment alternatives 1 and 2 • Preferred alternative • Revised UFC reduces demand
Basic	• Up to 20 water	• Disinfection	• Construction of	• Waterlines:	• Supports Main

Table 2.2-9. Summary of Potable Water Alternatives

Alternative	Components				Comments
	Water Supply	Water Treatment	Water Storage	Distribution System	
Alternative 2	supply wells located on Andersen AFB • Up to 11 water supply wells located on Navy Barrigada	and fluorination at the wellhead	new storage tank on Finegayan • Construction of new storage tank at Air Force Barrigada • Use of existing Barrigada tank • Abandonment of existing Navy storage tanks on Finegayan	transport of water to storage tanks • Improvements and interconnect Andersen AFB water system with Navy islandwide system	Cantonment alternatives 3 and 8
Long-Term Alternative 1	• Rehabilitation of the Lost River cofferdam • Potential to provide additional water supply to DoD in southern Guam during the dry season				•Supplemental supply if basic alternative inadequate
Long-Term Alternative 2	• Applicable to both potable water alternatives- Production of up to 12 MGd of potable water by desalination, which would require 18 MGd of brackish water • This alternative provides supplemental water in the event freshwater resources are inadequate to meet DoD demand.				•Supplemental supply if basic alternative inadequate
Long-Term Alternative 3	• Dredging of the Navy Reservoir to original design elevation to increase storage capacity • Part of long-term water system maintenance				•Supplemental supply if basic alternative inadequate

Either basic alternative would fully meet the DoD water demand for the Marine Corps relocation. The schedule for construction would need to be accelerated to meet the increasing DoD water demand during the period of construction. It is assumed that up to 10 wells at Andersen AFB would be required by 2014 to meet the DoD maximum daily demand. Construction workers' water demand would be met by the contractor, through the GWA water systems. Impacts to the GWA water system from this demand are addressed in Chapter 3 of this volume.

Permits would be required from Guam agencies for either alternative. A full list of permit requirements is provided in Chapter 3 of Volume 8.

Three long-term alternatives were developed to supplement Basic Alternatives 1 and 2. These include rehabilitation of the Lost River, desalination, and dredging the Navy Reservoir. Additional information is needed to fully define the long-term alternatives.

2.2.4.1 Basic Alternative 1

Basic Alternative 1 would include options for new water supply wells (up to 22 wells at Andersen AFB), rehabilitation of existing wells, transmission and distribution system upgrades, and interconnection with GWA. Basic Alternative 1 would require water supply, water treatment, water storage, and water distribution components to meet the demand of the buildup as summarized in Table 2.2-10 and presented in Figure 2.2-1. Development of these water system components would result in a future water supply as summarized in Figure 2.2-1 and Table 2.2-11.

Table 2.2-10. Basic Alternative 1—Proposed Water System Components

Component	*Description*
Water Supply	• Development of up to 22 new water supply wells (including one contingency well) on Andersen AFB • Use of five recently installed wells at Andersen AFB • Continued use of existing Navy wells on Finegayan • Rehabilitation of Navy Regional Medical Center wells
Water Treatment	• Disinfection and fluorination at the well heads
Water Storage	• Continued use of existing Navy and Air Force storage tanks • Construction of new storage tank on Finegayan • Abandonment of existing Navy storage tanks on Finegayan
Distribution System	• Waterlines to transport the water from supply wells to storage tanks • Waterlines to distribute water throughout Finegayan • An interconnect with the Navy's islandwide water system • Improvements to the Navy's islandwide water system (i.e., size pipes appropriately, replace corroded pipes, transport water to the south as well as north) •Replace water mains connecting existing Navy wells to the water system • A connection to the AF water system • A connection to the GWA water system

Source: NAVFAC Pacific 2008c

Table 2.2-11. Basic Alternative 1—Proposed DoD Water Supply and Demand

Water Supply Sources(Existing and Proposed)	*Water Supply (in MGd)*			
	Marine Corps Finegayan	*Andersen AFB*	*Navy*	*Total*
Main Cantonment Alternative 1 & 2				
Current Surface Water Supply			11.0	11.0
Current Groundwater Supply		4.7	3.1	7.8
Development of new water supply wells	11.1			11.1
Rehabilitation of existing Navy well			0.5	0.5
GWA Transfer Projected Need in 2019			-3.3	-3.3
Planned Supply Cantonment Alternative 1 & 2	**11.1**	**4.7**	**11.3**	**27.1**
Maximum Daily Demand using UFC Guidance	10.5	4.0	12.6	27.1
Planned Supply Cantonment Alternative 1 & 2 using Sustainability Principles	**6.9**	**4.7**	**11.3**	**22.9**
Maximum Daily Demand using Sustainability Principles	6.3	2.8	10.1	19.2

Note: MGd = million gallons per day
Source: NAVFAC Pacific 2008c

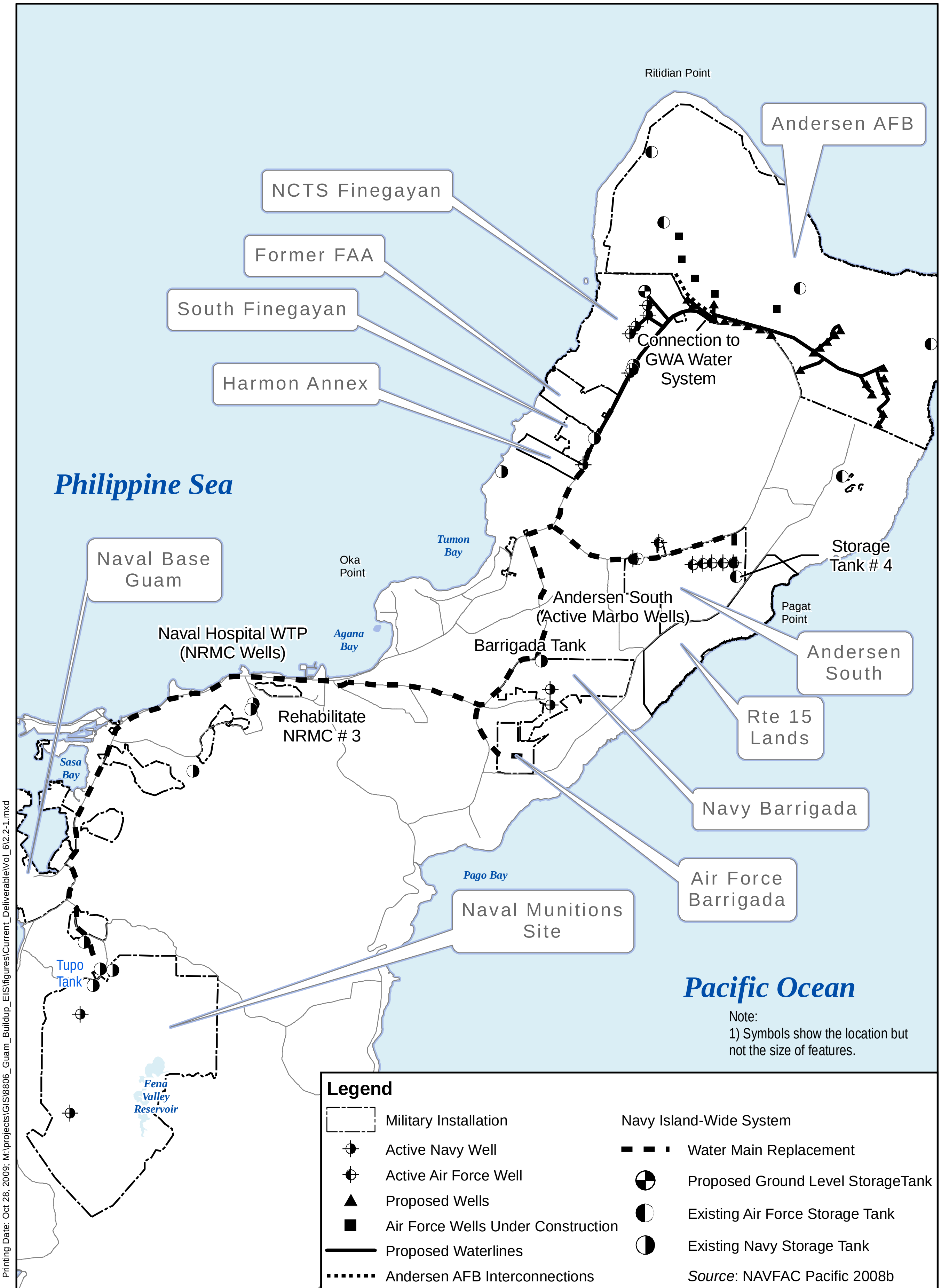

Figure 2.2-1
Basic Alternative 1 - Proposed Water System Components

This alternative would result in excess water of 0.6 MGd (2.3 mld) at Marine Corps Finegayan and a deficit of 1.3 MGd (3.0 mld) for the Navy's islandwide system for Main Cantonment Alternatives 1 and 2. The excess water from Marine Corps Finegayan could supply the additional water to the Navy's islandwide system. The water demand estimates are based on the conservative assumptions presented in the UFC water supply guidance (DoD 2001, 2005, 2006). Under average demand conditions, the Navy water supply is adequate. However, assuming the modified demand shown in Table 2.2-11, the capacity of the Navy water supply is sufficient.

<u>Water Supply</u>

Basic Alternative 1 would develop water supplies in northern Guam (water supply wells), central Guam (rehabilitation of the Navy Regional Medical Center's well), and southern Guam (Navy Reservoir improvements), and would include the capability to distribute water from north to south. The proposed locations for new water supply wells to be constructed under Alternative 1 are based on information regarding the sustainable and available yield of aquifer subbasins and other siting constraints as discussed below.

Potential Well Locations

There are numerous constraints imposed through DoD and GEPA guidance relating to well siting. This guidance is intended to minimize contamination of the water supply and interference between adjacent wells. All proposed DoD wells would be located on DoD land. DoD will consult with GEPA on applicability of this guidance and where wells would be located.

Potential water supply well locations were initially sited with consideration of the following land ownership and constraints:

- Limiting well production within subbasins so that the sustainable yield would not be exceeded
- Preferentially locating wells in parabasal zones (as opposed to basal zones) to achieve higher yield with lower chloride levels, thereby reducing the number of wells and associated costs
- Maintaining a 1,000-ft (305-m) distance from the shoreline to avoid saltwater intrusion
- Maintaining an approximately 800- to 1,000-ft (244- to 305-m) distance from other supply wells.

The parabasal zones—areas where the freshwater lens bottom is in contact with basement rock, where the basement surface rises above the freshwater-saltwater interface—are roughly drawn in Figure 2.2-2. It is assumed that the parabasal zone extends seaward to a point where the top of the impermeable volcanic basement underlies the limestone aquifer at depth of approximately 131 ft (40 m) below mean sea level (msl). A transitional parabasal/basal zone is assumed to exist in the area where the top of the impermeable volcanic basement underlies the limestone aquifer at depths between 131 and 196 ft (40 and 60 m) below msl. These assumptions are based on existing GWA well locations described as parabasal or transitional that appear to meet these characteristics, according to available volcanic basement contour maps.

The proposed well locations are clustered in the region of the parabasal zones because the wells are expected to have a higher capacity than wells in the basal zone and are less likely to have saltwater intrusion. Some considerations for the proposed locations include:

- According to volcanic-bedrock contour mapping, a substantial portion of the available potential high-yield parabasal zone exists on or near the military reservation boundary.
- If the parabasal zone were to yield less than the proposed well production, some of the wells may need to be relocated to the basal zone on DoD property, farther from the DoD boundary, and additional wells may need to be installed. This alternative layout is not presented in this document

because of the uncertainty about land use by Andersen AFB closer to the active facilities. Approximately twice the number of wells would be required if wells were to be located in the basal zone.

- The areas in Figure 2.2-2 that are excluded from use to avoid Andersen AFB land uses do not include a buffer to account for explosives arcs. Three of the proposed well locations fall within the inhabited building distance (IBD) explosive safety quantity distance (ESQD) arc. The planned Andersen AFB wells are located within the IBD EQSD arc. Because of the spatial limitations, some proposed well locations are near or within residential zones. The Air Force would review and approve facility locations at Andersen AFB. Facility design would incorporate Andersen AFB requirements. For instance, wells located near the runways would be frangible or flush mounted.

Figure 2.2-2 also presents the location of the well constraints. Additional constraints are listed in Table 2.2-12.

Table 2.2-12. Well Location Constraints

Location Constraint	*Comments/Approach to Well Placement*
DoD Property	• Wells are located on DoD property.
Sustainable Yield	• The combined capacity of the existing and planned wells is less than the 1991 sustainable yield estimate.
Parabasal/Basal Zones	• Wells are clustered in the parabasal zone to maximize production of the aquifer. Lower chloride levels and higher production are anticipated for parabasal zone wells. Wells are located more than 1,000 ft (305 m) from the shoreline to avoid saltwater intrusion.
Proximity to Existing and Proposed Air Force and GWA wells	• Maintain an approximately 800- to 1,000-ft (244- to 305-m) distance from other supply wells. • Monitor for saltwater intrusion. • Coordinate with GWA.
Current and Future Land Usage: - Impact on Air Force Mission and Quality of Life - Future Construction in Residential Area - Future Paving of the Utility Corridor	• All facility locations would be reviewed by and require the approval of the Air Force.
ESQD	• Wells are located outside all ESQD arcs, except three wells that fall inside the IBD arc.
Potential Contaminant Sources: - Fuel Pipeline in the Utility Corridor - Fuel Storage - Dry Cleaners - 78 IRP Sites including Active and Inactive Landfills - UIC Wells in the Main Base Area	• Maintain an approximately 800- to 1,000-ft (244- to 305-m) distance from contaminant sources where possible. • Water quality would be evaluated during the pilot hole testing and periodically during well use.
Chlorinated VOC Plumes in the Main Base Area UXO/MEC	• Monitoring wells with elevated levels of chlorinated VOCs are downgradient from the proposed well locations. • Water quality would be evaluated during the pilot hole testing. • Precautions would be taken during construction for UXO/MEC.
Sewer Main along Route 9	• DoD would consider conducting a study to evaluate the integrity of sewer mains.
Runway Approach	• DoD/Air Force requirements for design would be observed. • Well heads would be flush with the ground or frangible.
-Cultural Resources Sensitive Habitat	• Location specific studies are being conducted by DoD. Facility locations would be adjusted as required.

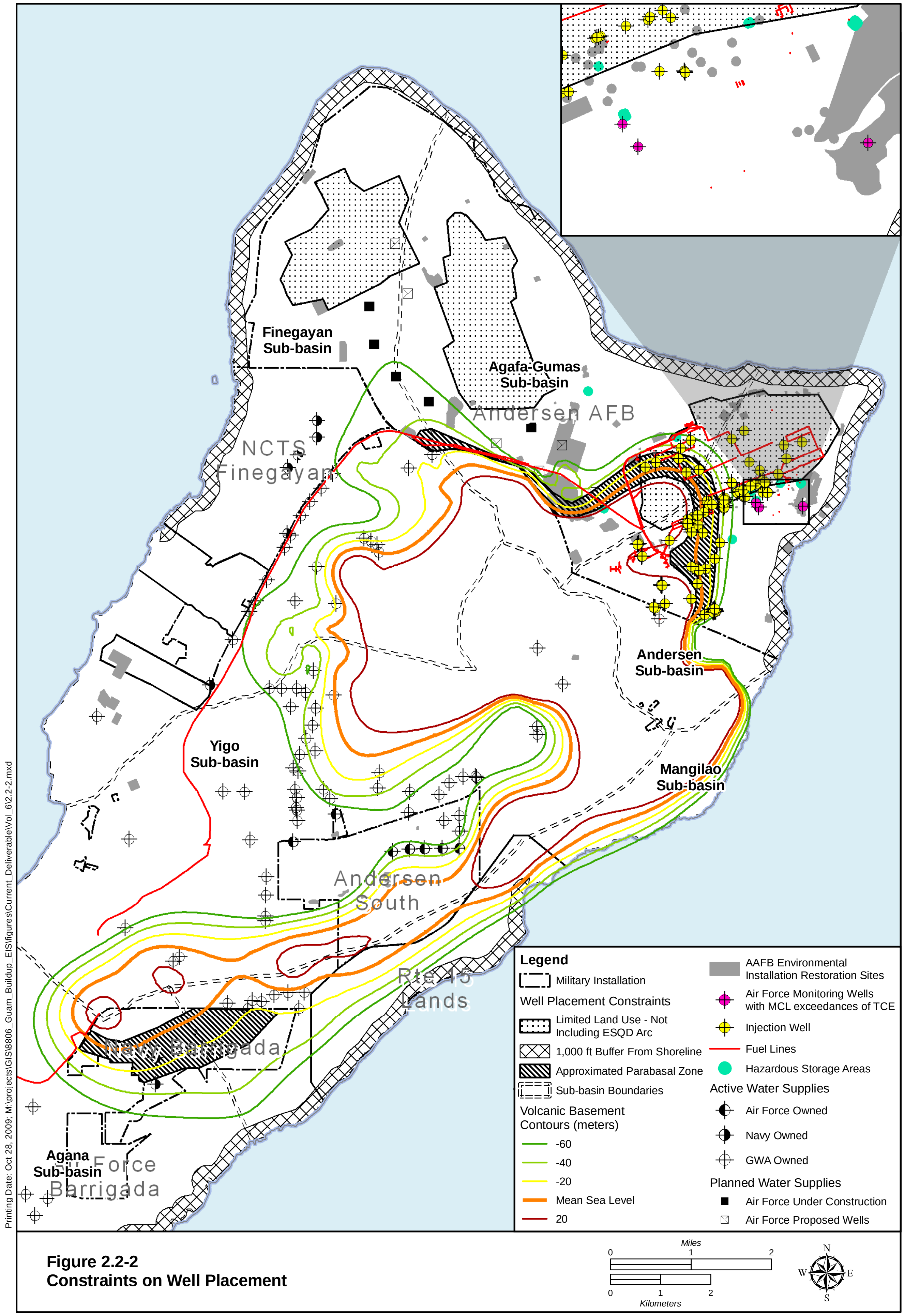

Figure 2.2-2
Constraints on Well Placement

Potential Contaminant Impacts on Sources of Drinking Water

Potential sources of contamination exist on or near Andersen AFB. These include the installation restoration sites, a utility corridor including a sewer line, and storm water injection wells. The proposed wells would be located away from these sites where possible. All well locations would be tested for water quality before installation. It is assumed that DoD would comply with all necessary stormwater requirements. Because the primary military buildup area would not be at Andersen AFB, impacts on stormwater resulting from the buildup would be minimal. If elevated contaminant levels were detected, the wells would be relocated or the design would be revised to include the appropriate treatment processes. A chlorinated-solvent plume containing trichloroethylene (TCE) and perchlorethylene (PCE) levels greater than the MCLs is identified in groundwater on Andersen AFB. Monitoring wells with elevated levels of chlorinated solvents are shown in Figure 2.2-2. This plume is downgradient from the wells and is not expected to affect the proposed well locations.

Unexploded ordnance and munitions and explosives of concern may be found at Andersen AFB. Provisions would be made as part of construction to address them.

Studies of cultural resources and sensitive habitat are ongoing. Well locations may be modified as a result of these studies.

As part of the well permitting process, GEPA would conduct a review of each well location and review site-specific data. Additionally, all federal projects proposed over the Northern Aquifer are subject to an aquifer protection review. Projects are reviewed for potential direct or indirect impacts on groundwater. Submittal of detailed site plans, plumbing plans, engineering studies, and calculations may be required.

Estimates of Sustainable and Available Yield

Sustainable yield is defined as the rate at which groundwater can be continuously withdrawn from an aquifer without impairing the quality or the quantity of the pumped water. To sustainably approach the hypothetically available sustainable yield, the means of water withdrawal has to be optimized.

The NGLA is divided into six subbasins based on hydrological divides in the subsurface: Agafa-Gumas, Agana, Andersen, Finegayan, Mangilao, and Yigo. Figure 2.2-2 shows the location of the subbasins. Two estimates of the NGLA have been published, one by the Northern Guam Lens Study (NGLS) (CDM 1982) and one by Barrett Consulting with John Mink (Barrett 1991).

The NGLS estimates were based on a steady-state condition and relied on conservative assumptions such that future development and groundwater management programs could be easily implemented. The NGLS was the first to divide the aquifer into a series of six subbasins and 47 management zones. The subbasin division is based primarily on topographic expression of basement topography forming effective hydrological divides in the subsurface. Based on the position of the freshwater lens, the subbasins can be either basal (freshwater lens floating on top of saltwater) or parabasal (freshwater lens bottom in contact with basement rock, where the basement surface rises above the freshwater-saltwater interface). Management zones are a construct to optimally manage well fields within the basin.

The second estimate of sustainable yield was prepared by Barrett (1991), who revised the simulation to a transient system rather than steady-state. Barrett argued that the NGLA is best described as a transient system because the majority of the recharge comes during the wet season and transient conditions best represent seasonal variations in recharge. The revised estimate of sustainable yield using transient conditions increased sustainable yield to approximately 70-80 MGd (265-303 mld).

Table 2.2-13 compares sustainable yield estimates of the NGLS (CDM 1982) and Barrett (1991) reports for each subbasin, and presents current estimates of well production and available yield. The majority of the Andersen and Agafa-Gumas subbasins lie beneath existing DoD property (Andersen AFB and Northwest Field). Additionally, a substantial portion of the Finegayan subbasin lies below the Naval Communication Station property abutting the Northwest Field to the south. The yield estimates presented here use the yield estimates presented by Barrett (1991) as the basis for determining available yield (Jensen 2006).

The management zones identified in the 1982 NGLS do not match the subbasin boundaries, which are based on the 1991 volcanic-basement contours. As a result of this discrepancy, the analysis presented here does not rely on the 1982 NGLS management zones. Additionally, the NGLS management zones were a construct used as a means of managing well fields. With the changes to the number and location of wells since the early 1980s, the zones described by the NGLS in 1982 appear to be outdated.

Barrett (1991) argued that the increased estimate is supported by increased withdrawals in the past decade along with the relative stability of the basal portions of the aquifer, especially in the heavily exploited Yigo and Finegayan subbasins. However, McDonald and Jensen (2003) suggest that there has been a distinct increase in chloride over time, which they interpreted as indicating overpumping in some subbasins.

Table 2.2-13. Estimates of Sustainable and Available Yield for Subbasins in the Northern Guam Lens Aquifer

Subbasin	*Well Production*	*Northern Guam Lens Study (CDM 1982)*		*Barrett (1991)*	
		Sustainable Yield	*Available Yield*	*Sustainable Yield*	*Available Yield*
Agana	10.7	11.7	1.0	20.5	9.8
Mangilao	1.9	3.9	2.0	6.6	4.7
Andersen	1.2	6.2	5.0	9.8	8.6
Agafa-Gumas	3.9	10.1	6.2	12.0	8.1
Finegayan	8.1	6.4	-1.7	11.6	3.5
Yigo-Tumon	23.5	19.1	-4.4	20.0	-3.5
TOTALS	**49.3**	**57.4**	**8.1**	**80.5**	**31.3**

Sources: CDM 1982, Barrett 1991, Personal communications, GWA and Navy, 26 July 2009.

Based on these estimates, it is clear that groundwater resources are underdeveloped within the Andersen and Agafa-Gumas subbasins, compared to the southern subbasins. A parabasal zone exists in both the Andersen and Agafa-Gumas subbasins, meaning that these subbasins have the potential for increased production rates. The majority of these subbasins lie under DoD land (see Figure 2.2-2). They are also close to the proposed location for the Main Cantonment at Finegayan. Therefore, Basic Alternative 1 proposes to develop 19 new water supply wells within the Agafa-Gumas and Andersen subbasins. Three wells are proposed for the Finegayan subbasins. Additionally, five wells were recently installed at Andersen AFB.

Components of the Water Systems Figure 2.2-1 and Table 2.2-14 present the well capacity and subbasin location for each of the proposed wells needed to meet new demands for potable water at the Finegayan Base Complex resulting from the military buildup on Guam. Additional planned wells at Andersen AFB are needed to meet demand at the base. DoD would work with GWA during design and implementation of the DoD wells and during well operation to maximize use of the aquifer.

Table 2.2-14. Basic Alternative 1—Proposed Well Details

Well Number	*Proposed Capacity (gpm)*	*Subbasin*
1	450	Agafa-Gumas
2	450	Andersen
3	250	Finegayan
4	450	Agafa-Gumas
5	450	Agafa-Gumas
6	450	Agafa-Gumas
7	400	Agafa-Gumas
8	450	Finegayan
9	450	Agafa-Gumas
10	250	Andersen
11	450	Andersen
12	250	Agafa-Gumas
13	250	Andersen
14	250	Agafa-Gumas
15	250	Agafa-Gumas
16	250	Finegayan
17	450	Andersen
18	250	Andersen
19	250	Agafa-Gumas
20	300	Agafa-Gumas
21	450	Andersen
22	300	Agafa-Gumas

Legend: gpm = gallons per minute.
Source: NAVFAC Pacific 2008c.

Well Construction

Wells would be constructed in limestone. For wells in the parabasal zone, it is assumed that wells would be terminated approximately 50 ft (15 m) below msl, and for wells in the basal/transitional zones, well termination is assumed to be 30 ft (9 m) below msl. Estimates of total well depth range between 512 and 577 ft (156 and 176 m) below grade. Geophysical surveys and drilling of investigatory wells would be undertaken before installation of each production well to establish correct well placement based on accurate volcanic basement contours.

Rehabilitation of Navy Regional Medical Center Wells

Water from one of the three wells at the Navy Regional Medical Center is biologically contaminated. The existing disinfection process would be evaluated and improved.

Water Treatment

Groundwater would be extracted and disinfected and fluorinated at the well head.

Water Distribution and Storage

Pumps at each well station would pump water from the wells to a storage tank after disinfection and fluorination. It is assumed that high-lift pumping equipment would not be required to pump treated water to the ground storage tanks.

Well Pumping Stations

Each well station would include a submersible well pump with an aboveground discharge pipe that would need to be protected. The discharge pipe would have an air/vacuum relief valve, check valve, surge relief valve, and flow meter. The well houses would be constructed with decorative concrete block walls and wood-truss-supported roofs with asphalt shingles. Standby generators would be provided at 11 well houses to provide power to pump water at average-daily-demand levels during power outages. The standby generators would be installed outside the well houses. The land area requirement for each well station is estimated to be a minimum of 1,000 ft^2 (93 m^2).

Transmission Mains

Transmission mains would convey water from the wells to the WTP. The mains would range from 8 to 30 inches (20-76 centimeters [cm]) in diameter and would be sized to provide velocities less than 6 ft (2 m) per second to minimize head losses from friction.

Water transmission mains would convey water from the wells to the distribution system. The treated water would be distributed throughout the Main Cantonment through both 8-inch (in) (20-cm) and 12-in (30-cm) water mains with valves and hydrants spaced at intervals of approximately 500 ft (152 m). Interconnections with Andersen AFB would permit the transfer of water between the DoD water systems. A connection to the GWA system shown in Figure 2.2-1 is also proposed.

Water Distribution Pipes

A network of water distribution pipes would be constructed in the Main Cantonment service area. For planning purposes, it is assumed that the pipes would follow the preliminary street layout, and pipe diameters would range between 8 and 12 in (20 and 30 cm). The size and locations of distribution piping would need to be coordinated with expected land uses, estimated domestic demands, and fire flow requirements for the structures that would be constructed on the base.

Water Storage

Approximately 5 million gallons (MG) of ground storage would be needed in the distribution system. The ground storage would be located in the northern end of the Marine Corp base. The tank would have a minimum of two sections to allow continuous operation during maintenance or repairs.

2.2.4.2 Basic Alternative 2

Basic Alternative 2 would support Main Cantonment Alternatives 3 and 8, which would locate housing areas at Finegayan and Navy and Air Force Barrigada. For Basic Alternative 2, new water supply wells would be installed at Andersen AFB and Navy Barrigada, existing wells would be rehabilitated, and the transmission and distribution systems would be upgraded. Basic Alternative 2 would require water supply, water (disinfection), water storage, and water distribution components, as summarized in Figure 2.2-3 and Table 2.2-15.

Table 2.2-15. Basic Alternative 2—Proposed Water System Components

Component	*Description*
Water Supply	• Development of up to 20 new water supply wells (including one contingency well) at Andersen AFB • Development of up to 11 new water supply wells (including one contingency well) at Navy Barrigada • Continued use of existing Navy wells at Finegayan
Water Treatment	• -Disinfection and fluoridation at the well heads.
Water Storage	• Continued use of existing Navy Barrigada storage tank • Construction of new storage tank at Finegayan • Construction of new storage tank at Air Force Barrigada • Abandonment of existing Navy storage tanks at Finegayan
Distribution System	• Waterlines to transport the water from supply wells to storage tanks • An interconnect with the Navy's islandwide water system • Improvements to the Navy's islandwide water system between Air Force Barrigada and Finegayan (i.e., extend system to Air Force Barrigada, size pipes appropriately, replace corroded pipes, transport water to the south as well as north) • Pumping stations

Source: NAVFAC Pacific 2009.

Alternative 2 addresses the water demands in northern Guam. Water requirements at Andersen AFB and the Navy bases are projected to be currently adequate and are not discussed in this alternative. It is estimated that water from wells installed on Navy Barrigada would be sufficient to meet the demand at Air Force Barrigada. Additional Marine Corps relocation–related demand at Barrigada would be met by the Finegayan water supply via the Navy's islandwide water system. As presented in Table 2.2-16, this alternative would result in excess water of 0.7 MGd (2.7 mld) at Marine Corps Finegayan and 0.4 MGd (1.5 mld) at Air Force Barrigada.

Table 2.2-16. Basic Alternative 2—Proposed DoD Water Supply and Demand

	Marine Corps Relocation Areas		
Units: MGd	*Finegayan Base Complex*	*Navy Barrigada*	*Air Force Barrigada*
Minimum Required (MDD + largest well)	7.0	5.7	3.6
MDD	6.4	5.7	3.3
Largest Well	0.65		0.29
Existing Supply	2.3		0.4
Additional Required	12.7		3.2
Future Planned Capacity	13.4		3.2
Total Future Capacity	13.4		3.6
Excess Water	0.7		0.4

Legend: MGd = million gallons per day
Source: NAVFAC Pacific 2009.

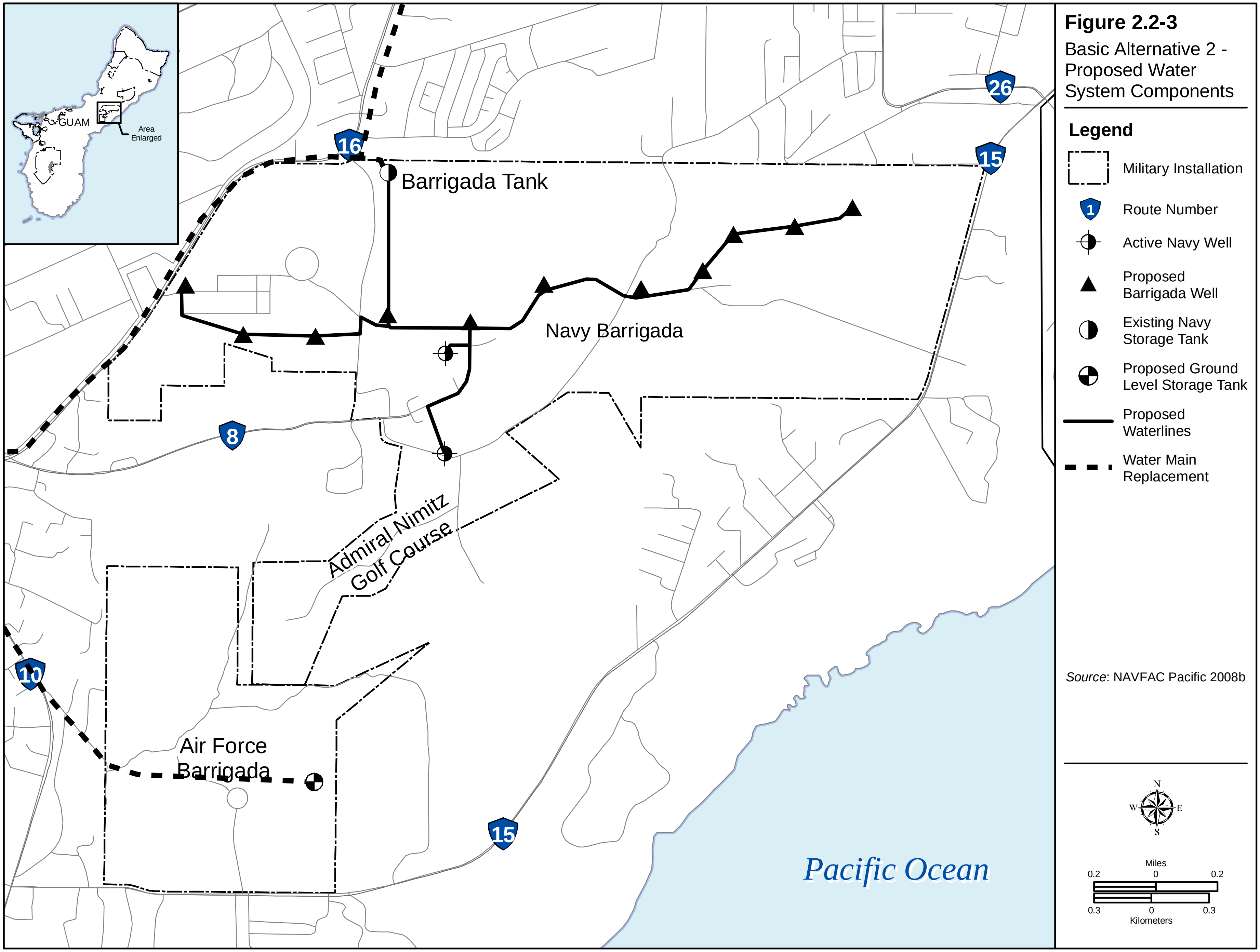

Figure 2.2-3
Basic Alternative 2 - Proposed Water System Components

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Water Supply

Basic Alternative 2 would develop water supplies (water supply wells) in northern Guam and would include the capability to distribute water from Finegayan to Air Force Barrigada. The proposed locations for new water supply wells to be constructed under Basic Alternative 2 are based on information regarding the sustainable and available yield of aquifer subbasins and other siting constraints as discussed for Basic Alternative 1 in Section 2.3.6.1. Wells would be placed on Navy Barrigada within the parabasal region (Figure 2.2-3).

Estimates of Sustainable and Available Yield

For Basic Alternative 2, wells are proposed at Andersen AFB in the Andersen and the Agafa-Gumas subbasins, which are underdeveloped compared to the southern subbasins. A parabasal zone exists in both the Andersen and Agafa-Gumas subbasins, meaning that they have the potential for increased production rates. The majority of these subbasins lie under DoD land (see Figure 2.2-2). They are also close to the proposed location for the Main Cantonment at Finegayan. Therefore, Basic Alternative 2 proposes to develop 20 new water supply wells within the Agafa-Gumas and Andersen subbasins.

Navy Barrigada is located within the Agana and Mangilao subbasins. Based on either the 1982 or 1991 estimate of sustainable yield (Table 2.2-12), sufficient yield remains available to meet the 2.8 MGd (10.6-mld) demand at Air Force Barrigada. Therefore, Alternative 2 proposes to develop up to 11 new water supply wells within the Agana and Mangilao subbasins.

The number of wells for Basic Alternative 2 is greater than the number of wells for Alternative 1 to meet the higher water demand. The causes of the higher water demand are as follows: additional industrial demand on Navy Barrigada and Air Force Barrigada, a higher growth factor from UFC requirements for Navy Barrigada and Air Force Barrigada due to their system size being smaller than the Finegayan system, lower expected yield from the new supply wells at Barrigada versus the wells at Andersen AFB, and additional water supply to accommodate the active duty population that lives on Navy Barrigada or Air Force Barrigada, but works on the Marine Corps base.

Components of the Water Systems

Figure 2.2-3 and Table 2.2-17 present the well capacity and subbasin locations for proposed wells needed to meet new demands for potable water at the Finegayan Base Complex and Barrigada housing areas resulting from the military buildup on Guam.

Table 2.2-17. Alternative 2—Proposed Well Details

Well Number	Proposed Capacity (gpm)	Subbasin
Located on Andersen AFB		
1	450	Agafa-Gumas
2	450	Andersen
3	150	Finegayan
4	450	Agafa-Gumas
5	450	Agafa-Gumas
6	450	Agafa-Gumas
7	450	Agafa-Gumas
8	270	Finegayan
9	450	Agafa-Gumas
10	450	Andersen
11	450	Andersen
12	450	Agafa-Gumas
13	450	Andersen
14	450	Agafa-Gumas
15	288	Agafa-Gumas
16	150	Finegayan
17	450	Andersen
18	450	Andersen
19	450	Agafa-Gumas
20	300	Agafa-Gumas
Located on Navy Barrigada		
1	200	Mangilao
2	200	Mangilao
3	200	Mangilao
4	200	Mangilao
5	200	Mangilao
6	200	Agana
7	200	Agana
8	200	Agana
9	200	Agana
10	200	Agana
11	200	Agana

Legend: gpm = gallons per minute
Source: NAVFAC Pacific 2009

Well Construction

Wells would be constructed in limestone as discussed for Alternative 1. Please see Section 2.3.6.1.

Water Treatment

Water treatment would be the same as discussed for Alternative 1. Please see Section 2.3.6.1.

Water Distribution and Storage

Water distribution and storage would be constructed in limestone as discussed for Alternative 1 in Section 2.3.6.1, except as described below.

Water Transmission Mains

The water from these wells on Navy Barrigada would be transported from the storage tank on Navy Barrigada to Air Force Barrigada through the Navy island-wide system (NIW) (30-in [76-cm] main) and a planned connection from the NIW to a planned reservoir on Air Force Barrigada (24-in [61-cm] main).

Water from the wells on Finegayan would be conveyed to Barrigada housing areas through the NIW main. The cost includes replacement of the NIW water main in sections, which are planned for use in Alternative 2 because the water mains are more than 50 years old and substantial water loss is expected in these water lines from leakage. Distribution of treated water to users within the bases is not included in this plan.

Water Storage

At Finegayan, approximately 3.6 MG of ground level storage would be needed in the distribution system. The ground level storage tank would serve two pressure zones and have at least two chambers to facilitate maintenance.

For Navy Barrigada, it is assumed that the existing 3-MG Barrigada reservoir can be used to meet the 1.6-MG minimum required storage for Alternative 2.

For Air Force Barrigada, a new 1-MG ground level tank is planned to meet the 0.95-MG minimum required storage. There is no existing storage in this area.

2.2.4.3 Long-Term Alternatives

The long-term alternatives would require follow-on analysis and tiered NEPA documentation. This may substantially change which long-term alternatives are pursued. Therefore, while a preliminary description of the long-term alternatives are presented in the following subsections, impacts related to these long-term alternatives are not assessed in this DEIS because they are not ripe for analysis.

Long-Term Alternative 1

Development of the Lost River (Tolaeyuus River) is considered a long-term alternative to provide additional supply to the Navy water system during the dry season. It is estimated that the Lost River supply would yield 1.7 to 5.6 MGd (6.4 to 21 mld) during the dry season, based on the U.S. Geological Survey (USGS) data collected between 1998 and 2001. Supply from the Lost River would be limited by downstream habitat considerations. The U.S. Fish and Wildlife Service have identified a minimum conservation flow of 1 cubic foot per second (0.03 cubic meters per second). The existing cofferdam would be rehabilitated, the reservoir area dredged, and a pump station and discharge pipeline would be installed for distributing the supply to the existing Fena Reservoir pump station. The water would be delivered either to the Navy reservoir or the Fena WTP. The capacity of the WTP and Navy distribution system would not be expanded, because the added supply is needed to compensate for the drawdown on the Navy reservoir during the dry season. Additional study is required to define the conceptual design of this alternative.

Long-Term Alternative 2

Desalination (removal of salt) of brackish water by reverse osmosis is a long-term alternative to meet projected DoD water demands in the event that the supply from freshwater wells is insufficient to meet DoD demand. Desalination of brackish water would replace the development of up to 31 new potable water supply wells at Andersen AFB and Barrigada.

Under the desalination option, a water treatment plant would produce up to a total of 14 MGd (53 mld) of potable water. The plant would accept 2.3 MGd (8.7 mld) of freshwater from the existing Navy wells at Finegayan. To supply the remaining approximately 12 MGd (45 mld) of potable water, it is assumed that 18 MGd (68 mld) of brackish water would be required. Brackish water wells would be placed at Andersen AFB, toward the coastline.

Brackish water would be supplied by up to 28 new brackish water wells and one contingency well, each with a capacity of 450 gpm. Wells would be separated by a distance of at least 1,000 ft (305 m) to avoid interference and upconing, and would be located within 1,000 ft (305 m) of the shoreline to avoid influencing existing freshwater wells. Well water extracted from the new wells would be collected, desalinated, and treated for water supply to the end user.

Desalination would include options for new brackish-water supply wells (up to 28 wells at Andersen AFB) and upgrades to transmission and distribution systems. Desalination would require water supply, water treatment, water storage, and water distribution components as summarized in Table 2.2-18 and presented in Figure 2.2-4.

Table 2.2-18. Desalination—Proposed Water System Components

Component	*Description*
Water Supply	• Development of up to 28 new brackish-water supply wells plus one contingency well at Andersen AFB
Water Treatment	• One 14-MGd (53-mld) WTP at Andersen AFB
Water Storage	• Potential construction of new storage tank at Finegayan
Distribution System	• Waterlines to transport the water from supply wells to treatment plants • Waterlines to transport treated water to storage tanks • Waterlines to distribute water throughout Finegayan • Replace water mains connecting existing Navy wells to the water system • -Pumping stations

Source: NAVFAC Pacific 2008c.

Water Supply

Brackish-water wells would be planned to supply the treatment plant with enough water to produce a total of 14 MGd (53 mld) of potable water. The plant would accept the 2.3 MGd (8.7 mld) of freshwater from the existing Navy wells at the Finegayan Base Complex. To supply the remaining approximately 12 MGd (45 mld) of potable water, it is assumed that 18 MGd (68 mld) of brackish water (3,000-4,000 mg/L TDS) would be required. The brackish-water supply wells would be designed with a higher capacity, 450 gpm, because these wells would be drawing saline water. This limit is consistent with the recommendations for supply wells presented in the 1982 NGLS. To meet the supply, 28 supply wells would be required. Consistent with the constraints for the freshwater wells, the brackish-water supply wells would be separated by a distance of at least 1,000 ft (305 m) to avoid interference and upconing. To avoid influencing existing freshwater wells, the supply wells would be placed within 1,000 ft (305 m) of the shoreline. The brackish-water wells would be screened within the brackish-water zone.

Proposed brackish-water supply well locations are shown in Figure 2.2-4. Most of the wells located near the northwest shoreline would be within the fenced area of the military reservation. The wells located outside of the fenced area might be relocated for security. The wells along the northern shoreline would be located in a limestone forest. These wells may need to be relocated because of habitat considerations. Most of the area around the Northwest Field is considered important habitat by the regulatory agencies. This area is home to the island’s last known nesting area of the endangered Mariana fruit bat. The area to the northeast is prime limestone forest, which is important habitat for many species. It may be necessary to identify alternate well locations in areas of Andersen AFB that are outside of the Andersen AFB constraints shown in Figure 2.2-4 or other limitations to be specified by the base.

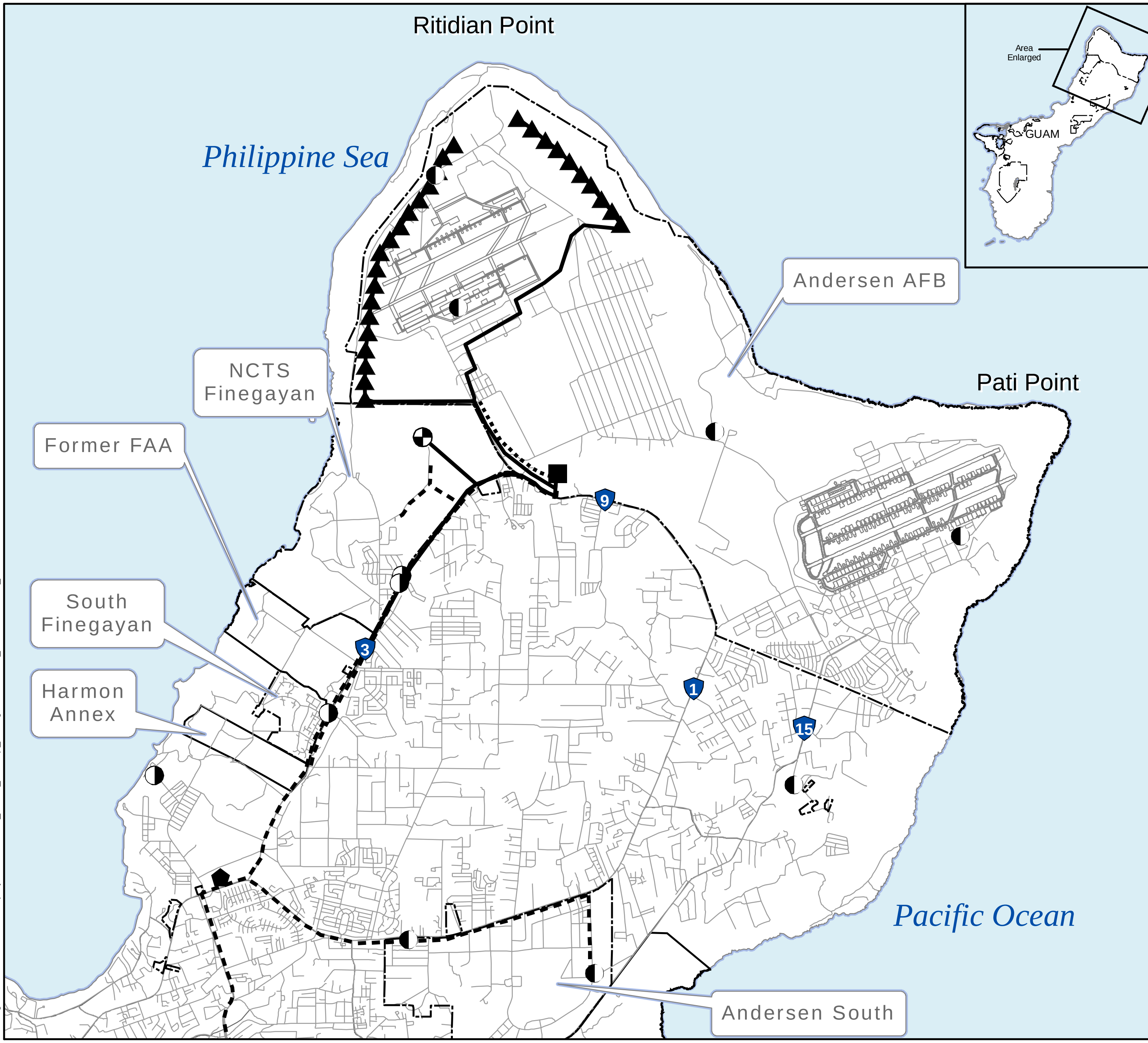

Figure 2.2-4
Long-Term Alternative 2 - Desalination

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Components of the Water Systems

Water system requirements would be the same as described for Alternative 1 in Section 2.3.6.1 except as noted below.

Well Construction

It is assumed that the well construction for the brackish-water wells would be similar to construction for the freshwater wells described in Section 2.3.6.1, but the wells in the brackish-water zone would be screened.

Water Treatment

Well water extracted from the proposed 28 new wells would be collected, desalinated, and treated for use as water supply by end users. This section presents a design basis for desalination, water treatment, treatment technologies and processes, and costs. The plant is designed for a peak treatment capacity of 14 MGd (53 mld). Before design, the water quality of the brackish water should be tested to determine the optimal treatment processes. The area required for installation of the proposed process units and support systems is estimated to be approximately 225,100 ft^2 (20,900 m^2).

Desalination plants produce liquid wastes (brine) that may contain high salt concentrations, chemicals used during defouling of plant equipment, and pretreatment residues. Brine discharges may be discharged directly into the ocean, combined with other discharges (e.g., power plant cooling water or sewage treatment plant effluent) before ocean discharge, discharged into a sewer for treatment in a sewage treatment plant, or dried and disposed of in a landfill.

Long-Term Alternative 3

Sediment dredging of the Navy Reservoir is included as a long-term option. This option is retained as part of the ongoing maintenance of the reservoir and to provide additional supply to DoD in southern Guam by increasing the storage capacity of the reservoir up to the original design capacity. Additional assessment is required to address potential obstacles related to mobilizing a dredge over long distances to the project site, which is in a remote location, as well as logistical difficulties in managing dredged material on Guam.

2.2.5 Supplemental Water Source Supply Studies

Additional studies have been completed or are planned to better define the elements of the Marine Corps base water supply sources. These studies evaluate the available information on NGLA sustainable yield, gather design-level information on well locations, and update the demand and supply requirements based on the latest population estimate (February 2009). The studies are as follows:

- Guam Water Utility Study (July 2009)
- Barrigada Utility Study to Support USMC Off-Base Housing Facilities Requirements (September 2009)
- Guam Potable Water Supplementary Analysis Letter Report (October 2009)
- University of Guam – Water and Environmental Research Institute of the Western Pacific Review of Northern Guam Lens Aquifer Sustainable Yield – Guam Water Utility Study for Proposed USMC Relocation (September 2009)
- Guam Water Well Testing Study
- NGLA GWUDI Evaluation
- USGS NGLA Study

These studies are described in the sections below. Also discussed are the time frames when information is expected to be available and the ways in which the resulting information would be incorporated into the design of the water system for the Marine Corps base, including location of the wells and protection of groundwater resources.

2.2.5.1 Guam Water Utility Study (July 2008)

This report identified all reasonable alternatives for potable water supply to support the proposed Marine Corps relocation to Guam and provide sufficient and detailed information to support the EIS/OEIS process. In 2007, AECOM Technical Services staff visited NAVFAC Pacific facilities on Guam and met with respective decision makers within NAVFAC and several other agencies on Guam to understand the regulatory requirements and design features for this project. This report presents the findings of the evaluations conducted based on the information gathered during the field study, and subsequent detailed analysis of the recommended water supply options. The demand calculations are based on population data in the Navy memorandum of September 14, 2006. Water supply for Main Cantonment Alternatives 1 and 2 and DoD water requirements throughout Guam are addressed in this report. The recommended alternative consisted of developing groundwater resources, rehabilitating selected DoD wells, providing an interconnection with GWA, and dredging sediment from the Navy Reservoir. Proposed well placement incorporated the sustainable yield estimates from Barrett 1991. Alternative 1 is based on this report.

A Potable Water Supplementary Analysis letter report (October 2009) has revised results presented in the *Guam Water Utility Study* as follows:

- The demand calculations would be based on the February 2009 DoD and Guam civilian population estimates.
- Ground storage would replace elevated storage at the Marine Corps base.
- Water treatment plants would be eliminated from the water systems because the GWUDI determination has not been made.
- Reduced UFW and no growth factor would be applied to demand estimates during the interim (or construction) period.
- Sustainability initiatives and water conservation requirements issued outside of the UFCs are considered.

This draft EIS/OEIS incorporates the planned revisions noted above for these documents.

2.2.5.2 Barrigada Utility Study to Support USMC Off-Base Housing Facilities Requirements (September 2009)

This study develops a detailed alternative to address water demand for Main Cantonment Alternatives 3 and 8. The water demand estimates are based on the February 2009 population estimates. The recommended alternative consists of groundwater resource development and well rehabilitation. Proposed well placement incorporated the sustainable yield estimates from Barrett 1991. Alternative 2 is based on this report.

2.2.5.3 Guam Potable Water Supplementary Analysis Letter Report

The report concludes that despite some differences in the DoD and civilian populations used in the water study report and the DEIS/OEIS, the description of the proposed Marine Corps water system and the evaluation of the GWA system are still valid.

2.2.5.4 University of Guam—Water and Environmental Research Institute of the Western Pacific Review of Northern Guam Lens Aquifer Sustainable Yield—Guam Water Utility Study for Proposed USMC Relocation (September 2009)

This report provides an expert technical review of the sustainable yield estimates for the NGLA contained in Groundwater in northern Guam: Sustainable Yield and Groundwater Development (Barrett 1992) to assess the validity of the estimates in sufficient detail and objectivity to assist in obtaining public and professional acceptance of the conclusions of the study. The sustainable yield estimates are a basis for determining the proposed well locations presented in the Guam water study report and the Barrigada water utility study described above. Additionally, the study addresses other related questions from DoD and USEPA on the proposed well locations. The main conclusions of the study related to the Guam water utility studies are as follows:

- The approach and methodology used in Barrett 1991 to estimate the sustainable yield are still valid. The recommendations in Barrett 1991 are appropriate for initial planning.
- The Barrett 1991 sustainable-yield estimates should be used instead of the earlier 1982 sustainable-yield estimates (CDM 1982) because the later values are based on an additional decade of field data. The 1982 sustainable-yield estimates are excessively conservative.
- A revised analysis would be more accurate because there is currently a larger data set available on well performance, recharge, and water table response.
- A state-of-the-art model would be a useful tool for long-term management of the aquifer, but is not likely to provide a significantly different outcome for sustainable yield.
- Use of the updated basement contour maps to locate the parabasal zone for well placement provides a higher degree of confidence in the productivity of the proposed wells.
- The wells would be located or "clustered" in the parabasal zone to maximize groundwater yield and water quality:
    - In this zone the freshwater lens is most likely to be thickest, have the lowest chloride content, and be least vulnerable to saltwater intrusion.
    - The subbasins are hydrologically separate entities. Therefore, the draft on one subbasin does not affect the adjacent subbasins.
    - Additional field studies and incremental assessment of well performance as the wells are installed would increase the likelihood of optimal yield, water quality, and sustainability of the resource.
- Sustainable-yield confirmation studies should be performed.

No revisions to the proposed well placement are required based on the conclusions of this report.

2.2.5.5 Guam Water Well Testing Study

This study would determine optimal well and well field configurations needed to meet the future Marine Corps base water demands. This study would develop groundwater source well-design criteria used in developing the Marine Corps base water supply system. Ten test wells would be installed to characterize the production capacity of well fields in the areas of interest: eight wells on Andersen AFB and two wells on Navy Barrigada. Geophysical logging of boreholes would be performed. Step-drawdown and 24-hour pumping tests at appropriate pumping rates would be performed to determine well capacities. Salinity and basic water quality parameters would be measured in the saturated zone. At the conclusion of pump tests, samples of the well water would be taken and analyzed by an EPA-certified laboratory for primary and secondary drinking water standard contaminants. One of the test wells would be further developed by reaming, installation of screen and filter pack, casing and seal, and additional subsequent-step drawdown testing and constant-rate testing. At the conclusion of well testing, the wells would be covered. The remaining test wells may eventually be converted to production wells.

Completion of the study with report documentation is anticipated at the end of 2010 with preliminary results available in time for the Final EIS/OEIS.

The results of this study could change the location and number of wells on Andersen AFB and Navy Barrigada or the water treatment requirements. This information would be incorporated into the NEPA process through a supplemental NEPA submission.

2.2.5.6 Northern Guam Lens Aquifer (NGLA) GWUDI Evaluation

Groundwater under the direct influence of surface water is groundwater with inadequate natural filtration when surface water filters through soils into the groundwater table (called “recharge”). This inadequate filtration through soils may lead to contamination of the groundwater from bacteria or contaminants in the soils. GEPA is currently conducting a study to determine if wells extracting water from the NGLA are GWUDI. Soils in northern Guam are highly porous, and past sampling has indicated that contaminants may enter the aquifer during sewer pump station spills and rain events. If portions of the aquifer sub-basins are identified as GWUDI well, then treatment requirements maybe imposed on individual wells that includes filtration and/or disinfection.

The results of the GEPA study are expected in late 2010. This DEIS/OEIS is developed assuming that the proposed and existing DoD wells are not subject to GWUDI. If the GWUDI determination is made in the future for the DoD well, a separate NEPA document would be developed to address the additional water treatment requirements.

2.2.5.7 USGS NGLA Study

DoD plans to support a USGS study of the NGLA that would include a state-of-the-art groundwater model and verification of the sustainable yield on all relevant and available site-specific data collected to date. The study would not be completed for 3-5 years. Given this time frame, the model is expected to be used in the long-term maintenance of the NGLA groundwater resource. If possible, a preliminary analysis using a finer grid model in the area of the proposed well locations as a tool for well siting.

2.3 WASTEWATER

2.3.1 Overview

The proposed military buildup on Guam would be located at Andersen AFB, NCTS Finegayan, South Finegayan, Andersen South, Barrigada, and Naval Base Guam at Apra Harbor. These areas are currently serviced by three wastewater treatment plants. Two of these wastewater treatment plants are owned and operated by the Guam Water Authority (GWA): the Northern District Wastewater Treatment Plant (NDWWTP), and the Hagatna WWTP. One of the wastewater treatment plants is owned and operated by the Navy: the Apra Harbor WWTP Figure 2.3-1 shows the locations of these wastewater treatment plants. Table 2.3-1 shows the areas that these treatment plants service.

Table 2.3-1. Wastewater Treatment Facilities Servicing Areas of the Proposed Military Buildup on Guam

Area of Proposed Military Buildup	*Wastewater Treatment Facility*	*Region/Subregion*
Andersen AFB	NDWWTP	North/Andersen AFB
NCTS Finegayan	NDWWTP	North/Finegayan
South Finegayan	NDWWTP	North/Finegayan
Andersen South	NDWWTP	Central/Andersen South
Barrigada	Hagatna WWTP	Central/Barrigada
Naval Base Guam	Apra Harbor WWTP	Apra Harbor/Naval Base Guam

Source: GWA 2007.

Table 2.3-2 shows information for each of the wastewater treatment plants, including design capacity, estimate of the current wastewater flow, and the current maximum treated-wastewater disposal flow under each plant's National Pollutant Discharge Elimination System (NPDES) permit. NPDES permits are issued to wastewater treatment plants and include provisions for the following:

- The plant must meet minimum standards for removal of pollutants
- The plant cannot discharge pollutants into a waterbody above limits that are set in the permit
- The owner of the plant must properly operate and maintain the plant
- The plant must be operated by trained and certified workers
- Wastewater throughout the plant and at the discharge must be routinely sampled and tested
- Test results must be reported to USEPA Region 9 and Guam EPA (GEPA)in reports called Discharge Monitoring Reports (DMRs).

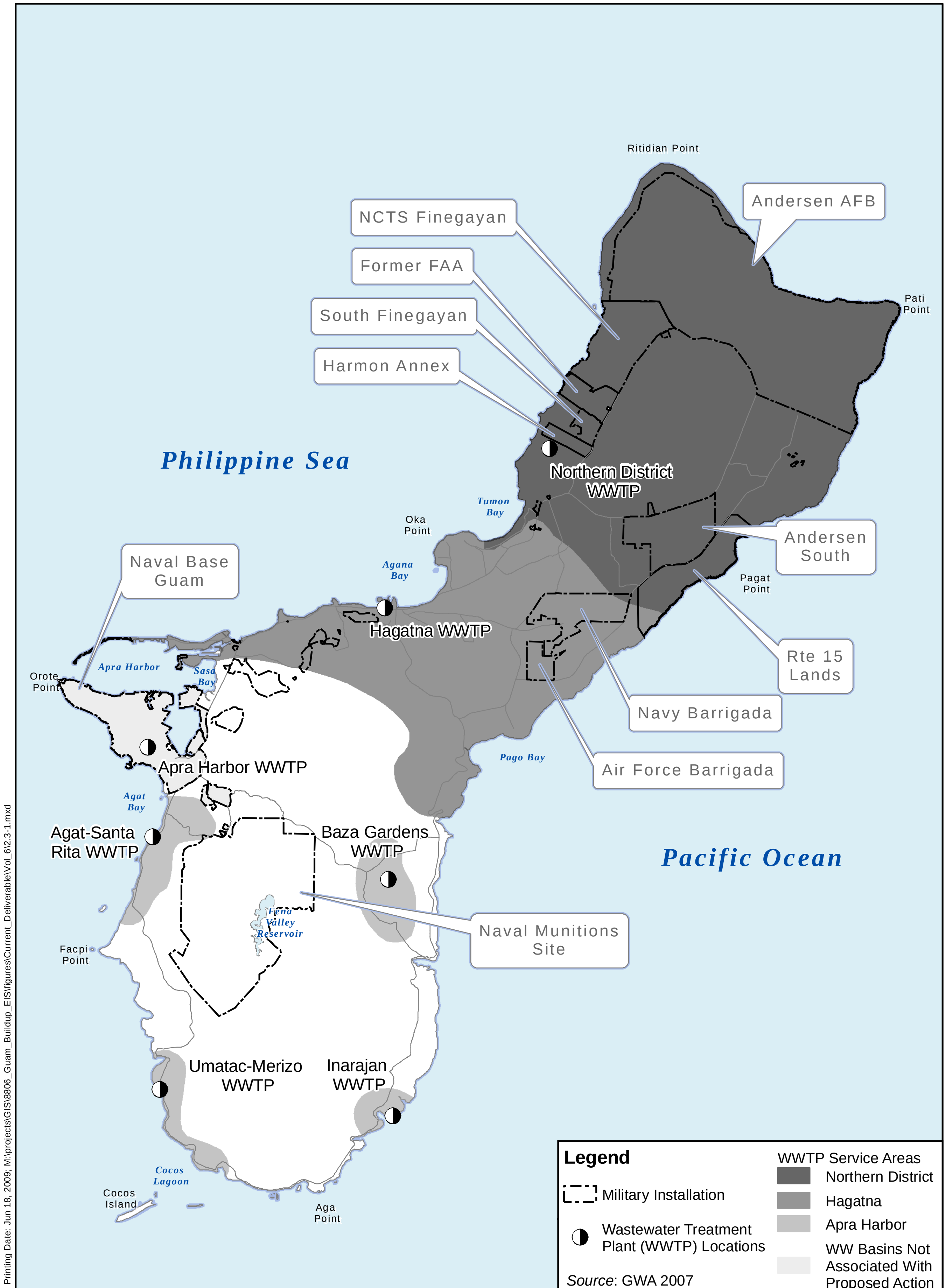


Figure 2.3-1
Wastewater Treatment Plant Locations and Service Areas, Guam

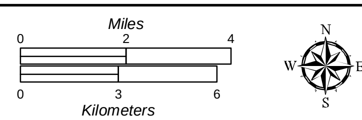


Table 2.3-2. Existing Wastewater Treatment Capacities and Demand within the Areas of Proposed Military Buildup

Treatment Plant	*Owner/ Operator*	*Treatment Level*	*Design Average Capacity (MGd)*	*Current Average Flow (MGd)*	*Design Peak Capacity (MGd)*	*NPDES Permit Maximum Daily Flow (MGd)*
Hagatna WWTP	GWA	Primary	12.0	4.7	21	12.0
NDWWTP	GWA	Primary	12.0	5.7	27	6.0
Apra Harbor WWTP	Navy	Secondary	4.3	2.9	9.0	4.3 (Average daily flow)

2.3.2 Available Wastewater Facilities

2.3.2.1 DoD Wastewater Facilities

Apra Harbor WW Treatment Facility

The current average wastewater flow to the Navy's Apra Harbor WWTP is 2.9 MGd (11.0 mld). Proposed increases in the Navy and U.S. Coast Guard population in the Apra Harbor area would increase the wastewater flow to the Apra Harbor WWTP by about 0.79 MGd (2.99 mld), for a total projected flow of 3.69 MGd (13.96 mld). With a design capacity of 4.3 MGd (16.3 mld), the Apra Harbor WWTP would have enough capacity to treat the projected total wastewater flow (3.69 MGd [13.69 mld]) to be generated as a result of proposed military buildup activities in the Apra Harbor area.. Therefore, no additional wastewater treatment capacity is needed at the Apra Harbor WWTP, and no changes to the NPDES permit would be necessary.

2.3.2.2 Non-DoD Wastewater Facilities (GWA Wastewater System)

As shown in Table 2.3-1, the Hagatna WWTP and the NDWWTP are GWA plants that service the areas where much of the military buildup will occur. GWA holds two NPDES permits: one for the NDWWTP and one for the Hagatna WWTP. Both permits were issued by USEPA Region 9 in June 1986. Both the Hagatna WWTP and NDWWTP each discharge to the Philippine Sea through an ocean outfall.

The NPDES permits for the Hagnata WWTP and the NDWWTP expired in 1991. Since that time USEPA Region 9 administratively extended the permit. The permits contained a variance that allows each plant to utilize only primary treatment processes instead of more advanced treatment processes that are typically required for sewage treatment plants. Primary treatment refers to sewage treatment that uses physical separation of solid material from the waste stream prior to discharge to a water body. More advanced treatment, called secondary treatment, provides for removal of organic matter and pollutants in sewage beyond what can be removed in primary treatment plants, typically by using bacteria as a means to digest and remove wastes. Secondary treatment variances are allowed under Section 301(h) of the Clean Water. Sewage treatment facilities that are granted a 301(h) secondary treatment variance must demonstrate that their discharge does not have an impact on the environment or water quality. They must also demonstrate that they adequately control industrial wastes that could enter their plants, and they must meet minimum standards for removal of pollutants in their treatment processes.

On September 30, 2009, USEPA Region 9 made a decision to deny the secondary variance for these plants, which effectively requires GWA to install full secondary treatment at both the Hagnata WWTP and the NDWWTP. This recent decision by USEPA was issued at the same time this DEIS/OEIS was in final preparation for release to the public. The alternatives presented in this DEIS/OEIS were adjusted to recognize this secondary variance denial, and reflect the need for secondary treatment plant upgrades for all alternatives evaluated.

DoD is consultating with USEPA, GEPA, and GWA concerning wastewater requirements from the Guam military buildup. The purpose of the consultation is to achieve a common understanding of the requirements for treatment plant upgrades that address not only the military buildup on Guam, but also address requirements associated with the recent secondary treatment Section 301(h) variance denial. All parties are committed to working collaboratively to develop solutions to satisify common goals. While these discussions may ultimately lead to modifications to specific timeframes for treatment plant upgrades and treatment plant permit modifications, they are not expected to result in significantly different facilities than those respresented in the wastewater alternatives presented in this EIS/OEIS.

2.3.3 Projected Wastewater Flows

The total projected wastewater flow generated from the proposed Marine Corps relocation and associated activities consists of both domestic and industrial flows. The projected domestic wastewater flow was calculated using per capita wastewater generation criteria from UFC 3-240-02N, *Wastewater Treatment System Augmenting Handbook* (DoD 2004), and the industrial flows were calculated using criteria from the Water Pollution Control Federation's Manual of Practice No. FD-5, *Gravity Sanitary Sewer Design and Construction* (Water Pollution Control Federation 1982). The criteria are as follows:

- Resident Personnel, 120 gpcd
- Transient Personnel, 35 gpcd
- Off-base civilian workers, 35 gpcd
- Industrial Users, 15,500 gpd/acre
- Consistent with Navy and Marine Corps policies and existing laws related to sustainability and reductions in energy and water use at military bases, the Marine Corps would incorporate technology to improve wastewater efficiency to the degree feasible and economical. Attempts would be made to reduce wastewater quantities and improve treatment and conveyance efficiencies.

Per capita wastewater generation of 120 gpcd was applied to estimate wastewater flow generated by the off-base nonmilitary population, which includes the local Guam population, Marine Corps relocation–related construction workforce, and induced population. The construction workforce was assumed to be two-thirds in northern Guam and one-third in central Guam, while induced population was assumed to be evenly distributed over the island. Domestic wastewater flow is determined by multiplying per capita wastewater generation by respective population. Industrial wastewater flow is calculated by multiplying the above industrial wastewater generation per unit area by industrial used land acreage.

2.3.3.1 Wastewater Flows Associated with Proposed Main Cantonment Alternatives 1 and 2

Locating the Marine Corps Main Cantonment and the Army AMDTF at Finegayan would increase wastewater flows to be generated at NCTS Finegayan, South Finegayan, and Andersen AFB. Table 2.3-3 shows the current population in these areas of northern Guam and the projected population at the end of the military buildup in 2019 if Main Cantonment Alternatives 1 and 2 were to be selected.

Table 2.3-3. Current and Projected DoD Population at Completion of Buildup in Northern Guam for Main Cantonment Alternatives 1 and 2

Service	*Active Duty*	*Dependents*	*Transient*	*On-Base Civilian*	*Civilian Workforce (living off base)*
Current					
Marine Corps	3	2	0	1	0
Air Force	2,145	2,950	0	805	402
Navy	39	66	0	351	1,130
Army	30	50	0	11	5
Projected Increase					
Marine Corps	8,552	9,000	2,000	1,710	855
Air Force	120	210	1,780	25	12
Navy	0	0	0	0	0
Army	630	950	0	126	63
Total Future Population in 2019					
Marine Corps	8,555	9,002	2,000	1,711	855
Air Force	2,265	3,160	1,780	830	414
Navy	39	66	0	351	1,130
Army	660	1,000	0	137	68

Source: Socioeconomic analysis in support of this DEIS.

Wastewater from these locations is currently conveyed to the NDWWTP in northern Guam for treatment and disposal. Projected year 2019 increases in average daily wastewater flows to the NDWWTP under Main Cantonment Alternatives 1 and 2 are summarized in Table 2.3-4.

Table 2.3-4. Current and Projected Civilian and DoD Flows at Completion of Buildup for Main Cantonment Alternatives 1 and 2

Source	*Current Wastewater Flow (MGd)*	*Projected Increase in Wastewater Flow (MGd)*	*Total Projected in 2019 Average Daily Flow (MGd)*
Northern District Wastewater Treatment Plant			
Civilian	5.20	2.69	7.88
Military	0.53	3.12	3.65
Marine Corps	0.00	2.71	2.71
Navy	0.15	0.00	0.15
Air Force	0.36	0.21	0.57
Army	0.01	0.21	0.22
Total	**5.73**	**5.81**	**11.54**

Sources: GWA 2008, NAVFAC Pacific 2008d.

As a result of the proposed military buildup, the total year 2019 average daily flow to the NDWWTP from military sources is projected to increase by 3.65 MGd (13.81 mld). This would result in a total average flow to the NDWWTP in year 2019 of 11.54 MGd (43.67 mld) from both military and civilian sources. The year 2019 peak daily flow to the plant would be calculated at 25.97 MGd (98.30 mld) (based ona ratio of 2.25 to 1 of peak flow to average flow from the original design calculations of the NDWWTP). Based on current conditions of the existing structures and equipment at the NDWWTP, the plant would need to be refurbished and upgraded to restore its original design capacity of 12 MGd average flow in order to meet the 11.54 MGd total projected flow shown in Table 2.3-2. Also, the NPDES permit would need to be modified to allow the original design treatment capacity of 12 MGd (45 mld) average daily flow and 27 MGd (102 mld) maximum daily flow in order to accommodate the projected ultimate flow from the planned Marine Corps relocation at completion of buildup for Main Cantonment

Alternatives 1 and 2. Currently the NPDES permit allows only a 6 MGd flow at the plant discharge, even though the plant design flow is 12 MGd.

A socioeconomic analysis of the proposed military buildup has estimated that induced civilian growth as a result of the military buildup could increase the islandwide population on Guam by up to approximately in the peak year of 2014, which includes populations from the construction workforce and associated induced population.This corresponds to a total wastewater peak average daily flow of up to 12.75 MGd (48.25 mld) at the NDWWTP in year 2014.

Table 2.3-5 summarizes existing civilian and peak DoD flows for northern Guam for Main Cantonment Alternatives 1 and 2. Included in this table are projected increases in northern Guam's civilian flows as a result of natural population growth, projected DoD increases associated with the military buildup, increases associated with the imported construction workforce, and civilian increases that could result from induced population growth in northern Guam.

Table 2.3-5. Projected Peak Wastewater Flows for Main Cantonment Alternatives 1 and 2

Source of Wastewater Flow	*Year*					
	2010	*2011*	*2012*	*2013*	*2014*	*2015*
Northern District Wastewater Treatment Plant						
Existing Guam Civilian	5.20	5.20	5.20	5.20	5.20	5.20
Existing DoD	0.53	0.53	0.53	0.53	0.53	0.53
Guam Civilian Increase	0.42	0.64	0.85	1.06	1.26	1.47
DoD Increase	0.24	0.48	0.53	0.57	2.71	2.95
Construction Workforce	0.26	0.66	1.14	1.43	1.47	0.97
Subtotal Direct DoD and Guam Civilian	**6.65**	**7.50**	**8.25**	**8.79**	**11.17**	**11.11**
Induced Civilian Increase	0.27	0.66	1.08	1.27	1.58	1.19
Total Average Daily Flow—all sources	**6.92**	**8.16**	**9.33**	**10.05**	**12.75**	**12.31**
Total Peak Daily Flow—all sources	**15.56**	**18.37**	**20.99**	**22.62**	**28.69**	**27.69**

Legend: measurements given in million gallons per day.

Peak daily flows in Table 2.3-5 are calculated from the plant-designed peak-to-average flow ratiosfor the NDWWTP (2.25 to 1). Under Main Cantonment Alternatives 1 and 2, both the projected peak increased average flow and maximum daily flow to the NDWWTP would be slightly over the NDWWTP originally designed treatment capacity of 12 MGd (45 mld) average daily flow and 27 MGd (102 mld) peak daily flow of, but would far exceed the NPDES permitted flow of 6 MGd (22.7 mld). Based on current conditions of the existing structures and equipments, the plant would need to be refurbished and upgraded to restore its original design capacity to accommodate peak increased flow during the peak period. In addition to these upgrades, additional treatment in the form of chemical addition to enhance solids removal would be needed to ensure discharge permit limits are met during the peak flow period. Lastly, the permit would need to be modified to allow the originally designed treatment capacity flows of 12 MGd (45 mld) average daily flow and 27 MGd (102 mld) maximum daily.

2.3.3.2 Wastewater Flows Associated with Proposed Main Cantonment Alternatives 3 and 8

Locating the Marine Corps' Main Cantonment and the Army AMDTF at Finegayan and their housing at DoD Barrigada properties would increase wastewater flows generated not only at Finegayan in northern Guam, but also at Navy Barrigada and Air Force Barrigada in central Guam. Table 2.3-6 shows the current military population in the Barrigada area of central Guam and the projected population at the end of the military buildup in 2019 if Main Cantonment Alternatives 3 and 8 were to be selected.

Table 2.3-6. Current and Projected DoD Population at Completion of Buildup in the Barrigada Area of Central Guam under Main Cantonment Alternatives 3 and 8

Service	Active Duty	Dependents	Civilians On Base
Current			
Marine Corps	0	0	0
Air Force	0	0	0
Navy	-	-	-
Army	0	0	0
Proposed Increase			
Marine Corps	2,181	5,683	1,058
Air Force	0	0	0
Navy	0	0	0
Army	342	950	166
Total Future Loading in 2019			
Marine Corps	2,181	5,683	1,058
Air Force	0	0	0
Navy	-	-	-
Army	342	950	166

Source: Socioeconomic analysis in support of this DEIS.

Wastewater from DoD Barrigada properties is currently conveyed to the Hagatna WWTP in central Guam for treatment and disposal. The projected DoD wastewater increases associated with the military buildup at Barrigada would be conveyed to northern Guam for treatment under this alternative. Projected year 2019 increases in average daily wastewater flow increases to the NDWWTP under Main Cantonment Alternatives 3 and 8 are summarized in Table 2.3-7.

Table 2.3-7. Current and Projected Civilian and DoD Flows at Completion of Buildup for Main Cantonment Alternatives 3 and 8

Source	Current Wastewater Flow (MGd)	Projected Increase in Wastewater Flow (MGd)	Total Projected in 2019 Average Daily Flow (MGd)
Northern District Wastewater Treatment Plant			
Civilian	5.20	2.69	7.88
Military	0.53	3.12	3.65
Marine Corps (Finegayan)	0.00	1.63	1.63
Marine Corps (Barrigada)	0.00	1.08	1.08
Navy	0.15	0.00	0.15
Air Force	0.36	0.21	0.57
Army (Finegayan)	0.01	0.21	0.22
Army (Barrigada)	0.00	0.17	0.17
Total	**5.73**	**5.81**	**11.54**

Legend: MGd = million gallons per day
Sources: GWA 2008, NAVFAC Pacific 2008d.

Under the proposed Main Cantonment Alternatives 3 and 8, the projected DoD wastewater increases from the proposed Barrigada housing would be conveyed to northern Guam for treatment. If the wastewater flows generated from military buildup, both at Finegayan area and Barrigada area, are still treated at the NDWWTP, the total year 2019 average flow to the NDWWTP would increase to11.54 MGd (43.67 mld).

This is the same flow that is projected for the NDWWTP for Main Cantonment Alternative 1 and 2. Therefore, recommendations for Main Cantonment Alternatives 3 and 8 would be the same as for Main Cantonment 1 and 2. These include refurbishing and upgrading the existing NDWWTP treatment processes to restore them to their original design capacity, adding chemical treatment to enhance solids removal during peak flow years, and modifying the NDPES permit to allow for the increased flows.

2.3.3.3 Projected Long-Range Wastewater Flows on Guam

Absent the military buildup in Guam, wastewater flows across Guam are expected to increase over time as part of normal civilian population growth. The wastewater flows presented in the previous section include expected wastewater flows that are part of normal civililan population growth during the period of time of the military buildup - years 2010 to 2019. After 2019, normal civilian population growth on Guam would continue, thereby generating additional wastewater flows from the population in the out years.

As part of DoD's ongoing consultation with GWA, GEPA and USEPA Region 9, GWA has indicated that if DoD selects an alternative in this EIS that involves using the NDWTP, long-range wastewater flows at the NDWTP beyond the military buildup (e.g.: beyond the year 2019) would quickly exceed the 12 MGd design capacity of the plant. GWA projects a future capacity need at the NDWWTP of 18 MGd. As mentioned previously in Section 2.3.2, USEPA Region 9 recently issued a decision to deny GWA's secondary treatment 301(h) variance, effectively requiring GWA to upgrade its NDWWTP and Hagatna WWTP to secondary treatment.The treatment plant upgrades needed to meet this new requirement should be planned to ultimately provide an 18 MGd plant capacity at the NDWWTP.

The analysis of wastewater presented in this EIS/OEIS centers on the impacts related to the proposed action that are the responsibility of the DoD to assess; namely the military buildup on Guam during the years 2010 to 2019. Thus, the EIS presents a detailed analysis of potential environmental impacts as they relate to a projected wastewater flow of 12 MGd that could be treated at the NDWWTP during this timeframe. This EIS also includes an analysis of potential environmental impacts that may be associated with upgrades to the NDWWTP to an 18 MGd capacity, but only as they relate to expected changes in water quality that could result from increased pollutant loads in the plant discharge from a larger 18 MGd plant. See Chapter 3 Section 3.2.4.2 for this analysis.

2.3.4 Screening Process

In support of Main Cantonment Alternatives 1 and 2, eight alternatives for increasing the treatment capacity in northern Guam were evaluated. These wastewater solutions were developed to support a Marine Corps Main Cantonment at Finegayan. All of the wastewater solutions involving an upgrade or tie-in to the GWA NDWWTP would necessarily be undertaken as joint ventures, and would require close coordination between DoD and GWA to ensure that planned facilities would provide capacity for total projected wastewater flows from both military and civilian sources. The eight wastewater alternatives evaluated are as follows:

- Expand and upgrade the existing primary treatment system at the GWA NDWWTP to accept the projected future flow and load from northern Guam (GWA facility and operation).
- Expand and upgrade the GWA NDWWTP to secondary treatment.
- Build a new DoD secondary treatment plant near the proposed development on DoD land and construct a new outfall (DoD facility and operation).
- Build a new separate DoD secondary treatment plant at the GWA NDWWTP site to treat the DoD load only (construction and operation of wastewater treatment facility not determined).

- Build a new DoD tertiary treatment plant near the selected Main Cantonment on DoD land and send effluent to a new or existing WTP (DoD facility and operation).
- Build a new DoD secondary treatment plant, and construct a new DoD outfall on the eastern coastline (DoD facility and operation).
- Build a new DoD tertiary treatment plant near the selected Main Cantonment and reuse the effluent; send the residual to the GWA NDWWTP outfall (DoD facility and operation; GWA outfall).
- Build a new DoD tertiary treatment plant near the selected Main Cantonment on DoD land and install injection wells (DoD facility and operation)

Eight wastewater alternatives to support Main Cantonment Alternatives 1 and 2 were initially evaluated through the screening process; three of them were retained as viable wastewater solutions for addressing projected increased wastewater flow. A summary of the eight wastewater alternatives for Main Cantonment Alternatives 1 and 2 and a fundamental evaluation of these alternatives are provided in Table 2.3-8.

Table 2.3-8. Summary of Alternatives Evaluated for Wastewater Systems in Support of Main Cantonment Alternatives 1 and 2

Wastewater System Alternative	*Evaluation Considerations*	*Recommendation*
Expand and upgrade the existing primary-treatment system at the GovGuam NDWWTP to accept the additional load	• Offshore construction would not be required, and a GWA outfall exists. • The discharge permit for the 301(h) waiver needs to be modified for additional flow. • The long-term impact of the primary effluent on the aquatic habitat is a concern. • No construction would occur on undeveloped land. • Public traffic disruption could occur during construction of relief interceptor. • GWA operates the NDWWTP. • Construction and operation costs would need to be shared with GWA. • Coordination with GWA on ongoing CIP projects would be required.	Retained
Expand and upgrade the GovGuam NDWWTP to secondary treatment	• Offshore construction is not required and a GWA outfall exists. • The existing permit needs updating for secondary treatment limits. • The long-term impact of the secondary effluent on the aquatic habitat is a concern. • No construction would occur on undeveloped land. • Public traffic disruption could occur during construction of relief interceptor. • GWA operates the NDWWTP. • Upgrading to secondary treatment would increase GWA sewer rates for non-DoD users. • Construction and operation costs would need to be shared with GWA. • Coordination with GWA on ongoing CIP projects would be required.	Retained

Table 2.3-8. Summary of Alternatives Evaluated for Wastewater Systems in Support of Main Cantonment Alternatives 1 and 2

Wastewater System Alternative	*Evaluation Considerations*	*Recommendation*
Build a new secondary-treatment plant near the proposed development on DoD land and construct a new outfall	• Offshore outfall construction would be required. • A new NPDES permit from USEPA would be required. • Construction on undeveloped land may be required, causing habitat disruption. • The long-term impact of the treated effluent on the coral reef habitat is a concern. • The construction site may contain historical artifacts. • New sewer line construction would be required for diverting DoD wastewater. • DoD owns the outfall. • GWA treatment revenue would be reduced.	Retained
Build a new separate DoD secondary-treatment plant at the GovGuam NDWWTP site to treat the DoD load only	• Offshore construction would not be required, and a GWA outfall exists. • The existing permit would require updating for revised limits. • Construction on undeveloped land may be required, causing habitat disruption. • The long-term impact of the blended primary and secondary effluent on the aquatic habitat is a concern. • The construction site may contain historical artifacts. • New sewer line construction is required for diverting DoD loads. • GWA owns the outfall. • GWA treatment revenue would be reduced.	Eliminated
Build a new tertiary-treatment plant near the proposed development on DoD land and send effluent to a new water treatment plant (or existing plant)	• Offshore construction would not be required. • GEPA regulates potable water supplies. • USEPA sets safe drinking water limits for local agencies. • Construction on undeveloped land may be required, causing habitat disruption. • The construction site may contain historical artifacts. • New sewer line construction is required for diverting DoD wastewater. • Construction of a new water line connection is required. • GWA purchases water from the DoD system, and monitoring requirements would be more stringent than current condition. • Construction and operation and maintenance costs would be high. • A longer planning effort and construction schedule would be required. • Public acceptance may be needed.	Eliminated

Table 2.3-8. Summary of Alternatives Evaluated for Wastewater Systems in Support of Main Cantonment Alternatives 1 and 2

Wastewater System Alternative	*Evaluation Considerations*	*Recommendation*
Build a new secondary-treatment plant and construct a new outfall on the eastern coastline	• Offshore construction would be required. • A new NPDES permit from USEPA would be required. • Construction on undeveloped land may be required, causing habitat disruption. • The new discharge would cause concern about the long-term impact of secondary effluent on aquatic habitat. • The construction site may contain historical artifacts. • New sewer line construction would be required for diverting DoD wastewater. • GWA treatment revenue would be reduced. • A longer planning effort and construction schedule would be required.	Eliminated
Build a new tertiary-treatment plant near the proposed development and reuse the effluent; send the residual to the GWA outfall	• Offshore construction would not be required, and a GWA outfall exists. • GEPA would regulate reclaimed water. • The existing permit would require updating for revised limits. • Construction on undeveloped land may be required, causing habitat disruption. • The long-term impact of the blended primary and tertiary effluent on the aquatic habitat is a concern. • The construction site may contain historical artifacts. • New sewer line construction is required for diverting DoD wastewater. • Construction of a new reused-water line is required. • GWA owns the outfall. • GWA treatment revenue would be reduced. • Construction and operation and maintenance costs would be high. • A longer planning effort and construction schedule would be required.	Eliminated

Table 2.3-8. Summary of Alternatives Evaluated for Wastewater Systems in Support of Main Cantonment Alternatives 1 and 2

Wastewater System Alternative	*Evaluation Considerations*	*Recommendation*
Build a new tertiary-treatment plant near the proposed development and install injection wells	• Offshore construction would not be required. • High energy demands would result. • A new groundwater recharge permit would be required from GEPA. • Construction on undeveloped land may be required, causing habitat disruption. • The construction site may contain historical artifacts. • New sewer line construction would be required for diverting DoD wastewater. • New pipeline construction would be required for diverting effluent to injection wells. • GWA's potable water supply is from the same aquifer. • GWA treatment revenue would be reduced. • Construction and operation and maintenance costs would be high. • A longer planning effort and construction schedule would be required. • Public acceptance may be needed.	Eliminated

In support of Main Cantonment Alternatives 3 and 8, six wastewater treatment solutions for increasing the treatment capacity were evaluated. These wastewater solutions were developed to support the Marine Corps housing option at Barrigada. All of the wastewater solutions involving an upgrade or tie-in to the GWA NDWWTP and the GWA Hagatna WWTP would necessarily be undertaken as joint ventures, and would require close coordination between DoD and GWA to ensure that planned facilities would provide capacity for total projected wastewater flows from both military and civilian sources. The six wastewater alternatives evaluated are as follows:

- Expand and upgrade the existing primary treatment system at the GWA NDWWTP to accept the additional flow and load from both central and northern Guam (GWA facility and operation).
- Expand and upgrade the GWA NDWWTP to secondary treatment.
- Expand and upgrade the existing primary treatment system at the GWA Hagatna WWTP to accept the additional flow and load from central Guam.
- Expand and upgrade the GWA Hagatna WWTP to secondary treatment.
- Build a new secondary treatment plant near the proposed development on DoD land and construct a new outfall.
- Build a new separate DoD secondary-treatment plant at the GovGuam Hagatna WWTP site to treat the DoD load only.

Three wastewater alternatives supporting Main Cantonment Alternatives 3 and 8 are retained as viable wastewater solutions.

A summary of the six wastewater alternatives for Main Cantonment Alternatives 3 and 8 and a fundamental evaluation of these alternatives are provided in Table 2.3-9.

Table 2.3-9. Summary of Alternatives Evaluated for Wastewater Systems in Support of Main Cantonment Alternatives 3 and 8

Wastewater System Alternative	*Evaluation Considerations*	*Recommendation*
Expand and upgrade the existing primary treatment system at the GWA NDWWTP to accept the additional flow and load from both central and northern Guam (GWA facility and operation).	• Offshore construction would not be required, and a GWA outfall exists. • The discharge permit for the 301(h) waiver needs to be modified for additional flow. • The long-term impact of the primary effluent on the aquatic habitat is a concern. • No construction would occur on undeveloped land. • Public traffic disruption could occur during construction of sewers. • GWA operates the NDWWTP. • Coordination with GWA on ongoing CIP projects would be required. • Requires force main from Barrigada housing to the NDWWTP.	Retained
Expand and upgrade the GWA NDWWTP to secondary treatment.	• Offshore construction is not required and a GWA outfall exists. • The existing permit needs updating for secondary treatment limits. • The long-term impact of the secondary effluent on the aquatic habitat is a concern. • No construction would occur on undeveloped land. • Public traffic disruption could occur during construction of relief interceptor. • GWA operates the NDWWTP. • Upgrading to secondary treatment would increase GWA sewer rates for non-DoD users. • Construction and operation costs would need to be shared with GWA. • Coordination with GWA on ongoing CIP projects would be required. • Requires force main from Barrigada housing to the NDWWTP.	Retained
Recondition and upgrade the existing primary treatment system at the GWA Hagatna WWTP to accept the additional flow and load from central Guam.	• Offshore construction would not be required, and a GWA outfall exists. • The discharge permit for the 301(h) waiver needs to be modified for additional flow. • The long-term impact of the primary effluent on the aquatic habitat is a concern. • No construction would occur on undeveloped land. • Public traffic disruption could occur during construction of sewers. • GWA operates the Hagatna WWTP. • Coordination with GWA on ongoing CIP projects would be required. • Require relief gravity sewer from the Barrigada housing to the Hagatna WWTP.	Eliminated

Table 2.3-9. Summary of Alternatives Evaluated for Wastewater Systems in Support of Main Cantonment Alternatives 3 and 8

Wastewater System Alternative	*Evaluation Considerations*	*Recommendation*
Expand and upgrade the GWA Hagatna WWTP to secondary treatment	• Offshore construction is not required and a GWA outfall exists. • The existing permit needs updating for secondary treatment limits. • No construction would occur on undeveloped land. • Public traffic disruption could occur during construction of sewer. • GWA operates the Hagatna WWTP. • Upgrading to secondary treatment would increase GWA sewer rates for non-DoD users. • Construction and operation costs would need to be shared with GWA. • Coordination with GWA on ongoing CIP projects would be required. • Require relief gravity sewer from the Barrigada housing to the Hagatna WWTP.	Eliminated
Build a new secondary-treatment plant near the proposed development on DoD land and construct a new outfall	• Offshore outfall construction would be required. • A new NPDES permit from USEPA would be required. • No construction would occur on undeveloped land . • The long-term impact of the treated effluent on the coral reef habitat is a concern. • New sewer line construction would be required for diverting DoD wastewater. • DoD owns the outfall. • GWA treatment revenue would be reduced. • Requires force main from Barrigada housing to the DoD stand along WWTP.	Retained

2.3.5 Alternatives Dismissed

The alternatives for wastewater solutions in support of Main Cantonment Alternatives 1 and 2 that were dismissed are summarized below. The rationale for dismissal is provided for each alternative.

2.3.5.1 Build a New DoD Tertiary-Treatment Plant near the Selected Main Cantonment on DoD Land and Send Effluent to a New or Existing Water Treatment Plant

Under this alternative, a new tertiary-treatment plant would be built near the proposed development on DoD land. Tertiary treatment falls into a category of direct potable reuse of reclaimed water; it normally consists of primary settlement, use of a submersible membrane bioreactor, disinfection, reverse osmosis, and advanced oxidation. The new tertiary-treatment plant would treat the DoD wastewater from existing sources and proposed future expansions in northern Guam, including the proposed Marine Corps relocation, and would inject treated effluent directly into the raw-water supply immediately upstream of a new WTP that would be constructed in northern Guam.

Although the discharge from the proposed tertiary-treatment plant would eliminate the need to construct an ocean outfall, the approach of discharging treated wastewater directly to a potable-water treatment plant does not have a proven track record. Only a few direct potable-water-reuse applications have been reported worldwide. Even without factoring in the extremely large capital investment required for this approach and its sophisticated process, gaining regulatory acceptance of direct potable-water reuse might be difficult. No direct potable-water-reuse programs currently operate in the United States. All reclaimed treated wastewater has been used as potable water in an indirect way, with a natural buffer (e.g., either a stretch of river or a groundwater aquifer) between introduction of the reclaimed water and its distribution to the potable-water treatment plant.

In addition, brine generated through reverse osmosis requires some kind of discharge. Typical brine disposal routes include evaporation, crystallization to solidify the salts, deep underground injection, and ocean or sewer discharge. From an economic standpoint, only the last two options may be feasible, and they require permission from either USEPA or GWA. Because no regulations have been promulgated on the potable reuse of reclaimed water, the process of establishing treatment requirements and performance monitoring standards for this option would add time and cost to the project.

2.3.5.2 Build a New DoD Secondary-Treatment Plant and Construct a New Ocean Outfall on the Eastern Coastline

Under this alternative, a new secondary-treatment plant would be built on the eastern side of Guam to treat DoD wastewater from existing sources and future sources (wastewater from the proposed military buildup in northern Guam, including the proposed Marine Corps relocation), and a new outfall would be constructed along the eastern coastline. This option would be feasible only if the majority of Marine Corps relocation were to occur on the east side of northern Guam. This alternative would require all existing wastewater flow and future flow associated with the Marine Corps relocation to be routed and diverted to the new treatment plant.

The construction of a new outfall would likely require implementation of mitigation measures to satisfy both the Guam Bureau of Statistics and Planning Office and the Guam Division of Aquatic and Wildlife Resources. The entire northeast coastline around Andersen AFB is designated as the Pati Point Marine Preserve. The Pati Point Marine Preserve contains 8 square miles (21 square kilometers)—approximately 4,900 ac (2,000 ha)—of reef environment, which would be restricted as a potential site for an ocean outfall. Also, construction of the plant on a site located in forested or preservation areas that are populated by native species of animals and vegetation may require implementation of mitigation measures to satisfy the Guam Division of Aquatic and Wildlife Resources.

2.3.5.3 Build a New DoD Tertiary-Treatment Plant near the Selected Main Cantonment and Reuse the Effluent; Send the Residual to the GovGuam NDWWTP Outfall

Under this alternative, a new tertiary-treatment plant would be built near the proposed development on DoD land. This new plant would treat DoD wastewater from both existing sources and the future proposed military buildup in northern Guam, including the proposed Marine Corps relocation. The treated effluent from the tertiary-treatment system would be reused for toilet flushing, wash water for vehicles and aircraft, landscape irrigation, and cooling water for building climate control; it could also be provided to other non-DoD end users. Excess effluent that is produced would be discharged to the existing NDWWTP outfall. To achieve the level of treatment required for these reuse practices, a wastewater treatment process would be needed, consisting of primary treatment, a membrane bioreactor, disinfection, and color removal. DoD would be responsible for the treatment, effluent reuse, and biosolids disposal associated with this alternative.

The total reclaimed water produced under this alternative could be an estimated 3.77 MGd (14.27 mld); however, the Finegayan area lacks sustainable and reliable demand for reuse of reclaimed water. A study assessing the demand for reclaimed-water usage and identifying a sustainable water-reuse rate structure would be required. In addition, a separate water distribution and dual plumbing system would be required, and the cross-connection risk would need to be addressed. These steps would add time and cost to the project. The installation of a dual plumbing system for existing buildings may not be economically feasible.

2.3.5.4 Build a New DoD Tertiary-Treatment Plant near the Selected Main Cantonment on DoD Land and Install Injection Wells

Under this alternative, a new tertiary-treatment plant would be built near the proposed development on DoD land. The new plant would treat DoD wastewater from existing sources and future proposed military buildup in northern Guam, including the Marine Corps relocation. Treated effluent would be injected into the underground aquifer for groundwater replenishment, increasing the sustainability of the groundwater in the NGLA. DoD would be responsible for treatment, groundwater monitoring, and biosolids disposal.

The NGLA is a sole-source aquifer that is located directly underneath northern Guam. northern Guam is underlain by a karst limestone plateau with high water conductivity that results in low retention times between injection wells and withdraw wells, and a minimum of soil aquifer treatment. Under these conditions, a very high degree of treatment (normally beyond USEPA primary drinking water standards) has to be achieved. In practice, even if tertiary treatment of effluent were applied for this kind of indirect potable reuse of reclaimed water, it is expected that this alternative would not be readily accepted by regulatory agencies. Because no regulations are promulgated on Guam regarding the indirect potable reuse of reclaimed water, the process of establishing treatment requirements and performance monitoring standards for this option would consume time and increase project costs.

2.3.5.5 Build a New Separate Secondary Treatment Plant at The GWA NDWWTP Site to Treat DoC Load Only

This option would build a new secondary treatment plant at the NDWWTP site, and treat the DoD wastewater from the DoD Finegayan properties including proposed USMC housings. The existing NDWWTP will be upgraded to have two separate and independent treatment process trains. The existing primary treatment will continue to treat flow from civilian population in northern Guam. The new process train consists of primary and secondary treatment, as well as UV disinfection, and solids treatment. The new treatment plant will have separate headworks, primary treatment, secondary treatment, UV disinfection, and sludge handling facilities to treat the load from DoD Finegayan properties. The new process train, including both liquid treatment and solids treatment, is a self-contained and complete secondary treatment system from the start to the end, and it will require jointly utilizing the existing NDWWTP ocean outfall for its secondary treated effluent disposal. This alternative requires constructing a new independent sewer main to convey all military generated wastewater in the DoD Finegayan properties to the NDWWTP site.

The alternatives for wastewater solutions in support of Main Cantonment Alternatives 3 and 8 that were dismissed are summarized below. The rationale for dismissal is provided for each alternative.

2.3.5.6 Recondition and Upgrade The Existing Primary Treatment System at The GWA Hagatna WWTP to Accept The Additional Flow and Load From Central Guam

In this Interim Alternative, the primary-treatment facilities of the NDWWTP would be refurbished and upgraded to accept the additional DoD flows and military buildup–related flows from Finegayan area.

The effluent pump station of the Hagatna WWTP would be refurbished to accept the additional DoD flows and military buildup–related flows from proposed Barrigada housing area. A new UV disinfection system would also be added for effluent disinfection. This interim alternative would require modification of the Hagatna WWTP's existing NPDES permit by USEPA Region 9 to increase the effluent-discharge limit from a maximum daily flow of 12.0 MGd (45.4 mld) to 21.0 MGd (79.5 mld). The proposed modifications to the Hagatna WWTP should be completed by 2011.

In addition, new sewer lines would need to be installed from the Barrigada to the Hagatna WWTP.

2.3.5.7 Expand and Upgrade The GWA Hagatna WWTP to Secondary Trreatment

Under this alternative, the existing Hagatan WWTP would be upgraded to secondary-treatment plant. By expanding and upgrading the existing primary system, the Hagatna WWTP can be converted to a new secondary treatment process . A trickling filter system was selected as the secondary treatment process not only because of its lower power requirement and less sludge production compared with a suspended growth system (such as Activated Sludge System) but also because of its simple and reliable operational nature. It is desirable to have a simple process to minimize future operation and maintenance requirements on the island of Guam.

This plant would treat DoD wastewater from existing sources and future sources (wastewater from the proposed military buildup in Barrigada, including the proposed Marine Corps relocation). This option would be feasible only if the majority of Marine Corps relocation were to occur in Barrigada area. This alternative would require all existing wastewater flow and future flow associated with the Marine Corps relocation to be routed and diverted to the Hagatna treatment plant.

2.3.5.8 Build a New Separate Secondary Treatment Plant at The GWA Hagatna WWTP Site to Treat DoD Load Only

This option would build a new secondary treatment plant at the Hagatna WWTP site, and treat the DoD wastewater from the DoD Barrigada properties including proposed USMC housings. The existing Hagatna WWTP will be upgraded to have two separate and independent treatment process trains. The existing primary treatment will continue to treat flow from civilian population in Central Guam. The new process train consists of primary and secondary treatment, as well as UV disinfection, and solids treatment. The new treatment plant will have separate headworks, primary treatment, secondary treatment, UV disinfection, and sludge handling facilities to treat the load from DoD Barrigada properties. The new process train, including both liquid treatment and solids treatment, is a self-contained and complete secondary treatment system from the start to the end, and it will require jointly utilizing the existing Hagatna WWTP ocean outfall for its secondary treated effluent disposal. This alternative requires constructing a new independent sewer main to convey all military generated wastewater in the DoD Barrigada properties to the Hagatna WWTP site.

Alternatives discharging wastewater from Barrigada Housing to Hagatna WWTP were eliminated because ofthe following reasons:

- The majority of the improvements due to Marine relocation to Guam will be located in northern Guam, where wastewater is routed to the NDWWTP. Collection of all DoD flows at one WWTP allows for efficient management of the wastewater treatment.
- Concentrating WWTP improvements associated with DoD wastewater at one plant owned by GWA will help with efficient utilization of GWA's limited CIP budget resources. This approach also relieves the logistical burden of upgrading two wastewater treatment plants in the same time period.

- The ocean outfall for the Hagatna WWTP does not have a diffuser installed, and is in a heavily populated area of Guam. The NDWWTP has a newly installed ocean outfall with a diffuser system that is currently undergoing design evaluation based on future flow forecasts and the effluent discharges in a relatively remote area of the island. It is preferable to route the wastewater flows to the NDWWTP to minimize the environmental impacts from the effluent discharge.

2.3.6 Alternatives Developed Forward for Wastewater

As discussed in Section 2.3.2, the alternatives presented in this DEIS were adjusted to recognize the secondary variance denial, and reflect the need for secondary treatment plant upgrades for all alternatives evaluated. Based on the evaluation, the following alternative was selected as the Preferred Alternative to meet the interim wastewater needs and to meet the year 2019 projected DoD demand at the completion of the DoD buildup. Under this Preferred Alternative (Basic Alternative 1) , in addition to providing upgrades to NDWWTP's primary treatment system to meet the interim wastewater demand, this basic alternative provides upgrading the NDWWTP to secondary treatment. Two options are provided to support the Main Cantonment Alternatives 1 and 2, and Main Cantonment Alternatives 3 and 8.

Basic Alternative 1a (Preferred Alternative) and 1b: Basic Alternative 1 (Basic Alternative 1a supports Main Cantonment Alternatives 1 and 2; Basic Alternative 1b supports Main Cantonment Alternatives 3 and 8) this alternative combines upgrade to the existing primary treatment facilities and expansion to secondary treatment at the Northern District Wastewater Treatment Plant (NDWWTP).The difference between Alternatives 1a and 1b is a requirement for a new sewer line from Barrigada housing to NDWWTP for Alternative 1b.

Induced civilian growth as a result of the military buildup could increase the islandwide population on Guam by up to approximately 40,000 in the peak year of 2014. Therefore, to provide the capacity to treat the interim wastewater flow generated by the construction workforce and induced population growth, this wastewater alternative would address the interim wastewater flow as well as the long-term wastewater flow.

Under Alternative 1a, the NDWWTP would be refurbished and the plant's primary treatment capacity would be upgraded to accept the additional DoD flows and military buildup–related flows and loads. Additionally, expansion of the plant to secondary treatment would be completed. Refurbishment of the primary system, upgrade of the primary system, and installation of a secondary system would be constructed in separate phases.

Interim wastewater flows to the NDWWTP from military and civilian sources are projected to increase to a peak of 12.75 MGd (48.25 mld) in 2014, which would slightly exceed the design capacity of 12 MGd (45 mld). Adding chemical coagulants (enhanced primary treatment) or increasing the surface overflow rate (within the normal design range) of the clarifier would improve plant operations so that the primary clarifier would be able to treat the additional 0.75 MGd (2.84 mld) without adverse effect on the NDWWTP. However, the permit limit of 6 MGd (23 mld) would still be exceeded and the plant would still need some refurbishment and upgrades to restore it to the original design capacity.

The existing NPDES permit of the NDWWTP is based on a maximum daily flow of 6 MGd (23 mld). Under this interim alternative, the liquid treatment system of the NDWWTP would be refurbished to restore the plant's originally designed treatment capacity of 12 MGd (45 mld) so that the plant would comply with regulations associated with treating the increased wastewater flow from the military buildup. At the same time, the plant's solids treatment system would be refurbished and upgraded to process sludge produced by treatment of 12 MGd (45 mld) of influent wastewater. The solids treatment system has two anaerobic digesters and a dewatering complex that are currently nonfunctional and in disrepair; the system would need to be rehabilitated and upgraded with sufficient capacity to treat solids generated at the plant. The dewatered stabilized solids would then be hauled away, most likey to a landfill. Potential future beneficial use somewhere on Guam could be explored in the future.

Based on the plant's current capacity, to accommodate anticipated interim flow and loadings while still achieving the existing primary-treatment requirement, the following existing components of the NDWWTP would have to be refurbished and upgraded:

- Headworks with odor control
- Two primary clarifiers
- Two anaerobic digesters
- Two centrifuge solids-dewatering systems with odor control
- Two chlorine contact tanks
- Effluent monitoring

The new ocean outfall that was put into service in December 2008 at the NDWWTP enables the plant to discharge a peak-hour treated flow of 27 MGd (102 mld) to the Philippine Sea. This would be enough disposal capacity to handle the increased flow during the peak period.

Under Alternative 1a, all DoD-generated wastewater, either from Andersen AFB or from the proposed Marine Corps relocation, would be conveyed to the NDWWTP for treatment. All flows from the current and proposed future military buildup at Andersen AFB would be conveyed through the existing GWA sewer to the NDWWTP, while wastewater flow generated from the proposed Marine Corps relocation at Finegayan would be conveyed via a new relief sewer line to the NDWWTP (Figure 2.3-2). A new 24-in (61-cm), 7,500-ft (2,300-m) gravity relief sewer would be connected from the collection system of the Marine Corps Finegayan area on the west side of the planned Marine Corps Finegayan development to the headworks of the NDWWTP. The proposed modifications to the NDWWTP and collection system should be completed by 2013.

The condition of the NDWWTP is constantly improving because substantial upgrades are being performed by GWA. The plant's final operational conditions should be based on assessment of the plant's processes with the most recent plant upgrades included.

In accordance with GWA's *Water Resources Master Plan* (GWA 2007), the NDWWTP has already planned and allocated budget for the Capital Improvements Plan (CIP) to achieve the designed treatment capacity of 12 MGd (45 mld) for both liquid and solid treatment processes by the year 2015. With implementation of the recommendations included in the CIP, the NDWWTP would have enough capacity to handle additional wastewater flow generated during the peak flow years.

The Navy would coordinate with GWA to expedite the planned CIP so that the NDWWTP would have enough capacity to bridge the gap between existing conditions and the final long-term wastewater solution. The proposed short-term modifications to the NDWWTP should be completed by 2013. The Navy would also need to coordinate with GWA to request a NPDES permit modification from USEPA Region 9 to increase the effluent discharge limitation from 6.0 MGd (22.7 mld) to 12 MGd (45.4 mld) average daily flow and the maximum daily discharge to 27 MGd (102 mld).

Alternative 1a would also upgrade the refurbished primary treatment system at the NDWWTP to secondary treatment, to treat both current wastewater flow and projected future flows from both civilian and military sources. A trickling filter system is proposed as the secondary treatment process. The following new process components and upgrades would be required at the NDWWTP for this alternative:

- Four trickling filters
- Four secondary clarifiers
- Two additional anaerobic digesters (the same size as existing ones)
- One additional centrifuge solids-dewatering system and odor control

The proposed secondary treatment upgrades to the NDWWTP should be completed by 2016. This alternative would require modifications to the NPDES permit from USEPA Region 9 to set new discharge limits and permit conditions.

To support Main Cantonment Alternatives 3 and 8, Alternative 1b includes upgrades to the existing primary treatment facility and expansion to secondary treatment at the NDWWTP to accept additional wastewater flow and load from both central and northern Guam.

Under Alternative 1b, in addition to all the proposed improvements presented in Alternative 1a, a new sewer line and lift pump stations would need to be installed to convey interim wastewater generated at Barrigada housing to the GWA NDWWTP for treatment. Figure 2.3-3 indicates the most likely routing of the proposed sewer lines. The proposed sewer lines and pump station should be completed by 2013.

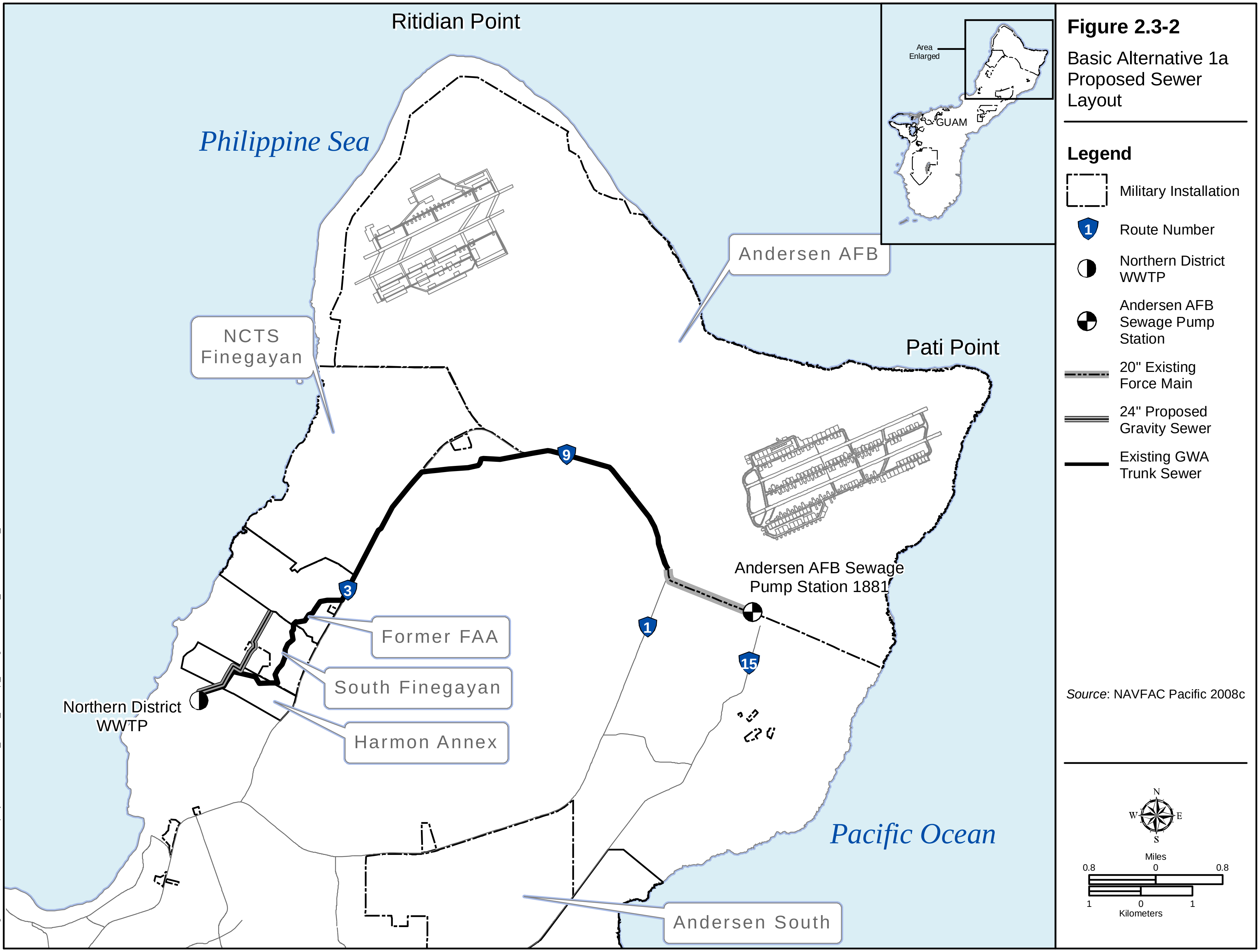
2.3.7 Long-Term Alternatives

The wastewater alternative outlined below is considered to meet the year 2019 projected DoD demand at the completion of the DoD buildup, assuming that the Main Cantonment would be located at Finegayan (Main Cantonment Alternatives 1 and 2) or split between Finegayan and Barrigada (Main Cantonment Alternatives 3 and 8). The wastewater alternative supporting Main Cantonment Alternatives 3 and 8 would still require implementation of the alternative in support of Main Cantonment Alternatives 1 and 2 because Main Cantonment Alternatives 3 and 8 would still use the Finegayan area for military facilities.

2.3.7.1 Long-Term Alternative 1: New DoD Only Stand Alone Secondary Treatment Facility on DoD Land at Finegayan Including a New Outfall in Support of all Main Cantonment Alternatives

Under Long-Term Alternative 1, to address interim wastewater needs, existing primary treatment facilities at the NDWWTP would have been refurbished to meet primary treatment standards as described in Basic Alternative 1 (section 2.3.4.1 in this Volume). The NDWWTP would have been refurbished and the plant's primary treatment capacity would have been upgraded to accept the additional DoD flows and military buildup–related flows and loads in the short term. Construction of a new stand alone DoD secondary wastewater treatment facility on DoD land at Finegayan would be considered a long-term alternative and discussed programmatically.

Interim wastewater flows to the NDWWTP from military and civilian sources are projected to increase to a peak of 12.75 MGd (48.25 mld) in 2014, which would slightly exceed the design capacity of 12 MGd (45 mld). Adding chemical coagulants or increasing the surface overflow rate (within the normal design range) of the clarifier would improve plant operations so that the primary clarifier would be able to treat the additional 0.75 MGd (2.84 mld) without adverse effect on the NDWWTP. However, the permit limit of 6 MGd (23 mld) would still be exceeded and the plant would still need some refurbishment and upgrades to restore it to the original design capacity.



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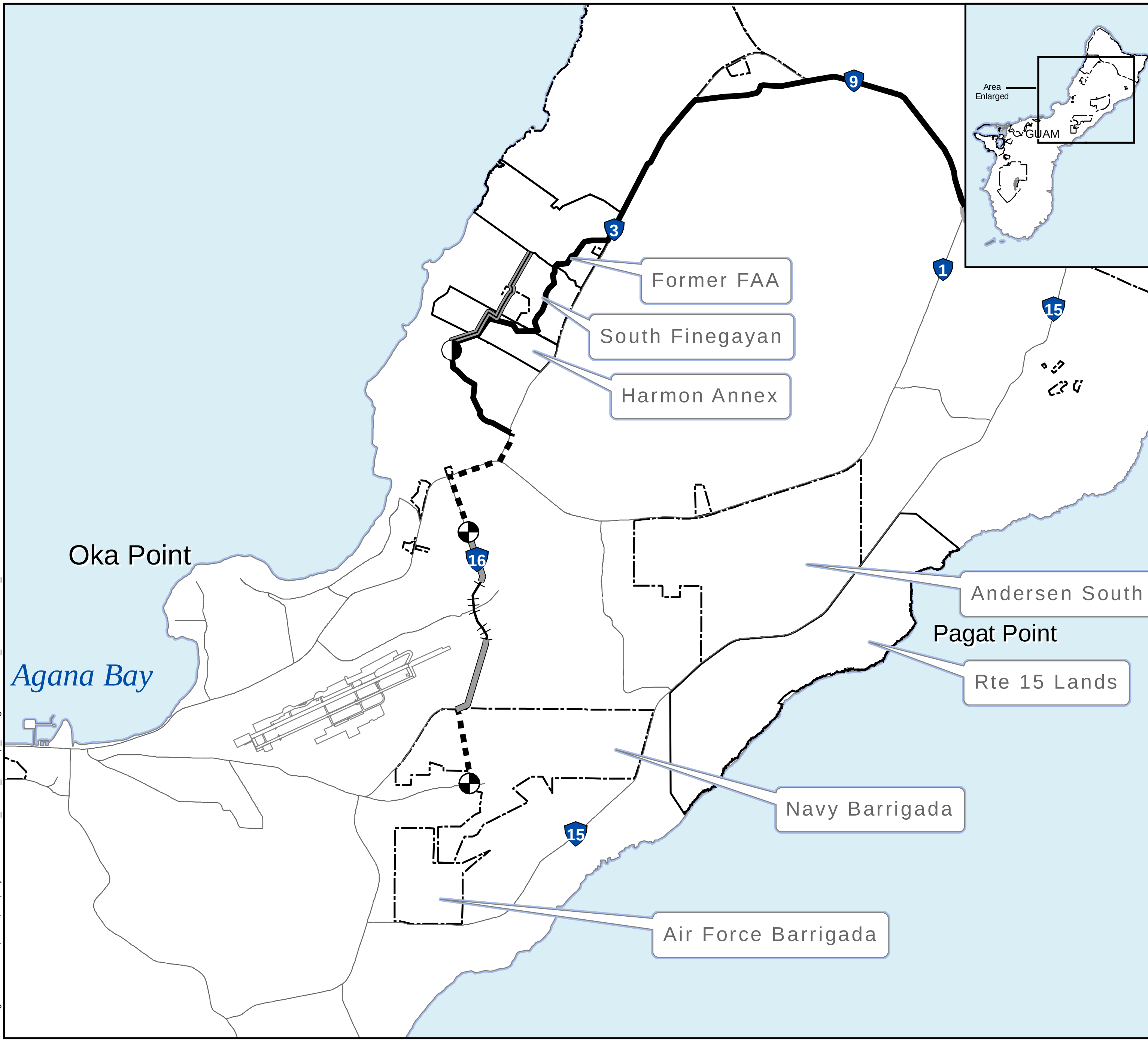


Figure 2.3-3

Basic Alternative 1b Proposed Sewer Layout

Legend

- Military Installation
- Route Number
- Northern District WWTP
- Pump Station
- 15" Proposed Gravity Sewer
- 18" Proposed Force Main
- 24" Proposed Gravity Sewer
- 20" Existing Force Main
- 24" Proposed Gravity Sewer
- Existing GWA Trunk Sewer

Source: NAVFAC Pacific 2008c

N W E S
Miles 0.8 0 0.8
1 0 1 Kilometers

The existing NPDES permit of the NDWWTP is based on a maximum daily flow of 6 MGd (23 mld). Under this interim alternative, the liquid treatment system of the NDWWTP would be refurbished to restore the plant's originally designed treatment capacity of 12 MGd (45 mld) so that the plant would comply with regulations associated with treating the increased wastewater flow from the military buildup. At the same time, the plant's solids treatment system would be refurbished and upgraded to process sludge produced by treatment of 12 MGd (45 mld) of influent wastewater. The solids treatment system has two anaerobic digesters and a dewatering complex that are currently nonfunctional and in disrepair; the system would need to be rehabilitated and upgraded with sufficient capacity to treat solids generated at the plant. The dewatered stabilized solids would then be hauled away, either to a landfill or for a beneficial use in the future.

Based on the plant's current capacity, to accommodate anticipated interim flow and loadings while still achieving the existing primary-treatment requirement, the following existing components of the NDWWTP would have to be refurbished and upgraded:

- Headworks with odor control
- Two primary clarifiers
- Two anaerobic digesters
- Two centrifuge solids-dewatering systems with odor control
- Two chlorine contact tanks
- Effluent monitoring

The new ocean outfall that was put into service in December 2008 at the NDWWTP enables the plant to discharge a peak-hour treated flow of 27 MGd (102 mld) to the Philippine Sea. This would be enough disposal capacity to handle the increased flow during interim period.

Under Long Term Alternative 1a, all military-generated wastewater, either from Andersen AFB or from the proposed Marine Corps relocation, would be conveyed to the NDWWTP for treatment. All flows from the current and proposed future military buildup at Andersen AFB would be conveyed through the existing GWA sewer to the NDWWTP, while wastewater flow generated from the proposed Marine Corps relocation at Finegayan would be conveyed via a new relief sewer line to the NDWWTP (as shown in Figure 2.3-2). A new 24-in (61-cm), 7,500-ft (2,300-m) gravity relief sewer would be connected from the collection system of the Marine Corps Finegayan area on the west side of the planned Marine Corps Finegayan development to the headworks of the NDWWTP. The proposed short-term modifications to the NDWWTP and collection system should be completed by 2013.

The condition of the plant is constantly improving because substantial upgrades are being performed, and the plant's final operational conditions should be based on assessment of the plant's processes with the most recent plant upgrades included.

In accordance with GWA's *Water Resources Master Plan* (GWA 2007), the NDWWTP has already planned and allocated budget for the CIP to achieve the designed treatment capacity of 12 MGd (45 mld) for both liquid and solid streams by the year 2015. With implementation of the recommendations included in the CIP, the NDWWTP would have enough capacity to handle additional wastewater flow generated during the short-term interim construction period.

The Navy would coordinate with GWA to expedite the planned CIP so that the NDWWTP would have enough capacity to bridge the gap between existing conditions and the final long-term wastewater solution. The proposed short-term modifications to the NDWWTP should be completed by 2013. The Navy would also need to coordinate with GWA to request a NPDES permit modification from USEPA

Region 9 to increase the effluent discharge limitation from 6.0 MGd (22.7 mld) to 12 MGd (45.4 mld) average daily flow and the maximum daily discharge to 27 MGd (102 mld).

Long-Term Alternative 1 would require DoD to construct its own independent sewage interceptor to collect wastewater generated from military activities both at Andersen AFB and in the Finegayan area in support of Main Cantonment Alternatives 1 and 2. The interceptor sewer would connect to the Andersen AFB collection system at its main gate lift station, run west along Route 3, and then combine the flow generated by the Marine Corps and Army into the proposed DoD secondary treatment plant located at the southwest corner of the DoD proposed Finegayan development. Approximately 33,300 ft (10,000 m) of 21-in (53-cm) sewer and 8,700 ft (2,700 m) of 24-in (61-cm) sewer would be required to convey flow from the Andersen AFB and Finegayan areas to the new DoD plant (Figure 2.3-4).

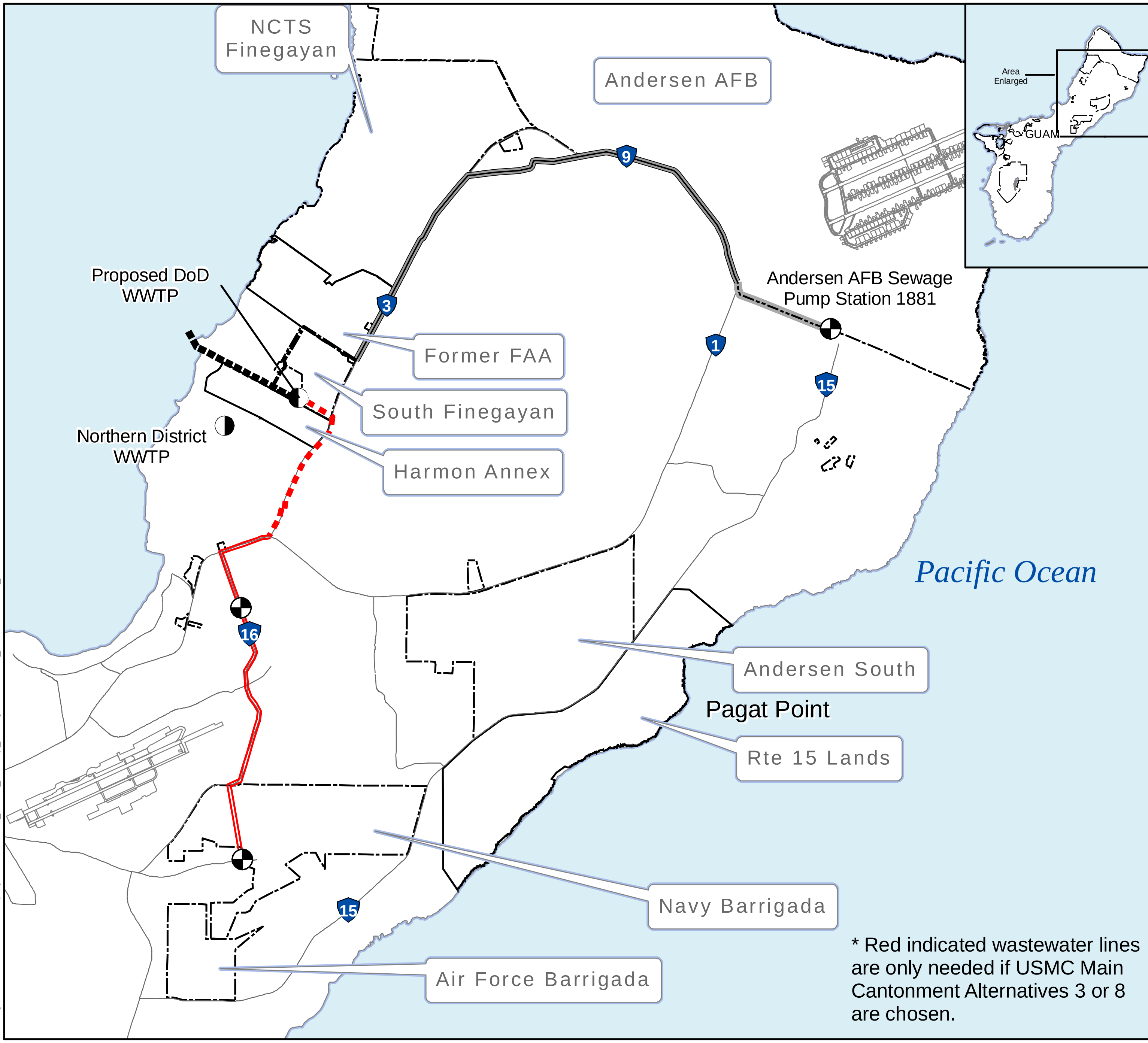
Long-Term Alternative 1 also proposes to construct a new secondary-treatment plant on DoD land and construction of a new DoD ocean outfall. Under this alternative, a newly constructed independent sewer main would convey all military-generated wastewater in northern Guam to a DoD secondary-treatment plant near the proposed Marine Corps Finegayan development on DoD land in support of Main Cantonment Alternatives 1 and 2. The new sewer main would carry a total average daily wastewater flow of 3.77 MGd (14.27 mld). The treated effluent from this secondary-treatment plant would be discharged via a new DoD ocean outfall into the Philippine Sea.

The new secondary-treatment plant would consist of the following components:

- Headworks (two screens and two aerated grit chambers with odor control)
- Three primary clarifiers
- Three trickling filters
- Three secondary clarifiers
- Two chlorine contact tanks
- Three anaerobic digesters
- Two centrifuge solids-dewatering systems with odor control
- Effluent monitoring and measurement
- New ocean outfall

Should main cantonment alternatives 3 or 8 be selected, an additional sewer modification from wastewater basic alternative 1 would be required to convey wastewater generated at Barrigada from the connection at GWA's NDWWTP sewer collection system to this new stand alone DoD secondary treatment facility. The new proposed forcemain sewer extension is shown on Figure 2.3-3. The proposed modified sewer lines and new pump station should be completed by 2015.

Figure 2.3-4
Long-Term Alternative 1 Proposed Sewer Layout for DoD Secondary Treatment



Legend

- Military Installation
- Route Number
- Proposed DoD WWTP
- Northern District WWTP
- Pump Station
- 30" Proposed Outfall
- 20" Existing Force Main
- 21" Proposed Gravity Sewer
- 24" Proposed Gravity Sewer

Only for Cantonment Alternatives 3 or 8*

- 18" Proposed Force Main
- Proposed Sewer from Basic Alternative 1b

Source: NAVFAC Pacific 2008c

Miles 0.8 0 0.8
Kilometers 1 0 1

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2.4 Solid Waste

2.4.1 Anticipated Demand

Projections for solid waste generation rates from the proposed military buildup on Guam are presented in Table 2.4-1. The table lists annual tonnages of solid waste resulting from the increased population. The table also provides a breakdown between on-base and off-base quantities of solid waste. These estimates are based on an assumed generation rate of 7.4 pounds (lb) (3.4 kilograms [kg]) per capita per day. The assumed generation rate includes residential, commercial, industrial, and construction waste streams (HDR/Hawaii Pacific Engineers 2008).

Table 2.4-1. Projected Solid Waste Estimates (tons)

Source of Solid Waste	*Year*										
	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*Totals (tons)*
On Base											
DoD Baseline and DoD Nonproject Related	25,249	25,249	25,730	25,851	26,040	26,220	26,220	26,220	26,220	27,207	260,205
DoD Proposed Action Related	1,551	4,180	4,180	4,180	28,796	40,772	40,772	40,772	40,772	40,772	246,748
Total On Base	**26,800**	**29,429**	**29,910**	**30,031**	**54,836**	**66,992**	**66,992**	**66,992**	**66,992**	**67,979**	**506,954**
Off Base											
Non-DoD Proposed Action Related	13,356	33,411	55,648	66,823	78,134	56,653	25,592	14,129	14,129	14,368	372,243
Total On and Off Base	**40,156**	**62,840**	**85,558**	**96,854**	**132,970**	**123,644**	**92,584**	**81,121**	**81,121**	**82,347**	**879,197**

Notes: DoD Nonproject Related includes DoD sources of solid waste not related to the military buildup.
Assumes per capita generation rate of 7.4 pounds (3.4 kilograms) per capita per day.
Civilian solid waste generation not related to the military buildup is not included.
Source: HDR/Hawaii Pacific Engineers 2008

2.4.2 Available Solid Waste Facilities

The current solid waste disposal sites on Guam are as follows:

- Navy Sanitary Landfill (accepts Navy-generated solid waste)
- Andersen AFB Landfill and Recycling Center (accepts Air Force–generated solid waste)
- GovGuam Ordot Dump (accepts all civilian solid waste)

The locations of the existing facilities are shown in Figure 2.4-1. The Navy Sanitary Landfill at Apra Harbor currently accepts solid waste from all of the Navy's military personnel, residents, DoD employees, and contractors located on base. This landfill also accepts commercial waste streams from base activities, including construction and demolition waste. The unlined landfill has been in use since 1965 and is currently operated by the Base Operations Support contractor, under the terms of the administratively extended Solid Waste Management Permit, No. 95-1009, dated December 26, 1995. The Navy has applied for a permit renewal from GEPA. The Navy currently plans to continue to fill the landfill to an elevation of 54 ft (16 m) above msl. The current landfill ranges in height from 20 ft (6 m) to 52 ft (16 m) above msl.

The Air Force owns and operates a landfill on Guam, located at Andersen AFB near Route 1 and the entrance road to Andersen AFB. The landfill provides service to military personnel and residents of the bases as well as commercial waste streams from base activities. A Base Operations Support contractor operates and maintains the facility under a current Resource Conservation and Recovery Act (RCRA) Subtitle D Permit. The landfill reached its original design capacity in September 2007; therefore, the Air Force recently constructed a 2-ac (0.81-ha) expansion to meet its disposal needs through 2009. Because the GovGuam landfill would not become available until July 2011, the Air Force would need to further expand the existing landfill or pursue diversional and/or operational measures to maximize landfill life.

The remaining non-DoD waste stream on Guam is disposed directly at the GovGuam Ordot Dump facility located in central Guam and via citizen drop-off transfer stations. The Ordot Dump does not accept construction or demolition debris; two on-island hardfills (i.e., for construction and demolition debris) are currently permitted and available to accept this type of waste. The Northern Hardfill is a privately owned landfill that accepts construction and demolition debris and is located on Route 15 (back road to Andersen AFB). Another privately owned facility allowed to accept construction and demolition debris is the Eddie Cruz Hardfill Facility located in Yigo.

The planned replacement for the GovGuam Ordot Dump is the new GovGuam Layon Landfill. The proposed site is located in Layon near the village of Inarajan, in the higher badland (highly eroded rocky) areas on the west side of the Dandan parcel, southwest of the former National Aeronautics and Space Administration (NASA) tracking station. Construction of the new facility began on February 25, 2009, and the landfill is expected to be ready for acceptance of solid waste by July 2011 (Gershman, Brickner, & Bratton 2009a). The Layon Landfill was designed to accommodate solid waste from all current and future DoD sources as well as civilian and commercial sources. The Layon Landfill would have a capacity of 15.8 million cubic yards (yd^3) (12.1 million cubic meters [m^3]) of solid waste as presented in the GEPA Draft Municipal Solid Waste Landfill Facility Permit (GEPA 2009).

Table 2.4-2 presents a comparison of the expected solid waste that would be generated during the military buildup versus the potential design capacity of the existing DoD facilities. Because the Andersen AFB Landfill is essentially at full capacity, only the Navy Sanitary Landfill is presented. It is assumed that the Navy Sanitary Landfill can be filled to a height of 54 ft (16 m) above msl (HDR/Hawaii Pacific Engineers 2008). The projection indicates that the Navy Sanitary Landfill would have the capacity to accommodate the on-base generated solid waste during the military buildup, assuming that the landfill was filled to a maximum height of 54 ft (16 m) above msl.

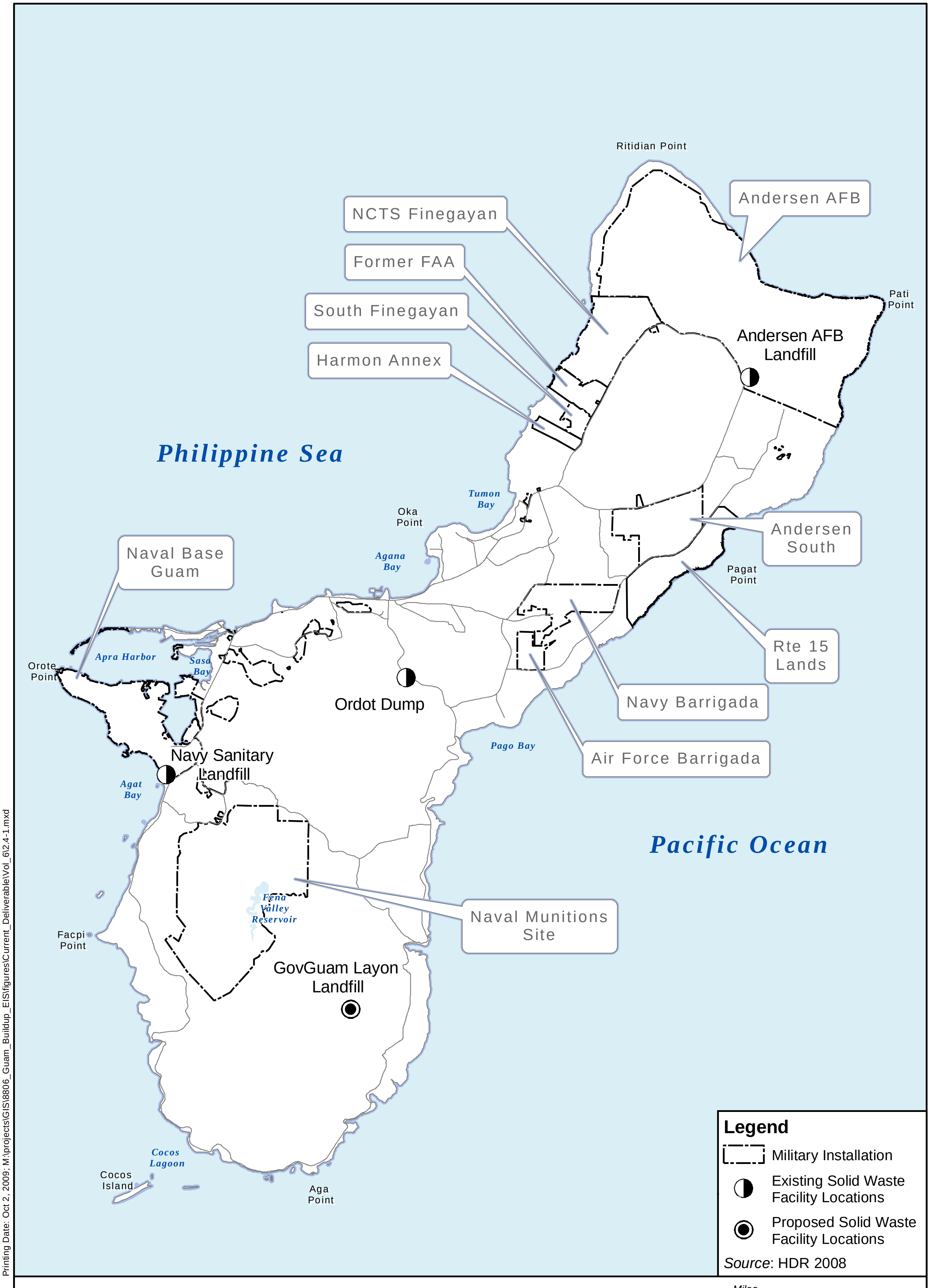

Figure 2.4-1
Solid Waste Facility Locations, Guam

Table 2.4-2. Solid Waste Projections versus Available Capacity (tons)

Solid Waste Projections			*Available Capacity at Navy Sanitary Landfill, Fill Elevation = 54 ft msl*	*Difference between Solid Waste Projections and Available Capacity*
From On-Base Baseline Population, 2010 to 2019	*From On-Base Population Increase, 2010 to 2019*	*Total—On-Base Baseline and Population Increase*		
237,431 [a]	269,522[a]	506,954	540,000[b]	33,046

Notes: [a] From Table 2.4-1; [b] Based on computed volume from Guam Solid Waste Utility Study for Proposed U.S. Marine Corps Relocation (HDR/Hawaii Pacific Engineers 2008), and converting to weight using an in-place density = 1,200 lb/yd^3 and solid waste to cover material ratio of 3:1.

2.4.3 Screening Process

Although the solid waste disposal demand as a result of the proposed military buildup (on base) would not exceed DoD's current capacity for solid waste in the next 10 years, it would be exceeded shortly thereafter. In July 2009, a letter of intent between the Navy, GovGuam, and Gershman, Brickner, & Bratton (GBB) was signed that establishes the Navy's intent to pursue a contractual arrangement for the use of GovGuam's new Layon Landfill (see Appendix C). With this additional alternative, the DoD community would have long-term capacity for solid waste disposal. Based on a comprehensive review of the available solid waste disposal alternatives for DoD on Guam in the *Guam Solid Waste Utility Study for Proposed U.S. Marine Corps Relocation* (HDR/Hawaii Pacific Engineers 2008) and the letter of intent mentioned above, the following alternatives were identified for evaluation:

- Install Liner and Other Improvements at Existing Navy Sanitary Landfill at Apra Harbor
- Continue to Use Unlined Existing Navy Sanitary Landfill at Apra Harbor Until New Layon Landfill is Completed by GovGuam in 2011, then Use Layon Landfill for Disposal of All DoD Solid Waste
- Construct New DoD Landfill in Central Guam
- Construct a WTE Facility
- Barge Waste off Guam to a Permitted Facility
- Construct New DoD Landfill in northern Guam
- Utilize Existing Landfill at Andersen AFB
- Expand Existing Landfill at Andersen AFB
- Use Potential New Private WTE Facility with Landfill at Atantano

A preliminary screening analysis was conducted and the technical aspects of the alternatives were developed to a conceptual level to allow evaluation of the relative viability of the nine identified alternatives. The alternatives were screened on the basis of environmental and regulatory issues, implementation and policy issues, and potential scheduling issues. Based on the screening analysis, eight of the nine identified alternatives were judged as nonviable and were eliminated from further consideration, as discussed below in Section 2.4.4.

A summary of these alternatives and fundamental evaluation is included in Table 2.4-3.

Table 2.4-3. Summary of Alternatives Evaluated for Solid Waste Disposal

Solid Waste Disposal System Alternative	*Evaluation Considerations*	*Recommendation*
Install Liner and Other Improvements at Existing Navy Sanitary Landfill at Apra Harbor	*Environmental/Regulatory:* A solid waste permit application to GEPA would be required to expand the landfill. *Environmental/Regulatory:* The current landfill is unlined and therefore the potential for leachate to affect groundwater exists. *Implementation/Policy:* Installing a new liner system over an existing landfill would have high construction costs and construction of a new liner system while maintaining active solid waste disposal operations would be logistically difficult. *Schedule:* Construction of the new liner system could not be completed before relocation of the Marine Corps.	Dismissed
Continue to Use Unlined Existing Navy Sanitary Landfill at Apra Harbor Until New Layon Landfill is Completed by GovGuam in 2011, then Use Layon Landfill for Disposal of All DoD Solid Waste	*Environmental/Regulatory:* The Layon Landfill would be lined with a double liner meeting federal and GEPA requirements. *Implementation/Policy:* GovGuam and GEPA favor use of a regional landfill for civilian and DoD solid waste disposal. *Implementation/Policy:* The Navy, GovGuam, and GBB have reached an agreement documented in a letter of intent that DoD would be able to dispose of waste at the new GovGuam landfill facility. *Implementation/Policy:* Layon Landfill has sufficient design capacity to handle increased solid waste generation by DoD and the civilian population. *Implementation/Policy:* Using the existing Navy Sanitary Landfill at Apra Harbor provides a short-term, low-cost solution until a lined landfill (i.e., Layon Landfill) becomes available. *Schedule:* Layon Landfill completion is expected sooner than improvements to the Navy Sanitary Landfill at Apra Harbor could be completed.	Retained
Construct New DoD Landfill in Central Guam	*Environmental/Regulatory:* Development of a landfill in this area could significantly affect groundwater and surface water resources. *Environmental/Regulatory:* Remnants of World War II structures exist at the site and would require a Section 106 consultation. Additionally, there is an active spring (Santa Rita) near the site that could require mitigation. *Implementation/Policy:* A lengthy NEPA review process would be required and it is likely that public support for a new landfill in Guam would be low. *Schedule:* A lengthy siting, planning, public review, and permitting process would be required.	Dismissed

Table 2.4-3. Summary of Alternatives Evaluated for Solid Waste Disposal

Solid Waste Disposal System Alternative	*Evaluation Considerations*	*Recommendation*
Construct a WTE Facility	*Environmental/Regulatory:* Per Guam Public Law 25-175, it is unlawful to operate a municipal solid waste incinerator or WTE facility on Guam. *Schedule:* A lengthy schedule would be required (5 years) to bring a WTE facility online.	Dismissed
Barge Waste off Guam to a Permitted Facility	*Environmental/Regulatory:* There are no nearby locations to dispose of waste that are able to handle the waste in an environmentally sound manner. *Implementation/Policy:* There is a high probability for cargo handling and trucking inefficiencies, which could result in shipping delays, resulting in high costs and potential public health issues.	Dismissed
Construct New DoD Landfill in Northern Guam	*Environmental/Regulatory:* The potential site is located over the NGLA, an environmentally sensitive potable groundwater source.	Dismissed
Use Existing Landfill at Andersen AFB	*Environmental/Regulatory:* The site is located over the NGLA, an environmentally sensitive potable groundwater source. *Implementation/Policy:* Very limited site capacity exists. *Implementation/Policy:* This option would not provide sufficient capacity for the military buildup.	Dismissed
Expand Existing Landfill at Andersen AFB	*Environmental/Regulatory:* The site is located over the NGLA, an environmentally sensitive potable groundwater source.	Dismissed
Use Potential New Private WTE Facility with Landfill at Atantano	*Environmental/Regulatory:* The DEIS for the solid waste management facility for the Island of Guam concluded that this site location was deficient based on the siting criteria. *Implementation/Policy:* Permits have not yet been obtained, and the process could be long and contentious. *Implementation/Policy:* Funding for the project is uncertain.	Dismissed

2.4.4 Alternatives Dismissed

A description of the alternatives for solid waste solutions that were dismissed, and the rationale for their dismissal, are summarized below.

2.4.4.1 Install Liner and Other Improvements at Existing Navy Sanitary Landfill at Apra Harbor

This alternative would consist of installing a liner system over the present Navy Sanitary Landfill at Apra Harbor. This landfill is operated by a Base Operations Support contractor for the Navy. The *Guam Solid Waste Utility Study for Proposed U.S. Marine Corps Relocation* (HDR/Hawaii Pacific Engineers 2008) looked at three filling scenarios and concluded that the landfill could be filled vertically an additional 50 ft (15 m), to a height of 100 ft (30 m) above msl, after a new liner is installed. This alternative would provide capacity for 1,305,000 tons (1,183,900 metric tons) based on a volume increase of 2,900,000 yd^3 (2,217,000 m^3), assuming that minor operational changes were made.

The utility study concluded that this alternative would provide 27 years of landfill life and was chosen as the Preferred Alternative; however, a new liner system would require approximately 3 years for design, permitting, and construction (assuming that the Navy would hire contractors to do this work) and therefore would not be ready by 2010 when the Marine Corps would begin to relocate. This alternative also assumes that the liner system could be installed at the Navy Sanitary Landfill at Apra Harbor simultaneously with active solid waste disposal operations that would need to continue until completion of the lined area. Conducting both operations very close to each other would be logistically challenging.

Because the landfill is unlined, there is a potential for leachate to affect the underlying groundwater. Studies are currently under way to assess the nature and extent of contamination and would provide recommendations for additional sampling and installation of additional monitoring wells if necessary. Should additional investigation indicate substantial contamination, corrective action would be required. One of the corrective action alternatives could be closure of the landfill and installation of a final cover. Because of these challenges and the fact that DoD and GovGuam have reached an agreement to use the new GovGuam Landfill in Layon, this alternative was dismissed.

2.4.4.2 Construct New DoD Landfill in Central Guam

This alternative would consist of constructing a new DoD landfill in central Guam in the northwest portion of the Ordnance Annex. This site has not been investigated in detail by the Navy, but was identified as a potentially suitable site. The utility study estimated that the site would provide a service life of 50 years. The conceptual design assumes a landfill footprint of approximately 50 ac (20 ha) that provides a design capacity of 6,350,000 yd^3 (4,855,000 m^3) or 2,860,000 tons (2,595,000 metric tons) (assuming an in-place density of 1,200 lb/yd^3 and a solid waste-to-cover material ratio of 3:1).

The utility study also concluded that a time period of approximately 4-5 years would be needed to design, permit, and construct this type of facility, assuming that no substantial challenges were encountered, which is unlikely. Remnants of World War II structures exist at the site and would require a Section 106 consultation. Additionally, there is an active spring (Santa Rita) near the site that could require permitting and mitigation. Because a new DoD landfill could not be designed, permitted, and built in time for the relocation of the Marine Corps, and because of the expected high capital cost of developing a new landfill site, this alternative was dismissed.

2.4.4.3 Construct a Waste-to-Energy Facility

This alternative would consist of constructing a WTE facility to dispose of the combustible portion of the DoD solid waste stream and reduce the volume of landfilled material. For the same reasons stated in Section 2.1.3.9, WTE power plants have conventionally been steam power plants that sort and burn solid wastes. Because the wastes are normally burned to generate steam, emissions of air pollutants are a primary issue. Combustion air emission controls and scrubbing of the waste exhaust air stream are normally required, and these add to the complexity and operating costs for the system.

For this alternative, the *Guam Solid Waste Utility Study for Proposed U.S. Marine Corps Relocation* (HDR/Hawaii Pacific Engineers 2008) assumed that the WTE facility would be constructed by DoD on federal land, but with no specific location identified. The facility would need to be located near a landfill because the byproduct ash material would need to be landfilled. The utility study assumed that the facility would have a capacity of 150 tons per day to handle the anticipated increase in waste from the military buildup. An extended time period is required for permitting and construction of a WTE facility. Generally, 3-5 years are required before startup of a new facility can occur.

Per Guam Public Law 25-175, it is unlawful for any person to construct or operate a municipal solid waste incinerator or WTE facility on Guam, as defined by the rules and regulations of USEPA or the laws of the U.S. Because of the lengthy schedule required to bring a WTE facility online and because of Guam Public Law 25-175, this alternative was dismissed.

2.4.4.4 Barge Waste Off Guam to a Permitted Facility

This alternative considers disposal of solid waste generated on Guam by shipping it to a location outside Guam that is environmentally sound and is permitted for solid waste disposal by a governmental agency. A majority of the materials that result in waste generation on the island are brought to Guam in cargo containers, resulting in an excess capacity of shipping containers that are sent back empty. These excess containers could be used to ship the waste outside Guam. However, shipment of DoD's solid waste would be subject to the availability of excess containers. Therefore, this alternative included scheduled barge service dedicated to the movement of DoD solid waste to a location outside Guam. This alternative would require that DoD construct a facility to shred and bail the solid waste somewhere in Apra Harbor. The facility would be sized to accommodate the anticipated flow of solid waste from the military buildup; the utility study assumed a facility size of 210 tons (191 metric tons) per working day.

Landfill sites in Southeast Asia were considered to help reduce shipping costs; however, there is a lack of appropriate sanitary landfills equipped with U.S.-equivalent protection standards. Because of the lack of viable disposal alternatives near Guam that meet these criteria, disposal of barged waste was assumed to be at a landfill in the state of Washington. Preliminary assessment indicates that the life-cycle costs associated with this alternative are very high. In addition, there is a high probability for cargo handling and trucking inefficiencies, which could result in shipping delays, resulting in high costs and potential public health issues. For these reasons and because of potential sociopolitical concerns, this alternative was eliminated from further consideration.

2.4.4.5 Construct New DoD Landfill in Northern Guam

This alternative assumes that the Navy would construct a new lined landfill somewhere in northern Guam; however, a specific site was not identified. The utility study determined that DoD construction of a new landfill in northern Guam was nonviable because it would be located over the NGLA, an environmentally sensitive groundwater protection zone providing the only important source of potable groundwater and almost 80% of the potable water for the island. The NGLA area had been ruled out as a suitable area for siting a new landfill during an environmental impact study process conducted by GovGuam (Guam DPW 2005). GEPA may be unlikely to approve a new landfill over the NGLA given the availability of less-sensitive available locations on the island; this alternative was therefore eliminated from further consideration.

2.4.4.6 Use Existing Landfill at Andersen AFB

This alternative consists of continued use of the existing landfill at Andersen AFB. The landfill reached its original design capacity in September 2007, with the anticipation that the new GovGuam Layon Landfill would be available. Because development of the GovGuam Layon Landfill was not complete, the Air Force constructed a 2-ac (0.81-ha) expansion to meet its disposal needs through 2009. Because the GovGuam landfill would now not become available until July 2011, the Air Force would need to further expand the existing landfill or pursue diversional and/or operational measures to maximize landfill life.

Therefore, using the existing landfill at Andersen AFB was judged as nonviable because its remaining site life is very limited; and similar to the previous alternative in northern Guam, the landfill is located above the NGLA, an environmentally sensitive groundwater protection zone providing the only important source of potable groundwater and almost 80% of the potable water for the island. For these reasons, this alternative was eliminated from further consideration.

2.4.4.7 Expand Existing Landfill at Andersen AFB

This alternative involves expanding the existing Andersen AFB landfill. As described above, Andersen AFB has implemented a 2-ac (0.81-ha) expansion to provided interim capacity until the GovGuam Landfill is opened. The existing landfill is located over the NGLA, a sensitive environmental area that provides almost 80% of the drinking water for Guam. Further expansion of the landfill at Andersen AFB was judged as nonviable because it would be located over the NGLA, an area that has been ruled out by GovGuam and GEPA in a previous landfill siting study. Similar to Section 2.4.4.5, it may not be advisable or possible to pursue permitting a large landfill expansion located above the NGLA; this alternative was therefore eliminated from further consideration.

2.4.4.8 Use Potential New Private WTE Facility with Landfill at Atantano

This alternative would involve using a planned WTE facility and landfill owned and operated by Guam Resource Recovery Partners located at Atantano. As described in the *Guam Solid Waste Utility Study for Proposed U.S. Marine Corps Relocation* (HDR/Hawaii Pacific Engineers 2008), the landfill would have a projected life of 19-21 years, assuming that the WTE facility was utilized and based on current Guam non-DoD municipal solid waste generation rates. Permits have not yet been obtained for construction of either the landfill at Atantano or the private WTE facility. This process could be long and contentious given the litigious history of the project and it is not clear how funding for the project would be obtained. Given these factors, this alternative is considered nonviable and was therefore eliminated from further consideration.

2.4.5 Alternative Retained

2.4.5.1 Preferred Alternative

The Preferred Alternative would consist of using the Navy Sanitary Landfill at Apra Harbor until the new Layon Landfill is completed by GovGuam in 2011, then using the Layon Landfill for disposal of all DoD solid waste. As described in Section 2.4.2, the Navy Sanitary Landfill has the potential to provide 10 years of capacity (until 2019) based on the computed demand in Table 2.4-1 and a capacity of 1,200,000 yd^3 (917,500 m^3) or 540,000 tons (490,000 metric tons), assuming a landfill height of 54 ft (16 m) above msl and completion of minor operational improvements. The Navy Sanitary Landfill is shown in Figure 2.4-2. Such operational improvements include reducing the daily cover to that which is required and using larger compaction equipment to achieve greater densities. Because the landfill is unlined, there is a potential for leachate to adversely affect the underlying groundwater. Studies are currently under way to assess whether or not the underlying groundwater has been affected by leachate. Based on the conclusions of these studies, further action may be required.

Once the new Layon Landfill is opened, DoD would send its solid waste to the GovGuam Layon Landfill. A site plan of the Layon Landfill is presented in Figure 2.4-3. The site selected for the Layon Landfill is approximately 317 ac (128 ha) in size, with a landfill footprint of 127.4 ac (51.6 ha) and a capacity of 15,808,794 yd^3 (12,086,690 m^3) or 9,485,276 tons (8,604,898 metric tons), assuming an in-place density of 1,200 lb/yd^3 (712 kg/m^3) (GEPA 2009). The construction of the Layon Landfill is proposed to occur in two phases. Phase 1 would include the reconstruction of approximately 1.3 miles (2.1 km) of existing Dandan Road to provide safe and suitable access for heavy trucks, construction of approximately 2 miles (3 km) of new road, and bulk excavation. Phase 2 would include the construction of the actual landfill facility.

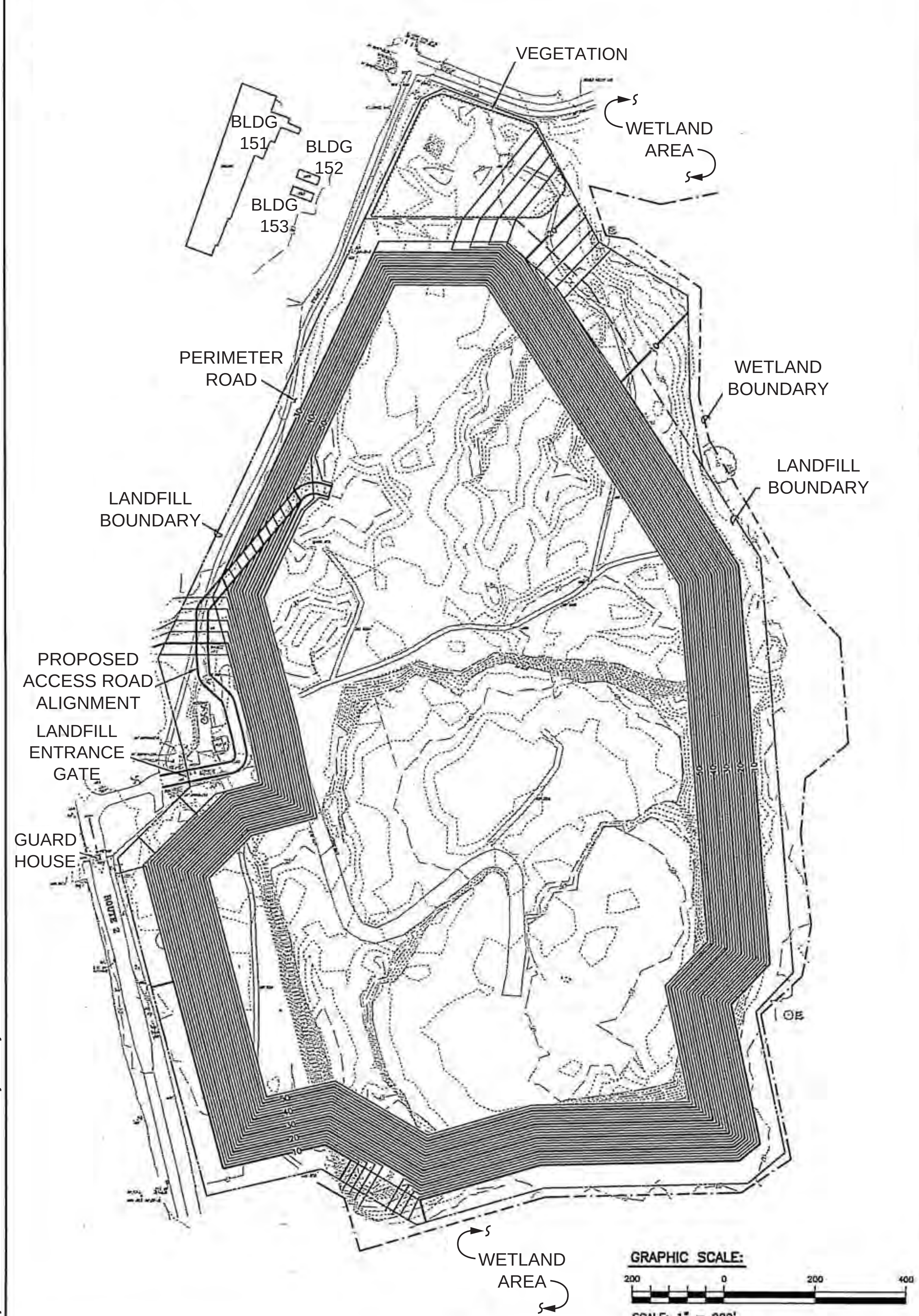

Figure 2.4-2
Navy Sanitary Landfill with Maximum Elevation = 54 ft MSL, Guam

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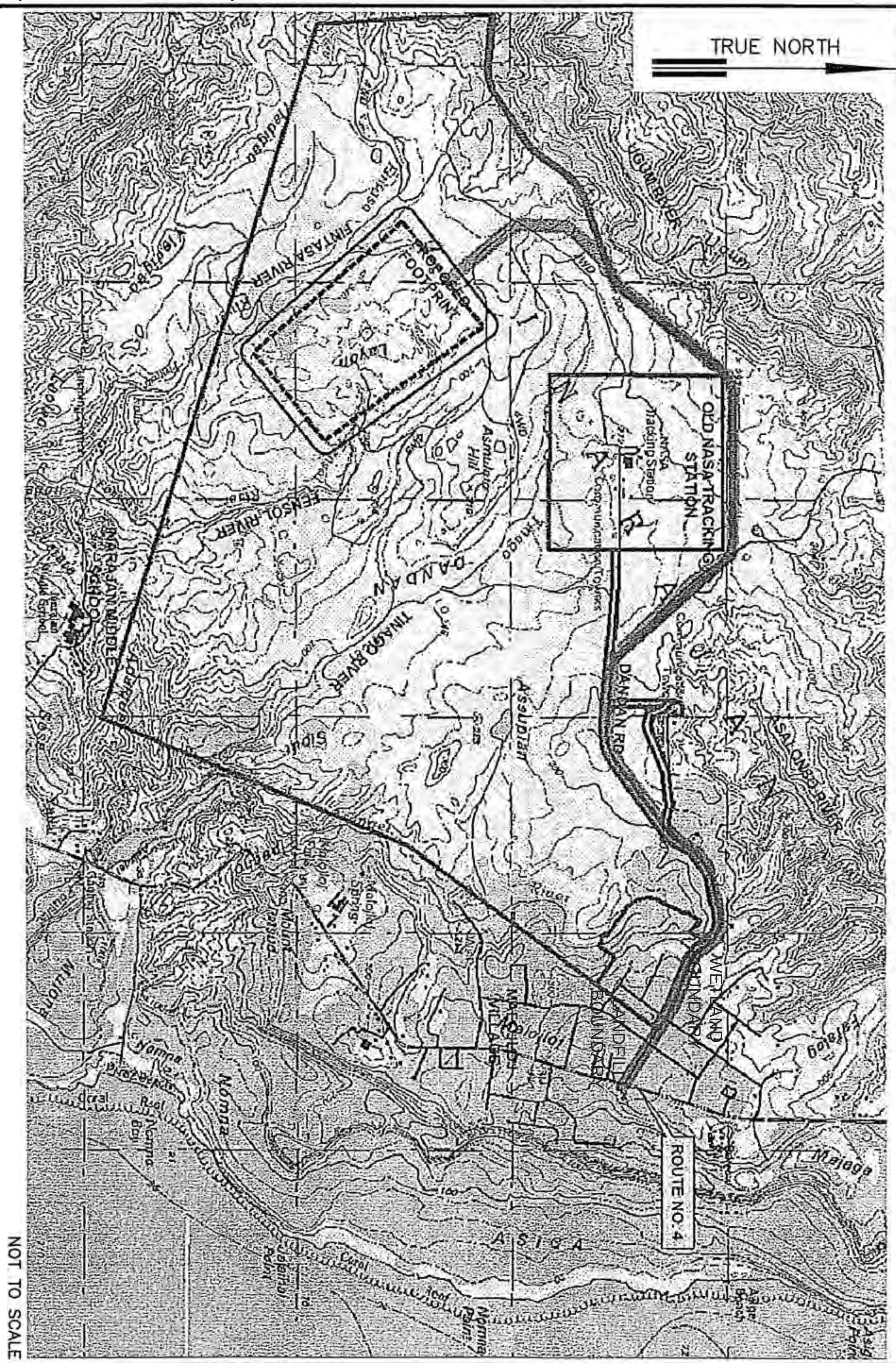

Figure 2.4-3
Layon Landfill Location, Guam

The landfill site would be accessed from Route 4 by approximately 3.3 miles (5.4 km) of reconstructed and new road. The landfill would be designed, built, and operated in compliance with Guam Solid Waste Disposal Rules and Regulations and would incorporate the following:

- Access road
- Berms
- Liner system
- Leachate collection system
- Landfill gas collection system
- Stormwater collection and disposal system
- Seismic design appropriate to site conditions
- Monitoring wells
- Security system
- On-site soil cover source
- Buffer zone

The Layon Landfill would be constructed as a mounded landfill. The final top elevation of the landfill would be approximately 460 ft (140 m) above msl. The landfill would be excavated approximately 15 ft (4.6 m) below existing grade to provide cover soils. The landfill footprint and shape would be more clearly defined during the design process to further reduce the impacts on the site based on refined geotechnical and hydrogeological surveys and analysis that is specific to the design.

Support facilities; an entrance control structure, scale and scale house, administration facility, leachate storage and treatment facility, and equipment and maintenance storage facilities, would be located adjacent to the access road in the buffer area in the northeast corner of the site. An area of 5 ac (2 ha) would be reserved for these facilities within the buffer area of the landfill.

The proposed Layon Landfill and its impacts were evaluated in the *Final Supplemental Environmental Impact Statement For the Siting of a Municipal Solid Waste Facility, Guam* (Guam DPW 2005). The design, permitting, and construction of the new landfill is being managed by GBB, the firm assigned receivership of GovGuam's solid waste program by the U.S. District Court of Guam as a result of a consent decree issued by USEPA. GBB recently awarded a construction contract for the initial phase of the landfill, and construction began on February 25, 2009. The current phase consists of constructing the landfill operations road and performing mass grading for landfill Cells 1 and 2. Invitations to bid on the construction of the Layon Municipal Sanitary Landfill Entrance Area Facilities and Cells 1 and 2 liner system were released on August 17, 2009.

Landfills are typically constructed in phases in accordance with an approved sequencing plan. The phases or "cells" are constructed to be large enough to handle waste for approximately 3-5 years. Once the active landfill phase is near capacity, a new landfill cell is constructed. The draft operations plan for the Layon Landfill (TG Engineers 2009) indicates that subsequent disposal cells would be constructed at intervals of 2-5 years. The initial phase at Layon Landfill would consist of Cells 1 and 2 that are 11.07 ac (4.48 ha) and 11.33 ac (4.58 ha) in size, respectively, with a combined waste capacity of 1,407,173 yd^3 (1,075,861 m^3) (GEPA 2009). Table 2.4-4 presents the projected solid waste generation rates from both the military buildup and the civilian Guam population by year. These two categories were added together to determine total estimated solid waste in tons, which were then converted to cubic yards. As shown in the table, in year 2014, Cells 1 and 2 would have reached their capacity and would have provided about 4 years of useful life, which is consistent with the phasing presented in the Layon Landfill Operations Plan.

Table 2.4-4 also provides an estimate of when the Layon Landfill would reach its ultimate capacity from solid waste generated by DoD and the Guam general population. Using a landfill air space capacity of 15,808,794 yd^3 (12,086,690 m^3), the table indicates that the landfill would reach capacity in 2043, 32 years after opening.

Table 2.4-4. Projected Solid Waste Generation

Year	*DoD-Related Solid Waste (tons/yr)* [1, 2]	*Guam General Population Solid Waste (ton/yr)* [1, 3]	*Total Solid Waste (tons/yr)*	*Total Solid Waste (yd^3/yr)* [4]	*Cumulative Total Solid Waste (yd^3)*
2011	62,840	176,417	239,257	398,761	398,761
2012	85,558	178,685	264,243	440,405	839,166
2013	96,854	180,920	277,774	462,956	1,302,123
2014	132,970	183,124	316,094	526,824	1,828,946
2015	123,644	185,302	308,947	514,911	2,343,857
2016	92,584	187,460	280,044	466,740	2,810,598
2017	81,121	189,595	270,716	451,194	3,261,791
2018	81,121	191,701	272,822	454,703	3,716,494
2019	82,347	193,775	276,123	460,204	4,176,699
2020	82,347	195,713	278,060	463,434	4,640,133
2021 to 2041	1,729,297	4,593,692	6,322,989	10,538,315	15,178,447
2042	82,347	243,607	325,954	543,257	15,721,705
2043	82,347	246,043	328,390	547,317	16,269,022

Notes:
[1]Assumes DoD waste generation rate of 7.4 pounds per person per day and a Guam general population waste generation rate of 5.28 pounds per person per day.
[2]Assumes that after 2019 the DoD population would remain constant.
[3]General Guam population after 2019 assumed to increase by 1% per year
[4]Assumes 1,200 pounds per cubic yard
2014 indicates the year which Layon Landfill Cells 1 and 2 would reach capacity.
2043 indicates the year which the Layon Landfill would reach total capacity.

The Layon Landfill is currently projected to be ready for acceptance of solid waste by July 2011 (Gershman, Brickner, & Bratton 2009a). The Layon Landfill has been designed to accommodate solid waste from all current and future DoD sources, as well as civilian and commercial sources.

Additionally, an important milestone was reached on April 3, 2009, when GEPA approved the *Final Integrated Hydrogeologic Assessment for the Layon Municipal Sanitary Landfill Site* (AMEC Geomatrix Consultants 2008). This document has established that the proposed landfill is not located over an important source of groundwater because of potential low yield and marginal back groundwater quality.

2.4.5.2 Construction and Demolition Debris

Construction and demolition (C&D) debris is expected to be generated as a result of proposed construction and proposed demolition of old structures to facilitate the proposed military buildup. These C&D projects are estimated to generate approximately 501,000 yd^3 (383,000 m^3) of new construction debris and 1,361,000 yd^3 (1,041,000 m^3) of demolition debris for a total of 1,860,000 yd^3 (1,422,000 m^3) of C&D debris. This debris would consist of wood, drywall, metal, concrete, asphalt, plastic/polyvinyl chloride, and other miscellaneous waste.

Very little hardfill capacity is currently available on-island to deal with the large volume of C&D debris that would be generated. The available DoD hardfills include the C&D hardfill at the Andersen AFB Landfill, and a designated C&D debris cell within the current inactive area of the Navy Sanitary Landfill. In 2008, GBB (the receivership firm responsible for GovGuam solid waste operations) enacted a ban on C&D waste at the Ordot Landfill. Currently all non-DoD C&D waste is disposed at privately operated hardfills. There are currently two private hardfill facilities in operation: the Northern Hardfill near Andersen AFB (estimated capacity of 30,000 yd3 [23,000 m3]) and the Eddie Cruz Hardfill (newly permitted at a capacity of 75,000 yd3 (57,300 m3) in Yigo). GovGuam does not own or operate a hardfill at this time.

Recent correspondence with GBB indicates that C&D waste would be accepted at the Layon Landfill for recycling and reuse. The C&D waste would be managed through a process that maximizes recycling and alternative reuse on-site. This process would include receiving and processing C&D (both military and nonmilitary), of which certain types can be used on the landfill site for operation and maintenance purposes (GBB 2009b).

In addition to the disposal option at the Layon Landfill, it is recommended that the military develop new hardfill capacity (such as at the Navy Sanitary Landfill) and upgrade and greatly expand its recycling programs to process solid waste and C&D debris. It is estimated that an efficient recycling program can recycle roughly 50% to 70% of C&D waste generated, thereby diverting it from island landfills and hardfills. Guidance for DoD management of C&D waste is provided in the *DoD Integrated (Non-Hazardous) Solid Waste Management Policy*, presented in the Deputy Under Secretary of Defense for Installation and Environment Memorandum, dated February 1, 2008. The memorandum sets a diversion goal for C&D waste of 50% by 2010.The memorandum also sets a DoD diversion goal for non-hazardous solid waste excluding C&D waste of 40% by 2010. The memorandum requires all DoD component installations to implement integrated solid waste management to achieve the goals set forth in EO 13423 (EO 13423). Additionally, a recent EO dated October 5, 2009, *Federal Leadership in Environmental, Energy, and Economic Performance*, establishes similar diversion goals to be achieved by 2015 (EO 2009).

At Andersen AFB, construction debris such as concrete, asphalt, and rock are piled together and processed through a rock crusher. The crushed debris is then mixed with dirt and used as daily cover for the landfill. Construction and demolition debris that cannot be crushed is disposed of in the hardfill section of the landfill.

Disposal of asbestos and other debris with low levels of contamination (e.g. polychlorinated biphenyls at less than 50 parts per million) can be disposed in a RCRA Subtitle D municipal solid waste landfill. However, it appears that a majority of this type of waste would be classified as “unacceptable” waste and would not be allowed at the Layon Landfill. The draft operations plan for Layon Landfill (TG Engineers 2009) establishes procedures for screening unacceptable waste and how it would be handled if it is brought to the landfill. The operations plan also provides guidance and procedures for handling special wastes such as sewage sludge, sandblast grits, baghouse dusts, inorganic filter cake, empty containers, and treated medical waste. Construction contracts implemented for the military buildup would establish requirements for contractors to test materials before demolition to determine whether materials contain excessive levels of lead-based paint or asbestos. Contractors would then be responsible for segregating the waste and disposing at proper facilities.

2.4.5.3 Solid Waste Reduction Initiatives

The policies and guidance being followed by the Navy for the military buildup require that new development be designed to meet the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) Silver Certification for New Construction (LEED-NC). The Navy's goal is to achieve LEED Silver requirements, and initiatives would be built into construction contracts. LEED Silver credits are awarded if more than 50% of nonhazardous construction and demolition debris is recycled or salvaged and additional credit is given if 75% recycling rates are achieved.

Currently two studies are being conducted regarding solid waste reduction. The first study is related to municipal solid waste recycling for long term DoD waste generation on Guam, including waste generated as part of the military buildup. The second study is related to C&D debris associated with the construction phase of the military buildup. The C&D debris study will estimate the quantity of material generated and what portion of the material could be potentially reused.

2.5 OFF BASE ROADWAYS

2.5.1 Introduction

This section provides a detailed description of the proposed action and alternatives comprising the offbase roadway improvements that would support the relocation of the Marine Corps to Guam, transient berthing of nuclear carriers at Apra Harbor, and placement of an Army AMDTF on the island. This section had been prepared by Federal Highway Administration. On base roadway improvements are described in the individual volumes for each proposed action.

The proposed off base roadway improvements are collectively referred to as the Guam Road Network (GRN), a related action to the relocation activity. The GRN also includes road projects that address organic growth on Guam without the military buildup (for analysis under the no-action alternative). The road projects for Tinian are discussed in Volume 3 and the access road impacts at Polaris Point for the proposed CVN action is covered in Volume 2.

2.5.1.1 Project Background

In response to the island's ongoing roadway problems, the *2030 Guam Transportation Plan* has programmed projects to address many of the immediate needs of Guam that have not been addressed in many years. The planned military buildup would include relocation of approximately 8,600 military personnel and 9,000 dependents from Okinawa, Japan; improvements to pier/waterfront infrastructure to support transient nuclear aircraft carriers on the island; and placement of an AMDTF on Guam, as well as related construction activities required to support these relocations. Troops would begin relocating to Guam in 2011; relocation would be complete by 2014. Buildup activities related to military facility construction would occur from 2010 through 2016, with peak construction and population in 2014. Road construction to support the military buildup would also need to commence in 2010 and be complete by 2016.

The existing traffic volumes, physical conditions, and designs of Guam's roads vary widely. As a result of the military buildup on the island, traffic volumes and congestion levels are anticipated to reach unacceptable levels. Military-related traffic would add to the congestion levels, worsening already poor conditions. In addition, the structural integrity of the roads and bridges would be compromised as a result of the increased number and weight of trucks.

The following subsections explain the need for the proposed action.

2.5.1.2 Roadway and Bridge Strength

The island of Guam has roadways and bridges with inadequate load capacity. An evaluation of background traffic loading and pavement condition of the existing roadways on Guam was conducted to identify the improvements that would be required to support the increased loading that is projected in the future (Parsons/PB 2008). The increased traffic and specifically the volume of truck traffic, especially during the construction period, have been assessed relative to the impact on the integrity of the existing roadway infrastructure (pavement and bridges). A summary of the heavy military vehicle use that would occur is provided in Table 2.5-1.

Table 2.5-1. Travel Projections for Heavy Military Vehicles

Typical Military Heavy Vehicles	*Max. Weight (lb)*	*Designated Route*	*Frequency (movements per month)*
MK48 Front Power Unit with Trailer	99,052	Finegayan to Apra Harbor (Routes 11, 1, 8, 16, 27, and 3)	75
		Finegayan to Naval Base Guam (Routes 1, 8, 16, 27, and 3)	75
		Finegayan to NMS (Routes 11, 1, 8, 16, 27, and 3)	4
		Finegayan to Andersen AFB (Routes 3 and 9)	8
		Finegayan to Andersen AFB South (Routes 3, 9, and 1)	8
MTVR with Howitzer (M777)	68,690	Finegayan to Apra Harbor (Routes 11, 1, 8, 16, 27, and 3)	14
LVSR MKR18	99,052	Finegayan to Apra Harbor (Routes 11, 1, 8, 16, 27, and 3)	79
		Finegayan to Naval Base Guam (Routes 1, 8, 16, 27, and 3)	
		Finegayan to NMS (Routes 11, 1, 8, 16, 27, and 3)	
		Finegayan to Andersen AFB (Routes 3 and 9)	
		Finegayan to Andersen AFB South (Routes 3, 9, and 1)	
STD MTVR AMK 23/25	64,800	Finegayan to Apra Harbor (Routes 11, 1, 8, 16, 27, and 3)	TBD
		Finegayan to Naval Base Guam (Routes 1, 8, 16, 27, and 3)	
		Finegayan to NMS (Routes 11, 1, 8, 16, 27, and 3)	
		Finegayan to Andersen AFB (Routes 3 and 9)	
		Finegayan to Andersen AFB South (Routes 3, 9, and 1)	
MTVR AMK 27/28	64,800	Finegayan to Apra Harbor (Routes 11, 1, 8, 16, 27, and 3)	TBD
		Finegayan to Naval Base Guam (Routes 1, 8, 16, 27, and 3)	
		Finegayan to NMS (Routes 11, 1, 8, 16, 27, and 3)	
		Finegayan to Andersen AFB (Routes 3 and 9)	
		Finegayan to Andersen AFB South (Routes 3, 9, and 1)	
Armored LVSR Cargo Truck	107,900	Finegayan to Apra Harbor (Routes 11, 1, 8, 16, 27, and 3)	TBD
		Finegayan to Naval Base Guam (Routes 1, 8, 16, 27, and 3)	
		Finegayan to NMS (Routes 11, 1, 8, 16, 27, and 3)	
		Finegayan to Andersen AFB (Routes 3 and 9)	
		Finegayan to Andersen AFB South (Routes 3, 9, and 1)	
Armored LVSR Wrecker	116,500	Finegayan to Apra Harbor (Routes 11, 1, 8, 16, 27, and 3)	TBD
		Finegayan to Naval Base Guam (Routes 1, 8, 16, 27, and 3)	
		Finegayan to NMS (Routes 11, 1, 8, 16, 27, and 3)	
		Finegayan to Andersen AFB (Routes 3 and 9)	
		Finegayan to Andersen AFB South (Routes 3, 9, and 1)	
Armored LVSR Tractor	114,900	Finegayan to Apra Harbor (Routes 11, 1, 8, 16, 27, and 3)	TBD
		Finegayan to Naval Base Guam (Routes 1, 8, 16, 27, and 3)	
		Finegayan to NMS (Routes 11, 1, 8, 16, 27, and 3)	
		Finegayan to Andersen AFB (Routes 3 and 9)	
		Finegayan to Andersen AFB South (Routes 3, 9, and 1)	

Note: TBD = To Be Determined
Source: Marine Corps 2008; Parsons/PB 2008.

A pavement analysis was conducted to systematically identify and quantify the structural effects on Guam's roadways that would result from military buildup, primarily those activities associated with constructing the infrastructure to support the relocation of Marines to Guam. The pavement analysis focused on the roadways that would be used during the construction and buildup period. The pavement analysis included the following elements:

- An evaluation of the existing pavement (i.e., measuring pavement depth to determine structural properties)
- Calculations of truck loading on roadways connecting the Port of Guam to the Finegayan area, Andersen AFB, and rock quarries on the east side of the island
- A determination of the design thickness of the pavement
- Prioritization of projects based on planned construction-loading activities
- Determinations of constructability and the availability of materials for road and military construction

A functional evaluation of the pavement found that the overall condition of the pavement is very good, requiring only preventive maintenance (e.g., surface seal) under current traffic conditions; however, the structural pavement analysis found that the existing pavement is sound but not structurally adequate, the depth of the pavement base and subbase is inconsistent throughout the study area, and existing drainage is inadequate, with substantial areas where water flows over the roadway rather than through drainage structures. Flooding of roadways on Guam occurs primarily along Route 1. Inadequate drainage systems and structures can cause weakening of the base and subbase and premature failure of the pavement, and can be hazardous to the traveling public. As part of the pavement analysis, equivalent single-axle loading for trucks was calculated to determine projected future truck traffic.

The condition of 10 bridges within Guam's transportation network was also evaluated. The locations of bridges on Guam are shown in Figure 2.5-1. These bridges would be essential to the construction and operational activities associated with the military buildup. The bridges were evaluated to determine structural adequacy for military and construction traffic before, during, and after redeployment (Table 2.5-2).

The analysis found that Agana Bridge #1 has insufficient inventory and operating ratings and would not be able to support the proposed loadings associated with the hauling of construction materials and equipment. (The inventory rating is the load that a bridge can carry for an indefinite number of loading cycles without detriment to the bridge. The operating rating corresponds to a maximum load that can be carried on an infrequent basis without detriment to the bridge.) For this reason, replacement of this bridge would be required. Four of the other bridges have ratings below the appropriate load-bearing capacities for many military vehicles. The structural integrity of the Commercial Port Bridge was not evaluated because it is a culvert. Unlike a culvert that also acts as a bridge, this culvert has fill on top of it and a retaining wall confines the roadway structure. Ylig Bridge is currently being replaced by GovGuam.

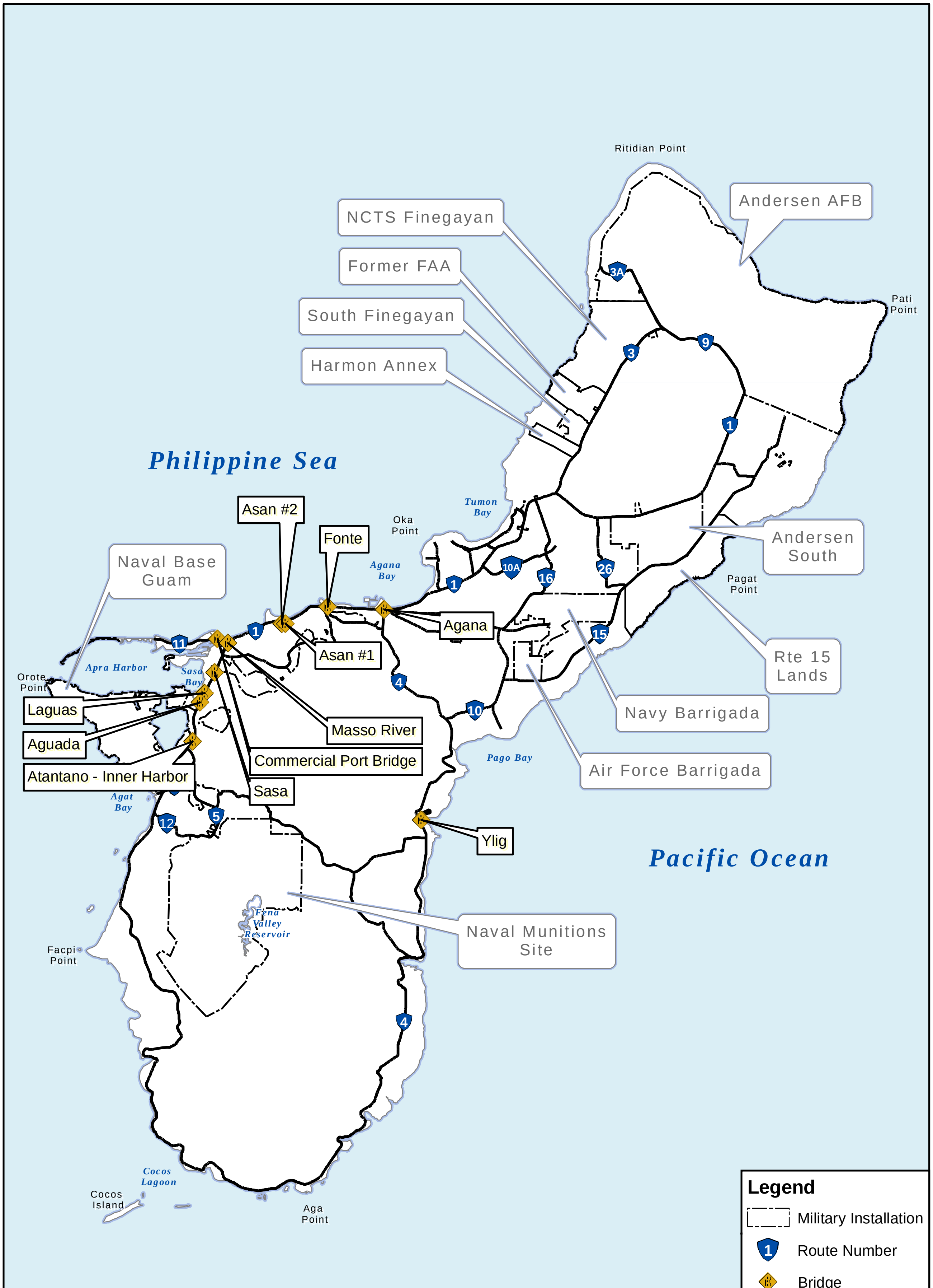

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Figure 2.5-1
Bridges on Guam

Table 2.5-2. Structural Data for Bridges on Guam

Route	*Structure*	*Year Built*	*Load Ratings**	
			Inventory Rating (tons)	*Operating Rating (tons)*
1	Atantano Bridge	1970	36	60
1	Agueda Bridge	1987	36	60
1	Laguas Bridge	1985	36	60
1	Sasa Bridge	1985	36	60
1	Masso Bridge	1980	36	60
1	Asan Bridge #2	1985	36	60
1	Asan Bridge #1	1983	36	60
1	Fonte Bridge	1982	36	60
1	Agana Bridge #1	1945	20	33

*Notes: * Inventory and operating ratings based on 2004 Federal Highway Administration bridge inspection reports.*

2.5.1.3 Roadway Capacity

The effect on the population of Guam during the period of peak construction and population (2014) and complete relocation of the Marines (2014) was determined. The analysis included a projection of the number of construction-related trucks and other traffic that would use roads connecting the Port of Guam to the Finegayan area, Barrigada area, Andersen AFB, and rock quarries on the island.

A traffic model was created to evaluate the need for additional traffic lanes (roadway widening) that would be required for the project. The traffic study found that traffic would double along segments of three primary routes: Route 3 (Route 28 to NCTS Finegayan), Route 3 (NCTS Finegayan to Route 9), and Route 9 (Route 3 to Andersen AFB North Gate). Certain roadways on Guam would lack sufficient capacity to handle the increased traffic load.

2.5.1.4 Roadway Access

To support the movement of cargo across the island and avoid normally congested corridors, new options for truck routes and access points are needed. A preferred truck route was identified (Routes 1, 3, 8, 9, 11, 16, and 27) for cargo being hauled from the Port of Guam to the northern part of the island. The route from the quarry was identified to include Route 15 and Chalan Lujuna. These preferred routes are shown in Figure 2.5-2. Preliminary transportation studies have identified individual projects to provide new intersections that would serve as military access points along existing roadways. The military access points were identified by the military and are for commercial and/or residential access.

2.5.1.5 Mass Transit

The traffic projections developed by the Guam DPW show that congestion levels in both the short term and the long term would result in substantial delays, as measured by the ratio of traffic volume to roadway capacity. Analysis indicated that it is unlikely that sufficient additional roadways or traffic lanes could be built to completely eliminate traffic congestion. Mass transit would help address this need. Existing mass transit routes and service areas are depicted in Figure 2.5-3.

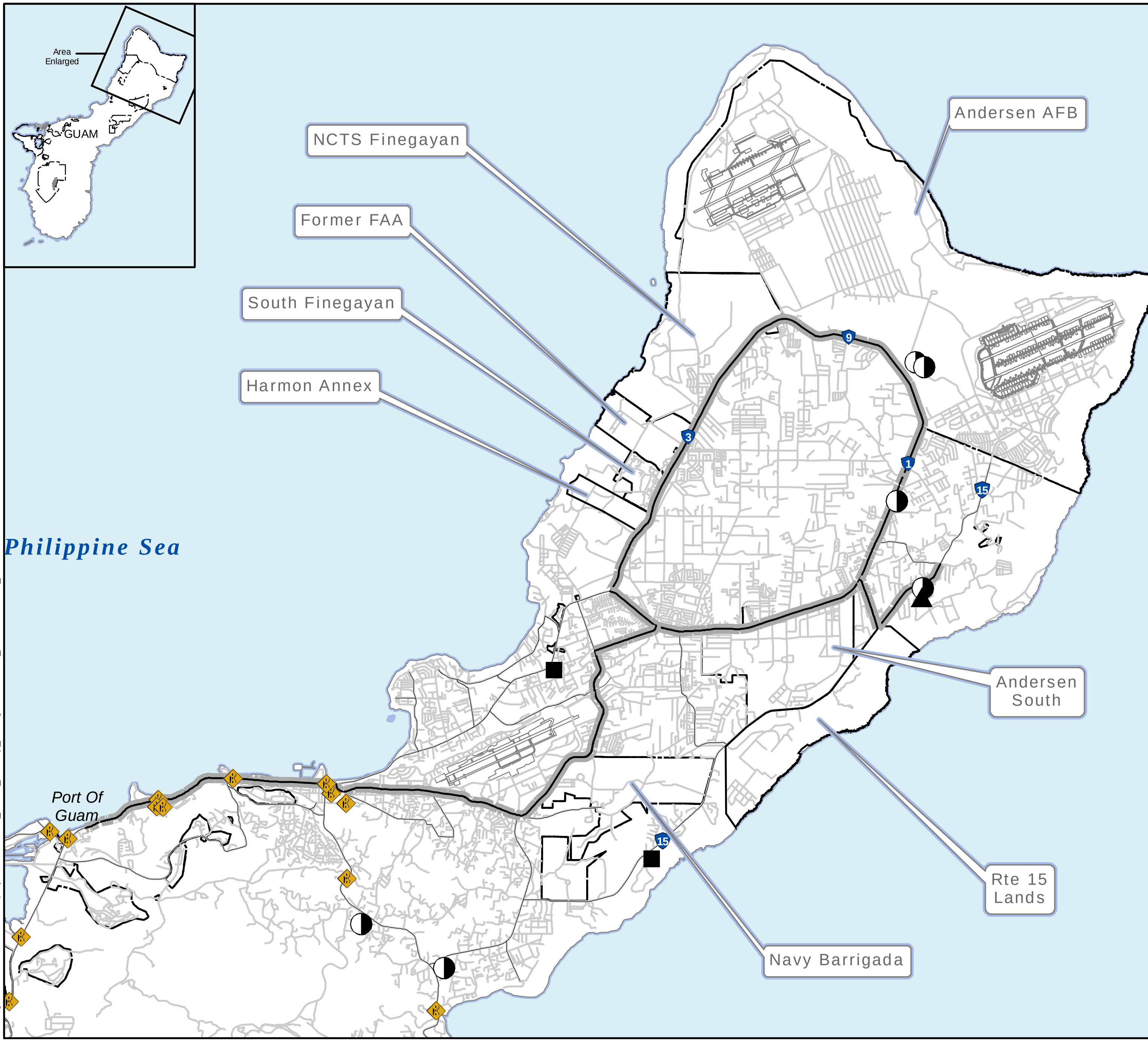

Figure 2.5-2
Preferred Routes for Hauling Cargo from Port of Guam

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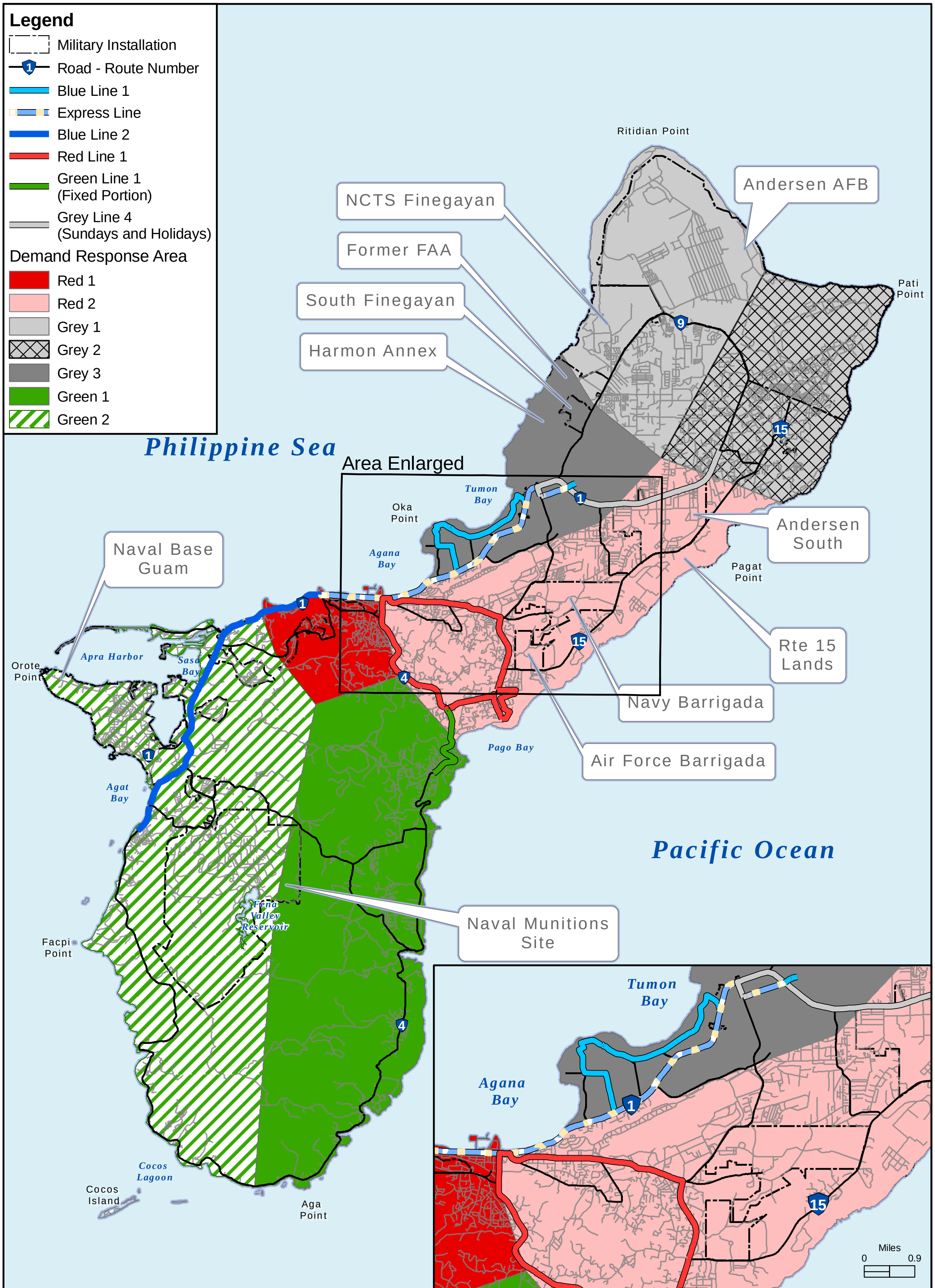

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Figure 2.5-3
Existing Mass Transit Network and Demand Service Areas on Guam

As part of the *2030 Guam Transportation Plan*, a new Core Bus System has been proposed to help support islandwide mobility during the 2010-2014 time period. Although most construction worker housing areas would be expected to include vans or buses to and from the work sites, the Core Bus System is expected to be operational by 2012. The new system is designed to connect major employment and population centers. The system consists of five new fixed routes. All major military facilities that house workers or are major employment destination points would be connected by this new system. The Dededo area (near NCTS Finegayan) would be especially well served because it is one of the major population centers; by 2030 it would experience a 50% increase in population. Projections show that ridership has the potential to reach 1.32 million annual trips.

The Core Bus System would also provide direct service between the Naval Base and Tumon Bay, which is the major tourist area on the island. A total of 50 buses are needed to operate this service, and GovGuam is pursuing a Federal Transit Administration Section 5309 discretionary grant to fund the acquisition of these vehicles. The proposed mass transit fixed-route network is depicted in Figure 2.5-4 and Figure 2.5-5.

2.5.1.6 Safety

Transportation safety on Guam is managed by the Guam DPW's Office of Highway Safety and is funded through Federal Highway Administration safety improvement funds. The focus of safety education and enforcement programs has been to prevent accidents related to speed, imprudent driving, and driving under the influence. The *2030 Guam Transportation Plan* recommends that traffic information and data management systems be completely overhauled and upgraded with computerized systems and equipment. To provide efficient and safe access to military lands during the construction of relocation facilities, the proposed Guam road improvements would be designed in accordance with standards that would improve traffic safety. The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) (23 USC 148) requires that U.S. territories develop a strategic highway safety plan as a major part of the core highway safety improvement plan. The Guam DPW is in the process of identifying hazardous traffic locations on the island and implementing safety on island roadways. *The Guam Territorial Transportation Improvement Plan* contains 16 hazard elimination projects. Six of these projects are site-specific:

- Route 4, Jeff's Pirate Cove
- Route 14 Resurfacing
- Route 1 Pedestrian Safety Fence at JFK High School
- Route 1 JFK Pedestrian Underpass/Overpass
- Route 15 Santa Rosa Yigo, Road Hardening
- Route 1 Deadman's Curve

The remaining 10 projects are islandwide:

- School zone signs
- Village road safety signs (newly paved local roads) and regulatory/warning signs
- Seashore protection
- Highway hazard elimination project
- Pavement markers for primary roads and Phase I markings replacement

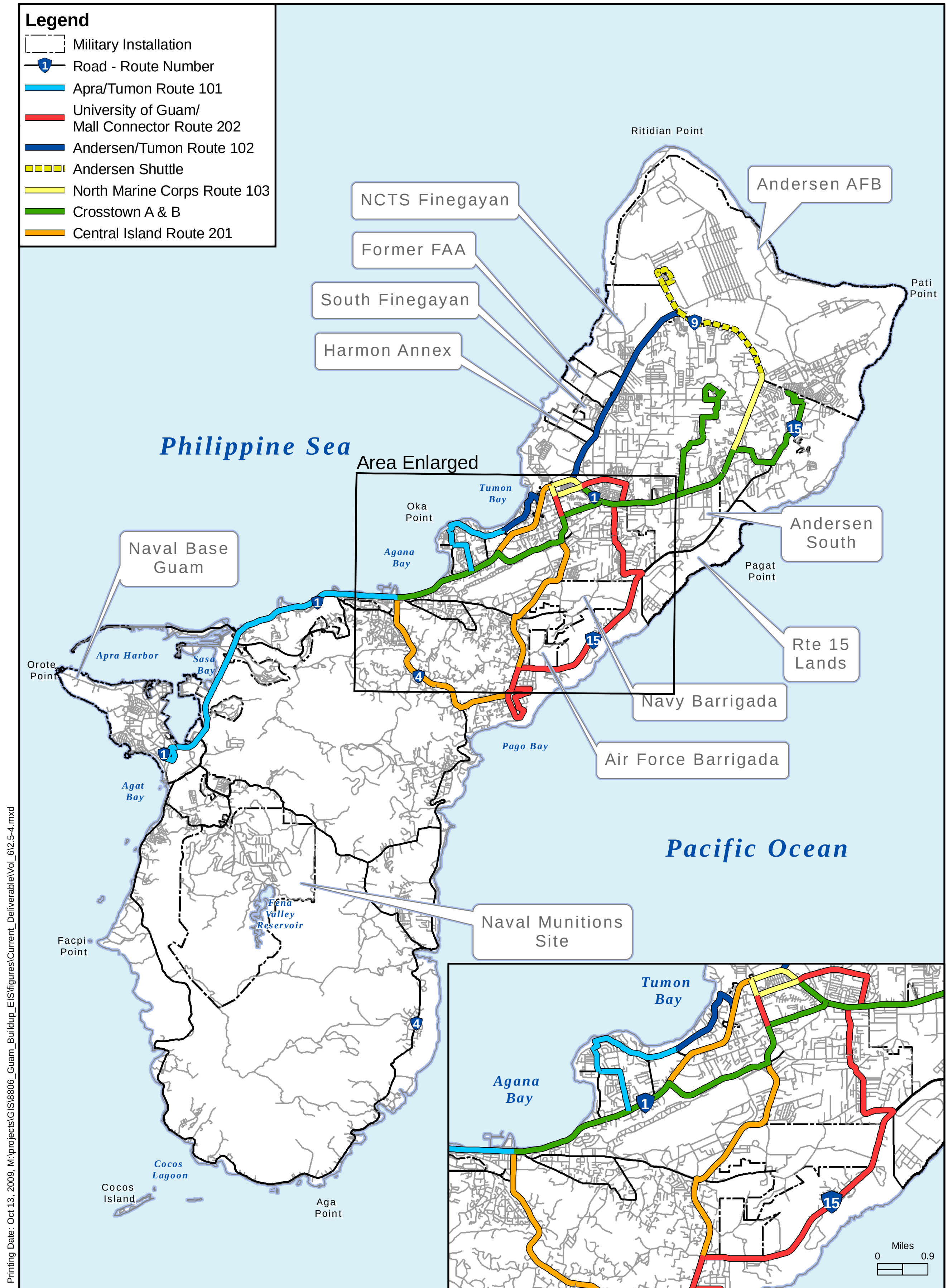


Figure 2.5-4
Proposed Mass Transit Network on Guam

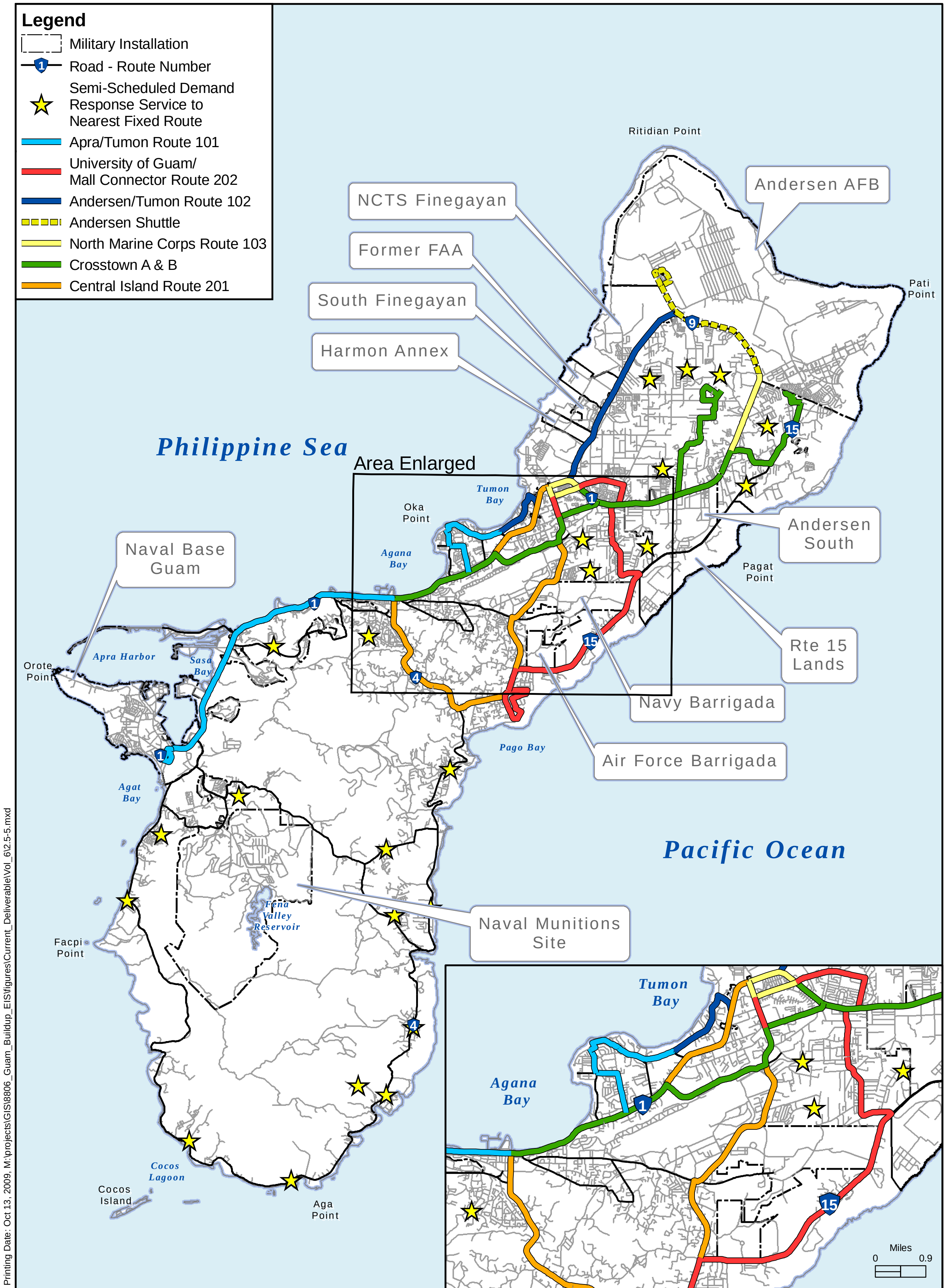


Figure 2.5-5
Mass Transit Network on Guam

- Construction for safety improvements
- Route sign installation
- Anti-skid surfacing and traffic signalization
- Skid-resistant surfacing and guardrails for Route 4 in Yona
- Highway barrier and rail rehabilitation

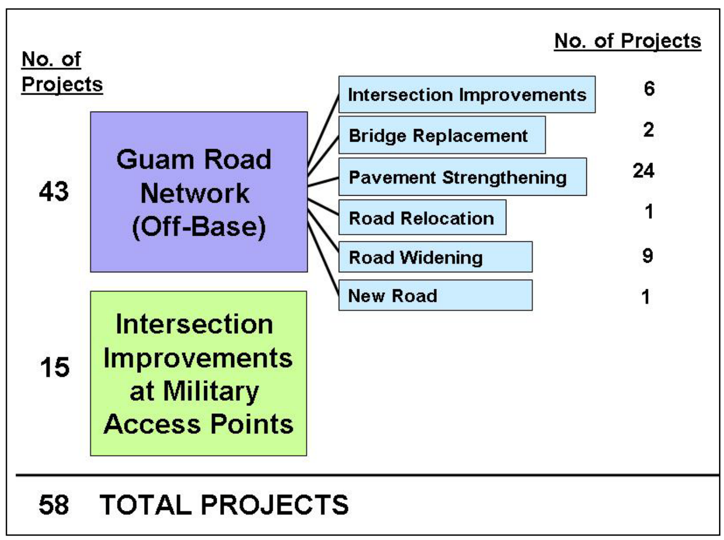
Hazard elimination projects on Route 1 (Jeff's Pirate Cove) and Route 4 (Deadman's Curve) are the only two specific location projects that have been funded. There is an existing safety hazard with key roadways on Guam and a need for safety improvements.

2.5.1.7 Proposed Action

The proposed action would enable and improve roadway connectivity, capacity, and pavement strength for military construction and deployment in support of the relocation. Logistical routes for construction-related transport would connect the Port of Guam with Navy and Air Force bases, the Finegayan area, the Naval Munitions Site, concrete batch plants, rock quarries, and precast concrete panel fabrication sites associated with the military buildup on the island. In addition to improvements to the construction routes, traffic associated with the presence of the military personnel and their dependents would require roadway modifications, thus the collective roadway projects are called the GRN (see overview in Figure 2.5-6).

As shown in the adjacent chart, 58 individual projects have been identified from recent transportation and traffic studies on the island of Guam. These consist of 43 GRN (off-base) projects and 15 intersection improvement projects at military access points (gates). The 43 GRN (off-base) projects are composed of six types of roadway improvements:

- Intersection improvement projects
- Bridge replacement projects (involving five bridges)
- Pavement strengthening (combined with roadway widening at some locations)
- Roadway relocation (Route 15)
- Roadway widening
- Construction of a new road (Finegayan Connection)



These 58 projects cover four geographic regions on Guam: North, Central, Apra Harbor, and South (Figure 2.5-7). The characteristics of each of the 58 projects are summarized in Table 2.5-3 (with each project assigned a GRN number). The locations of these GRN projects are shown in Figure 2.5-8.

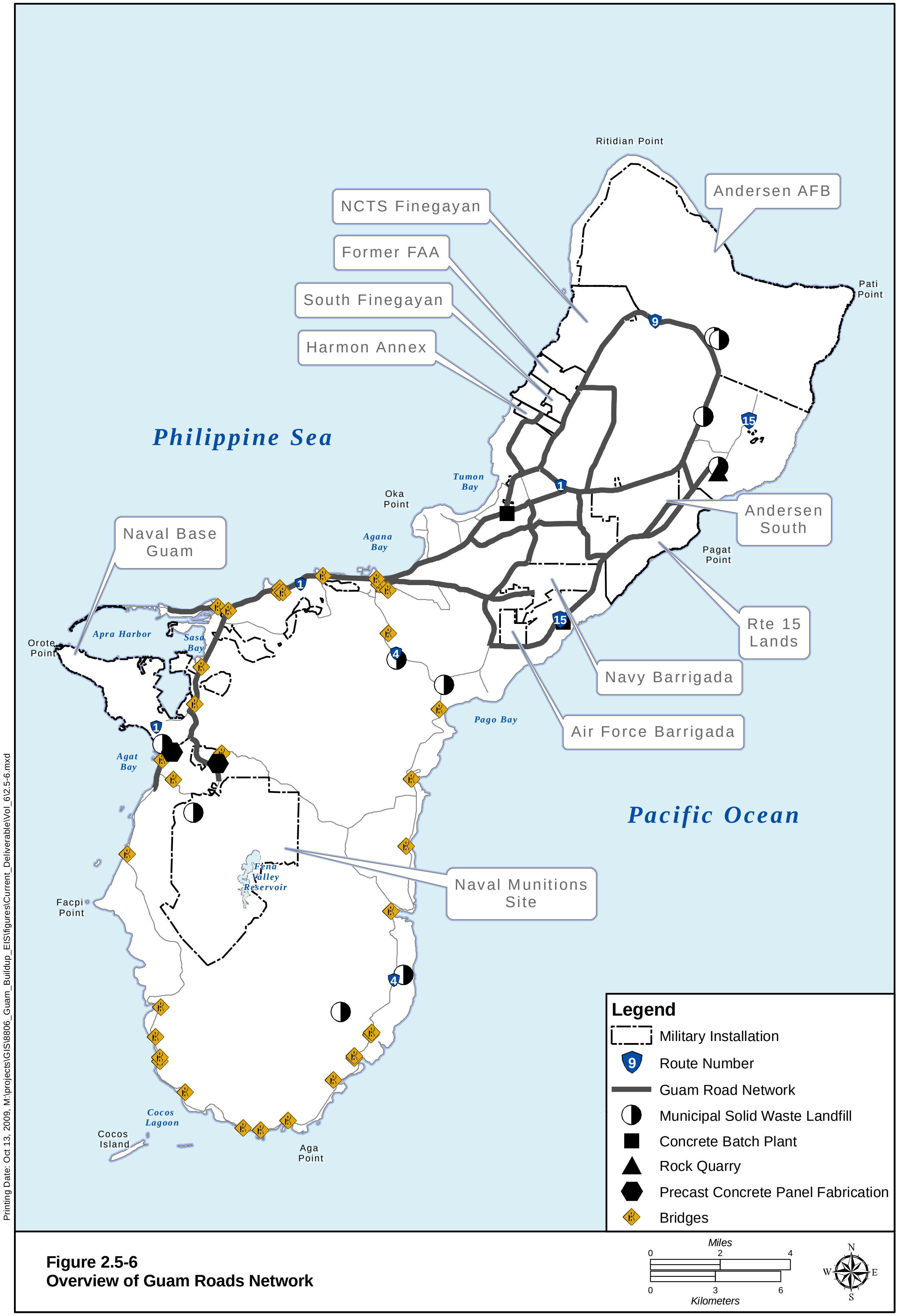


Figure 2.5-6
Overview of Guam Roads Network

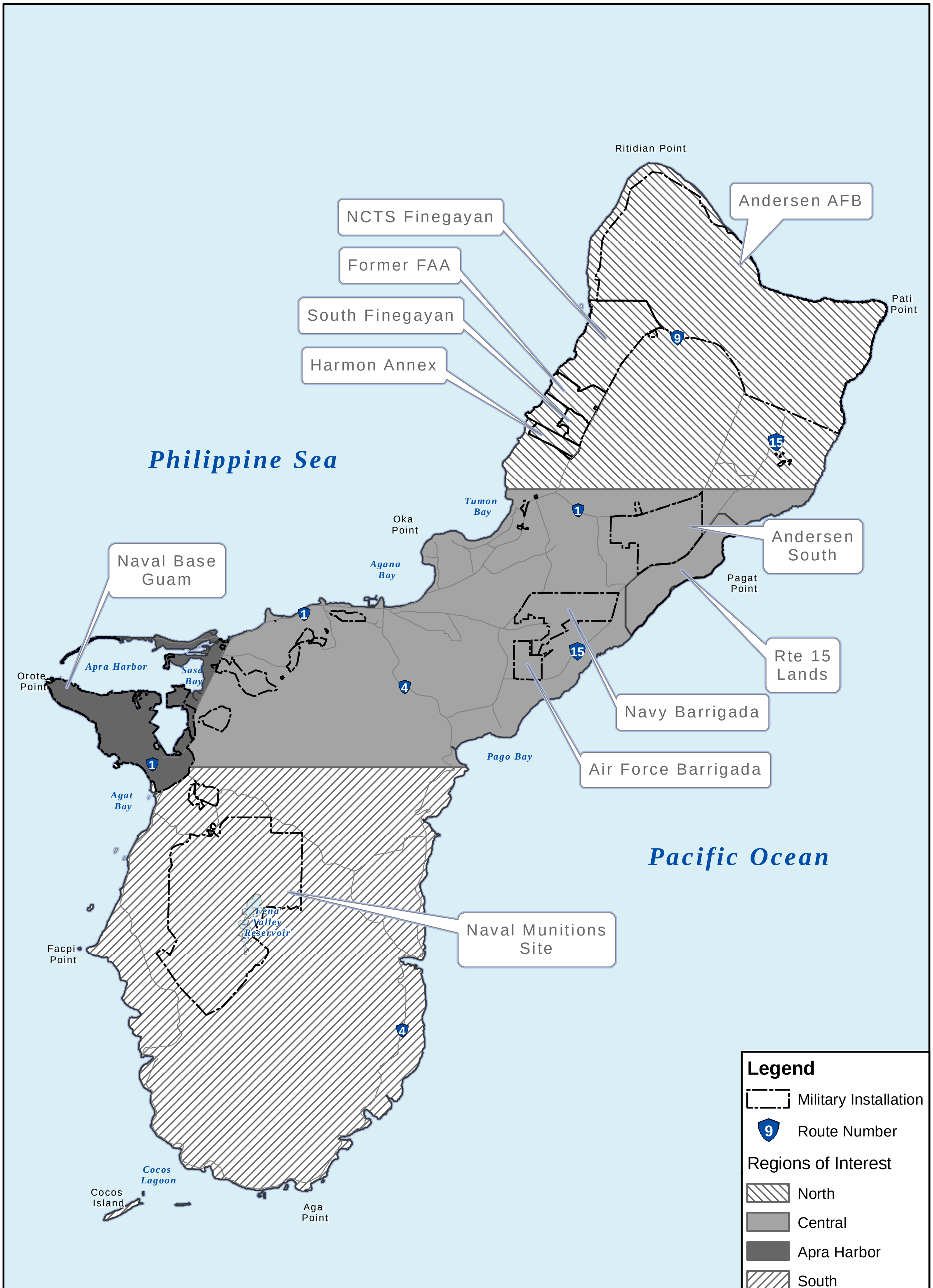


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Figure 2.5-7
Geographic Regions of Guam

Table 2.5-3. Guam Road Network Projects by Island Region

GRN No.	*Route*	*Segment Limits*	*Road Length ft (m)*	*Requirements*
North				
8	3	Route 28 to Route 1	13,500 (4,091)	Pavement strengthening (four lanes), including reestablishment of second southbound through lane at Okkodo High School access.
9	3	NCTS Finegayan to Route 28	11,900 (3,606)	Pavement strengthening (widen from two to four lanes), add median and shoulders. At the Route 3/28 intersection, add an additional southbound left-turn lane and add northbound right-turn lane.
10	3	NCTS Finegayan to Route 9	4,150 (1,258)	Pavement strengthening, widen from two lanes to four lanes, add median and shoulders. At the Route 3/3a intersection, eliminate Y-intersection, provide four-legged intersection with one right-turn lane on Route 3A, and a northbound left-turn lane on Route 3.
22	9	Route 3 to Andersen AFB (North Gate)	6,300 (1,909)	Pavement strengthening (widen from two lanes to four lanes), add median and shoulders.
22A	9	Andersen AFB North Gate to Route 1 (Andersen AFB Main Gate)	9,200 (2,788)	Pavement strengthening (two lanes), add median and shoulders.
23	1	Chalan Lujuna to Route 9 (Andersen AFB)	14,250 (4,318)	Pavement strengthening (four lanes).
38	3	NCTS Finegayan (Commercial Gate)	-	MAP 2, proposed location 0.5 mile (0.8 km) west of Route 9, across from Chalan Kareta would be signalized; eastbound, left-turn lane (300 ft [91 m], combined through/right-turn lane; westbound, left-turn lane (150 ft [46 m]), combined through/right-turn lane; northbound, left-turn lane (480 ft [146 m]), through/right-turn lane; southbound, left-turn (150 ft [46 m]), through, and combined through/right-turn lane.
38A	3	NCTS Finegayan (Commercial Gate)	-	MAP 2, proposed to be a T-intersection 1,215 ft (368 m) south of Flores Para Eso St. Would be signalized; eastbound, left-turn lane (300 ft [91 m]), combined through/right-turn lane; northbound, left turn (480 ft [145 m]), through, combined through/right-turn lane; southbound, through, and combined through/right-turn lane.
39	3	NCTS Finegayan (Main Gate)	-	MAP 3, would be located at Bullard Avenue; would be signalized; eastbound, two left-turn lanes (300 ft [91 m]), free right turn with acceleration lane on Route 3; northbound, two left turns (600 ft [183 m]), two through lanes, southbound two through lanes, right-turn lane (600 ft [183 m]).
39A	3	NCTS Finegayan (Main Gate)	-	MAP 3, located across from signalized intersection with Route 28. Eastbound, two left-turn lanes (300 ft [91 m]), one through lane, free right turn with acceleration lane on Route 3; northbound, two left turns (600 ft [182 m]), two through lanes, and right-turn lane, southbound, two left-turn lanes, two through lanes, right-turn lane (600 ft [182 m]), westbound two left-turn lanes, through, and right-turn lane.

Table 2.5-3. Guam Road Network Projects by Island Region

GRN No.	*Route*	*Segment Limits*	*Road Length ft (m)*	*Requirements*
41	3	South Finegayan (Residential Gate)	-	MAP 5, aligned with Kamute Avenue, would be signalized; eastbound, two left-turn lanes (200 ft [61 m]), free right turn with acceleration lane on Route 3; northbound, two left turns (700 ft [213 m]), two through lanes, southbound, through and combined through right turn. A southbound left-turn lane for Kamute Avenue would also be needed (150 ft [46 m]).
41A	3	South Finegayan (Residential Gate)	-	MAP 5, located 680 ft (206 m) south of Hahasu Drive. Would be signalized; eastbound, two left-turn lanes (200 ft [61 m]), free right turn with acceleration lane on Route 3; northbound, two left turns (700 ft [212 m]), two through lanes, southbound, through and combined.
42	9	Andersen AFB (North Gate)	-	MAP 6, proposed between Routes 3 and 1 would be stop-controlled with stop for access from base; eastbound left-turn lane (600 ft [183 m]), two through lanes; westbound, one through lane and one right-turn lane (220 ft [98 m]); southbound, left-turn lane, free right-turn lane with acceleration lane (becomes second westbound through lane).
57	28	Route 1 to Route 3	21,000 (6,364)	Pavement strengthening, widen two to three lanes with shoulders. At the Route 28/27A intersection, provide northbound left-turn, through, combined through/right-turn, southbound left turn, through, and combined through/right-turn, eastbound left-turn, through, and right-turn lane.
117	15	Route 15/29 Intersection	-	Intersection improvements to signalize, additional northbound, southbound left-turn lanes, southbound right-turn lane.
124	New Road	Route 1/16 Intersection to South Finegayan	10,641 (3,225)	New two-lane road parallel to Route 3, with left-turn lanes at existing access points, with 4-ft (1.2-m) median and 4-ft (1.2-m) paved shoulders. At the Route 1/16 intersection, improve the existing at-grade intersection.
Central				
1	1	Route 1/8 Intersection	940 (285)	Intersection improvements (0.24 mile [0.24 km] on Route 1 and 0.09 mile [0.14 km] on Route 8) to provide two left-turn lanes and two right-turn lanes for northbound Route 8 approaching Route 1.
2	1	Route 1/3 Intersection	2,400 (727)	Intersection improvements (0.15 mile [0.39 km] on Route 1 and 0.04 mile [0.06 km] on Route 3) to provide southbound left, combined left/right, and free right with acceleration lane; east to north double left-turn lane.
3	1	East of Route 4	85 (26)	Agana Bridge replacement.
6	1	Route 27 to Chalan Lujuna	18,200 (5,515)	Pavement strengthening (four lanes). At the Route 1/28 intersection, add an additional eastbound left-turn lane, southbound Route 28 approach to include two right-turn lanes and shared left/through lane. At the Route 1/26 intersection, add an additional westbound left-turn lane, eastbound right-turn lane. Northbound Route 26 approach should include left-turn, combined left-turn/right-turn, and right-turn lane.

Table 2.5-3. Guam Road Network Projects by Island Region

GRN No.	*Route*	*Segment Limits*	*Road Length ft (m)*	*Requirements*
7	1	Route 3 to Route 27	4,600 (1,394)	Pavement strengthening (six lanes). At the Route 1/27 intersection, provide double eastbound left-turn lanes, eastbound right-turn lane, and triple westbound left-turn lanes. Northbound Route 27 approach to include left-turn, combined left-turn/through and two right-turn lanes. At the Route 1/27A intersection, add an additional eastbound left-turn lane, additional northbound Route 27A right-turn lane.
11	Chalan Lujuna	Route 1 to Route 15	4,350 (1,318)	Pavement strengthening (two lanes), safety/operational improvements.
12	15	Smith Quarry to Chalan Lujuna	6,100 (1,848)	Pavement strengthening (two lanes), safety/operational improvements.
13	1	Route 11 to Asan River	8,472 (2,567)	Pavement strengthening (four lanes).
14	1	Asan River to Route 6	6,437 (1,951)	Pavement strengthening (four lanes).
15	1	Route 6 (Adelup) to Route 4	9,100 (2,758)	Pavement strengthening (six lanes).
16	8	Tiyan Parkway/Route 33 (east) to Route 1	8,290 (2,512)	Pavement strengthening, widen from four/six lanes to six lanes with median.
17	8	Route 10 to Tiyan Parkway/Route 33 (east)	7,904 (2,395)	Pavement strengthening (four lanes).
18	16	Route 27 to Route 10A	4,505 (1,365)	Pavement strengthening (six lanes). At the Route 16/27 intersection, add an additional northbound lane, southbound left-turn lanes, change westbound right-turn to combine through/right-turn lane.
19	16	Route 10A to Sabana Barrigada Drive	5,448 (1,651)	Pavement strengthening (four lanes). At the Route 16/10A intersection, add an additional northbound and southbound off-ramps to provide one left-turn, combined left-turn/through/right-turn, and right-turn lane. Restripe to provide additional westbound left-turn lane.
20	16	Sabana Barrigada Drive to Route 8/10	8,691 (2,634)	Pavement strengthening (four lanes).
21	27	Route 1 to Route 16	5,448 (1,651)	Pavement strengthening (six lanes).
28	26	Route 1 to Route 15	12,900 (3,909)	Pavement strengthening, widen from two lanes to four lanes. At the Route 26/25 intersection, provide northbound left-turn, through, through/right, southbound left-turn, two throughs, and right-turn, eastbound left-turn, left-through, and right-turn lane. Southbound right-turn should have raised island and free right to westbound Route 25 curb lane.
29	25	Route 16 to Route 26	8,050 (2,439)	Pavement strengthening, widen from two lanes to four lanes.
30	10	Route 15 to Routes 8 and 16	7,847 (2,378)	Pavement strengthening (four lanes)
31	8A	Route 16 to Navy Barrigada	8,865 (2,686)	Pavement strengthening (two lanes)
32	15	Route 10 to Connector (Chalan Lujuna end)	41,500 (12,576)	Pavement strengthening (two lanes). Signalize the intersection at the Route 15/26 intersection.

Table 2.5-3. Guam Road Network Projects by Island Region

GRN No.	*Route*	*Segment Limits*	*Road Length ft (m)*	*Requirements*
33	1	Route 8 to Route 3	31,647 (9,590)	Pavement strengthening (six lanes). At the Route 1/14 North San Vitoris intersection, add southbound right-turn lane. At the Route 1/14A intersection, add northbound/southbound left-turn lanes, southbound right-turn lane. At the Route 1/10A intersection, add southbound left-turn lane, northbound right-turn lane. At the Route 1/14B intersection, change eastbound right-turn lane to shared right-turn/left-turn lane. At the Route 1/14 southern intersection (known as the ITC intersection), include southbound right-turn lane. At the Route 1/30 intersection, add an additional northbound left-turn lane, change existing lanes on eastbound approach to combined left-turn/through, and two right-turn lanes.
35	1	Various	364 (110)	Replace bridges (Atantano, Laguas, Sasa, and Fonte).
36	15	Route 15 Realignment	11,200 (3,394)	Relocate Route 15 onto existing DoD property to allow firing range in vicinity.
44	1	Andersen South (Main Gate)	-	MAP 8 (Turner Street) would be signalized; westbound Route 1 left-turn lane (500 ft [152 m], restripe existing two-way left turn lane); eastbound Route 1 right-turn lane (1,000 ft [305 m]); and northbound two left-turn lanes (300 ft [91 m]) and right-turn lane.
46	15	Andersen South (Secondary Gate)	-	MAP 10, unnamed road, 1.16 miles (1.87 km) east of Route 26 would be stop-controlled with stop for access from base; eastbound Route 15 left-turn lane (250 ft [76 m]); southbound, left-turn lane (150 ft [46 m]) and right-turn lane.
47	16	Barrigada (Navy)	-	MAP 11, approximately 1,315 ft (401 m) north of northerly post office driveway. New four-lane access road connected to Route 16 as a T-intersection. Route 16/Access Road would be signalized. Northbound Route 16, two through lanes and combined through/right lane. Southbound Route 16, two left-turn lanes (one lane 425 ft [130 m], the other lane drop from third southbound through lane), and two through lanes; westbound, two left-turn lanes and free right-turn lane.
48	8A	Barrigada (Navy)	-	MAP 12, extension of north/south road from Route 16/Sabana Barrigada Drive to Route 8A with one lane in each direction.
49	15	Barrigada (Air Force)	-	MAP 13, new access across from Chada Street would be signalized; eastbound left-turn lane (250 ft [76 m]), combined through/right-turn lane; westbound, left-turn lane (150 ft [46 m]), combined through/right-turn lane; southbound, left-turn lane (150 ft [46 m]), combined through/right-turn lane; northbound, combined left/through/right-turn lane.
49A	15	Barrigada (Air Force)	-	MAP 13A, new access across from Chada Street would be signalized; eastbound, two left-turn lanes (500 ft [152 m]), combined through/right-turn lane; westbound, left-turn lane (150 ft [46 m]), through lane, right-turn lane (1,000 ft [305 m]); southbound, two left-turn lanes (500 ft [152 m]), combined through/right-turn lane; northbound, combined left/through/right-turn lane.

Table 2.5-3. Guam Road Network Projects by Island Region

GRN No.	*Route*	*Segment Limits*	*Road Length ft (m)*	*Requirements*
63	16	Route 10A to Sabana Barrigada Drive	5,448 (1,651)	Pavement strengthening, widening from four to six lanes, with median.
74	8A	Route 16 to Navy Barrigada	8,865 (2,686)	Pavement strengthening (two lanes), widen to provide median and shoulders.
113	7	Route 7/Route 7A	-	Intersection improvements to add signing, striping, and minor intersection construction to establish two-lane circulation around Y-intersection.
Apra Harbor				
4	11	Port to Intersection with Route 1	9,150 (2,773)	Pavement strengthening of two lanes.
5	11	Route 1/11 Intersection	1,480 (448)	Intersection improvements (0.12 mile [0.19 km] on Route 1).
24	1	Route 11 to Route 2A	16,247 (4,923)	Pavement strengthening (four lanes).
26	2A	Route 1 to Route 5	4,577 (1,387)	Pavement strengthening (four lanes)
50	1	Naval Base Guam	-	MAP 14, at existing signalized intersection of Route 1/Route 2A
South				
25	5	Route 2A to Route 17	6.379 (1,944)	Pavement strengthening (two lanes). Route 5/17 intersection. Add right-turn lane on Route 17 approaching Route 5.
27	5	Route 17 to Naval Munitions Site	3,954 (1,205)	Pavement strengthening (two lanes).
52	12	Naval Munitions Site	-	MAP 16, proposed relocation of existing access point to Harmon Road for safety/operational improvements.
110	2	Route 2/12 Intersection	-	Intersection improvements to convert northbound right-turn lane to combined through/ right-turn lane.

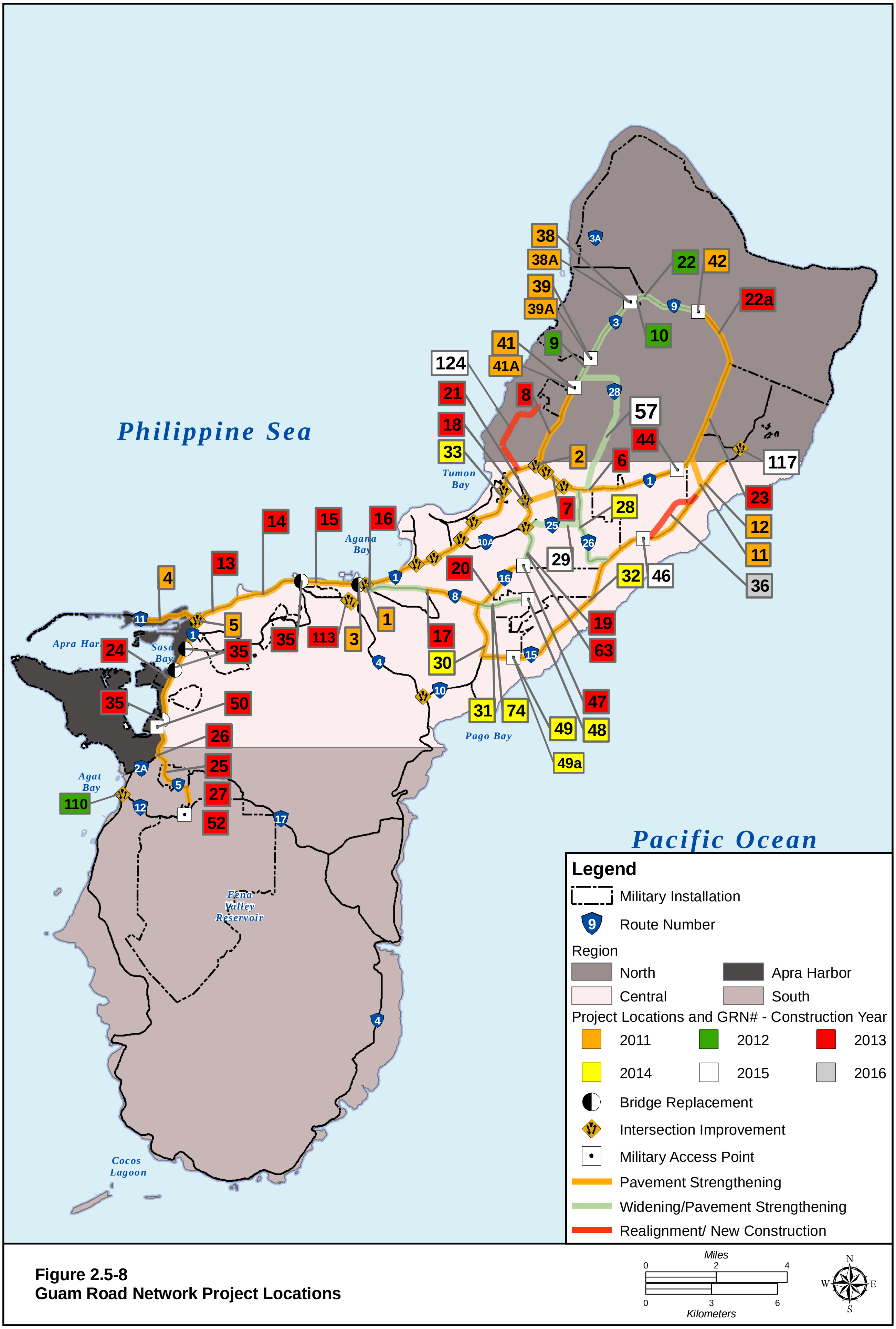

Figure 2.5-8
Guam Road Network Project Locations

2.5.1.8 Construction Schedule

Construction of the GRN would occur from 2010 to 2016 (a 7-year period) with peak construction in 2013. The military buildup associated with the relocation would be complete by the end of 2014.

To plan for construction of the GRN, islandwide traffic forecasts were prepared to define traffic associated with the increase in off-island construction workers and off-island indirect workers. Table 2.5-4 identifies a preliminary schedule of the GRN projects that would be completed in each of the 7 construction years.

Table 2.5-4. Guam Road Network Construction Projects to be Completed Each Year

Construction Year	*Projects to be Completed*
2010	(None)
2011	1, 2, 3, 4, 5, 11, 12, 38, 38A, 39, 39A, 41, 41A, 42
2012	9, 10, 22, 110
2013	6, 7, 8, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22A, 23, 24, 25, 26, 27, 35, 44, 47, 50, 52, 63, 113
2014	28, 30, 31, 32, 33, 48, 49, 49A, 74
2015	29, 46, 57, 117, 124
2016	36

2.5.1.9 Typical Construction Activities

Construction of the GRN would result in typical roadway and ancillary-facility construction activities at multiple locations. Typical roadway construction work is described in Table 2.5-5**.**

The types of construction activities might be combined in any particular project. In addition, projects would include matching existing access connections, pavement striping, and signing. As appropriate, intelligent traffic systems, modifications to comply with Americans with Disabilities Act requirements, and safety lighting may be included.

Depending on the road condition and loading, pavement strengthening may consist of one or more of the following methods:

- Full-depth reconstruction (removing the full depth of subbase, base, and asphalt pavement and replacing it with new high-quality crushed base and asphalt pavement to allow the existing and new roadway profile to remain the same).
- Full-depth reclamation and overlay (pulverizing the existing asphalt pavement and base to a depth of 8 in (20 cm) to 12 in (30 cm), followed by removal of the top 4 in (10 cm) to 6 in (15 cm) of pulverized material and stabilization of the remaining 4 in (10 cm) to 8 in (20 cm) of material by adding emulsion, cement, and other additives. A 4-in (10-cm) to 6-in (15-cm) layer of asphalt pavement is placed over the stabilized base.) This alternative provides pavement strengthening while minimizing both demand for natural resources and traffic impacts due to the fast process (roadway profile to remain the same).
- Mill and overlay (plus isolated surface preparation) could include the removal of the top inch of existing pavement and placing a 2-in (5-cm) to 6.5-in (16.5-cm) layer of asphalt. This process is not valid for most of the routes because the pavement profile of existing curbs, gutters, or roadway approaches cannot be raised.

Table 2.5-5. Typical Construction Activities

Item	*Work Activity*	*Description*
1	Intersection Improvement (including Military Access Points)	Intersection improvements can include construction of additional turning lanes, construction of acceleration or deceleration lanes, construction of channelizing islands, installation of traffic signals, or installation of new traffic loop sensors.
2	Bridge Replacement	Bridge replacements to correct structural deficiencies, increase load capacity, and comply with seismic requirements would be conducted in phases. The superstructure for a new bridge could consist of a cast-in-place concrete deck on precast prestressed box beams. The substructure would consist of concrete abutments founded on drilled shaft foundations. The new structure would be lengthened to adequately accommodate the hydraulic flow of the river. The width of the new structure would accommodate more or wider lanes and a median, with sidewalks and barriers on each side, as required. A friction course would be applied to the bridge. The final step would be demolition of the existing bridge.
3	Pavement Strengthening	Existing asphalt pavement sections would be strengthened by rehabilitating the existing pavement materials in place and placing an asphalt overlay or by reconstructing with new materials. The widened pavement section would be constructed of residual material from the existing pavement rehabilitation, new material, or a combination thereof, and an asphalt overlay. Pavement strengthening would also include matching existing access connections, pavement striping, signing, intelligent traffic systems, and safety lighting. A project would match the existing horizontal and vertical alignment where practical with adjustments to roadway super elevation as required. Minor realignment of the road may be necessary to accommodate design elements.
4	Road Relocation (Route 15 only)	Route 15 would be realigned to accommodate the location of military firing ranges. New asphalt pavement would be constructed on the new alignment. The roadway cross section would consist of one lane in each direction, outside shoulders, and inside shoulders, with an unpaved median that would accommodate future widening. Bicycles would be accommodated in the outside shoulders of the shared roadway. Realignment would also include the construction of one or more new bridges to grade separate Route 15 and the range road(s), obliterating existing Route 15 pavement, building removal, connecting to existing roadways or other access roads, utility relocation, pavement striping, signing, property fence, and guardrail installation.
5	Road Widening	The widened pavement section would be constructed of residual material from the existing pavement rehabilitation, new material, or a combination thereof, and an asphalt overlay. Bicycles would be accommodated in the outside shoulders of the shared roadway.
6	New Road Construction (Finegayan Connection only)	New roadway would be constructed on a new alignment with new asphalt pavement constructed on compacted base or engineered fill.

2.5.2 Alternatives Development Process

The Navy evaluated alternatives as part of the siting process to identify suitable candidate locations for consideration of primary facility components. The alternatives siting process for the Marine Corps relocation is described in Volume 2 of this EIS/OEIS. As described in this evaluation, the process resulted in the selection of four alternatives (or action alternatives) that are carried forward in the analysis.

The variation among alternatives is associated with the Main Cantonment and training facility components of the proposed action. The Main Cantonment would be the main base of operations for the

Marine Corps, and under two alternatives, it would also be the main base of operations for the Army AMDTF (see Volume 5). The operational components of all four alternatives are as described in Volume 2, Sections 2.3 through 2.5 of this EIS/OEIS.

2.5.3 Alternatives

Each of the four alternatives would be evaluated for two scenarios described below. In addition, the no-action alternative would also be analyzed, taking into consideration only expected natural growth.

- *2014 (Peak Construction):* Each alternative was evaluated for environmental conditions in future year 2014, which represents peak construction associated with the military buildup. The end of year 2014 would represent full military relocation.
- *2030:* Each alternative was evaluated for environmental conditions in future year 2030, consistent with the 2030 Guam Transportation Plan, assuming that military buildup has occurred.

2.5.3.1 Alternative 1

Alternative 1 involves utilizing NCTS Finegayan (1,181 ac [578 ha]), obtaining access to Federal Aviation Administration land (677 ac [274 ha]) south of NCTS Finegayan, and purchasing non-DoD land in the Harmon area (327 ac [132 ha]) south of South Finegayan, for a total of 2,113 ac (853 ha). A detailed view of the Main Cantonment configuration associated with this alternative is presented in Figure 2.5-9.

The Main Cantonment would include housing facilities, base operations and support facilities, various headquarters and administrative support facilities, quality-of-life facilities (e.g., shops, schools, and recreation), training areas, and open space. Military personnel, including the Army AMDTF, and their dependents would generally live, work, recreate, and shop in the north to northwest part of Guam. Most ground-training activities (i.e., nonfiring and firing) would occur on the east coast of Guam; the principal battalion-level training area would be on Tinian. Waterfront activities would be at Apra Harbor, but most Marine Corps vehicle traffic would be in the northern half of the island, except during embarkation. Amphibious Readiness Group embarkation and berthing would be at contiguous wharves, but the U.S. Coast Guard would need to be relocated to Oscar/Papa Wharves. Under this alternative, the new deep-draft aircraft carrier berth would be at the former ship repair facility. The water and wastewater proposals under this alternative would provide the greatest capacity and benefit to populations outside of the military relocation. The existing NDWWTP would be upgraded with secondary treatment capacity. Upgrades and improvements to the existing GPA system would be funded, but no new power generation capacity would be provided. Solid waste would be managed on DoD property.

The roadway projects that would be required for Alternative 1 are listed in Table 2.5-3Error! Reference source not found., with the exception of GRN #38, 39, 41, 47, 48, 49, 49A, 63, and 74.

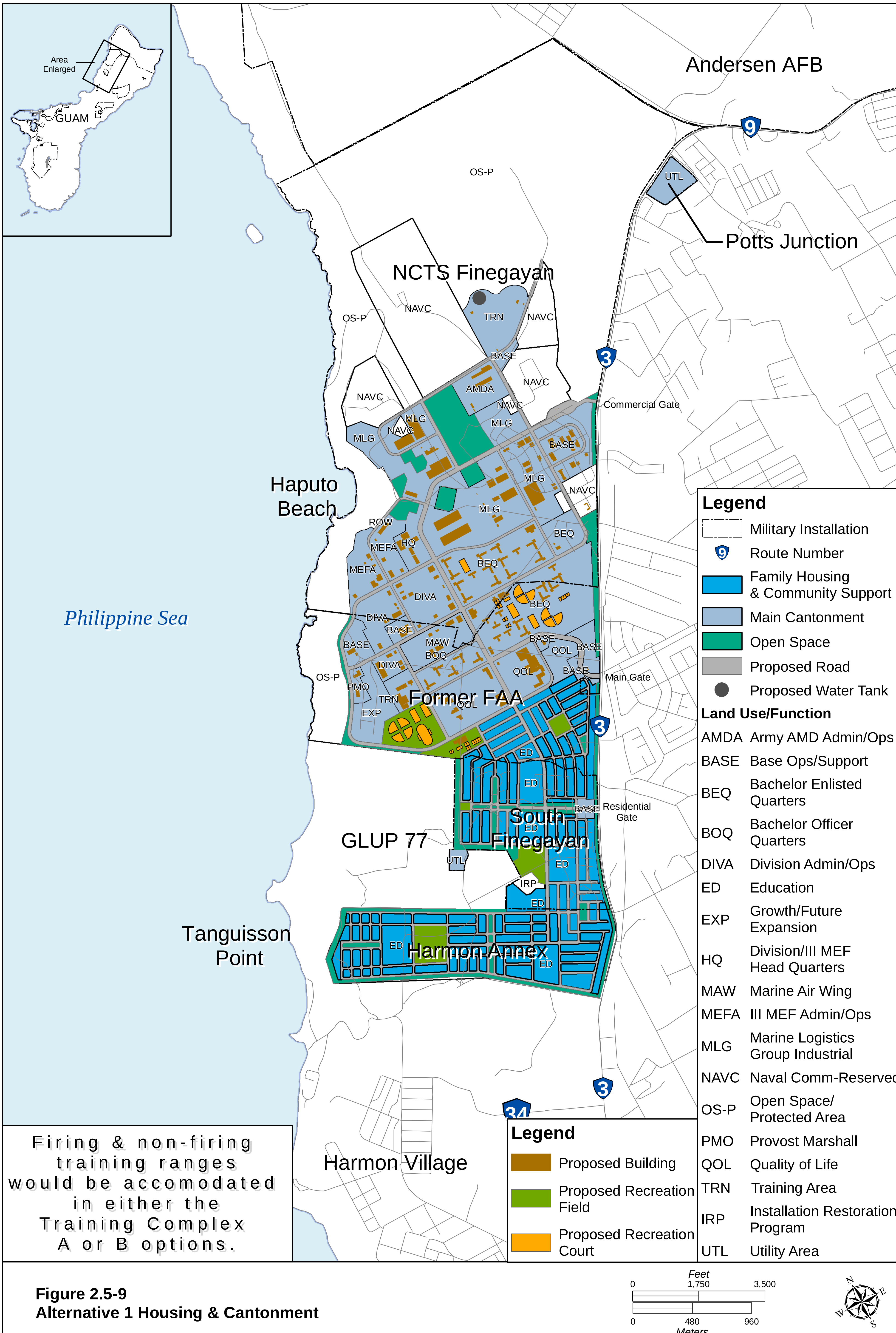

Figure 2.5-9
Alternative 1 Housing & Cantonment

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2.5.3.2 Alternative 2

Alternative 2 involves using NCTS Finegayan (1,250 ac [578 ha]) and Federal Aviation Administration land (677 ac [274 ha]) for a total of 1,855 ac (751 ha). A detailed view of the Main Cantonment configuration associated with this alternative is presented in Figure 2.5-10.

The roadway projects that would be required for Alternative 2 are listed in Table 2.5-3Error! Reference source not found., with the exception of GRN #38A, 39A, 41A, 47, 48, 49, 49A, 63, and 74.

2.5.3.3 Alternative 3

Alternative 3 involves utilizing NCTS Finegayan (1,250 ac [506 ha]), South Finegayan (283 ac [115 ha]), with portions of military housing and quality-of-life services at Navy and Air Force Barrigada (433 ac and 377 ac, respectively [175 ha and 153 ha, respectively]) for a total of 2,343 ac (848 ha). A detailed view of the Main Cantonment configuration associated with this alternative is presented in Figure 2.5-11.

The roadway projects that would be required for Alternative 3 are listed in Table 2.5-3Error! Reference source not found., with the exception of GRN #20, 31, 38A, 39A, 41, 41A, and 124.

2.5.3.4 Alternative 8

Alternative 8 involves using Federal Aviation Administration land (677 ac [274 ha]), NCTS Finegayan (1,181 ac [578 ha]), South Finegayan (283 ac [115 ha]), with portions of military housing and quality-of-life services at Navy and Air Force Barrigada (433 ac [175 ha]), for a total of 2,574 ac (1,042 ha). A detailed view of the Main Cantonment configuration associated with this alternative is presented in Figure 2.5-12.

The roadway projects that would be required for Alternative 8 are listed in Table 2.5-3, with the exception of GRN #38, 39, 41, 47, 48, 49, 63, and 74.

2.5.3.5 Firing Range Options

Depending on the selection of the firing range option, the alternatives described for the relocation include the Main Cantonment action alternatives with either a Firing Range Option A or Option B. Option A would require the realignment of Route 15 (GRN #36), while Option B would not require the realignment of Route 15.

2.5.3.6 No-Action Alternative

Under the no-action alternative, Marine Corps units would remain in Okinawa and not relocate to Guam, the visiting aircraft carrier would berth at Kilo Wharf, improvements to Apra Harbor would occur, and an Army AMDTF would not be positioned on Guam. No additional training capabilities (beyond what is proposed in the MIRC EIS/OEIS and the Intelligence, Surveillance, and Reconnaissance/Strike EIS would be implemented for theCNMI or Guam. The project objectives and the U.S. government/Government of Japan treaty and associated agreements would not be met. There would be no land acquisition, dredging, new construction, or infrastructure upgrades associated with Marine Corps or Army forces stationed on Guam. There would be no construction costs associated with this alternative. The Air Force military population would grow as projected for Intelligence, Surveillance, and Reconnaissance/Strike (see "Cumulative Projects," Volume 7). The Navy and Army do not project population increases. The no-action alternative does not meet the purpose and need of the proposed action. Although this alternative serves as a baseline, roadway capacity improvement projects would be conducted by the GovGuam to accommodate organic growth on Guam.

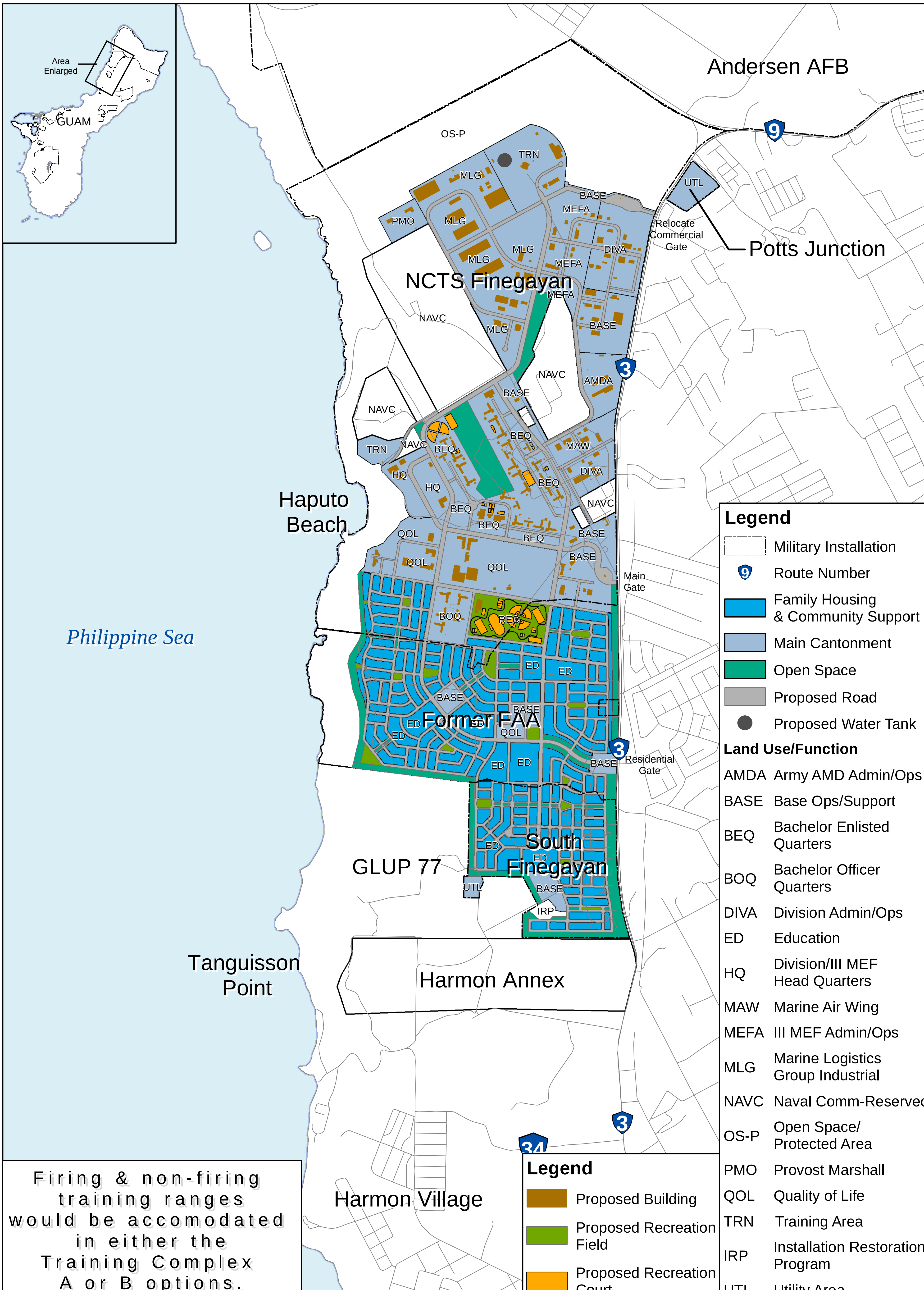

Figure 2.5-10
Alternative 2 Housing & Cantonment

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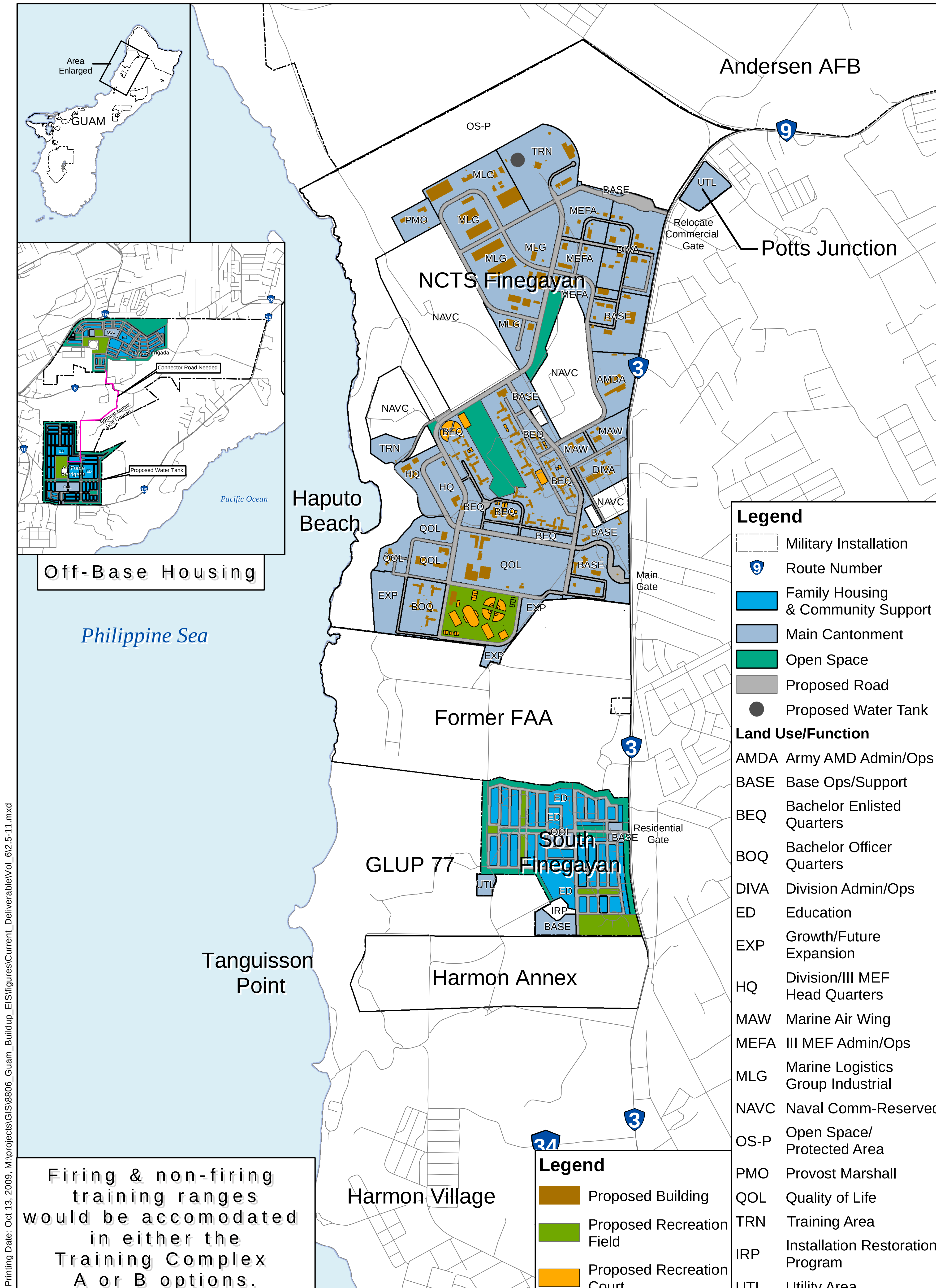

Figure 2.5-11
Alternative 3 Housing & Cantonment

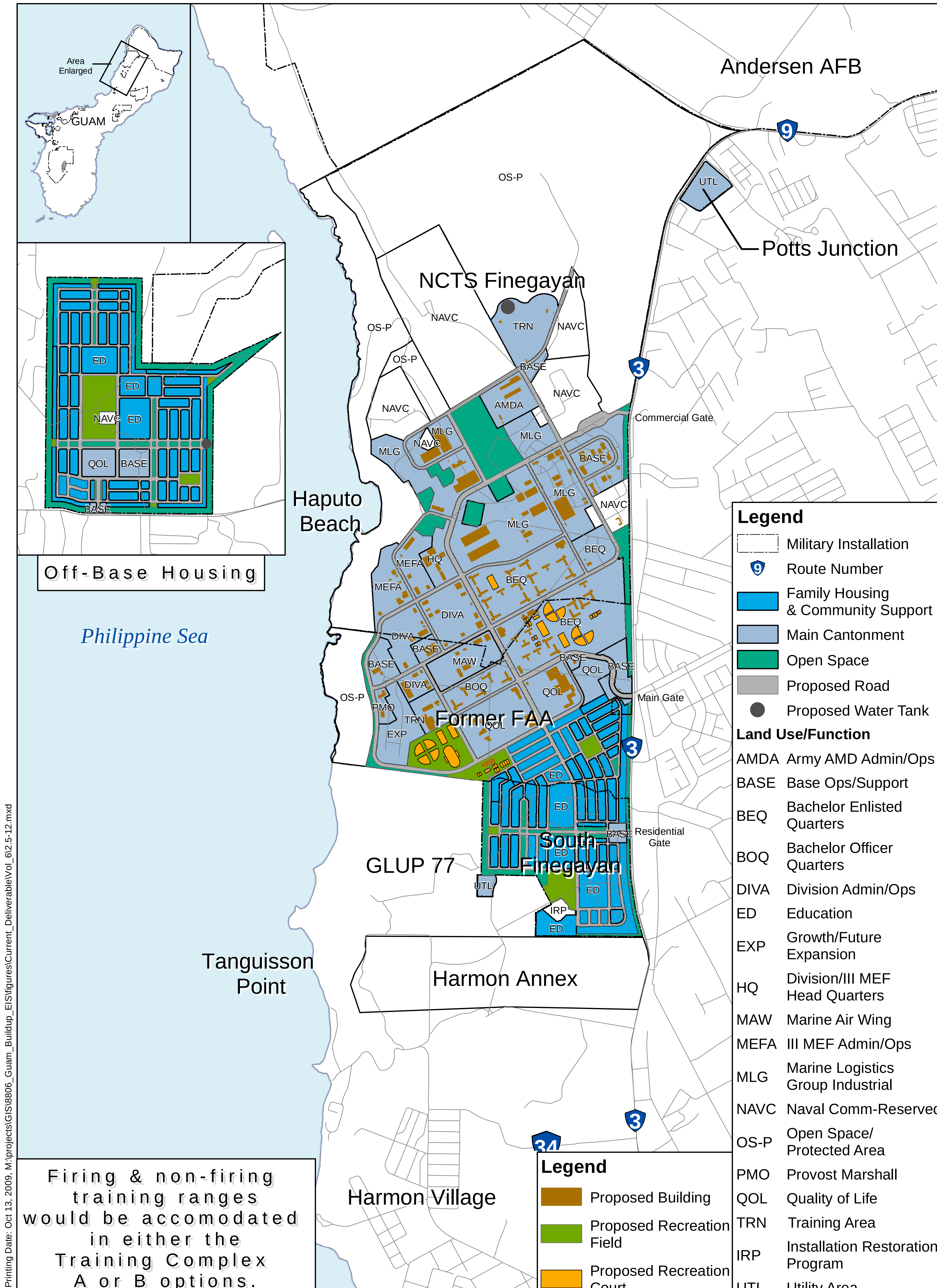

Figure 2.5-12
Alternative 8 Housing & Cantonment

Existing (2009) (Preproject)

The no-action alternative evaluates existing environmental conditions for the baseline year of 2009, assuming that no military buildup would occur.

2014 (Peak Construction)

The no-action alternative evaluates environmental conditions for future year 2014, assuming that construction associated with military buildup would not occur. Seven GovGuam roadway capacity improvement projects would occur, as identified in Table 2.5-6 and Figure 2.5-13.

Table 2.5-6. Government of Guam Roadway Capacity Improvement Projects

Year	*Project No.*	*Route*	*Segment Limits*	*Requirements*
2014				
Road Segment Projects	01	10A	Route 1 to Airport	Widen two/four lanes to four lanes
	02	10A	Airport to Route 16	Widen two lanes to six lanes
	03	27 Ext.	Route 16 to Route 1	Widen two to four lanes
	04	Tiyan Parkway	Route 10A to Route 8	Widen two to four lanes
Intersection Projects	05	7	Route 7/Route 7A, Route 24	Reconfigure Y-intersection
	06	1	Route 1/Route 14 (ITC)	Add southbound right-turn lane, improve adjacent development access near intersection
	07	1	Route 1/Route 30	Additional turn lanes pending further study
2030				
Road Segment Projects	08	26	Route 1 to Route 15	Widen two to four lanes
	09	25	Route 16 to Route 26	Widen two to four lanes
	10	7A	Route 8 to Route 4	Widen three lanes to four lanes
	11	2	Route 2A to Erskin	Widen two lanes to three lanes (add center left-turn lane)
Intersection Projects	12	16	Route 16/Route 10A	Restripe/sign existing lanes
	13	1	Route 1/Route 27A	Add eastbound right-turn lane
	14	1	Route 1/Route 10A	Add northbound right-turn lane
	15	1	Route 1/Route 27	Add southbound left-turn lane
	16	1	Route 1/Route 3	Add northbound left-turn lane
	17	1	Route 16/Route 14A	Add northbound/southbound right-turn lane
	18	16	Route 16/Route 27	Add turn lanes pending further study
	19	4	Route 4/Route 10	Add southbound through lane
	20	1	Route 1/Route 14 (NSV)	Add northbound left-turn lane

2030

The no-action alternative evaluates environmental conditions for future year 2030, assuming that military buildup would not occur. Twenty GovGuam roadway capacity improvement projects would occur, as identified in Table 2.5-6 and Figure 2.5-13.

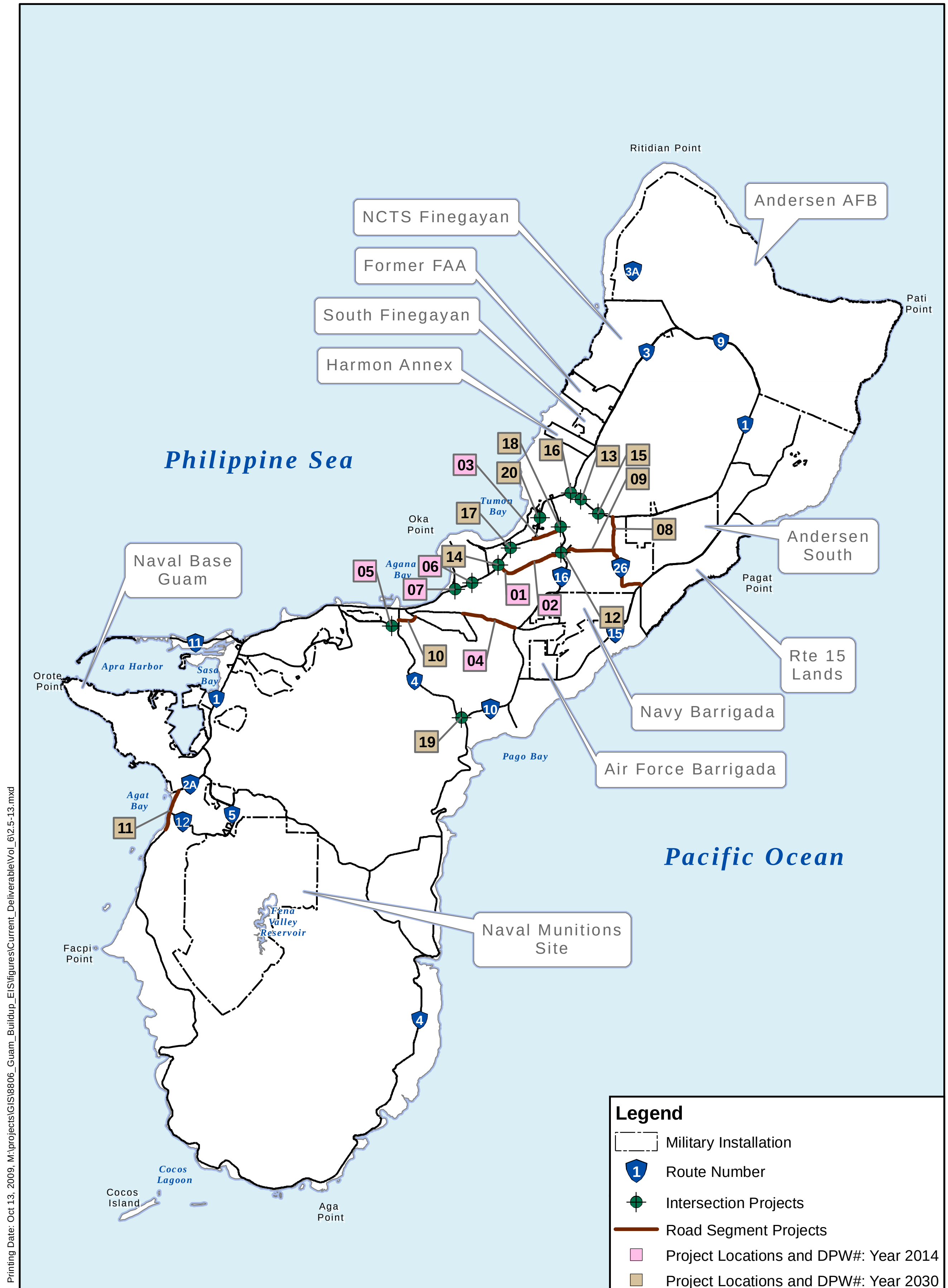

Figure 2.5-13
Government of Guam Organic Growth Project Locations

2.5.3.7 Summary of Guam Road Network Projects Required for Each Alternative

All GRN projects identified in Table 2.5-3 would be required for each of the four alternatives, with the following exceptions:

- Alternative 1 would not require GRN #38, 39, 41, 47, 48, 49, 49A, 63, or 74. This alternative would consist of 49 projects.
- Alternative 2 would not require GRN #38A, 39A, 41A, 47, 48, 49, 49A, 63, or 74. This alternative would consist of 49 projects.
- Alternative 3 would not require GRN #19, 20, 31, 38A, 39A, 41, 49A, or 124. This alternative would consist of 50 projects.
- Alternative 8 would not require GRN #38A, 39A, 41, 47, 48, 49, 63, or 74. This alternative would consist of 50 projects.

2.5.4 Preferred Alternative

The Navy has identified Alternative 2 as the Preferred Alternative.

2.5.5 Permits and Regulatory Requirements

Environmental permits and approvals that would be required for the GRN are summarized as follows:

- ESA Section 7 consultation with U.S. Fish and Wildlife Service would be required for impacts on habitat for threatened and endangered species. Roadway projects are included in the Section 7 consultation for the entire proposed action.
- CWA Section 404 permits from the U.S. Army Corps of Engineers would be required for construction activities at bridges and culverts that cross any jurisdictional waters or wetlands. As part of this permit process, the U.S. Fish and Wildlife Service and USEPA would be reviewing any impacts on wetlands and associated mitigation measures.
- Water Quality Certification from GEPA for activities that require a CWA Section 404 permit.
- Section 106 consultation with the State Historic Preservation Officer would be required for effects on cultural and historic resources that would occur as a result of the proposed action. A separate Section 106 consultation, with a corresponding Programmatic Agreement, would be conducted for the roadway projects.
- A coastal consistency determination from the Guam Bureau of Statistics and Plans would be required to evaluate the effect of the proposed action on coastal resources. Except for federal lands, the entire island of Guam is considered a coastal zone.

Additional permits from GEPA may be required for temporary emissions sources and wastewater discharges. A stormwater pollution prevention plan may be required to address stormwater contamination from storage of hazardous materials, potential for erosion from uncontrolled stormwater, and other stormwater management issues. FHWAwould be responsible for obtaining all permits required for construction of off base roadway projects.

CHAPTER 3.
UTILITIES

3.1 AFFECTED ENVIRONMENT

This section includes information related to existing electrical utilities, potable water supplies, wastewater systems, solid waste, and roadways on Guam that could be directly or indirectly affected by the proposed military buildup. The region of influence (ROI) for this resource includes the Department of Defense (DoD) lands and lands that support public utilities servicing DoD that would be directly affected by the proposed military buildup. It also includes the public utilities that may be indirectly affected by the projected increase in the construction workforce and other induced growth.

3.1.1 Power

The ROI for power includes the generation units and transmission and distribution (T&D) system supporting the existing island-wide power system (IWPS). DoD, Guam Power Authority (GPA), and independent power producers (IPPs) also operate backup diesel generators dedicated to mission critical and emergency functions, but these generators are reserved for those functions; therefore, they are not considered in this analysis.

The existing IWPS consists of generation units owned by GPA, generation contracted to GPA, and DoD-owned generation units whose output is available to GPA based on a customer service agreement between GPA and the DoD. The list of generation units is included in the GPA generation status report that is prepared daily and submitted to the Navy's Utility Group. The names of power-generating facilities and an example of the information presented in the generation status report are provided in Table 3.1-1, with an additional column showing the type of unit. At the time of the below report, GPA had an installed capacity of 553.4 megawatts (MW). GPA's generation units available for use had a capacity of 429.8 MW. Figure 3.1-1 shows the power facility locations on Guam. GPA's demand forecast has indicated that the reserve capacity (or excess capacity to ensure reliability) would be exceeded in 2017, based on GPA's load projections for the IWPS without the DoD proposed buildup (GPA 2008).

Table 3.1-1. Example of the Information Presented in the Guam Power Authority Generation Status Report

Plant	*Rated Capacity*	*Actual Capacity*	*Capacity Used*	*Unit Type*
GPA Steam				
Cabras #1	66	66	52	Base load
Cabras #2	66	66	47	Base load
Cabras #3	40	39	37	Base load
Cabras #4	40	39	37	Base load
Tanguisson #1	26.5	26.5	15	Base load
Tanguisson #2	26.5	26.5	15	Base load
Enron IPP Piti #8	44	0	0	Base load
Enron IPP Piti #9	44	44	42	Base load
GPA Steam Total	**353.0**	**307.0**	**245.0**	
GPA Diesels				
Manengon	10	8.8	0	Peaking
Dededo CT #1	23	21	0	Peaking
Dededo CT #2	23	0	0	Peaking
Dededo	10	5	0	Peaking
Macheche	22	20	0	Peaking
Temes (Piti)	40	40	0	Peaking
Yigo CT	22	0	0	Peaking
Talafofo	10	4	0	Peaking
Mount Tenjo	26.4	24	0	Peaking
Marbo CT	16	0	0	Peaking
GPA Diesel Total	**202.4**	**122.8**	**0**	
GPA Total	**555.4**	**429.8**	**245.0**	
DoD Diesels				
NCTS Finegayan	7.5	7.5	0	Backup, dedicated
Radio Barrigada	4	4	0	Backup, dedicated
Orote	19.8	19.8	0	Backup
Naval Hospital	2	2	0	Backup, dedicated
DoD Total	**33.3**	**33.3**	**0**	
System Total	**588.7**	**463.1**		
Peak Load Total			245	

Legend: CT = combustion turbine; GPA = Guam Power Authority; NCTS = Naval Computer and Telecommunications Station.
Notes: All units in megawatts.

A summary of Navy service outages for all DoD facilities currently on Guam from October 2005 to July 2006 indicates the following:

- During this period, 214 outages occurred.
- GPA system failures accounted for 39 of those outages; of these 39, 10 were generation outages and 29 were T&D system outages.
- The internal distribution system for DoD facilities accounts for 175 of the outages.

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Figure 3.1-1
Power Facility Locations, Guam

This summary covers a relatively short period and is not intended to provide a comprehensive evaluation of IWPS performance or to detail outages down to specific circuits or devices. The summary does show that nearly 85% of the outages in the 9-month period were external to the GPA system. A more detailed evaluation of the outage data would identify specific system components (lines, breakers, switchgear, transformers, or similar components) that represent a larger portion of the outages and would reveal the upgrades that would have the greatest effect on system performance. The age of the generation units within the IWPS varies from less than 10 years to more than 30 years old.

Table 3.1-2 summarizes the base-load generation units that provide most of the energy consumed on Guam and their "thermal efficiency." Thermal efficiency is sometimes called "energy efficiency"; when expressed as a percentage, the thermal efficiency must be between 0% and 100%. Thermal efficiencies are typically less than 50% because of inefficiencies in converting energy sources into electric power, such as friction and heat loss.

Table 3.1-2. Guam Power Authority Base-Load Generation Units

Power Plant	*Generation (MWh)*	*% of Total*	*Thermal Efficiency (%)*
Cabras #1	156,953	16	34.35
Cabras #2	138,191	15	34.13
Cabras #3	131,124	14	42.18
Cabras #4	137,732	14	40.84
Tanguisson #1	47,140	5	26.46
Tanguisson #2	39,123	4	25.29
Enron IPP Piti #8	160,932	17	42.91
Enron IPP Piti #9	144,994	15	42.78
Total	**956,189**	**100**	

Legend: IPP = independent power producers; MWh = megawatt-hours.

The existing power generation units and T&D systems within the north, central, Naval Base Guam, and south regions of Guam are described in Sections 3.1.1.1 through 3.1.1.3.

According to Fitch Ratings, GPA has shown an ongoing process of improvement. Recent bond rating upgrade shows the impact of that commitment. Fitch Ratings affirms the rating on Guam Power Authority's (GPA) $375 million of outstanding electric system revenue bonds at 'BB+'. The Rating Outlook remains Positive. The rating is supported by a continuation of the solid track record of GPA's governance structure, a more stable financial profile, and improving system reliability and operating performance. The Positive Outlook reflects the improved relationship with the public utilities commission's (PUC) approval of a base rate increase and other charges, and the PUC's willingness to respond to the fuel cost volatility in 2008 and provide GPA with a third fuel cost recovery via the Levelized Energy Adjustment Clause.

Fitch believes that a rating upgrade is dependent on continued improvements in debt service coverage for full obligations (including the capitalized lease), increases in liquidity to a level sufficient to protect against volatile fuel prices and adverse economic impacts, and natural disasters (typhoons and earthquakes). Additionally, the rating and Outlook reflect the continued progress on the pay down of government past account receivables. Other Rating considerations include:

- Absence of competition
- Key load center transmission lines being placed underground, providing protection from outages due to typhoons

- Ongoing exposure to natural disasters
- Tourism-based economy (mitigated by current military presence and future expansion)
- Dependence on oil for generation and the need for the PUC to approve timely recovery of fuel costs thought the LEAC.

GPA, the only retail provider of energy on the Island of Guam, serves 45,751 customer accounts and a population of approximately 175,000. Fitch's rating definitions and the terms of use of such ratings are available on the agency's public site, www.fitchratings.com. Published ratings, criteria and methodologies are available from this site, at all times.

GPA's 2010 budget was approved in August 2009 during a meeting of the Consolidated Commission on Utilities. Commissioners approved the Authority's FY10 Budget with an anticipated $386 million estimated revenues ($139M non-fuel and $247M in fuel revenues). Despite lower projected electricity sales due primarily to the economic slowdown on the island, the Authority's budget reflects a more conservative forecast that maintains key funding for projects aimed at improving service.

3.1.1.1 North

Andersen Air Force Base (AFB)

The T&D system at Andersen AFB is currently operating near capacity and would need to be expanded to meet increases in future DoD loads. The T&D system is primarily underground with some overhead power lines. The Navy would continue to install new lines underground to provide enhanced resistance to damage from typhoons.

No power generation is available at Andersen AFB.

Finegayan

The Finegayan area currently has limited development and is a potential site for major facilities associated with the DoD buildup. DoD has a facility on standby to generate 7.5 MW for a communication facility at the Naval Computer and Telecommunications Station (NCTS). The IWPS does not have access to this power generation unit because the unit is fully dedicated to mission-critical functions at NCTS. This NCTS generator facility is permitted as a standby generation unit and as a unit to meet special power requirements.

The GPA Macheche combustion turbine (CT) is located on non-DoD land and is currently permitted for 4,280 hours per year of operation. It has a rated capacity of 22 MW and actual capacity of 20 MW. It was constructed in 1993.

3.1.1.2 Central

Andersen South

GPA facilities at Marbo and Yigo provide generation capacity in the Andersen South area. Neither of these units is presently used for any substantial source of generation, and neither has been used for approximately 2 years. These units would need some level of rehabilitation to operate reliably as intermediate generation (generation that is not used continuously but is used for more than peak loads). These units are listed as having system capacity but are not operating at this time. Marbo is rated at 16-MW capacity and Yigo at 22-MW capacity. Marbo is permitted to operate 2,640 hours per year and Yigo for 4,280 hours per year. The construction date for Marbo is unknown and Yigo was constructed in 1993.

Barrigada

The Dededo generation facilities and Radio Barrigada facility are in the central area of Guam but physically separated. Radio Barrigada is a DoD asset and not available to the GPA system because its use is dedicated to a specific mission. At the time the Power Generation Technical Study was done, the Dededo facilities, except Dededo CT #2 as shown in Table 3.1-1, are available to provide generation capacity as needed by the generation system. The Dededo generation facility comprises two CTs and four diesel units. Each Dededo CT has a rated capacity of 23 MW and the diesel generators have 10 MW rated capacity (four 2.5-MW units). Dededo CT #1 was constructed in 1992, CT #2 in 1994, and the diesel units in 1972. Dededo CT #2 was recently reconditioned by GPA and is now available to generate power.

Piti/Nimitz Hill

The Cabras and Piti generation units provide the majority of energy produced by the IWPS. These facilities have been upgraded and are some of the most reliable facilities for efficiently generating power for the system. The Cabras and Piti units are used primarily as base load generation units except when out of service for maintenance or failures. The majority of the fuel storage for the IWPS is also located in the harbor area because of its proximity to generation units and the supply ship unloading facilities. These units are permitted as base load generation units and can operate continuously, year round. Table 3.1-3 shows their ratings and status.

Table 3.1-3. Cabras and Piti Generation Units

GPA Steam	*Rated Capacity*	*Actual Capacity*	*Year Constructed*
Cabras #1	66	66	1974
Cabras #2	66	66	1975
Cabras #3	40	39	1996
Cabras #4	40	39	1996
Enron #8 (Piti)	44	44	1999
Enron #9 (Piti)	44	44	1999

Note: All units megawatts.

Manengon is a diesel unit located in the hills toward the eastern side of Guam. It is permitted for only 4,640 hours per year. It is rated at 10 MW capacity with an actual capacity of 8.8 MW.

Naval Base Guam

The Orote Power Plant is a DoD asset. The Orote facility is operational and can connect to the IWPS and generate power to the system. The facility has not generated substantial power to the IWPS for many years and is not currently suitable to provide extended operation support to the IWPS. The site would need additional system upgrades to provide the necessary reliability to the system and consideration for expanded fuel storage and would need modification to the existing air permit for the site. The Orote facility is not permitted for extended operation and must notify the Guam Environmental Protection Agency (GEPA) before scheduled operation. These permit restrictions would need to be changed to allow more flexibility and more hours of operation should the Orote facility be used to provide substantial generation capacity to the IWPS. The Orote Power Plant has a rated and actual capacity of 19.8 MW. The date of construction is unknown.

The Naval Hospital facility is dedicated to support the hospital and would not provide capacity or supply to the IWPS.

3.1.1.3 South

At the Naval Munitions Site, generation capacity at Talafofo and Mount Tenjo is a GPA asset and can provide power generation support to the IWPS. These units are permitted for up to 50% operation (4,640 hours per year). Talafofo has a rated capacity of 10 MW and an actual capacity of 4 MW. The Mount Tenjo facility has a rated capacity of 26.4 MW and an actual capacity of 24 MW. Both units were constructed in 1993.

3.1.2 Potable Water

The ROI for potable water includes the Andersen AFB and Navy water systems, which would be directly affected by the proposed military buildup, and the Guam Waterworks Authority (GWA) water system, which could be indirectly affected by increased water demands associated with the construction workforce and induced population growth. Locations of the components of the primary water system that are associated with each of these water systems (i.e., active and planned water supplies, storage facilities, and water distribution lines) are presented in Figure 3.1-2 and Figure 3.1-3. The three water systems are described in detail in Section 3.1.2.1.

3.1.2.1 Water Systems

Andersen AFB Water System

Andersen AFB gets its water from Andersen Northwest Field and Andersen South. It includes an off base water supply; disinfection, storage, and transmission system; and an on base water distribution system. The off base water supply and transmission system includes nine water production wells, two booster pump stations, three storage tanks, chlorination facilities, one fluoridation facility, and approximately 80,000 feet (ft) (24,400 meters [m]) of water lines. The existing on base water distribution system includes a pump station, three storage tanks, and approximately 700,000 ft (213,350 m) of water lines.

Water is currently supplied to Andersen AFB from seven of the nine off base water production wells; the remaining two wells are inactive. An additional five wells were constructed on the Andersen Northwest Field. Water supplied from the off base production wells is stored, disinfected, fluoridated, and then pumped to the main base. The off base production wells draw water from the Northern Guam Lens Aquifer (NGLA).

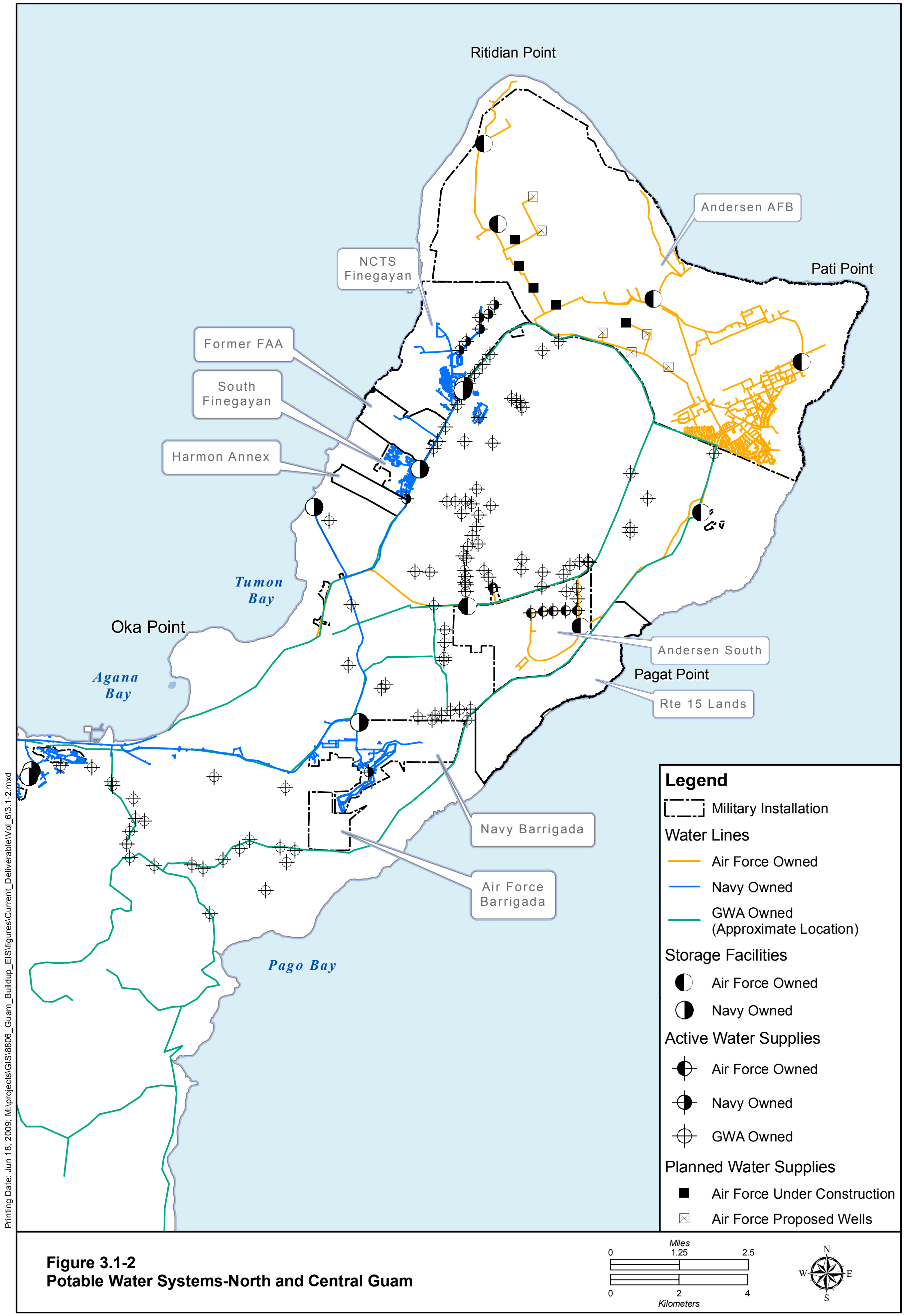

Figure 3.1-2
Potable Water Systems-North and Central Guam

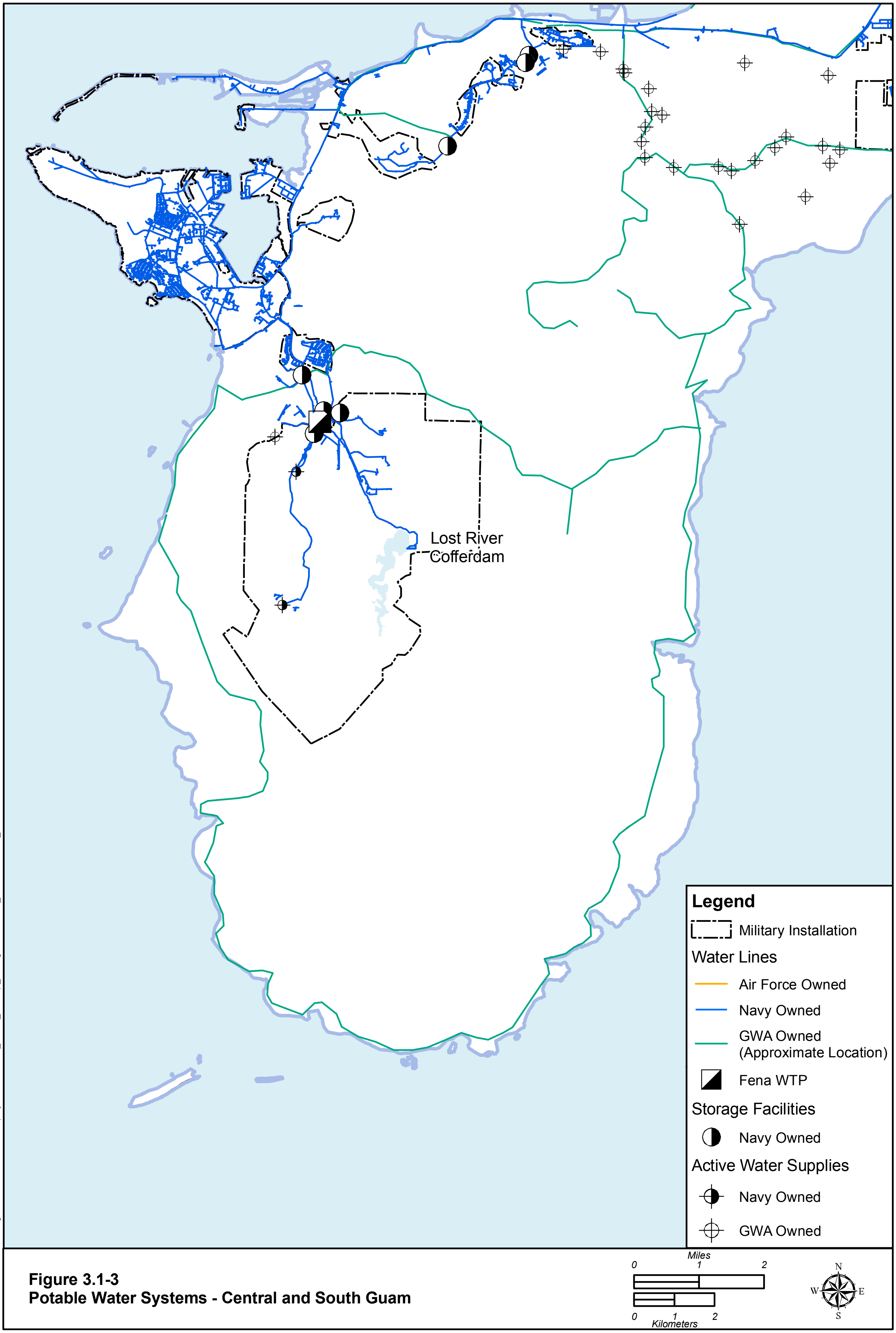

Figure 3.1-3
Potable Water Systems - Central and South Guam

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Navy Water System

The Navy water system services NCTS Finegayan, South Finegayan, Navy Barrigada, Nimitz Hill, the Naval Hospital, the Naval Munitions Site, and the Naval Base Guam. The existing Navy water system is an island-wide system extending from the Navy Reservoir in southern Guam to NCTS Finegayan near the northern tip of Guam. Water for the system is supplied primarily from the Fena Water Treatment Plant (WTP). Water is distributed from the treatment plant to storage tanks designed to serve different service zones and transfer water to other DoD lands across Guam. Most of the transmission lines from the storage tanks to the distribution systems are 24-inch (in) (61-centimeter [cm]) pipelines. The Navy system is interconnected to supply water to GWA and for emergency service capability. Under a 1991 memorandum of understanding with the Government of Guam (GovGuam), the Navy system provides up to 4 million gallons per day (MGd) (15 million liters per day [mld]) to the GWA water system. Transmission lines connecting the Navy water system and the Andersen AFB system also exist, but they are presently out of service.

Primary water supply sources for the Navy's island-wide water system are located in the southern region of Guam and include Almagosa Springs, Bona Springs, and the Fena Reservoir surface water impoundment. Water from the above three sources are treated at the Fena WTP and are distributed through a network of storage tanks, transmission lines, and booster pump stations. Groundwater wells are the primary source of potable water at Finegayan and Navy Barrigada. A brief description of the water supply sources in each of the Navy service areas is provided below.

- At NCTS Finegayan and South Finegayan, water is supplied primarily by on-site groundwater wells. If necessary, water can also be supplied by interconnections with the GWA system or the Navy's island-wide system.
- At Navy Barrigada, water is supplied primarily by groundwater wells. As a backup, the water storage system is connected to the Navy's island-wide system.
- At the Naval Hospital, water can be provided from either the Navy island-wide water system or from on-site groundwater wells. Currently, two wells are operational.
- At the Naval Base Guam and other Navy areas south of the Piti Power Plant, potable water is supplied entirely by the Fena WTP.

GWA Water System

The baseline condition of the GWA water system is described in GWA's *Water Resources Master Plan* (WRMP). The overall condition of the water system's equipment is identified as poor in the WRMP with substantial corrosion in all infrastructure. The water system has a 50% Unaccounted for Water (UFW) rate compared to an acceptable rate of 15% or less. Problems with the GWA infrastructure result from the effects of natural disasters, poor maintenance, and vandalism. According to the WRMP, the water system infrastructure does not meet the basic flow and pressure requirements for all customers. The water system did not consistently comply with regulatory requirements. The unreliable drinking-water delivery system resulted in frequent bacterial contamination from sewage spills, causing "boil water" notices to be sent to residents. Maintenance to improve the system has been conducted since the water system was assessed in 2005. GWA plans improvements to the distribution system principally to improve the continuity of the water supply. Improvements include a corrosion control program, pipe and equipment replacement, distribution system improvements, improvements to the GWA Northern Public Water System's raw-water transmission line, and filtration compliance for groundwater under the direct influence of surface water.

The GWA water system consists of three public water systems known as the Northern, Central, and Southern Public Water Systems, serving the respective areas of Guam with some overlaps.

The GWA Northern Public Water System is the largest system serving all public areas in the north and central parts of the island south of Andersen AFB and serves an approximate population of 146,050. This system consists of 119 groundwater wells, 14 storage facilities (11 in use), and 10 booster pump stations (nine in use). The GWA Northern Public Water System is important to the Marine Corps relocation because of its proximity to the relocation areas and because the system is supplied primarily by the same aquifer that serves the DoD systems.

The GWA Central Public Water System consists of one spring, eight storage facilities (five in use), and nine booster stations (six in use). The main source of water for this system is the Navy water system; water is purchased through 54 metered interconnections, of which 15 are reported to be inactive. Water from the Northern Public Water System can also be fed via water mains to the Central Public Water System.

- The GWA Southern Public Water System supplies the southern and southeastern parts of Guam. It consists of two groundwater wells, four springs, 14 storage facilities, 16 booster stations (14 in use), and the Guam Water Treatment Plant.

Financially, during the 1997 to 2002 time frame, GWA demonstrated losses of nearly $80 million (Deloitte Touche Tohmatsu 2003) partly because of bad debt write-offs and the lack of rate increases. In 2001, a $9 million judgment was made against GWA for failure to pay for water delivery from the Navy. Also at this time, GWA carried $12 million debt to GPA and $3.5 million to a private vendor (Reuters 2009).

The United States Department of Justice (DOJ) filed a civil suit against GWA and GovGuam in December 2002 for failure to comply with the Safe Drinking Water Act and the Clean Water Act (CWA). The Stipulated Order for Preliminary Relief for Civil Case No. 02-0035 (SO) was negotiated in June 2003. The SO requires GWA to improve water and wastewater conditions so that it would comply with all applicable regulations, including the National Primary Dinking Water Regulations and Maximum Contaminant Levels for microbiological contaminants, and to provide reliable water services to the public on Guam. The SO requires the following steps:

- Ensure United States (U.S.) Environmental Protection Agency (USEPA) oversight of plans and other submittals relating to the SO.
- Reorganize staff and hire qualified personnel as general manager, financial officers, engineers, etc.
- Develop a WRMP.
- Develop a plan to ensure that optimal chlorine levels are maintained at chlorination points and throughout the distribution system.
- Ensure that there are adequate chlorine supplies on Guam.
- Implement a project to upgrade the groundwater chlorination system.
- Develop and implement a potable-water leak detection and response program.
- Develop and implement a water meter improvement program.
- Develop an inventory of operation and maintenance parts and ensure that the parts are available.
- Develop and implement an emergency response plan.
- Develop and implement a preventive maintenance program.
- Comply with specific financial and reporting requirements.

As described in the 2003 independent audit of GWA finances, compliance with the SO was estimated at \$225 million. GWA intended to meet this obligation initially by borrowing approximately \$160 million. Between 2003-2005, GWA sold bonds, settled litigation related to the authority's debt, and received rate relief. Improvements have reduced labor and operating costs by more than 20% (Reuters 2009).

As part of compliance with the SO, GWA submitted the Guam WRMP in 2007. The GWA WRMP lists the following goals:

- Institute sound asset management and capital planning.
- Develop foundation for sound management, operations and maintenance, and financial planning.
- Engage the customer and achieve the appropriate level of service.
- Achieve long-term resource sustainability.
- Establish a road map for full regulatory compliance.

The plan includes descriptions of the components of the water system, the water budget, a water-lost control program, a water conservation program, development of and results from hydraulic modeling of the water system, an assessment of facility conditions, and a comprehensive capital improvements program (CIP) for the water system.

The WRMP states that substantial improvements to the distribution system are of primary concern. The improvements were developed to improve service levels; satisfy storage, flow, and pressure requirements to meet fire protection criteria; and reduce the high level of water loss from the system. The full cost of the CIP for water through 2025 is estimated at \$550 million. GWA developed the following projects to support the needed improvements:

- Conversion of the Ugum WTP to a 4.0-MGd (15.1-mld) membrane filtration facility
- Modification of the Ugum WTP intake at the diversion in the Ugum River
- Transmission line construction
- Supervisory Control and Data Acquisition (SCADA) improvements
- Corrosion control program
- Raw-water storage land acquisition and storage tank construction at Ugum WTP

Progress has been made in implementing the WRMP projects. Many major capital projects have been completed. Some of the projects have been delayed and fines have totaled approximately \$250,000. GWA has invested more than \$80 million in capital improvements since 2003 (Reuters 2009). As documented in the *Quarterly Stipulated Order Compliance Progress Report No. 20*, some of the important improvements to the GWA water system are as follows:

- Implementation of a leak detection plan—GWA has a crew dedicated to leak detection. In Fiscal Year 2007 alone, more than 11,000 leaks were repaired.
- Residual disinfection—Implementation of an Interim Disinfection Residual Level Monitoring Program is in progress with biweekly sampling at 93 selected locations, daily sampling at disinfected wells, and twice-daily sampling at high-risk wells.
- Chlorine supply—GWA has contracted with a vendor to always have an adequate supply of chlorine on the island.
- Water meter improvement program—GWA has replaced more than 97% of the industrial meters and 68% of the residential meters.
- Emergency response plan—The plan has been prepared and partially integrated into the Guam Emergency Response Plan.

- Preventative maintenance program—A plan has been prepared. GWA has implemented a computerized maintenance management system.
- Transmission line projects—The Sinajana Transmission Line project is under way.

The progress made by GWA in providing a reliable water system has been recognized by USEPA. As stated in the *EPA Progress Report 2006: Pacific Southwest Region* (USEPA 2006):

> Last year, however, improvements to the island's drinking water and wastewater treatment systems, along with EPA oversight of the Guam Waterworks Authority (GWA), resulted in the safest drinking water Guam has experienced in decades. The GWA improved its management by hiring a new chief engineer on loan from EPA, and increasing the number of certified operators at its wastewater treatment plant. Better generators, pumps, and motors were installed; the disinfection system was improved.

In preparation for the military buildup and to complete the remaining capital improvements, GWA has prepared a 5-year CIP for fiscal years 2009 to 2013. GWA estimates that the cost for expanding the system to accommodate the induced population would total $200 million for 16 wells plus storage facilities and transmission lines. The GWA program has not been presented to DoD in detail. However, discussions have been initiated between GWA and DoD to begin working through the details to coordinate GWA support for the proposed buildup. One example is a proposal for co-management by GWA and DoD of the NGLA. It is not clear whether the CIP would be adequate to meet the needs of the induced and construction worker populations. The CIP would be financed through surplus system revenues, grants, and loans (Deloitte Touche Tohmatsu 2008, Reuters 2009). Substantial rate increase relief is anticipated.

3.1.2.2 DoD Water Storage Facilities

The capacity of the existing DoD storage facilities is listed in Table 3.1-4. The storage capacity by area is shown in Table 3.1-5.

Table 3.1-4. Department of Defense Water Storage Facilities

Tank	*Capacity (Gallons)*	*Capacity (MGd)*	*Owner*	*Location*	*Type*
Water Storage Tank	150,000	0.15	Andersen AFB	Andersen AFB, Northwest Field	At-grade, steel
Water Storage Tank	150,000	0.15	Andersen AFB	Andersen AFB, Northwest Field	Steel
Storage Tank No. 2	250,000	0.25	Andersen AFB	Andersen South	Partially buried concrete
Storage Tank No. 4	480,000	0.48	Andersen AFB	Andersen South	Partially buried concrete
Santa Rosa Storage Tank	2,000,000	2.00	Andersen AFB	Andersen South	Buried concrete
Facility 19008	250,000	0.25	Andersen AFB	Andersen AFB	Ground level concrete
NCTS South, Finegayan South	250,000	0.25	Navy	South Finegayan	Elevated
NCTS Elevated	250,000	0.25	Navy	North Finegayan	Elevated
NCTS Ground (inoperative in 2005)	200,000	0.20	Navy	North Finegayan	Ground
Barrigada	3,000,000	3.00	Navy	NCTMS Barrigada	Reinforced concrete covered by earth
Naval Hospital	1,000,000	1.00	Navy	Naval Hospital	Reinforced concrete covered by earth
Nimitz Hill	1,000,000	1.00	Navy	Nimitz Hill	Reinforced concrete covered by earth
Adelup	3,000,000	3.00	Navy	Naval Hospital/ Nimitz Hill	Reinforced concrete covered by earth
Maanot	500,000	0.50	Navy	Apra Harbor/ Naval Munitions	Reinforced concrete at grade
Tupo	5,000,000	5.00	Navy	Apra Harbor/ Naval Munitions	Reinforced concrete covered by earth
Naval Magazine	700,000	0.70	Navy	Apra Harbor/ Naval Munitions	Reinforced concrete covered by earth
Apra Heights Tank	5,000,000	5.00	Navy	Apra Harbor/ Naval Munitions	Reinforced concrete covered by earth

Legend: AFB = Air Force Base; MGd = million gallons per day; NCTS = Naval Computer and Telecommunications Station;
Source: NAVFAC Pacific 2008b.

Table 3.1-5. Department of Defense Water Storage Capacity by Area

Area	*Total Existing Capacity (MG)*
South Finegayan	0.25
North Finegayan	0.25
Andersen Northwest Field	0.30
Andersen Main Base	0.25
Andersen South	2.73
Apra Harbor/Naval Munitions	11.2
Barrigada	3.00
Navy Hospital/Nimitz Hill	5.00
Total	**23**

Legend: MG = million gallons.
Source: NAVFAC Pacific 2008b.

3.1.3 Wastewater

The ROI for wastewater includes wastewater systems on Guam that would be directly or indirectly affected by the proposed military buildup. Wastewater flows from DoD lands are presently treated by the GWA Northern District Wastewater Treatment Plant (NDWWTP), the GWA Hagatna Wastewater Treatment Plant (WWTP), and the Navy Apra Harbor WWTP. The NDWWTP would be handling most of the increased wastewater treatment demand from the DoD buildup. The Navy Apra Harbor WWTP would handle the increased wastewater treatment demand from the ship based transient DoD personnel. The NDWWTP and Hagatna WWTP are also anticipated to treat most of the increased wastewater flows that would be generated by the temporary construction workforce and the increased civilian population. Descriptions of all three wastewater systems are provided in Section 3.1.3.

GWAs wastewater infrastructure (treatment plants, collection piping, and pump stations) has slowly deteriorated over the years. This, coupled with natural disasters such as typhoons and flooding, has resulted in frequent sewage spills at pump stations and collection piping, collapse of collection piping, and failure of treatment plant equipment. Lack of GWA resources, particularly restrictions on fees that can be collected from the public for sewer services, have severely limited GWA's ability to adequately maintain and update their wastewater treatment system. As a result, GWA has experienced frequent violations of its NPDES permit conditions, including inability to adequately treat wastewater and exceedances of the allowed pollutant levels in plant discharges.

On April 4, 1997, USEPA Region 9 issued a tentative decision to deny the reissuance of the Clean Water Act Section 301(h) secondary treatment variance to GWA for the NDWWTP and the Hagatna WWTP because, in USEPA Region 9's view, GWA failed to provide sufficient information that both plants meet 301(h) secondary treatment variance criteria. Central to this tentative denial was USEPA's assessment that the Hagatna WWTP and Northern District WWTP had failed to meet minimum standards for primary treatment, including adequate removal of pollutants, violations of pollutant discharge permit limits, and inability to demonstrate that plant discharges are not impacting water quality or the environment.

GWA provided additional information to USEPA Region 9 in an attempt to address the inadequacies cited in the USEPA Region 9 tentative secondary treatment variance denial. However, lack of maintenance on GWAs aging plants due to resource shortfalls continued to limit GWA's progress in improving their wastewater treatment program and bringing the plants into permit compliance.

In December 2002 the U.S. Department of Justice filed a civil lawsuit against GWA and the Government of Guam (GovGuam) for failure to comply with the Clean Water Act (CWA) and its NPDES permits. As noted in Section 3.1.2, this civil lawsuit also sued GWA for failure to comply with the Safe Drinking

Water Act for issues associated with their potable water system. As a result of the lawsuit, a Stipulated Order for Preliminary Relief was issued that requires GWA to improve the conditions of their water and wastewater systems (Civil Case No. 02-0035). For wastewater, the Stipulated Order required GWA to comply with their NPDES permits, and required that GWA establish a comprehensive program to provide safe and reliable wastewater services to the public. The SO established definitive milestones for improving the GWA's management and organizational structure, operations, financial administration, facility construction and rehabilitation, and staff training. The SO requirements also included detailed wastewater construction and rehabilitation projects in central and northern Guam, including:

- Construction of a new ocean outfall at the Hagatna WWTP by January 1, 2008.
- Construction of a new ocean outfall at the Northern District WWTP by January 1, 2009.
- Implementation of corrective actions to restore primary treatment to the original design operational capacity at the Hagatna WWTP and the Northern District WWTP by March 2, 2007.
- Implementation of corrective actions to restore operational capacity at the Agana Main Sewage Pump Station by March 2, 2007.
- Implementation of corrective actions to stop overflows of raw sewage from the Agana Main Sewage Pump Station, including development of an implementation schedule.
- Assessment of the Chat Wastewater Pump Station and sewer collection and conveyance system, including development of an implementation schedule.

In 2003, an independent audit of GWA finances was conducted which estimated the cost for GWA to comply with the SO at $225 million. GWA intended to meet this obligation initially by borrowing approximately $160 million. Between 2003 and 2005, GWA sold bonds, settled litigation related to the authority's debt, and received rate relief. Improvements have reduced labor and operating costs by over 20 percent (Reuters, 2009).

As part of compliance with the SO, GWA developed the Guam Water Resources Master Plan (WRMP) in 2007. The Water Resources Master Plan lists the following goals:

- Institute sound asset management and capital planning
- Develop a foundation for sound management, operations, and maintenance and financial planning
- Engage the customer and achieve the appropriate level of service
- Achieve long-term resource sustainability
- Establish a road map for full regulatory compliance

The plan includes descriptions of the components of the wastewater treatment facilities, wastewater collection system, an estimation of current and future wastewater flows, wastewater collection system hydraulic modeling development and results, sewer hook-up program for un-sewered properties (e.g.: septic tanks), a facility conditions assessment, and a comprehensive wastewater system capital improvements plan (CIP). The Water Resources Master Plan did not consider future wastewater flow increases that could result from the military buildup on Guam; however, the flow estimates for the NDWWTP were overestimated by roughly double due to faulty flow measuring devices.

The primary objectives of the CIP are to improve the operations of the system and to meet the requirements of SO. The total capital needs through 2025 are substantial at an estimated $900 million in 2007 dollars. The full cost of the CIP for wastewater identified by the Water Resources Master Plan is estimated at $335 million. The GWA developed the following projects to support the needed improvements in central and northern Guam:

- Improve the Hagatna WWTP by adding an additional primary clarifier for redundancy, new solids screens, improved grit removal, and an effluent pump station.
- Construct a new primary clarifier for future flows and system reliability at the Northern District WWTP.
- Repair existing sludge handling facilities and construct a new sludge digester and new sludge dewatering facilities for centralized sludge treatment and system reliability at the Northern District WWTP.
- Upgrade sewer capacities at the Hagatna WWTP and the Northern District WWTP.
- Provide sewer hook-ups for the Hagatna WWTP and the Northern District WWTP un-sewered properties (e.g.: septic tanks). This has been identified as a high priority effort because septic systems have the potential to impact Guam's sole source aquifer used for drinking water (the Northern Guam Lens Aquifer).
- Implement a wastewater collection system recurring inspection program.
- Implement a wastewater collection system replacement and rehabilitation program.
- Install System Control and Data Acquisition (SCADA) improvements; these are systems that collect data at the treatment plants and at pump stations, and transmit this data to a central control facility.

Progress has been made to implement the projects called for in the Water Resources Master Plan . Many major capital projects have been completed. However, some of the projects have been delayed, resulting in fines of approximately $250,000. GWA has invested over $80 million in capital improvements since 2003 (Reuters 2009). As documented in the Quarterly SO Compliance Progress Report No. 20, some of the significant improvements to the GWA wastewater system include:

- Sewer Hook-up Revolving Fund – this program provides financial assistance to low-income owners of septic systems that are slated for hookup to the GWA sewer collection system, GWA developed a program, and the fund is now available for public use.
- Hagatna WWTP Ocean Outfall – The outfall was put into service on January 23, 2009.
- Northern District WWTP Ocean Outfall – The outfall was put into service on December 15, 2008.
- Assessment of the Chat Wastewater Pump Station and Sewer Collection and Conveyance System – GWA submitted an Engineering Assessment, and constructed a new pump station and new sewer lines that are currently in service.
- Agana Main Sewage Pump Station Renovation – GWA completed repairs and the pump station was put back on line and worked as the headworks for the Hagatna WWTP.
- Hagatna WWTP Renovation – GWA completed refurbishment of the plant and put it into full service on March 29, 2007.
- Northern District WWTP Renovation – GWA has completed portions of the treatment plant refurbishment.

In 2007, GWA established a private/public partnership with Veolia LLC to operate GWA's Hagatna WWTP and Northern District WWTP. In 2008, citing an overburdened wastewater system, GWA imposed a development moratorium for areas in central Guam, and issued a request for proposals in order to use a private partner for upgrading the wastewater collection system in central Guam. The project was estimated to cost from $30 million to $40 million, and expected to bid in September 2009 and complete in two years. It would increase the capacity of central Guam sewer collection system and help improve treatment efficiency at the Hagatna WWTP.

NPDES Discharge Monitoring Reports (DMR) for the Hagnata WWTP and the Northern District WWTP from January to June, 2009 indicate that despite progress made by GWA to bring their facilities into compliance, the plants continue to violate their permit conditions. Discharges from the Hagatna WWTP and the NDWWTP do not consistently meet the minimum primary treatment standards for removal of organic matter and suspended solids. Both plants also experience routine violations of their effluent discharge pollutant limits, including exceedances of their maximum flow (6 MGd), and exceedances of their suspended solids and biological oxygen demand limits.

Between the years 1998 and 2001, GWA revised their permit renewal application and submitted additional information to USEPA Region 9 to request a continuance of their 301(h) secondary treatment variance. These submittals included information related to the installation of new extended ocean outfalls for the Hagnata WWTP and the Northern District WWTP. The new outfalls were put into service in December 2008, and the Hagatna WWTP was refurbished to restore its original designed capacity in 2007.

In January 2009, USEPA Region 9, upon review of this new information from GWA, again issued a tentative decision to deny the 301 (h) secondary treatment variance, followed by a final decision to deny the variance September 30, 2009, USEPA Region 9. This final variance denial decision by USEPA Region effectively requires GWA to install full secondary treatment at both the Hagnata WWTP and the Northern District WWTP. In its final decision, USEPA Region 9 stated that they denied the variance because the treatment plants did not meet several Clean Water Act 301(h) criteria, including the following:

- The discharge does not meet the mandatory minimum standard of primary treatment.
- GWA has not demonstrated that the discharge would attain or maintain water quality to allow recreational activities in and on the water.
- GWA has not demonstrated that the discharge would attain or maintain water quality to allow protection and propagation of a balanced indigenous population of shellfish, fish, and wildlife.
- The applicant's monitoring data are insufficient to demonstrate compliance with Guam's water quality standards.
- The applicant has not developed a program to control toxic pollutants from nonindustrial sources.

USEPA Region 9 has indicated that they will issue an Administrative Order that outlines specific requirements to bring the NDWWTP to secondary treatment standards as well as interim provisions to refurbish the plant to meet the mandatory minimum standards for primary treatment. The interim provisions will include monitoring requirements to develop a basis of design for the needed secondary treatment. GWA anticipates major system refurbishment (e.g. primary clarification, grit chamber, chlorine contact tank, drying beds, etc.) that is currently underway at the NDWWTP would improve the plant performance to meet its existing compliance requirements at current flows. GWA has also suggested that completion of the on-going development moratorium project that limits development and new sewer connection, and mitigation of septage discharge at the Hagatna WWTP, would improve plant performance and lead to permit compliance.

The recent 301(h) secondary treatment variance denial decision by USEPA was issued at the same time this DEIS/OEIS was in final preparation for release to the public. However, the alternatives presented in this DEIS/OEIS have been changed to reflect the need for secondary treatment at the NDWWTP to address the projected flows to the plant during the period of the Guam military buildup (2010 to 2019).

DoD is engaged in ongoing consultation with GWA, USEPA Region 9, and GEPA concerning wastewater requirements from the Guam military buildup. The purpose of this consultation is to achieve a common understanding of the requirements for treatment plant upgrades that address not only the military buildup on Guam, but also those associated with the recent 301(h) secondary treatment variance denial. All parties are committed to working collaboratively to develop solutions that meet everyone's needs . While these discussions may ultimately lead to specific timeframes for treatment plant upgrades, they are not expected to result in significantly different facilities than those represented in the wastewater alternatives in this EIS/OEIS.

In preparation for the military buildup and to complete the remaining planned water and wastewater capital improvements, GWA has prepared a new five year CIP for fiscal years 2009 to 2013. GWA estimates the cost for expanding its system to accommodate the military buildup induced population to cost a total of $200 Million, including $66 Million for wastewater infrastructure improvements. The CIP will be financed through surplus system revenues, grants and loans (Reuters 2009; Deloitte Touche Tohmatsu 2008). USEPA Region 9 is working with GWA and GEPA to identify grant money to assist in funding the immediate need for primary treatment plant upgrades.

The wastewater flows presented in Section 2.3.3 include expected wastewater flows that are part of normal civilian population growth during the period of time of the military buildup - years 2010 to 2019. After 2019, normal civilian population growth on Guam would continue, thereby generating additional wastewater flows from the population in the out years. As part of DoD's ongoing consultation with GWA, GEPA and USEPA Region 9, GWA has indicated that if DoD selects an alternative in this EIS/OEIS that involves using the NDWWTP, long-range wastewater flows at the NDWWTP beyond the military buildup (e.g.: beyond the year 2019) would quickly exceed the 12 MGd design capacity of the plant. GWA projects a future capacity need at the NDWWTP of 18 MGd. As mentioned previously in Section 2.3.2, USEPA Region 9 recently issued a decision to deny GWA's secondary treatment 301(h) variance, effectively requiring GWA to upgrade its NDWWTP and Hagatna WWTP to secondary treatment. Therefore, the treatment plant upgrades needed to meet this new requirement should be planned to ultimately provide an 18 MGd plant capacity at the NDWWTP.

The analysis of wastewater presented in this EIS/OEIS centers on the impacts related to the proposed action that are the responsibility of the DoD to assess; namely the military buildup on Guam during the years 2010 to 2019. Thus, the EIS presents a detailed analysis of potential environmental impacts as they relate to the military buildup and total projected wastewater flow of 12 MGd that could be treated at the NDWWTP during this timeframe. This EIS/OEIS also includes an analysis of potential environmental impacts that may be associated with upgrades to the NDWWTP to an 18 MGd capacity, but only as they relate to expected changes in water quality that could result from increased pollutant loads in the plant discharge from a larger 18 MGd plant. See Chapter 3 Section 3.2.4.2 for this analysis. Nevertheless, treatment plant upgrades to expand the NDWWTP to a 18 MGd capacity would not result in different treatment processes than those represented in the wastewater alternatives in this EIS/OEIS, but would simply be sized larger. It is expected that GWA will need to conduct additional engineering analysis to properly size the NDWWTP to accommodate the projected future 18 MGd plant capacity.

3.1.3.1 Northern District Wastewater Treatment Plant

The NDWWTP is owned by GWA and operated by Veolia under contract with GWA. The treatment plant treats wastewater flows from civilian populations and DoD installations that are located in northern Guam. Andersen AFB, NCTS Finegayan, and South Finegayan contribute wastewater flows to the NDWWTP.

The wastewater collection system maintained by Andersen AFB consists of a network of gravity sewers, four major pump stations, and force mains located on the south side of the airfield. Two small sewage pump stations collect wastewater generated from facilities located on the north side of the airfield and convey the wastewater via force main to the gravity collection system on the south side of the airfield. The system also collects wastewater generated by the industrial and residential areas on the base. The average daily wastewater flow generated by Andersen AFB in 2008 is approximately 0.36 MGd (1.36 mld). Wastewater generated by Andersen AFB is discharged off base into the GWA sewage collection system at a sewer manhole located near the Andersen AFB main gate. The wastewater is then conveyed to the NDWWTP for treatment.

The wastewater collection system at NCTS Finegayan is primarily gravity sewer system consisting of two main trunk lines. The wastewater is conveyed to the NDWWTP via a GWA wastewater collection system. At South Finegayan, the wastewater collection system is a gravity sewer system connected to the GWA wastewater collection system. The wastewater is conveyed to the NDWWTP. The current average wastewater flow generated by NCTS Finegayan is approximately 0.17 MGd (0.64 mld).

Facilities and infrastructure at Andersen South have been abandoned and are not being maintained. The original sewers in the area flowed to a sewer pumping station located along the northern edge of the site. Sewage from the pump station discharged to a GWA sewer collection system and was subsequently conveyed to the NDWWTP for treatment. Neither the sewer lines nor the sewer pumping station are in operating condition and Andersen South contributes no wastewater flows to the NDWWTP.

The NDWWTP is a primary treatment plant designed for an average daily flow of 12.0 MGd (45.4 mld) and a peak capacity of 27 MGd (102 mld). Communication with GWA has indicated that the current average daily flow to the NDWWTP from civilian and military sources is approximately 5.7 MGd (22 mld) (GWA 2008a).

The NDWWTP discharges treated effluent through a newly constructed 34-in (86-cm) outfall into the Philippine Sea approximately 2,100 ft (640 m) offshore at a depth of approximately 150 ft (45 m) near Tanguisson Point. Section 301(h) of the CWA allows the USEPA administrator to waive secondary treatment requirements for publicly owned treatment works that discharge into marine waters under a modified National Pollutant Discharge Elimination System (NPDES) permit. The NDWWTP had received a 301(h) modified permit (NPDES Permit No. GU0020141) that expired on June 30, 1991. This permit authorized the NDWWTP to discharge a maximum daily flow of 6 MGd (23 mld). Because GWA failed to provide sufficient information for USEPA to conclude that the GWA permit renewal application met the 301(h) criteria, USEPA issued a tentative decision on April 4, 1997, denying the reissuance of a 301(h) variance to GWA. GWA revised the permit renewal applications by installing a new extended outfall and planned CIP for restoring the treatment capacity of the plant. The new outfall was put into service in December 2008. Based on plant operation performance and data provided by GWA on the actual discharged wastewater qualities, USEPA denied GWA’s application for a renewed variance from full secondary treatment in September 30, 2009, and concluded that the CWA 301(h) criteria have not been met at the NDWWTP.

3.1.3.2 Hagatna Wastewater Treatment Plant

The Hagatna WWTP is owned and operated by GWA. The treatment plant treats wastewater flows from civilian populations and DoD lands that are located in central Guam. Navy and Air Force Barrigada, the Naval Hospital, and DoD lands located in the Nimitz Hill area contribute wastewater flows to the Hagatna WWTP.

The existing Navy Barrigada sewer system consists of approximately 13,000 ft (3,962 m) of gravity sewer lines ranging from 6 to 8 in (15 to 20 cm) in diameter. The existing Naval Hospital sewer system consists of approximately 14,800 ft (4,511 m) of gravity sewer lines ranging from 6 to 10 in (15 to 25 cm) in diameter. The Nimitz Hill sewer system consists of gravity sewer lines ranging from 6 to 15 in (15 to 38 cm) in diameter. There is one lift station for the Naval Hospital sewer system and one lift station for the Nimitz Hill sewer system. Sanitary sewer systems servicing Barrigada, the Naval Hospital, and Nimitz Hill are connected to GWA interceptor sewers. Wastewater generated at these DoD lands is conveyed to GWA's Hagatna WWTP for treatment. The current average wastewater flow generated by Navy Barrigada is approximately 0.34 MGd (1.28 mld).

The Hagatna WWTP is a primary treatment facility designed to treat an average daily flow of 12.0 MGd (45.4 mld) and a peak flow of 21 MGd (79 mld). Communication with GWA has indicated that the current average daily flow to the Hagatna WWTP from civilian and military sources is approximately 4.4 MGd (16.6 mld) (GWA 2008b). Treated effluent is discharged from the WWTP through a newly constructed 42-in (107-cm) outfall into Agana Bay approximately 2,178 ft (664 m) offshore at a depth of approximately 275 ft (84 m) under a USEPA-administrated permit (NPDES Permit No. GU0020087) that expired on June 30, 1991. The permit contained a 301(h) variance allowing for less than secondary treatment and authorized the Hagatna WWTP to discharge a maximum daily flow of 12 MGd (45.4 mld). GWA failed to provide sufficient information for USEPA to conclude that the GWA permit renewal applications for both plants met the 301(h) criteria. As a result, USEPA issued a tentative decision on April 4, 1997, denying the reissuance of a 301(h) variance to GWA. GWA revised the permit renewal applications by installing a new extended outfall for each of these two plants. The new outfall for the Hagatna WWTP was put into service in December 2008 and the Hagatna WWTP was refurbished to restore its original designed capacity in 2007. Based on plant operation performance and data provided by GWA on the actual discharged wastewater qualities, USEPA denied GWA's application for a renewed variance from full secondary treatment on September 30, 2009, and concluded that the CWA 301(h) criteria have not been met at the Hagatna WWTP.

3.1.3.3 Apra Harbor WWTP

The Apra Harbor wastewater collection and treatment system is Navy owned and operated. It services Naval facilities at the Naval Base Guam, Apra Heights, and Naval Munitions Site. The Apra Harbor wastewater system also collects and treats discharged sludge flow from the Navy's Fena WTP. The existing wastewater collection system includes nine major sewer trunk or subtrunk lines consisting of about 35 miles (56 kilometers) of sewer lines ranging from 6 in to 36 in (15 to 91 cm) in diameter, and 24 sewer pumping/lift stations.

Wastewater is conveyed to the Apra Harbor WWTP for treatment. The Apra Harbor WWTP is a secondary treatment facility designed to treat an average daily flow of 4.3 MGd (16 mld) and a peak flow of 9 MGd (34 mld). The treatment plant currently receives an average daily flow of approximately 2.9 MGd (11 mld). Treated effluent is discharged through an ocean outfall into Tipalao Bay under NPDES Permit No. GU0110019. This permit authorizes the Apra Harbor WWTP to discharge an average monthly flow of 4.3 MGd (16.3 mld). The Navy-owned outfall also discharges effluent from the GWA Agat-Santa Rita WWTP (NPDES Permit No. GU0020222). A military construction project to rehabilitate/upgrade the existing Apra Harbor WWTP is currently under way.

3.1.4 Solid Waste

The ROI for solid waste includes solid waste facilities on Guam that would be directly or indirectly affected by the proposed military buildup. Solid waste from DoD lands is presently disposed of at the Navy Sanitary Landfill or the Air Force landfill at Andersen AFB. Solid waste from non-DoD sources is disposed of at GovGuam facilities. Descriptions of the existing Navy, Air Force, and GovGuam solid waste facilities are provided in the following sections.

3.1.4.1 Navy Sanitary Landfill

The Navy owns and operates one landfill facility on Guam. The Navy Sanitary Landfill is located in the southeastern portion of the Apra Harbor Navy Base. The landfill is bounded to the northeast, east, and south by wetlands; to the northwest by Perimeter Road; and to the west by Shoreline Drive (Figure 3.1-4). A natural vegetative barrier blocks views of the landfill from the nearby Navy Exchange and Commissary.

The landfill has been in use since 1965 and is currently operated by the Base Operations Support contractor, DZSP-21, under the terms of the administratively extended Solid Waste Management Permit, No. 95-1009, dated December 26, 1995. The Navy has applied for a permit renewal from GEPA.

The Navy Sanitary Landfill filling operations do not appear to have followed any particular final filling plan. However, a grading plan was developed in 1996 and proposed a maximum elevation of 48 ft mean sea level (msl) for the landfill.

The Navy Sanitary Landfill serves all DoD lands and their tenants, including the following:

- Apra Harbor Navy Base
- Naval Munitions Site
- Nimitz Hill
- Naval Hospital
- NCTS Barrigada
- South Finegayan
- NCTS Finegayan

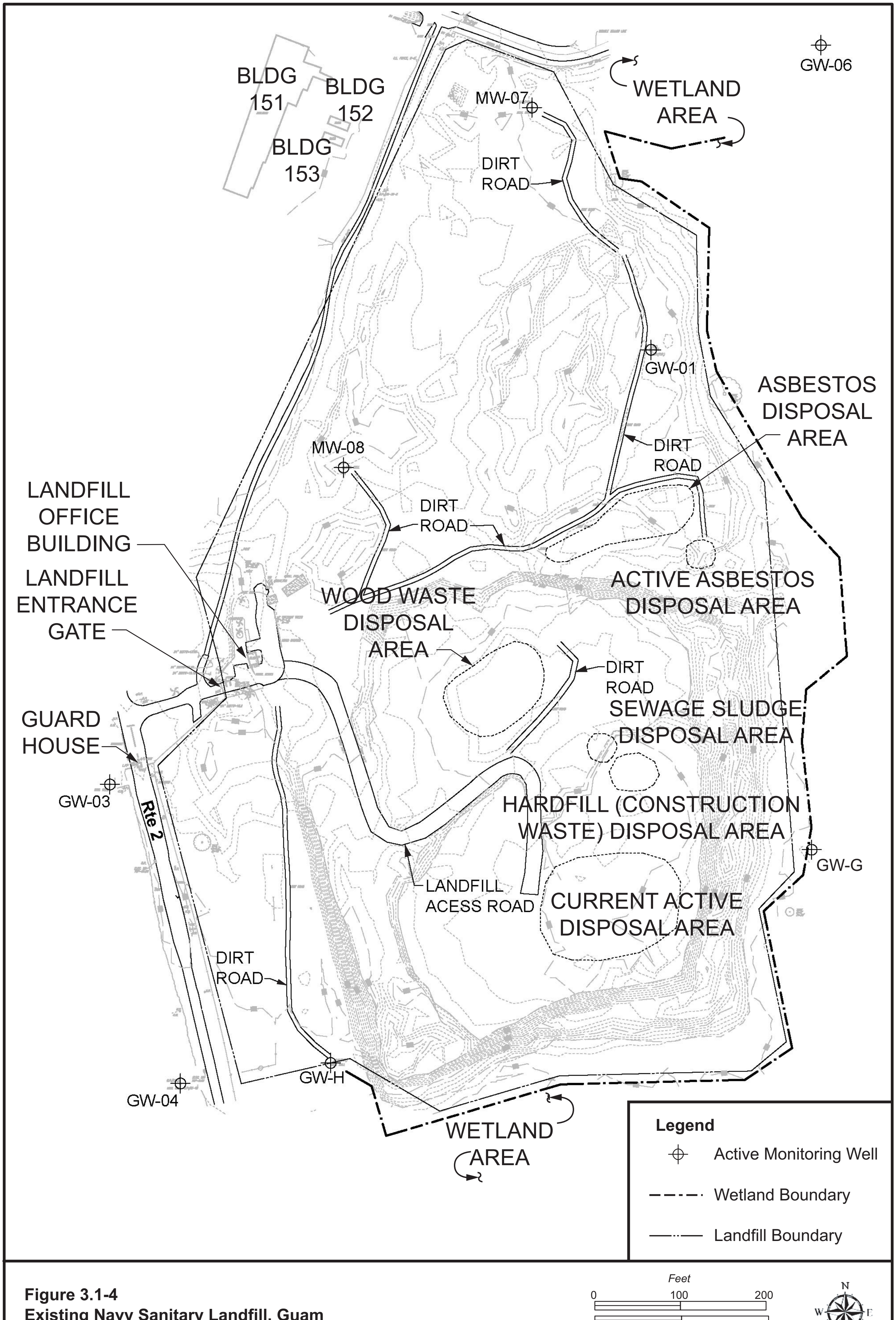

Figure 3.1-4
Existing Navy Sanitary Landfill, Guam

The landfill also receives waste from Navy ships berthed in Apra Harbor. Naval activities on Guam generate approximately 21 tons (19 metric tons) of solid waste daily that is placed at the landfill. The Navy Sanitary Landfill currently accepts waste from housing, commercial, and industrial activities; hardfill from on-base construction projects; sterilized waste from ships; asbestos waste; and wastewater treatment sludge that has passed the paint filter test.

The Navy landfill is unlined and occupies an area of approximately 60 acres (ac) (24 hectare [ha]). An active waste placement area is in the southeast corner of the landfill site. Other designated and segregated areas of the landfill site include areas for asbestos, hardfill (e.g., concrete), wood waste, and sewage sludge. Soils and backfill are used for daily cover. Concrete debris is often used for berming and landfill road maintenance.

Foreign refuse from ships is collected in special containers strategically located along the ship's berthing. Containers are picked up and transported to a specifically designed facility using steam for the decontamination and sterilization of ship waste. After the sterilization process, a compactor truck transports the waste to the Navy landfill for disposal.

Asbestos-containing material is accepted at the landfill on a case-by-case basis. The landfill is notified at least 24 hours before the receipt of incoming asbestos waste. After receiving approval for disposal, certified asbestos contractors arrive with the asbestos waste prebagged and sealed in compliance with GEPA and Navy regulations. A landfill operator inspects the seals of the asbestos bags for their integrity and accompanies the asbestos contractor to the designated area for disposing asbestos. The contractor places the waste and covers it with at least 6 in (15 cm) of soil cover. The landfill operator is required to observe the process and ensure that the landfill remains in compliance with its permit. Sludge from Navy's WWTP is accepted at the Navy Sanitary Landfill if the sludge passes a paint-filter test, demonstrating that the sludge meets landfill requirements of no free liquid.

Solid waste prohibited from being disposed of in the landfill includes the following:

- Hazardous waste
- Liquids
- Oily wastes, oil-based paints, and petroleum products
- Metal and appliances
- Whole or partially whole vehicles, vehicle parts, and tires
- Batteries
- Wet sewage sludge
- Flammables

Collection truck operators visually inspect waste loads in each container for prohibited wastes. If prohibited wastes are found, the load would not be collected until the material has been removed for proper disposal.

An office located at the landfill entrance is the only on-site structure. There are no scales for weighing incoming loads of solid waste. Collected solid waste volumes are estimated by the refuse collection truck driver or landfill personnel at the Navy landfill control office. Wastes deposited at the landfill via other vehicles and haulers, such as ship waste, WWTP sludge, and construction/demolition waste, are estimated by the landfill personnel. Waste disposal to the landfills is tracked through daily trip tickets, daily disposal logs, weekly metric reports, and semiannual and annual reports submitted to GEPA and Naval Facilities Engineering Command, Marianas (NAVFAC Marianas).

Groundwater at the landfill facilities is monitored at two upgradient wells, two downgradient wells, and four wells located within the landfill boundary. Groundwater is currently monitored on a quarterly basis. Landfill gas (methane) is also monitored on a quarterly basis. Groundwater and gas monitoring data are reported to GEPA in semiannual solid waste reports. The groundwater monitoring is conducted on a quarterly basis. Using the current monitoring program, statistically significant concentrations of chlordane and five volatile organic compounds have been detected in the downgradient wells in recent years, but these levels are below any drinking water maximum contamination levels.

The base operator support contractor maintains a litter control fence along the edge of the landfill operations area and along the operations area access road to prevent the escape of windblown litter.

Recycling Facilities

The Navy does not have an official recycling program. However, small-scale localized recycling is being implemented, such as cardboard recycling at the Exchange and Commissary.

NAVFAC Marianas has initiated an effort to "partner" with Andersen AFB in its recycling efforts. By collecting and transferring recyclable waste from Navy facilities to the Andersen AFB recycling center, the Navy hopes to reduce the flow of waste into the Navy landfill and increase the profitability of the Air Force's investment into its recycling equipment by adding volume of recyclable waste. However, the current volume of recyclable waste generated by the Navy is likely well below the amount needed to construct and operate a dedicated Navy recycling center that is capable of supporting itself in terms of cost.

3.1.4.2 Air Force Solid Waste Facilities

Landfill Facilities

The Air Force owns and operates a single landfill on Guam, located at Andersen AFB near Route 1 and the entrance road to Andersen AFB. The current landfill is a vertical expansion constructed over an unlined landfill area and began operation in late 1998. The landfill expansion has a design capacity of 172,000 cubic yards (CY) (131,503 cubic meters [m^3]) and had an expected life of 10 years. The current landfill footprint occupies an area of approximately 79 ac (32 ha). A base operator support contractor operates and maintains the facility under a current Resource Conservation and Recovery Act (RCRA) Subtitle D permit.

The landfill is also constructed over a sole-source aquifer. Federal law prevents new landfills or landfill expansions to be constructed over sole-source aquifers. However, the Andersen AFB landfill was exempted from this siting restriction.

The landfill expansion is constructed with a double liner system that provides an added measure of protection should one of the liners fail. This site is also equipped with fire hydrants at the corners of the property and a base landfill wash rack.

The landfill is made up of two major sections: a solid waste disposal area and a hardfill disposal area. Waste delivered to the landfill facility is first identified and segregated. Waste consisting of cardboard, paper, glass, plastic, scrap metal, and aluminum is taken to Andersen AFB's Arc Light Recycling Center (discussed below). Typical municipal waste such as food waste and other types of biodegradable trash is placed in the solid waste disposal area and then compacted and covered with roughly 6 in (15 cm) of soil daily. Wood (e.g., crates) and green waste are segregated into separate piles and shredded by a large wood chipper. The resulting wood chips are provided to local residents and base operators for mulching and landscaping purposes. Construction debris like concrete, asphalt, and rock are piled together and processed through a rock crusher. The crushed debris is then mixed with dirt and used as daily cover for the landfill. Construction and demolition debris that cannot be crushed is disposed of in the hardfill section of the landfill.

For several years, the Air Force and Navy have structured their long-term solid waste collection and disposal plans based on the expectation that GovGuam would open a new, fully compliant Subtitle D landfill by September 2007 per the terms of a federal consent decree. At this time, the Air Force and possibly the Navy would become GovGuam customers, using the GovGuam landfill and other solid waste management facilities.

Because GovGuam had not established a new landfill by September 2007, the Air Force was left with few options to meet its solid waste disposal needs in the near future. The Air Force landfill reached its original design capacity in September 2007. The Air Force recently constructed a 2-ac (0.81-ha) expansion to meet its disposal needs through 2009. Because the GovGuam landfill would not become available until July 2011, the Air Force would need to further expand the existing landfill or pursue diversional and/or operational measures to maximize landfill life.

Recycling Facilities

Andersen AFB has taken the lead in recycling efforts on Guam. Beginning in 1997, the base constructed the Arc Light Recycling Center (Facility 2408) to support its voluntary recycling program. This center is operated by a private contractor and currently receives and processes cardboard, wastepaper, aluminum cans, glass, and plastic bottles. The glass is ground to fill sandbags and provide backfill at construction sites. The other items are separated, stacked, and compressed into large bales that are sold off-island a few times a year through a broker. In addition, palm fronds and other green waste are ground at the base landfill, producing mulch that is available to installation residents through a “Self-Help Store.”

The operating cost of the recycling center is approximately $300,000 annually, far greater than the $30,000 in revenues that the center generates through sales of recyclable materials. However, the recycling program saves the Air Force an estimated $1.7 million in costs each year by diverting 45% to 52% of the base’s trash (i.e., 8,650 tons [7,847 metric tons]) from being disposed of at the Andersen AFB landfill, thus prolonging the life of this landfill.

A list of recycling equipment that the base owns and operates is provided in Table 3.1-6.

Table 3.1-6. Recycling Equipment at Andersen AFB

Equipment	*Model/Make*	*Quantity*
Baler	Model EX602 Horizontal	2
Weight scale	Series 9711-326	1
Recycling trailer, 17 feet × 8 feet (6-foot B/L wheels), with pintel hook attachment		1
Andela glass pulverizer	Model GP-07	1
Toter containers, 96 gallons (for family housing units)		1,500
Dumpsters, 8 cubic yards (for industrial/commercial facilities)		40
Source: Air Force Solicitation 2007		

Andersen AFB has an educational program that influences installation activities and informs residents about the importance of waste recycling, the base’s voluntary recycling program, and Air Force facilities and services available to allow them to participate in recycling efforts at the base.

3.1.4.3 GovGuam Solid Waste Facilities

The current solid waste management system on Guam consists of the disposal site Ordot Dump and three waste transfer stations (Dededo, Ayat, and Malojloj). The GovGuam hardfill in Malojloj is no longer operational. These facilities and other permitted private hardfills (Northern Hardfill and Eddie Cruz Hardfill) serve the entire civilian community of Guam. Trash collection is provided by Guam Department of Public Works (DPW) and several private trash haulers.

Currently, the Ordot Dump is the only facility available on Guam for the disposal of municipal, commercial, and industrial waste. The first use of the site as a dump is not documented. However, the site was used for waste disposal by the Japanese during their occupation of Guam in the early 1940s (World War II). After the liberation of Guam, the Navy continued to use the site as a disposal area. Ownership of the Ordot Dump was transferred from the Navy to GovGuam in 1950 under the Organic Act. The Guam DPW is primarily responsible for the collection of solid waste on Guam and operation of the Ordot Dump.

The Ordot Dump receives approximately 526 tons (477 metric tons) of waste/day or 191,990 tons (174,089 metric tons) per year. The dump has grown to full capacity, covering an estimated 54 ac (22 ha) to date. The dump is unlined and improperly designed, operated, maintained, and monitored to safely accept industrial and municipal waste. The dump does not incorporate any of the features of a modern landfill, such as soil cover; a liner system to prevent the infiltration of leachate to surface and groundwater; a leachate collection and treatment system; groundwater monitoring wells; a stormwater diversion, collection, and management system; gas monitoring and venting systems; and erosion and sedimentation control.

The Ordot Dump was created in a natural flowing ravine before regulatory standards for siting a landfill were established. Although the dump has been filled in the ravine, the general slope of the area remains southward approximately 500 ft (152 m) to the Lonfit River. Leachate emanates from the dump and flows to the river, a violation of the federal CWA. In February 2004, USEPA, DOJ, and GovGuam entered into a consent decree to resolve issues related to this unauthorized discharge of pollutants to the Lonfit River.

The consent decree outlines specific tasks and time requirements that the GovGuam has agreed to complete to correct the violation. These tasks included the closure of the Ordot Dump by October 2007 and the siting, design, and construction of a new municipal solid waste landfill facility that is fully compliant with federal RCRA Subtitle D but that has not yet been completed. The opening of the new landfill, which began construction on February 25, 2009, would coincide with the mandated regulated closure of Ordot Dump.

The Ordot Dump is still in operation; however, it is at full capacity and it is unknown how much longer it can continue to receive waste. Following its eventual closure, the Consent Decree mandates a 30-year postclosure maintenance plan that would include monitoring of the gas, stormwater, leachate, cover system, and monitoring wells.

The new landfill site (Layon Landfill) selected by GovGuam is located near the village of Inarajan. The selection of this site was based on landfill siting criteria set forth in RCRA Subtitle D, the Guam Solid Waste Disposal Rules and Regulations (Guam Code Annotated [GCA] Title 22, Division 4, Chapter 23), and other guidelines. These criteria are used to evaluate the potential site impacts of the landfill on surface and groundwater quality, wetlands, floodplains, nearby communities, traffic, air quality, biological resources, archaeological and historic resources, land use, airport safety, aesthetics, noise levels, property values, and utilities. The proposed landfill site is approximately 317 ac (128 ha), with a landfill footprint of 127.4 ac (52 ha), and with a design capacity of 15.8 million CY (12.1 million m^3) that would provide at least 30 years of service life (HDR|Hawaii Pacific Engineers 2008).

Girshman, Brickner, and Bratton, Inc. (GBB), the receivership firm managing GovGuam's solid waste program, recently awarded a construction contract for the initial phase of the landfill and construction that began on February 25, 2009. The current phase consists of constructing the landfill operations road and performing mass grading for landfill Cells 1 and 2. Invitations to bid on the construction of the Layon Municipal Sanitary Landfill Entrance Area Facilities and Cells 1 and 2 were released on August 17, 2009. Cells 1 and 2 are approximately 11.0 ac (4.5 ha) each, with planned waste filling depths of approximately 100 ft (30 m). The Layon Landfill is currently projected to be ready for acceptance of solid waste by July 2011. The landfill would be designed and operated in compliance with the federal RCRA Subtitle D Municipal Solid Waste Landfill Facility regulations and Guam's solid waste disposal regulations (GCA Title 22, Division 4, Chapter 23). These regulations serve to minimize and mitigate any potential adverse affects on human health and the environment created by the landfill.

Integrated Solid Waste Program

In 1983, GEPA adopted a solid waste management plan for Guam and regulations for solid waste collection and disposal. In 2000, GovGuam began the process of upgrading and modernizing its solid waste facilities with the adoption of the *Integrated Solid Waste Management Plan for the Island of Guam* (ISWMP) through Public Law 25-175 (December 12, 2000). In addition, the Guam legislature enacted more than 40 laws related to solid waste management and disposal from October 1983 to September 2006. Unfortunately, these legislative attempts have largely failed to improve the effectiveness and efficiencies of Guam's solid waste management program. The program has been plagued by funding inefficiencies; poor permit, tipping, and user fee collection rates; poor waste collection records; delays in meeting mandated and planned performance criteria (such as privatization of waste collection and disposal activities); and a consent decree requiring the closure of the Ordot Dump and the construction of a new landfill. To address these efficiencies and the consent decree, GEPA prepared a draft update to the ISWMP in September 2006 (GEPA 2006). The plan has not yet been adopted by the Guam legislature. The goal of the updated plan is to develop a truly "integrated" solid waste management system that provides waste management through diversion, recycling, composting, and processing. The integration would also consolidate all current solid waste management efforts on Guam (civilian and military) into one system to the extent possible. GovGuam has been consulting with the military for several years regarding the potential consolidation of their individual solid waste programs or components of these programs (e.g., recycling facilities).

The 2006 ISWMP identifies the objectives, performance criteria, and key elements of the integrated solid waste management system going forward. The plan addresses and provides recommendations for the following:

- The closure of the Ordot Dump
- The transfer of DPW's solid waste duties to a newly formed public utility corporation (to be known as the Guam Solid Waste Authority) under the oversight of the Consolidated Commission on Utilities
- The privatization of all solid waste operations
- A waste source and characterization study
- Source reductions, recycling, composting, resource recovery, and waste reduction
- The development of a new landfill and regulated landfill disposal
- The development of solid waste transfer stations around the island for accepting, segregating, and consolidating waste streams for recycling or landfill disposal
- Program funding requirements and potential funding sources (including the collection of permit and user/tipping fees)

- Special handling requirements and facilities for construction/demolition waste, household hazardous wastes, bulky metallic waste and white goods (e.g., washers, refrigerators), and green waste
- A public education program

The plan update revises Guam's solid waste load projections to the year 2037 (which approximates the conservative lifespan of the new landfill) and includes waste generated from future military buildup.

The goals and key components of this plan would not be realized without future legislation that makes the plan's recommendations mandatory and provides the funding mechanisms needed to implement the plan. To date, this legislation has not been forthcoming. In mid-December 2007 the federal courts appointed federal receivership of Guam's solid waste management program to ensure the prompt closure of Ordot Dump, the construction of a new compliant landfill, and implementation of the 2006 ISWMP.

3.1.5 Roadway Projects

Because of potential impacts on public and military utilities and infrastructure from associated roadway improvements, the existing infrastructure located within the Guam Road Network (GRN) are described. Public utilities in the GRN study area include electricity, water and wastewater facilities, telecommunications, fuel pipelines, and solid waste disposal. In addition, separate military-operated water and wastewater systems are either originating or terminating in the Apra Harbor and Andersen AFB areas, where roadway improvements are also considered.

3.1.5.1 North

Table 3.1-7 indicates the presence of each particular utility along the major roadway routes within the study area in the north region. The major roadway routes within northern Guam include Routes 1, 3, 9, 15, and 28.

Table 3.1-7. Existing Utilities within Guam Road Network Routes

Region	*Route*	*GPA Power*	*Navy Power*	*Power Plant*	*GPA Fuel*	*Telephone*	*Cable TV*	*Fiber Optic*	*GWA Sanitary Sewer*	*Navy Sanitary Sewer*	*Wastewater Treatment Plant*	*GWA Water*	*Navy Water*
North	1	X		X		OH	OH	X				X	
	3	X	X			OH and UG	OH	X	X	X		X	X
	9	X				OH	OH and UG	X		X		X	
	15	X				OH	OH	X				X	
	28					OH			X			X	
Central	1	X	X	X	X	OH and UG	OH and UG	X	X	X	X	X	X
	7	X				OH			X			X	
	8	X				OH and UG	OH and UG	X	X			X	X
	8A	X				OH and UG	OH		X	X		X	
	10	X				OH and UG	OH	X	X			X	
	15	X				OH and UG	OH		X			X	
	16	X			X	OH and UG	OH	X	X			X	X
	25*												
	26*												
	27	X		X		OH and UG	OH	X	X			X	X
Apra Harbor	1	X	X	X		OH and UG	OH and UG	X		X			X
	2A	X	X			OH and UG	OH						X
	11	X	X	X			OH and UG	X	X	X		X	X
South	2	X				OH and UG			X			X	
	5	X	X	X		OH and UG	OH		X	X		X	X
	12	X				OH			X			X	

Legend: GPA = Guam Power Authority; GWA = Guam Waterworks Authority; OH = overhead; UG = underground.
Note: * Utility data not currently available for Routes 25 and 26.

Power

GPA and IPPs generate power for the north region's study area. In addition, Navy-produced power is transmitted through northern Guam to Andersen AFB. GPA provides full electric utility services generated from power plants to individual users. Power is generated through the combustion of crude oil. Power generation in northern Guam comprises a GPA power plant located in Yigo and a joint power plant operated by GPA and Pruvient Energy Guam, Inc., located in Tanguisson.

Transmission of GPA and Navy power throughout northern Guam is through overhead power transmission lines. In northern Guam, 34.5-kilovolt (kV) overhead power lines are present along Routes 1, 3, 9, and 15. Overhead conductors with wooden cross arms on concrete poles are used at most locations, although a few wooden poles are still in use. The predominant service voltage is supplied through pole-mounted transformers that are provided with lightning surge arresters to protect downstream equipment.

Potable Water

GWA and the Navy operate and maintain water source facilities in the north region's study area. GWA's Northern Public Water System serves the population in northern Guam through an extensive network of wells. GWA's water distribution system is a collection of legacy pipe systems built principally by the Navy and then turned over to GovGuam to operate for the civilian population. GWA's water system combines transmission and distribution pipes into a common network, with isolation and pressure-reducing valves used to ensure that water reaches customers throughout northern Guam. The main water transmission and distribution pipe network in northern Guam is aligned along the existing major road network, either directly under the roads or adjacent to the roads in the existing roadway right-of-way (ROW). Parallel lines run the length of most of Routes 1, 3, 9, 15, and 28 to serve the most populated areas in the northern system.

The existing Navy water system is an island-wide system extending from the Navy Reservoir in southern Guam to NCTS Finegayan near the northern tip of Guam. Water for the system is supplied primarily from the Fena WTP. Water is distributed from the treatment plant through a network of reservoirs, transmission mains, and booster pump stations. Water is also supplied to Naval facilities from on-site groundwater wells.

In northern Guam, the Navy services NCTS Finegayan and South Finegayan primarily by on-site groundwater wells. If necessary, water can also be supplied by interconnections with the Navy water system along Route 3.

Wastewater

GWA provides wastewater services for the population in the north region, Andersen AFB, NCTS Finegayan, and South Finegayan. The system is made up of gravity sewer pipes and force mains, sewage pump stations, siphons, a WWTP, and an ocean outfall. Similar to the water transmission and distribution network, the wastewater network is aligned along the existing road network, either directly under the roads or adjacent to the roads in the existing roadway ROW. The Northern District WWTP is a Class III, primary treatment plant. This plant is located on the northwestern coast of Guam and provides wastewater treatment for northern Guam.

In addition to areas served by the GWA collection systems, approximately 41% of the island residents live in the areas of the north region that are not served by collection systems. High concentrations of properties in northern Guam use septic systems to collect and dispose of wastewater in areas that are not sewered.

Solid Waste

GBB has assumed all of the responsibilities, functions, duties, powers, and authority of the Solid Waste Management Division (SWMD) of the Guam DPW. The SWMD provides collection of residential solid waste materials in the north region's study area. The SWMD also manages disposal of residential and commercial solid waste.

The Air Force owns and operates a landfill at Andersen AFB in the north region. The landfill is located near Route 1 and the entrance to Andersen AFB. The landfill handles disposal of solid waste and hardfill. The Air Force also constructed the Arc Light Recycling Center near the main entrance. The recycling center is run by a private contractor and handles mixed recyclables for residents located on and off the base.

Telecommunications

The two main providers of telecommunication services (i.e., telephone, television, and fiber optics) for Guam are GTA Teleguam and MCV Broadband. Most of the transmission of telephone and television lines throughout northern Guam is through overhead transmission lines. Portions of the telephone and television lines and all of the fiber optic lines are buried underground. Main transmission and distribution lines are aligned along all of the existing major roadways in northern Guam.

3.1.5.2 Central

Table 3.1-7 indicates the presence of each particular utility along the major roadway routes within the central region. The major roadway routes within central Guam are Routes 1, 8, 8A, 10, 15, 16, 25, 26, and 27, and the Chalan Lujuna roadway.

Power

GPA and IPPs generate power for the central region. In addition, the Navy transmits power through the central region for DoD facilities on the island. GPA provides full electric utility services generated from power plants to individual users. Power is generated through the combustion of crude oil. Three power plants are in the northern portion of central Guam: GPA power plants in Macheche and Dededo and a joint power plant operated by GPA and supplied by Shell Guam, Inc., located in Marbo. A GPA power plant at Manengon Hills is located in the southern portion of the central region.

Transmission of GPA and Navy power throughout central Guam is through overhead power transmission lines. Both 34.5-kV and 115-kV overhead power lines are present throughout many of the major roads in central Guam. The transmission network in the central region runs along Routes 1, 8, 10, 15, 16, 26, and 27, and the Chalan Lujuna roadway. Overhead conductors with wooden cross arms on concrete poles are used at most locations, although a few wooden poles are still in use. The predominant service voltage is supplied through pole-mounted transformers that are provided with lightning surge arresters to protect downstream equipment.

Fuel lines for GPA, the Navy, the Air Force, and Shell are located along Route 16 between the Tiyan Guam Airport and the Tanguisson Power Plant in central Guam.

Water

The GWA and the Navy operate and maintain water source facilities in the central region. The Navy system is interconnected to supply water to GWA and for emergency service capability. The Central Public Water System serves the east side of central Guam through the U.S. Navy Fena WTP. The west side of central Guam is served through an extensive network of wells. GWA's water distribution system is a collection of legacy pipe systems built principally by the Navy and then turned over to GovGuam to operate for the civilian population. The GWA water system combines transmission and distribution pipes into a common network, with isolation and pressure-reducing valves used to ensure that water reaches customers throughout central Guam. The main water transmission and distribution pipe network in central Guam is aligned along the existing major road network, either directly under the roads or adjacent to the roads in the existing roadway ROW.

The existing Navy water system is an island-wide system extending from the Navy Reservoir in southern Guam to NCTS Finegayan near the northern tip of Guam. Water for the system is supplied primarily from the Fena WTP. Water is distributed from the treatment plant through a network of reservoirs, transmission mains, and booster pump stations. Water is also supplied to Naval facilities from on-site groundwater wells.

In central Guam, the Navy services Navy Barrigada and the Naval Hospital primarily by on-site groundwater wells. As a backup, water can also be supplied by interconnections with the Navy water system along Routes 1, 8, and 16.

Wastewater

GWA provides wastewater services for the population of central Guam. The system is made up of gravity sewer pipes and force mains, sewage pump stations, siphons, WWTPs, and ocean outfalls. Similar to the water transmission and distribution network, the wastewater network is aligned along the existing road network, either directly under the roads or adjacent to the roads in the existing roadway ROW. The Hagatna WWTP is a Class III, primary treatment plant located adjacent to Agana Bay in central Guam. One other WWTP is in central Guam (Pago Socio WWTP); however, it is not located adjacent to the GRN.

In addition to areas served by the GWA collection systems, approximately 41% of the island residents live in areas not served by collection systems. High concentrations of properties in central Guam use septic systems for wastewater collection and disposal in areas that are not sewered.

Solid Waste

GBB has assumed all of the responsibilities, functions, duties, powers, and authority of the SWMD of the Guam DPW. The SWMD provides collection of residential solid waste materials in central Guam. The SWMD also manages disposal of residential and commercial solid waste. In central Guam, the SWMD operates the Ordot Dump and a transfer facility at Dededo. The Ordot Dump is scheduled to close in mid-2011. Residents within the central region can recycle, for free, cardboard and glass at the Dededo Transfer Station and Ordot Dump.

Telecommunications

The two main providers of telecommunication services (i.e., telephone, television, and fiber optics) for central Guam are GTA Teleguam and MCV Broadband. Most of the transmission of telephone and television lines throughout central Guam is through overhead transmission lines. Portions of the telephone and television lines and all of the fiber optic lines are buried underground. The main transmission and distribution network is aligned along nearly all of the existing major roadways within central Guam.

3.1.5.3 Apra Harbor

Table 3.1-7 indicates the presence of each particular utility along the major roadway routes within the

Apra Harbor region. The major roadway routes within the Apra Harbor region include Routes 1, 2A, and 11.

Power

GPA and many IPPs generate power for the Apra Harbor region. In addition, the Navy produces power for DoD facilities. GPA provides full electric utility services generated from power plants to individual users. Power is generated through the combustion of crude oil. One GPA power plant is located in Cabras and three IPP power plants are located at Temes, Mec, and Orote Point.

Transmission of GPA and Navy power throughout the Apra Harbor region is through overhead power transmission lines. The Apra Harbor region contains overhead 34.5-kV lines along Route 1. Overhead conductors with wooden cross arms on concrete poles are used at most locations, although a few wooden poles still are in use. The predominant service voltage is supplied through pole-mounted transformers that are provided with lightning surge arresters to protect downstream equipment.

Water

GWA and the Navy operate and maintain water source facilities in the Apra Harbor region. The Navy system is interconnected to supply water to GWA and for emergency service capability. The Central Public Water System serves the Apra Harbor region through the U.S. Navy Fena WTP. The GWA water distribution system is a collection of legacy pipe systems built principally by the Navy and then turned over to GovGuam to operate for the civilian population. GWA's water system combines transmission and distribution pipes into a common network, with isolation and pressure-reducing valves used to ensure that water reaches customers throughout the Apra Harbor region. The main water transmission and distribution pipe network in the Apra Harbor region is aligned along Routes 1 and 11, either directly under the roads or adjacent to the roads in the existing roadway ROW.

The existing Navy water system is an island-wide system extending from the Navy Reservoir in southern Guam to NCTS Finegayan near the northern tip of Guam. Water for the system is supplied primarily from the Fena WTP. Water is distributed from the treatment plant through a network of reservoirs, transmission mains, and booster pump stations. Water is also supplied to Naval facilities from on-site groundwater wells.

In the Apra Harbor region, the Navy water system services the Naval Base Guam through the Fena WTP. Transmission lines for the Navy water system run along Routes 1, 2A, and 11.

Wastewater

GWA and the Navy provide wastewater services for the Apra Harbor region's population. The system is made up of gravity sewer pipes and force mains, sewage pump stations, siphons, a WWTP, and an ocean outfall. Similar to the water transmission and distribution network, the wastewater network is aligned along the existing road network, either directly under the roads or adjacent to the roads in the existing roadway ROW. The Navy operates a wastewater treatment plant located in the Apra Harbor region.

Solid Waste

GBB has assumed all of the responsibilities, functions, duties, powers, and authority of the SWMD of the Guam DPW. The SWMD provides collection of residential solid waste materials in the Apra Harbor region's study area. The SWMD also manages disposal of residential and commercial solid waste.

The Navy-owned and operated landfill is located at the southeastern area of Naval Base Guam. The landfill currently accepts all solid waste and hardfill generated by all DoD lands on Guam. The Navy landfill also accepts solid waste from Navy ships, as well as asbestos and wastewater treatment sludge. The Navy does not currently have an official recycling program.

Telecommunications

The two main providers of telecommunication services (i.e., telephone, television, and fiber optics) for the Apra Harbor region's study area are GTA Teleguam and MCV Broadband. Most of the transmission of telephone and television lines throughout the Apra Harbor region's study area is through overhead transmission lines. Portions of the telephone and television lines and all of the fiber optic lines are buried underground. The main transmission and distribution network is aligned along the existing major roadways within the Apra Harbor region's study area.

3.1.5.4 South

Table 3.1-7 indicates the presence of each particular utility along the major roadway routes within southern Guam. The major roadway routes in southern Guam include Routes 2, 5, and 12.

Power

GPA generates power for the south region. GPA provides full electric utility services generated from power plants to individual users. Power is generated through the combustion of crude oil. A power plant is located in Tenjo within southern Guam.

Transmission of GPA power throughout the study area in southern Guam is through overhead power transmission lines. Along Routes 2A and 2 in the southwest portion of the island are 34.5-kV overhead lines. Along Route 5, 34.5-kV overhead lines also cross southern Guam. Overhead conductors with wooden cross arms on concrete poles are used at most locations, although a few wooden poles are still in use. The predominant service voltage is supplied through pole-mounted transformers that are provided with lightning surge arresters to protect downstream equipment.

Water

GWA and the Navy operate and maintain water source facilities in southern Guam. The Navy system is interconnected to supply water to GWA and for emergency service capability. Southern Guam is served by the U.S. Navy Fena WTP. GWA's water distribution system is a collection of legacy pipe systems built principally by the Navy and then turned over to GovGuam to operate for the civilian population. GWA's water system combines transmission and distribution pipes into a common network, with isolation and pressure-reducing valves used to ensure that water reaches customers throughout southern Guam. The main water transmission and distribution pipe network in southern Guam is aligned along the major roadways, either directly under the roads or adjacent to the roads in the existing roadway ROW.

The existing Navy water system is an island-wide system extending from the Navy Reservoir in southern Guam to NCTS Finegayan near the northern tip of Guam. Primary water supply sources for the Navy's island-wide water system are located in the southern region of Guam and include Almagosa Springs, Bona Springs, and the Fena Reservoir surface water impoundment. Water for the system is primarily supplied from the Fena WTP. Water is distributed from the treatment plant through a network of reservoirs, transmission mains, and booster pump stations. Water is also supplied to Naval facilities from on-site groundwater wells.

In southern Guam, the Navy's water system services the Navy Munitions Site through the Fena WTP. Transmission lines for the Navy water system run along Route 5.

Wastewater

GWA provides wastewater services for the population of southern Guam. The system is made up of gravity sewer pipes and force mains, sewage pump stations, siphons, WWTPs, and ocean outfalls. Similar to the water transmission and distribution network, the wastewater network is aligned along the existing road network, either directly under the roads or adjacent to the roads in the existing roadway ROW. The Agat-Santa Rita WWTP, a Class II treatment plant, is located on the west coast of Guam. The Agat-Santa Rita WWTP serves the area bounded to the north by the intersection of Routes 2 and 2A, to about the midpoint of Route 12 to the east, and to Taelayag Beach on the south (near where Route 2 heads inland to the east as opposed to directly on the coast). Three other WWTPs (i.e., Baza Gardens WWTP, Inarajan WWTP, and Umatac-Merizo WWTP) are in southern Guam; however, they do not serve areas adjacent to the GRN.

Solid Waste

GBB has assumed all of the responsibilities, functions, duties, powers, and authority of the SWMD of the Guam DPW. The SWMD provides collection of residential solid waste materials in southern Guam. The SWMD also manages disposal of residential and commercial solid waste. Within southern Guam, the SWMD operates the Agat Transfer Station, where residents can recycle, for free, cardboard and glass.

Telecommunications

The two main providers of telecommunication services (i.e., telephone, television, and fiber optics) for the south region's study area are GTA Teleguam and MCV Broadband. Most of the transmission of telephone and television lines throughout southern Guam is through overhead transmission lines. Portions of the telephone and television lines, as well as all of the fiber optic lines are buried underground. The main transmission and distribution network is aligned along nearly all of the existing major roadways within southern Guam.

3.2 ENVIRONMENTAL CONSEQUENCES

3.2.1 Approach to Analysis

3.2.1.1 Methodology

The impact analysis for utilities compares the existing capacity and demand on a utility to the projected capacity and demand. This is done for each of the utility alternatives. Military and civilian populations on Guam are projected to increase as a result of the proposed military buildup. Projected population changes are used to forecast future demand for a utility, based on average per capita usage. Changes in facility usage or new facility construction may also contribute to the total projected demand. Demand projections are then compared to the planned capacity under each utility alternative.

For roadway projects, potential impacts on public and military utilities and infrastructure that would result from construction and operation of the associated roadway improvements for each of the proposed project alternatives are analyzed separately. It is important to note that the utility information gathered to date was acquired using geographic information systems; therefore, it inherently contains a fairly high level of approximation regarding horizontal location. Furthermore, no information is currently available regarding the vertical depth of buried utilities. Another factor considered in the analysis of impacts on utilities is the methods of construction. It has been safely ascertained through historical reference and observation that many of the existing underground utilities were constructed rather hastily and did not adhere to generally accepted construction standards; therefore, an analysis of utility impacts must include that any particular utility within the area of a construction project involving digging and/or grading activities has been identified as needing to be relocated.

3.2.1.2 Determination of Significance

A determination of significant adverse effect is made when the projected increase in demand for a utility would exceed the planned capacity for that utility such that the utility provider would not be able to service additional demands while maintaining the same level of service for existing customers.

Potential adverse effects of demand exceeding capacity include brownouts/blackouts for power, low water pressure or rotating water shutoffs for potable water, discharge of inadequately treated wastewater or sewer backups, and solid waste accumulation at various collection points if a landfill is unable to accept additional waste.

Utility impacts caused by the proposed roadway improvements are assessed following the Federal Highway Administration's *Guidance for Preparing and Processing Environmental and Section 4(f) Documents (T 6640 8A)* (Federal Highway Administration 1987). Utility impacts would involve project effects that are assessed within this document under the category of construction impacts.

3.2.1.3 Issues Identified during Public Scoping Process

The public scoping process identified concerns, both from the public and regulatory stakeholders, about impacts from the proposed military buildup to public utilities on Guam and received comments for DoD to partner with GovGuam to improve utilities and infrastructure for all residents.

With regard to power, respondents requested that the military evaluate options for developing alternative energy sources, such as wind generation, waste-to-energy, solar power, and ocean thermal energy conversion. Respondents requested that the environmental impact statement/overseas environmental impact statement (EIS/OEIS) address impacts of the proposed military buildup on the civilian power supply and plans for the military to partner with local utility providers to increase the capacity of public power facilities.

With regard to potable water, respondents requested that the EIS/OEIS evaluate the impact that the military buildup would have on the existing potable water supply and the sustainable yield of the NGLA. Respondents requested that alternative sources of potable water, such as surface water, groundwater, recycled water, and desalination, be considered to meet the projected increase in potable water demand.

Wastewater concerns were primarily focused on assessing impacts on sewer lines, pump stations, and sewage outfalls. Respondents expressed a desire for the military to fund improvements to GWA wastewater facilities that accept military wastewater flows as a way of mitigating impacts on these facilities and bringing them into regulatory compliance.

With regard to solid waste, respondents requested that the EIS/OEIS assess impacts of the military buildup on landfill capacity and operations, including potential impacts on the planned GovGuam landfill and impacts associated with the temporary construction workforce. Respondents requested that the EIS/OEIS consider opportunities for the military to partner with the local government to share solid waste facilities.

3.2.2 Power

Projected interim power demands from the proposed military buildup are summarized in Table 3.2-1, which reflects existing Guam civilian and DoD power demands, projected increases in Guam civilian demands caused by natural population growth, projected DoD increases associated with the military buildup, increases associated with the imported construction workforce, and civilian increases that could result from induced growth.

Table 3.2-1. Projected Power Demand and Supply

GPA Power System	*Demand (MW)*									
	Interim Period without 25% Growth Factor					*Long-Term without 25% Growth Factor*				
	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*
Islandwide, including anticipated growth (existing DoD and GPA baseline projected growth included)										
Existing Guam	281	287	294	299	303	306	309	312	315	318
Guam Induced Civilian Increase (induced growth caused by military increase)	4.93	12.25	19.99	23.44	29.24	22.08	11.23	7.75	7.75	7.88
Construction Worker Increase	1.18	2.99	5.19	6.51	6.70	4.43	1.38	0.00	0.00	0.00
DoD Increase (less 39.8 MW load from transient aircraft carriers)	1.83	2.18	5.04	11.35	17.99	33.31	35.29	35.29	35.29	36.26
Total Demand	**288.94**	**304.42**	**324.21**	**340.29**	**356.93**	**365.82**	**356.90**	**355.03**	**358.03**	**362.14**
Total Available Supply	**490.00**	**490.00**	**550.00**	**550.00**	**550.00**	**630.00**	**630.00**	**630.00**	**630.00**	**630.00**
Future Supply Accounting for 1.52 Reliability Factor	322.37	322.37	361.84	361.84	361.84					
Future Supply Accounting for 1.52 Reliability Factor						414.47	414.47	414.47	414.47	414.47
Supply – Demand (net excess or shortfall without transient loads)	33.43	17.95	37.63	21.55	4.91	48.66	57.58	59.44	56.44	52.33
Transient Load Highest requirement with CVN group)						39.82	39.82	39.82	39.82	39.82
Supply – Demand (net excess or shortfall with transient loads)	**33.43**	**17.95**	**37.63**	**21.55**	**4.91**	**8.84**	**17.76**	**19.62**	**16.62**	**12.51**

Source: NAVFAC Pacific 2008d. Guam Power Authority Integrated Resource Planning (IRP 2008) for existing Guam growth projections.

The projections account for all on-base DoD power demands that would be generated by active duty personnel and their dependents, the on-base civilian workforce, and industrial demands from on-base facilities. Power demands from projected civilian induced growth caused by the military buildup are included. To meet the increased power demand as the military buildup progresses, the work associated with the interim alternatives would begin in 2010 and the additional power would be available by 2012 and available in time to service the projected demand. Table 3.2-1 summarizes the power situation.

The power demands of the construction workforce while working on base are considered by all interim alternatives. The additional power capacity would be available to the IWPS at that time. GPA would need to upgrade local power systems to accommodate housing for the construction workforce.

A socioeconomic analysis of the proposed military buildup has estimated that civilian growth induced by the military buildup could increase the island-wide population on Guam by up to 40,000 in the peak year of 2014. Preliminary evaluation of the affects of this population increase on the electrical system shows a power demand of approximately 0.74 kilowatt per person. This amount represents two-thirds of the current average electrical demand per person on Guam of 1.1 kw. Per person power consumption was obtained from CIA world factbooks using 2006 data (9,682.897 kw-hours per person / 365 days per year / 24 hours per day = 1.1 kw per person), the most recent available data from this source (Nationmaster.com 2006).

The predicted population growth on Guam induced by the DoD buildup varies from 6,651 people in 2010 to 39,481 people in 2014 (peak impact) and down to 10,639 in 2019. These changes correspondingly increase demands on the electrical system by 4.93 MW (2010 initial) to 29.24 MW (2014 peak) to 7.88 MW (2019 long-term). The expected growth rate on Guam was obtained from GPA data for baseline growth of power demand and shows a projected demand increase of 37 MW between 2010 and 2019 (10 years in the future).

3.2.2.1 Interim Alternative 1 (Preferred Alternative)

Description

Interim Alternative 1 would recondition existing combustion turbines and upgrade T&D systems and would not require new construction or enlargement of the existing footprint of the facility. This work would be undertaken by the GPA on its existing permitted facilities. Reconditioning would be made to existing permitted facilities at the Marbo, Yigo, Dededo No. 1, and Macheche combustion turbines. These combustion turbines are not currently being used up to permit limits. T&D system upgrades would be on existing above ground and underground transmission lines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Potential Mitigation Measures

Adequate power supply during the interim period is based on ensuring that the DoD requirements for power are presented to the utility provider, GPA in sufficient time to allow GPA to plan for the increased loads. DoD has had initial discussion with GPA to outline the potential loads to allow GPA to do the necessary due diligence to plan for these requirements.

The Public Utilities Commission requires that GPA maintain a generation reliability standard that their outages cannot exceed “1 day in 4.5 years”. To reliably meet this requirement, past GPA analysis has identified that a generation capacity in the installed system of approximately 1.52 times the system’s peak demand level is required to provide the necessary reserve margin. During the interim period the peak load for the IWPS is projected to reach 357 MW, applying the 1.52 reserve capacity, GPA would need a generation capacity of 543 MW to meet the PUC requirement. GPA has an installed generation capacity of 550 MW. To reach its installed capacity, GPA will need to recondition existing generation units and return them to full service capability. In addition to the efforts to recondition existing generation units, the following measures are being undertaken to mitigate the buildup’s interim and long term electrical demands on the island wide power system:

1. In support of the on-base development related to the Guam buildup, a comprehensive energy management plan is being developed for Guam. The plan has interest from several federal executive departments and will focus on reducing the energy footprint of DoD infrastructure, a “Nega Watt” approach and the development of renewable energy sources for Guam. Nega Watt and renewable energy efforts will be coordinated closely with GPA. The strategy is comprised of the following basic elements with a listing of some of the measures being taken with respect to existing and proposed facilities:

a. Conservation and demand reduction:
<u>Existing Infrastructure</u> <u>Buildup Infrastructure</u>
Facility Energy Audits Smart Metering on all buildings
Energy Conservation Programs Demand reduced through sustainability
Energy Conservation Investment User training and education
Program (ECIP) Smart base technology

b. Sustainable Design/Development Strategies
<u>Existing Infrastructure</u> <u>Buildup Infrastructure</u>
LEED projects being implemented All Facilities LEED Silver
Sustainable Program Officer
Sustainable Systems Integration
Modeling (SSIM)

c. Sustainable Infrastructure
<u>Existing Infrastructure</u> <u>Buildup Infrastructure</u>
Foot Print Reduction Low Impact Development
Adaptive Reuse of Facilities Integrated Site Design
Brown Field Development Passive Solar Orientation
Carbon Sequestration
Reuse of Construction and Demolition
Debris
Transportation Demand Management

d. Renewable Energy
<u>Existing Infrastructure</u> <u>Buildup Infrastructure</u>
Solar Hot Water System Conversions Solar Hot Water Systems
Integrated Solar Photovoltaic Systems Photovoltaic Compatible Facilities
Renewable Energy Studies

2. Unified Facilities Criteria (UFC) incorporate energy conservation standards and policy from various Executive Orders and public laws to provide guidance and goals for new and renovated DoD facilities. These conservation measures would result in a reduced increased demand for utilities. Many of these conservation standards and policy were initiated in compliance with the Energy Policy Act of 2005. The following provisions would be incorporated into the planning, design and construction of DoD facilities:
    a. New Bachelor Enlisted and Officer Quarters (BEQ and BOQ) would be designed and constructed in accordance with the Energy Policy Act of 2005.
    b. New buildings (except residential) would be designed to comply with **American Society of Heating, Refrigerating and Air Conditioning Engineers** (ASHRAE) Standard 90.1. Based on UFC guidance, the building design would also strive to achieve an energy consumption level that is 30% below ASHRAE Standard 90.1.
    c. New residential buildings would be designed to comply with the International Code Council (ICC) International Energy Conservation Code. Based on UFC guidance, the building design would also try to achieve an energy consumption level that is 30% below International Energy Conservation Code standards.

d. All new purchases of energy consuming products would be either ENERGY STAR-qualified or FEMP-recommended.
e. Relevant energy conservation measures to be considered include:
    i. Optimizing building orientation to reduce cooling loads or energy loads to cool the buildings
    ii. Building insulation optimization
    iii. Sealing building envelope for air tightness
    iv. "cool roof"
    v. Using motion detectors to reduce lighting and to setback cooling in unoccupied buildings
    vi. Natural Lighting
f. Energy compliance analysis and life cycle cost analysis:
    i. Systems modeling is being used to analyze usage of energy conservation measures and provide comparative life cycle costs. This process comprehensively examines energy, water, transportation, ecological resources, green building, social/cultural and economic factors. Within the parameters of energy, this modeling evaluates: building insulation, windows, infiltration, lighting, HVAC systems, delivery efficiency, water use, conventional water heating, solar thermal water heating, and building integrated Photovoltaics. This modeling approach follows a three step process:
        1. First it considers measures to make the building work more efficiently. This includes orientation, solar shading/high performance facades, and building envelope/air tightness considerations.
        2. Secondly, use of various levels of system efficiencies are considered, analyzing energy usage, capital and life cycle costs.
        3. Thirdly, it considers what potential renewable systems could be utilized for the specific location and facilities.

    To date, this analysis has been performed on two types of buildings: BEQ and duplex housing. The modeling analysis has thus far resulted in the following estimates of energy savings:

    - BEQ – 31% savings for $1.88/SF
    - Duplex House – 32% savings for $4.93/SF

DoD is committed to meet the required 30% energy savings and has identified approaches to reach this goal. The areas that would allow meeting that goal for the bachelor enlisted quarters (BEQ) are listed in Table 3.2-2.

Table 3.2-2. Approaches Associated With Achieving 30% Reduction in Facilities Demand

BEQ Energy Modeling Summary		
Package Summary	*Baseline*	*Efficiency Approach*
Windows	Code Minimum	High Efficiency
Infiltration	0.5 ACH	0.25 ACH
Lighting	100% Incandescent Fixtures	50% Incandescent/ 50% Compact Fluorescent
HVAC	Standard Efficiency Packaged Terminal AC	High Efficiency Packaged Terminal AC
DHW Use Reduction	USEPA 1992 Baseline	40% DHW Reduction
Environmental Benefit and Cost Indicators		
% Energy Use Improvement	N/A	31.20%
% CO2 Emissions Improvement	N/A	31.20%
Additional Capital Cost ($/SF)	N/A	$1.88/SF
Simple Payback Years	N/A	~2

Note: Baseline Defined as ASHRAE 90.1; DHW = domestic hot water; ACH = air flow change rate; HVAC= heating, ventilation and air conditioning; AC= air conditioning

f. The modeling has validated that it is possible to meet the 30% energy reduction at a minimal cost resulting in a lower energy footprint for the new facilities. DoD is committed to meeting the 30% reduction and will be looking to leverage additional savings where deemed appropriate and affordable on a facility by facility basis. Since the energy compliance behavior of the occupants, proper maintenance of systems, and other life cycle aspects will play a major role in the ability to sustain the full savings, the power demand requirements used for planning purposes provided to GPA were conservatively reduced by 10% instead of the 30% energy savings goal. This conservative approach will cover unknown contingencies and provide GPA with reasonable planning data to address the new demand requirements in a cost effective manner.

3. In addition to the efforts to minimize the energy footprint of the Guam buildup infrastructure, measures will be taken to mitigate the impact of the new development that would occur off-base as a result of the buildup. The improvements to GPA's IWPS' transmission and distribution capability to support the increased on-base demand for power will result in new power lines, thereby freeing up capacity on the existing infrastructure to address the anticipated off-base growth in demand for power. Reconditioning GPA's combustion turbines located in northern Guam will increase the reliability of the IWPS and provide reliable sources of power generation to support the existing and future off-base populations during emergencies. Efforts are continuing to work closely with GPA to ensure that the new requirements imposed on the IWPS do not degrade the overall reliability of the system to the detriment of all users. GPA is in the process of modeling the identified buildup power demands and will be working with DoD to identify system improvements that can be implemented to sustain system reliability and improve it where deemed

appropriate. DoD will help GPA develop strategies to obtain funding to implement the necessary improvements mentioned above.

4. Currently, DoD has 33 MW of power generation capability. 18.6 MW at the Orote Power Plant, 7.5 MW at the Finegayan Plant and the remainder in various locations as backup power for critical infrastructure. In addition to this existing capacity, it is expected that the new Marine Base at Finegayan will incorporate another 5+ MW of emergency generator capability to support its critical infrastructure. These assets can be utilized to reduce peak demand on the GPA system during days when GPA capacity might be insufficient for short time periods if requested by GPA. This may be a possibility during the interim period before the planned IWPS improvements can be implemented and at any future time in the event GPA has a system failure and needs the support.

If it appears that interim demand would exceed the generation capacity of the GPA system, DoD can work with GPA to adjust the construction tempo as a mitigation. This concept is discussed further in adaptive management, Volume 7 Interim Alternative 2

Description

Interim Alternative 2 is a combination of reconditioning of existing permitted GPA facilities, an increase in operational hours for existing combustion turbines, and upgrades to existing T&D systems. Interim Alternative 2 would not require new construction or enlargement of the existing footprint of the facility. Reconditioning would be performed on the existing permitted GPA facilities at the Marbo, Yigo, and Dededo combustion turbines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Potential Mitigation Measures

The potential mitigation measures for power under Interim Alternative 2 would be similar to those described for Interim Alternative 1.

3.2.2.2 Interim Alternative 3

Description

Interim Alternative 3 is a combination of reconditioning existing GPA permitted facilities at Marbo, Yigo, and Dededo and upgrades to the DoD power plant at Orote. Upgrades would be made to existing T&D. The proposed reconditioning to the existing power generation facilities at Marbo, Yigo, and Dededo would not require new construction or enlargement of the existing footprint of the facility. For the Orote power plant, upgrades would include a new fuel storage facility to facilitate longer run times between refueling. This would disturb approximately 1 acre (4,047 square m). This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Potential Mitigation Measures

The potential mitigation measures for power under Interim Alternative 3 would be similar to those described for Interim Alternative 1.

3.2.2.3 Long-Term Alternative 1

Long-Term Alternative 1 reconditions and modifies the existing GPA system to support part of the proposed load from the GPA grid. In addition, the GPA system would provide a new power generating facility at Cabras/Piti to support the remainder of the required loads and increase the base load capacity of the power system to meet increased base load needs. Oil, diesel, or liquified natural gas (LNG) would be used as fuel.

Long-term power alternative 1 involves T&D upgrades as well as ocean thermal energy conversion or geothermal as potential options for base load alternative energy. The T&D upgrades and the sustainable sources of energy that would lessen the reliance on fossil fuels are described in Section 2.1.5.3, in this volume.

Implementation of Long-Term Alternative 1 is expected to fully meet projected power demands for electrical capacities in 2015. A conceptual design for this alternative would be developed and analyzed in a subsequent tiered NEPA document before implementation. This conceptual design would more accurately determine the required capacity of the new power plant by taking into account any changes to the UFC criteria and any other changes that may occur. The currently proposed capacity of 80 MW may be adjusted. Close coordination with appropriate agencies would be undertaken during the tiered NEPA process. Air modeling for this alternative would be performed and any necessary air permits would be obtained at that time.

3.2.2.4 Long-Term Alternative 2

Long-Term Alternatives 2 recapitalizes and modifies the existing GPA system to support part of the proposed load from the GPA grid and provide a new generating facility at Potts Junction to support the remainder of the required loads. Oil, diesel, or liquified natural gas (LNG) would be used as fuel.

Long-term power alternative 2 involves T&D upgrades as well as ocean thermal energy conversion or geothermal as potential options for base load alternative energy. The T&D upgrades and the sustainable sources of energy that would lessen the reliance on fossil fuels are described in Section 2.1.5.3, in this volume.

Implementation of Long-Term Alternative 2 is expected to fully meet projected year 2015 power demands for electrical capacities. A conceptual design for this alternative would be developed and analyzed in a subsequent tiered NEPA document before implementation. This conceptual design would more accurately determine the required capacity of the new power plant by taking into account any changes to the UFC criteria and any other changes that may occur. The currently proposed capacity of 80 MW may be adjusted. Close coordination with appropriate agencies would be undertaken during the tiered NEPA process. Air modeling for this alternative would be performed and any necessary air permits would be obtained at that time.

3.2.2.5 Long-Term Alternative 3

Long-Term Alternative 3 would rely on GPA to determine the best approach to supply the required power to all their customers, including DoD. Implementation of Long-Term Alternative 3 is expected to fully meet projected year 2015 power demands for electrical capacities. A solution for this alternative would be developed and analyzed in a subsequent tiered NEPA document before implementation. Close coordination with the appropriate agencies would be undertaken during the tiered NEPA process, and air quality modeling for this alternative would be performed and any necessary air permits would be obtained at that time. Long-Term Alternative 3 would involve using existing GPA assets/generating stations and upgrading capacity to meet projected demand increases.

3.2.2.6 Summary of Impacts

The following is a summary of operational impacts on existing utilities that would be associated with increased power demands. Environmental impacts are not included in this section, but are detailed in the individual resource chapters of Volume 6. Analysis of long-term alternatives was not done because those alternatives are not yet ripe for project-specific analysis. Table 3.2-3 shows anticipated supply and demand in 2014 and 2016.

Table 3.2-3. Supply and Demand in 2014 and 2016

Alternatives	*Supply (2014)*	*Demand (2014)*	*Power Surplus (2014)*	*Supply (2016)*	*Demand (2016)*	*Power Surplus (2016)*
Interim Alternative 1	361.84	356.93	4.91	414.47	356.90	57.58
Interim Alternative 2	361.84	356.93	4.91	414.47	356.90	57.58
Interim Alternative 3	361.84	356.93	4.91	414.47	356.90	57.58

Implementation of any of the three interim alternatives would result in adequate power in all years, including the peak year of 2014. However, this scenario is dependent upon reconditioning the required generating units and upgrading the T&D systems in time to meet the increased demand. Should that not happen for some reason, the resulting impacts could be power outages by either brownouts or blackouts. Several potential mitigations are discussed above as a contingency should this scenario occur. See Volume 7 for a discussion on mitigation measures and adaptive management. Table 3.2-4 summarizes the potential impacts on the power utility for the interim alternatives based on successful reconditioning of existing generation units in time to meet the increased demand.

Table 3.2-4. Summary of Interim Alternative Impacts for Power

Potentially Affected Resource	*Interim Alternative 1**	*Interim Alternative 2*	*Interim Alternative 3*
Power	LSI	LSI	LSI

Legend: LSI = Less than significant impact. *Preferred Alternative

Since all power demands are met in the interim by implementation of a selected interim alternative and because the power system would be subject to greater demand but could be operated within existing permitted capacity, the impact of the proposed DoD buildup on the power utility for Interim Alternative 1 was determined to be less than significant. For Interim Alternative 2, all power demands are also met in the interim but air permits for one or more of the power generation facilities would require modifications. While this impact would be greater than Interim Alternative 1, it is still considered less than significant since all interim power needs would be met. Interim Alternative 3 would require upgrades to the Navy generating facility at Orote and modifying the permit for Orote and some of GPA's existing units. While the impact of Interim Alternative 3 is greater than Interim Alternative 1 and similar to Interim Alternative 2, it is still considered less than significant since all interim power needs would be met.

3.2.3 Potable Water

3.2.3.1 Basic Alternative 1 (Preferred Alternative)

DoD Water System

Basic Alternative 1 would consist of installation of up to 22 new potable water supply wells at Andersen Air Force Base (AFB), rehabilitation of existing wells, interconnection with the GWA water system, and associated T&D systems. A new 5 MG (19 ML) water storage tank would be constructed at ground level at Finegayan.

Implementing Alternative 1 would result in a total planned water supply of 27.1 MGd (103 mld) for the DoD water system at buildout (Table 3.2-55) accounting for water transferred to GWA of 3.3 MGd (12.5 mld) from Fena Reservoir. The Navy transfers up to 4 MGd (15 mld) to GWA according to off base demand. Due to GWA's planned expansion, it is projected that in 2019 GWA will require less than the maximum transfer amount specified in the MOU. Currently, the transfer amount to GWA is less than the maximum, averaging approximately 3.5 MGd (13.2 mld). This planned supply is expected to fully meet the projected future DoD maximum daily demand of 27.1 MGd (102.6 mld). The planned supply also meets the projected average daily demand at each military base.

Given the planned supply, the Navy system has adequate water for average daily demand but a shortfall for maximum daily demand of 1.3 MGd (4.9 mld). Presently, based on personal communications with Navy utility managers on Guam, there is no existing water shortage being experienced, except during severe drought periods. The 1.3 MGd shortfall for maximum daily demand is based on planning criteria, which provides guidance for future project programming. Implementation of long-term alternatives would fully resolve the projected shortfall. Alternatively, the shortfall can be addressed through transfer of excess water from northern Guam through the Navy island-wide system. Maintenance to restore the ability to transfer excess water from the Andersen AFB system to the Navy island-wide water system would be needed. If this shortfall occurs, it is possible that water outages or low pressure conditions would take place within the water system. Water outages or low water pressure can result in microbiological and other contaminants entering the distribution system, potentially resulting in illness. Water outages or low water pressure can also prevent effective fire fighting and degrade the basic sanitary needs of the population.

As discussed in Section 2.2.1.1, by using sustainability measures, the Marine Corps base could reduce its estimated maximum daily demand by 40% compared to Unified Facilities Criteria (UFC) guidance. Additionally, the existing bases are expected to comply with Executive Order 13423, which specifies a 16% reduction in water usage over the 2007 baseline by 2015. An estimate of the water demand on the military bases incorporating these adjustments is presented in Table 3.2-6. Table 3.2-6 presents the DoD water supply and demand estimates assuming reductions for compliance with the executive orders regarding water conservation and sustainability efforts for this project. Using an estimate of the revised demand, the planned water supply is sufficient overall and for each base to meet the average daily demand and maximum daily demand.

To meet the increased maximum water demand as the military buildup progresses, construction of planned water components would begin in 2010. Pilot test wells would be drilled to verify the production capacity of the wells, and DoD well development would be coordinated with GWA and would comply with GEPA permit requirements to optimize groundwater withdrawal from the NGLA. Pilot test well results and/or coordination of groundwater withdrawal with GWA could result in some adjustment to the proposed locations of wells.

Table 3.2-5. Potable Water Alternative 1 Proposed DoD Water Supply and Demand

Water Supply Source	*Marine Corps Finegayan*	*Andersen AFB*	*Navy*	*Total*
Cantonment Alternatives 1 & 2				
Current Surface Water Supply			11	11
Current Groundwater Supply		4.7	3.1	7.8
Development of New Water Supply Wells	11.1			11.1
Rehabilitation of Existing Navy Well			0.5	0.5
GWA Transfer Projected Need in 2019			-3.3	-3.3
Planned Supply Cantonment Alternatives 1 & 2	**11.1**	**4.7**	**11.3**	**27.1**
Maximum Daily Demand using UFC Guidance	**10.5**	**4.0**	**12.6**	**27.1**
Projected Excess (Supply – Demand)	0.6	0.7	-1.3	0

Source: NAVFAC Pacific 2008b. *All units are MGd.*

Table 3.2-6. DoD Water Supply and Demand Estimates Using Executive Order Compliance and Sustainability Factor

Water Supply Source	*Marine Corps Finegayan*	*Andersen AFB*	*Navy*	*Total*
Cantonment Alternatives 1 & 2				
Current Surface Water Supply			11	11
Current Groundwater Supply		4.7	3.1	7.8
Development of new water supply wells	6.9			6.9
Rehabilitation of existing Navy well			0.5	0.5
GWA Transfer Projected Need in 2019			-3.3	-3.3
Supply Cantonment Alternatives 1 & 2	**6.9**	**4.7**	**11.3**	**22.9**
Maximum Daily Demand Using Executive Order Compliance and Sustainability Principles	**6.3**	**2.8**	**10.1**	**19.2**
Projected Excess (Supply – Demand)	0.6	1.9	1.2	**3.7**

Source: NAVFAC Pacific 2008b. All units are MGd.

GWA Water System

The GWA water system is not a component of the Alternative 1 water supply. The Navy would continue to transfer up to 4 MGd (15 mld) to GWA under the current memorandum of understanding. As noted above, it is projected that the transfer amount in 2019 will be reduced to 3.3 MGd (12.5 mld) due to GWA planned water system expansion.

Projected initial water demands on the GWA water system are summarized in Table 3.2-7Summarized in Table 3.2-7Error**! Not a valid bookmark self-reference.**, the total civilian demand on the GWA water system (including demand associated with the construction workforce and induced civilian growth) is projected to reach 61.5 MGd (233 mld) in 2014. The GWA water system currently has the capacity to supply 48.4 MGd (183 mld) of potable water. Planned GWA expansions would increase that capacity to 55.4 MGd (210 mld). According to GWA's 2010-2014 capital improvement plan, GWA plans on installing 16 potable wells with a combined capacity of 7 MGd (26 mld). There are shortfalls during the buildup even with GWA's planned expansion. The existing shortfall of 2.3 MGd (8.7 mld) in 2010 increases to a maximum of 6.1 MGd (23 mld) in 2014. To address this shortfall, the DoD is willing to transfer excess water production capacity to GWA, if requested. Alternately, GWA could install more potable water wells or adaptive management practices can be implemented by DoD such as slowing the pace of construction. More information on adaptive management is provided in Volume 7.

Table 3.2-7, which summarizes the existing demand on the GWA water system (including projected increases in civilian demand related to natural population growth), projected increases associated with the imported construction workforce, and civilian increases in demand that would result from induced growth as a result of the military buildup. Demand projections are then compared to the planned GWA potable water supply to identify whether shortfalls would be expected during the construction phase.

Summarized in Table 3.2-7**Error! Not a valid bookmark self-reference.**, the total civilian demand on the GWA water system (including demand associated with the construction workforce and induced civilian growth) is projected to reach 61.5 MGd (233 mld) in 2014. The GWA water system currently has the capacity to supply 48.4 MGd (183 mld) of potable water. Planned GWA expansions would increase that capacity to 55.4 MGd (210 mld). According to GWA's 2010-2014 capital improvement plan, GWA plans on installing 16 potable wells with a combined capacity of 7 MGd (26 mld). There are shortfalls during the buildup even with GWA's planned expansion. The existing shortfall of 2.3 MGd (8.7 mld) in 2010 increases to a maximum of 6.1 MGd (23 mld) in 2014. To address this shortfall, the DoD is willing to transfer excess water production capacity to GWA, if requested. Alternately, GWA could install more potable water wells or adaptive management practices can be implemented by DoD such as slowing the pace of construction. More information on adaptive management is provided in Volume 7.

Table 3.2-7. Projected Water Supply and Demand on the GWA Water System

GWA Water System	*Year*									
	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*
Potable Water Demand[a]										
Existing Guam Civilian[b]	48.9	49.3	49.8	50.2	50.6	51.1	51.5	51.9	52.3	52.7
Construction Workforce	0.6	1.5	2.7	3.3	3.4	2.3	0.7	0.0	0.0	0.0
Induced Civilian Increase	1.2	3.1	5.1	5.9	7.4	5.6	2.8	2.0	2.0	2.0
Total Projected Demand	50.7	54.0	57.5	59.5	61.5	58.9	55.0	53.9	54.3	54.7
Potable Water Supply										
Existing GWA Supply[c]	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4	48.4
Projected Excess before Expansion (Supply-Demand)	-2.3	-5.6	-9.1	-11.1	-13.1	-10.5	-6.6	-5.5	-5.9	-6.3
GWA Planned Expansion[d]	0	0	7	7	7	7	7	7	7	7
Total Planned Supply	48.4	48.4	55.4	55.4	55.4	55.4	55.4	55.4	55.4	55.4
Projected Excess after Expansion (Supply-Demand)	-2.3	-5.6	-2.1	-4.1	-6.1	-3.5	0.4	1.5	1.1	0.7

Notes: All units are MGd. This table does not include GWA's effort to detect and fix leaks, UFW.
[a] Demand is based on a 50% UFW rate and population estimates provided in Volume 6, Table 2.2-5
[b] Includes projected increases in civilian demand related to natural population growth.
[c] Includes 4 MGd transferred from Navy to GWA.
[d] GWA Draft Capital Improvement Plan 2010-2014
Source: GWA 2007.

If this shortfall occurs, water outages or low pressure conditions could take place in parts of the water system. Water outages or low water pressure can result in microbiological and other contaminants entering the distribution system potentially resulting in illness. Water outages or low water pressure can also potentially prevent effective fire fighting and degrade the basic sanitary needs of the population. Water rationing may be implemented. It is probable that the impacts would fall disproportionally on the low income and poor.

The baseline condition of the GWA water system is described in the GWA WRMP. The overall condition of the water system equipment is identified as poor with substantial corrosion in all infrastructure. The water system has a 50% UFW rate compared to an acceptable rate of 15% or less. Problems with the GWA infrastructure result from the effects of natural disasters, poor maintenance, and vandalism. According to the WRMP, the water system infrastructure does not meet the basic flow and pressure requirements for all customers. Maintenance to improve the system has been conducted since the water system assessment was made in 2005. GWA plans improvements to the distribution system principally to improve continuity of the water supply. Improvements include a corrosion program, pipe and equipment replacement, distribution system improvements, northern system raw water transmission line improvements, and filtration compliance for groundwater under the direct influence of surface water.

The projected water demand for the Guam civilian population throughout 2010-2019, not including the effects of the military buildup, exceeds the current GWA water system capacity. To meet the projected demand on the GWA water system, it is imperative that the GWA begin planned expansions by 2010. In preparation for the military buildup, and to complete the remaining capital improvements, GWA has prepared a 5-year CIP for fiscal years 2010-2014. The CIP would be financed through surplus system revenues, grants, and loans (Reuters 2009; Deloitte Touche Tohmatsu 2008). Significant rate relief is anticipated. It is assumed that water supply expansions would be funded through collection of user fees from GWA customers. This would include user fees to be paid by contractors funded by the DoD that would be providing housing for construction workers.

The GWA program has not been presented to DoD in detail; however, discussions have been initiated between GWA and DoD to begin working through the details to coordinate GWA support for the proposed buildup. One example of the coordination efforts is a proposal for co-management by GWA and DoD of the Northern Guam Lens Aquifer. Given the information provided in recent CIP, the proposed GWA expansion is not sufficient to meet the added demand resulting from the buildup.

As shown in Table 3.2-7, housing for the construction workers, which are expected to reach a maximum population of approximately 18,000 in 2014, is expected to create increased demand for water in northern Guam by up to 3.4 MGd (12.9 mld). GWA has indicated to DoD that it will require new sources of water to meet the expected demand related to the buildup. GWA does not have the resources or the time to correct their unaccounted for water problem, estimated to be approximately 50% in order to use this water for the new demand. As presented in the CIP, GWA sees new wells as their option to partially meet this new demand and they have prepared a plan that identifies numerous potential well sites. Although, GWA currently has plans to drill wells in the near future, much of this water will offset wells that are being shutdown or subjected to reduced pumping due to high chlorides. GWA has indicated that they do not possess the financial resources to drill new wells in time to meet the early demands expected as a result of the buildup. In the CIP, well construction is identified in 2012.

With the standup of the Joint Region Marianas, the Region is in the process of evaluating the overall capacity of the joint DoD water system on Guam. Although this evaluation is in its infancy, there may potentially be 3 MGD of water that could be transferred to assist GWA with its water needs in northern Guam while they drill wells and install the associated infrastructure. Navy surface water resources may also be available to GWA in addition to the current allotment of up to 4 MGd.

Discussions between DoD and GWA can facilitate an understanding of the total impact of the development on the community infrastructure, the NGLA, the NDWWTP and on the construction progress. Although control of where temporary housing for construction workers is located resides with construction contractors and Gov Guam through its planning process, DoD is interested in avoiding adverse impacts through effective planning. Contractors proposing workforce housing will be responsible for coordinating site approvals and permits with local Guam planning and zoning agencies, and with GWA. DoD can require minimum housing standards for worker housing through contract provisions and selection criteria, which should guide the contractors to select locations with adequate utility infrastructure.

Northern Guam Lens Aquifer

"Sustainable yield" is defined as the rate at which groundwater can be continuously withdrawn from an aquifer without impairing the quality or the quantity of the pumped water. The peak average well withdrawal from the NGLA is shown in Table 3.2-8. The estimated well production includes the average daily demand for the Marine Corps relocation, Andersen AFB, and Navy Hospital; and the average daily demand for GWA population in north and central Guam excluding the demand met by surface water resources (up to 4 MGd (15 mld) transferred from Fena Reservoir). Although the Main Cantonment is proposed to be located on the Finegayan subbasin, most of the groundwater supply would be taken from Agafa-Gumas and Andersen subbasins because the Finegayan subbasin is near capacity.

Table 3.2-8. Total Well Withdrawal and Yield Estimates Projected for 2014 (Peak Year)

Wells	*Total*
GWA Maximum Average Daily Demand on Groundwater Resources	56
Cantonment Alternatives 1 & 2	
DoD Estimated Average Daily Demand on Groundwater Resources based on UFC (Finegayan, Andersen AFB, and Navy Hospital)	7.5
Total Well Withdrawal (Using UFC)	63.5
DoD Estimated Average Daily Demand based on Sustainability	6.5
Total Well Withdrawal (Using Sustainability)	**62.4**

In order to compare the estimated available yield of the NGLA with the demand at full build, Table 3.2-8 presents the approximate DoD and civilian well withdrawal assuming average daily demand at the Marine Corps base and off base. Because sustainable yield defines the rate at which groundwater can be *continuously* withdrawn from an aquifer without impairing the quality or the quantity of the pumped water, it is more appropriate to consider the average daily demand instead of the maximum daily demand when assessing potential impacts on the aquifer. Total average well demand from the NGLA of 63.5 MGd (240 mld) is below the 1991 sustainable yield estimate of 80.5 MGd (305.7 mld) but exceeds the 1982 sustainable yield estimate of 57.5 MGd (217.7 mld). However, as discussed in Chapter 2, the 1991 estimate is considered a more accurate estimate of the sustainable yield.

A sensitivity analysis was performed to determine the effect of using the average DoD daily demand estimates and various GWA UFW loss rates on the available yield of the NGLA. Figure 3.2-1 graphically represents the effect of reducing GWA's UFW loss rate, with DoD and GWA wells producing enough water to meet the average daily demand. With adequate well water withdrawal to meet the DoD and GWA average daily demands, peak well withdrawal would occur in 2014, with well withdrawal rates ranging between 64 MGd (242 mld) and 50 MGd (189 mld), depending on the UFW loss rate assumed for GWA. Note that DoD plans to support an updated sustainable yield study to be completed by the USGS. Please refer to Volume 6 Chapter 2 for more information regarding this future study.

As shown in Figure 3.2-1, planned DoD well expansion would not exceed the estimated sustainable yield and would therefore have less than significant impact on the NGLA.

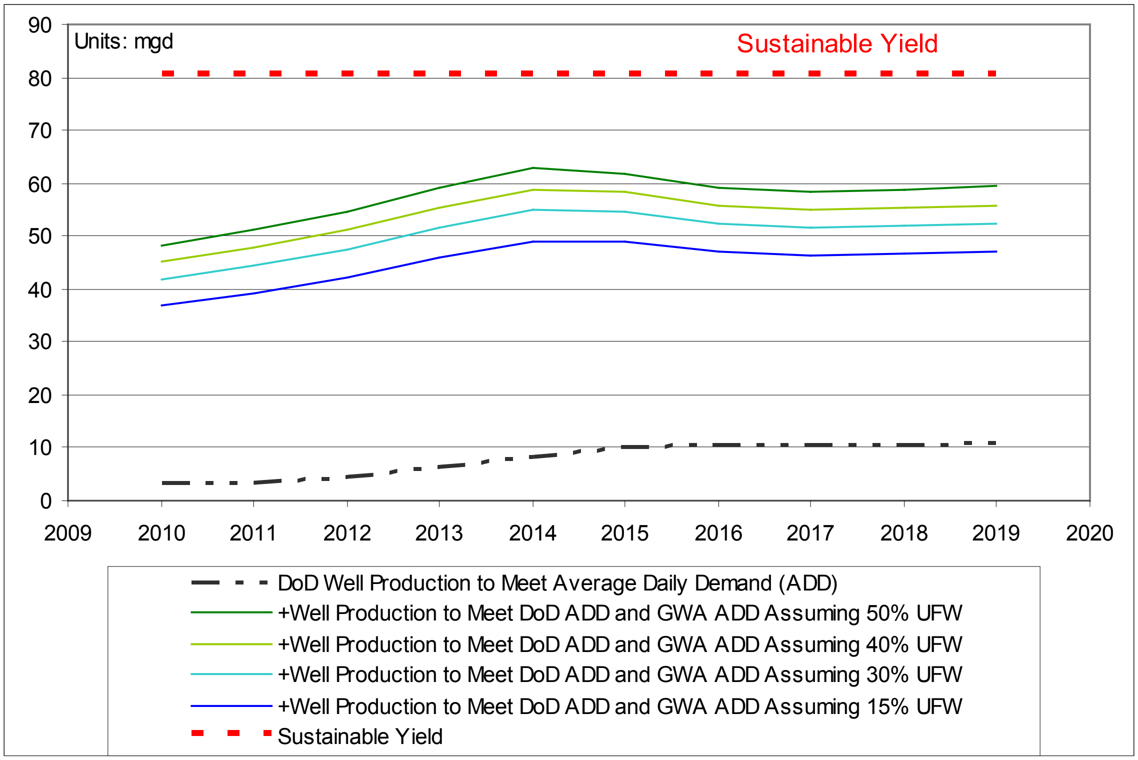

Figure 3.2-1. Well Withdrawal to Meet DoD Average Daily Demand and GWA Average Daily Demand (15-50% UFW for GWA)

Potential Mitigation Measures

Mitigation for Potential GWA Potable Water Shortfalls within DoD Control

If enough new planned GWA wells are not brought online by 2010, the proposed project has the potential to result in significant impacts on the Guam water supply. To mitigate those impacts, DoD could transfer excess water production capacity to GWA, if requested. Current assessments indicate the Andersen Air Force Base water system has well production capacity in excess of current and future Air Force requirements. Additionally, the wells at NCTS Finegayan can produce more than is presently needed by NCTS. However, some of the excess water well capacity at NCTS would be needed to support the on-base construction activities at Finegayan. Thus, in the northern DoD water system, there would be excess water production capacity that could be made available to GWA to meet their interim requirements. GWA would need to formally request this support through the Region's Utilities Department, who would determine water availability and appropriate rates reimbursement. The DoD expects that GWA or the developer requesting additional water would install the necessary piping to make the interconnections with DoD water systems.

The availability of excess DoD water production capacity to GWA water systems may be encumbered by the following:

- The lack of interconnections points between the former AAFB water system and the Navy island-wide system may increase the effective distance between the GWA water system requiring additional water and the DoD water resource
- Poor condition of certain DoD water mains that may require line segment replacement in order to interconnect

- Repair and maintenance of wells would periodically reduce DoD water supplies
- Droughts would reduce the capacity of DoD water production capacity
- Unforeseen increases in future DoD water demands that would reduce the excess water supply available to GWA

DoD would also undertake adaptive management, such as adjusting the construction tempo if off-base water demand from construction workforce housing and induced population growth outpace available supply and infrastructure. Adaptive management is discussed in more detail in Volume 7.

Mitigation for Potential GWA Potable Water Shortfalls outside DoD Control

Alternatively, GWA could implement improvements to reduce water losses associated with UFW. UFW is water that is not metered, such as the water lost through leaks or use without meters. GWA initiated a water loss control program in 2005 (GWA 2007). If the program were to reduce the UFW from the estimated 50% loss rate to approximately 40% by 2013, sufficient supply would be available within the GWA water system to meet the increased demand. This level of reduction is consistent with GWA's stated reduction goal of 20% for an aggressive but reasonable water loss program over a 5- to 10-year period (GWA 2007).

GWA would have the ability to assess a system development charge (SDC) to contractors and workforce housing developers that could be used to fund improvements to the water system. To address the timing gap between availability of SDC funds and construction of needed improvements to meet the anticipated demands, GWA may request an interconnection with the DoD water system, as discussed above, or seek other USGOV funding sources. These options would minimize impacts to existing rate payers.

Finally, if the GWA cannot meet the projected increase in demand resulting from induced civilian growth, GovGuam could implement measures to control the rate of induced growth through the building permit process and/or by restricting the number of water and sewer connection requests that are approved. Limitations on permits and water or sewer connections could delay completion of the DoD buildup.

GWA could also accelerate their leak detection program, which would reduce apparent water demand and eliminate the shortfall. Through the workforce housing permit approval process, GovGuam may charge development impact fees that could enhance financing options that could go toward acceleration of projects to improve the GWA water system.

Mitigation for Potential Impacts on NGLA

As a result of the ongoing discussions between GWA, CCU and DoD representatives, which culminated in a face-to-face meeting on October 7-8, 2009, it was generally agreed that a joint planning effort was needed for water resource development in the Northern Guam Lens Aquifer (NGLA) to ensure responsible development and preservation of the sole source aquifer. This could be done with an advisory panel composed of representatives from the various stake holders. Some of the proposed responsibilities of the advisory panel included:

- Co-management of the NGLA
- Measures to protect the NGLA
- Well placement
- Water exchange
- Rate structure
- Interconnections
- Well Head protection

- Support for workforce housing and DoD special purpose entity (SPE) housing

Additionally, as part of the adaptive management process, monitoring of groundwater quality during well development and use would be performed to ensure that increased pumping does not adversely affect the NGLA. Careful monitoring of the chloride concentrations in the subbasins and the capability to shift demand to wells farther from affected subbasins would reduce any potential negative impacts on groundwater. Additional details on mitigation are provided in Volume 7.

3.2.3.2 Basic Alternative 2

DoD and GWA Water Systems

Basic Alternative 2 would consist of installation of up to 20 new potable water supply wells at Andersen AFB, up to 11 new potable water supply wells at Barrigada, rehabilitation of existing wells, interconnection with the GWA water system, associated transmission and distribution systems upgrades. Additionally, new 3.6 MG (13.6 ML) and 1 MG (3.8 ML) water storage tanks would be constructed at ground level at Finegayan and Barrigada, respectively. Therefore, impacts on the DoD and GWA water systems under Alternative 2 would be similar to those described for Alternative 1.

Northern Guam Lens Aquifer

Total DoD and GWA well production estimates under Alternative 2 would be similar to those described for Alternative 1 (Section 3.2.3.1). However, relocation of water supply wells to Navy Barrigada would change well production estimates by aquifer subbasin. Well withdrawal within the Agana and Mangilao subbasins (Volume 6 Chapter 2 Figure 2.2-3) would increase by approximately 3.3 MGd (12.5 mld). The peak average well withdrawal from the NGLA is shown in Table 3.2-9. The estimated well withdrawal includes the average daily demand for the Marine Corps relocation, Andersen AFB, and Navy Hospital; and the average daily demand for GWA population in north and central Guam excluding the demand met by surface water resources (up to 4 MGd (15 mld) transferred from Fena Reservoir).

Table 3.2-9. Total Well Withdrawal and Yield Estimates Projected for 2014 (Peak Year)

Wells	*Total*
GWA Maximum Average Daily Demand on Groundwater Resources (2014)	56
Cantonment Alternatives 3 and 8	
DoD Additional Average Daily Demand on Groundwater Resources based on UFC (Finegayan, Andersen AFB, and Navy Hospital)	8.9
Total Well Withdrawal (Using UFC)	64.9
DoD Additional Average Daily Demand based on Sustainability Estimates	7.8
Total Well Withdrawal **(Using Sustainability)**	**63.8**

Potential Mitigation Measures

Potential mitigation measures would be as described for Alternative 1.

3.2.3.3 Long-Term Alternative 1

Develop Lost River

Development of the Lost River (Tolaeyuus River) is considered a long-term alternative to provide additional supply to the Navy water system during the dry season. It is estimated that the Lost River supply would yield 1.7 to 5.6 MGd (6.4 to 21 mld) during the dry season, based on the U.S. Geological Survey (USGS) data collected between 1998 and 2001. Supply from the Lost River would be limited by downstream habitat considerations. The U.S. Fish and Wildlife Service has identified a minimum conservation flow of 1 cubic foot per second (0.03 cubic meters per second). The existing cofferdam would be rehabilitated, the reservoir area dredged, and a pump station and discharge pipeline would be installed for distributing the supply to the existing Fena Reservoir pump station. The water would be delivered either to the Navy reservoir or the Fena WTP. The capacity of the WTP and Navy distribution system would not be expanded, because the added supply is needed to compensate for the drawdown on the Navy reservoir during the dry season. Additional study is required to define the conceptual design of this alternative.

No mitigation measures are considered at this time since this is a programmatic level long-term alternative.

3.2.3.4 Long-Term Alternative 2

Desalination

Desalination (removal of salt) of brackish water by reverse osmosis is a long-term alternative to meet projected DoD water demands in the event that the supply from freshwater wells is insufficient to meet DoD demand. Desalination of brackish water would replace the development of up to 31 new potable water supply wells at Andersen AFB and Barrigada.

No mitigation measures are considered at this time since this is a programmatic level long-term alternative.

3.2.3.5 Long-Term Alternative 3

Dredge Fena Reservoir

Sediment dredging of the Navy Reservoir is included as a long-term option. This option is retained as part of the ongoing maintenance of the reservoir and to provide additional supply to DoD in southern Guam by increasing the storage capacity of the reservoir up to the original design capacity. Additional assessment is required to address potential obstacles related to mobilizing a dredge over long distances to the project site, which is in a remote location, as well as logistical difficulties in managing dredged material on Guam.

No mitigation measures are considered at this time since this is a programmatic level long-term alternative.

3.2.3.6 Summary of Impacts

Table 3.2-10 summarizes the potential impacts of each basic alternative. An analysis of long-term alternatives was not developed because those alternatives are not ready for project specific analysis. A text summary is provided below.

Table 3.2-10. Summary of Potential Potable Water Impacts

Potentially Affected Resource	*Basic Alternative 1**	*Basic Alternative 2*
DoD Water System	LSI	LSI
GWA Water System	SI-M	SI-M
NGLA	LSI	LSI

Potentially Affected Resource	Basic Alternative 1*	Basic Alternative 2

Legend: SI-M = Significant impact mitigable to less than significant; LSI = less-than-significant impact. *Preferred Alternative

Implementation of Potable Water Basic Alternative 1 would result in a total planned water supply of 27.1 MGd (104 mld) for the DoD water system to serve the Marine Corps relocation. This planned supply is expected to fully meet the projected future DoD demand of 27.1 MGd (103 mld). Therefore, the proposed military buildup would have less-than-significant impact on the existing DoD water system.

There are projected shortfalls in the GWA system considering the existing supply and the planned well expansion defined in GWA's draft Capital Improvements Plan for 2010-2014. The increased demand of the construction workforce and induced civilian growth would occur fairly rapidly and is expected to challenge GWA to implement their expansion plans in a very short time. GWA continues to improve their system through maintenance efforts including an ongoing leak detection and repair program. GWA may request water supply from the DoD system. Current projections indicate that there will be water available in the DoD water system for transfer to GWA. If water supply is still inadequate, GovGuam could implement measures to control the rate of induced growth. Additionally, DoD can reduce the pace of contract awards. For this reason, the projected impact on the GWA water system is deemed significant but mitigable by GWA accelerating their system improvements adequately to meet the increased demand and/or the DoD transfer excess water production capacity to GWA in the interim to meet the increased demand, and reduction of the buildup pace through GovGuam permitting and slowing the rate of contractor award by DoD. Additionally, the projected GWA demands may be overstated since the UFW rate used in calculations is based on information in the 2007 GWA WRMP may have been significantly reduced through maintenance.

Planned DoD well expansion would increase groundwater withdrawal from the NGLA but would not exceed the estimated sustainable yield and would therefore have less than significant impact on the NGLA. If ground water monitoring data indicates the groundwater withdrawal by DoD would compromise the sustainable yield of the NGLA, the DoD would pursue other long-term alternatives or other mitigation measures, including adaptive management. These mitigation measures are discussed further in Volume 7.

The summary of impacts for Basic Alternative 2 are the same as described for Basic Alternative 1.

3.2.4 Wastewater

As explained in section 3.1.3, the GWA NDWWTP would handle most of the increased wastewater treatment demand from the DoD buildup. The Navy Apra Harbor WWTP would handle the increased wastewater treatment demand for all increases at Apra Harbor, such as the shipboard transient population. The Navy Apra Harbor WWTP has been shown to have adequate current capacity, both physically and in its permit, to handle the estimated future wastewater demand. The GWA Hagatna WWTP would handle some of the increased wastewater treatment demand from the construction workforce and increased civilian population. Hagatna WWTP has been shown to have adequate capacity to handle this estimated increased demand. Thus, only the NDWWTP is analyzed for environmental consequences in this section.

As a result of the proposed military buildup, if Cantonment Alternative 1 or 2 is selected, the total year 2019 average daily flows to the NDWWTP from military and civilian sources are projected to increase to 11.5 MGd (43.7 mld). (Table 2.3-4). If Cantonment Alternative 3 or 8 is selected, the total year 2019 end state average daily flows to the NDWWTP from military and civilian sources are projected to increase to 11.5 MGd (43.7 mld). (Table 2.3-7). The year 2019 flow projections for these plants account for increased DoD wastewater flows to be generated by DoD active duty personnel and their dependents and by the on-base civilian workforce. The projected year 2019 wastewater flow also accounts for GWA forecasts for growth of the natural civilian population and induced growth of civilians caused by the military buildup in both northern Guam and central Guam.

Including these sources, the projected end state increase in wastewater flow in northern Guam as a result of the military buildup would not exceed the NDWWTP's design capacity of 12 MGd (45 mld). At the end state, however, the permit limit of 6.0 MGd (23.0 mld) would still be exceeded, and the plant would still need refurbishment to restore it to the original design capacity. A socioeconomic analysis of the proposed military buildup has estimated that induced civilian growth as a result of the military buildup could increase the island-wide population on Guam by up to approximately 40,000 in the peak year of 2014. Assuming this induced growth would be evenly distributed among the north, central, and Apra Harbor regions of Guam, the induced civilian demand for wastewater treatment in northern Guam is estimated to reach 1.6 MGd (6.0 mld) of water in both northern and central Guam. The construction workforce would generate up to an additional 1.5 MGd (5.7 mld) of wastewater flow to be treated at the NDWWTP in the peak year of 2014.

Thus, while the year 2019 wastewater treatment demand estimates would be within the physical capability of the NDWWTP design basis, the demand would peak in 2014 with the combined impacts of the Marine Corps relocation, construction workforce, and civilian growth and be in excess of that physical capacity at approximately 12.8 MGd average. In addition, the regulatory scenario requires attention regarding permit and secondary treatment issues.

3.2.4.1 Basic Alternative 1a (Preferred Alternative) and 1b

Basic Alternative 1 (Alternative 1a supports Main Cantonment Alternatives 1 and 2; and Alternative 1b supports Main Cantonment Alternatives 3 and 8) combines upgrade to the existing primary treatment facilities and expansion to secondary treatment at the Northern District Wastewater Treatment Plant (NDWWTP).The difference between Alternatives 1a and 1b is a requirement for a new sewer line from Barrigada housing to NDWWTP for Alternative 1b.

<u>Basic Alternative 1a</u>

Projected wastewater flows to the NDWWTP are summarized in Table 3.2-11. Table 3.2-11 also summarizes existing Guam civilian and DoD flows, projected increases in flows from Guam civilians related to natural population growth, projected DoD increases associated with the military buildup, increases associated with the imported construction workforce, and civilian increases that could result from induced growth under Main Cantonment Alternatives 1 and 2 for northern Guam.

Table 3.2-11. Projected Wastewater Flows to the NDWWTP under Main Cantonment Alternatives 1 and 2

Source of Wastewater Flow	*Year*									
	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*
Existing Guam Civilian	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20
Existing DoD	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
Guam Civilian Increase	0.42	0.64	0.85	1.06	1.26	1.47	1.67	1.87	2.07	2.26
DoD Increase	0.24	0.48	0.53	0.57	2.71	2.95	2.99	3.03	3.07	3.12
Construction Workforce	0.26	0.66	1.14	1.43	1.47	0.97	0.30	0.00	0.00	0.00
Subtotal Direct DoD And Guam Civilian	**6.65**	**7.50**	**8.25**	**8.79**	**11.17**	**11.11**	**10.69**	**10.62**	**10.86**	**11.11**
Induced Civilian Increase	0.27	0.66	1.08	1.27	1.58	1.19	0.61	0.42	0.42	0.43
Total Flow – All Sources	**6.92**	**8.16**	**9.33**	**10.05**	**12.75**	**12.31**	**11.29**	**11.04**	**11.28**	**11.54**

Source of Wastewater Flow	*Year*									
	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*

Note: All units are in million gallons per day.
Source: NAVFAC Pacific 2008c.

DoD wastewater flows include all on-base DoD wastewater flows that would be generated by active duty personnel and their dependents, the on-base civilian workforce, and industrial flows from on-base facilities. Increased wastewater flow from induced civilian growth resulting from the military buildup is included.

Wastewater flows to the NDWWTP from military and civilian sources are projected to increase to a peak of 12.8 MGd (48.3 mld) in 2014, which is somewhat more than the design capacity of 12 MGd (45 mld). Adding chemical coagulants or increasing the surface overflow rate (within the normal design range) of the clarifier would improve plant operations so that the primary clarifier would be able to treat the additional 0.8 MGd (2.8 mld) without adverse effects on the NDWWTP. However, the permit limit of 6 MGd (23 mld) would still be exceeded, and the plant would still need refurbishment and upgrades to restore it to the original design capacity.

Implementing Basic Alternative 1a would accomplish the required refurbishment of the NDWWTP to accept the projected increase in wastewater flows. DoD would coordinate with GWA to expedite the planned improvements and request for a NPDES permit modification to increase the effluent discharge limitation from 6.0 MGd (22.7 mld) to 12.0 MGd (45.4 mld), then comply with its modified NPDES permit requirements.

Under Basic Alternative 1, all military-generated wastewater, either from Andersen AFB or from the proposed Marine Corps relocation, would be conveyed to the NDWWTP for treatment. All flows from the current and proposed future military buildup at Andersen AFB would be conveyed through the existing GWA sewer to the NDWWTP, while wastewater flow generated from the proposed Marine Corps relocation at Finegayan would be conveyed via a new relief sewer line to the NDWWTP (as shown in Figure 2.3-2). The proposed modifications to the NDWWTP primary treatment system and collection system should be completed by 2013.

This alternative also provides secondary treatment at NDWWTP to comply with USEPA requirement to meet Guam Water Quality Standards. A trickling filter system is proposed as the secondary treatment process. The following new process components and upgrades would be required at the NDWWTP for this alternative:

- Four trickling filter
- Four secondary clarifiers
- Two additional anaerobic digesters (the same size as existing ones)
- One additional centrifuge solids-dewatering system and odor control

The new ocean outfall that was put into service in December 2008 at the NDWWTP would provide enough capacity to handle disposal of the increased long-term future flows.

These upgrades are same to support either Main Cantonment Alternatives 1 and 2 or Main Cantonment Alternatives 3 and 8. The proposed secondary treatment upgrades to the NDWWTP should be completed by 2016

<u>Basic Alternative 1b</u>

Basic Alternative 1b supports the proposed Main Cantonment Alternatives 3 and 8. This alternative includes upgrades to the NDWWTP to allow wastewater generated at Barrigada housing site to be conveyed to the GWA NDWWTP for treatment. Those upgrades to the NDWWTP would be identical to those described under Basic Alternative 1a, and will not be repeated here.

Under this alternative, a new sewer line and two pump stations would need to be installed to convey wastewater generated at Barrigada to the GWA NDWWTP for treatment. The primary-treatment facilities of the NDWWTP would be refurbished and upgraded to accept the additional DoD flows and military buildup–related flows in northern Guam. The estimated wastewater flows to the NDWWTP under Main Cantonment Alternatives 3 and 8 are shown in Table 3.2-11.

Table 3.2-12. Projected Wastewater Flows to the NDWWTP under Main Cantonment Alternatives 3 and 8

Source of Wastewater Flow	*Year*									
	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*
Existing Guam Civilian	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20	5.20
Existing DoD	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
Guam Civilian Increase	0.42	0.64	0.85	1.06	1.26	1.47	1.67	1.87	2.07	2.26
DoD Increase	0.24	0.48	0.53	0.57	2.71	2.95	2.99	3.03	3.07	3.12
Construction Workforce	0.26	0.66	1.14	1.43	1.47	0.97	0.30	0.00	0.00	0.00
Subtotal Direct DoD and Guam Civilian	**6.65**	**7.50**	**8.25**	**8.79**	**11.17**	**11.11**	**10.69**	**10.62**	**10.86**	**11.11**
Induced Civilian Increase	0.27	0.66	1.08	1.27	1.58	1.19	0.61	0.42	0.42	0.43
Total Flow – All Sources	**6.92**	**8.16**	**9.33**	**10.05**	**12.75**	**12.31**	**11.29**	**11.04**	**11.28**	**11.54**

Note: All units are in million gallons per day.
Source: NAVFAC Pacific 2008c.

Under Alternative 1b, new sewer line would need to be installed to convey wastewater generated at Barrigada to the GWA NDWWTP for treatment. Figure 2.3-3 indicates the most likely routing of the proposed sewer lines. The proposed sewer lines and pump station should be completed by 2013.

Potential Mitigation Measures

Potential mitigation measures have been divided into two categories: those within DoD control and those outside of DoD control. The following potential mitigations cover the condition of demand exceeding the design capacity of the NDWWTP and assume that the near-term upgrades of the primary treatment system and permit issues would have been resolved.

Potential mitigations within DoD control:

1. The construction tempo could be reduced to reduce the peak construction workforce. This is discussed further in Volume 7 under adaptive management.
2. The execution of construction could be incentivized to reduce on-island construction workforce requirements by using off-island prefabrication techniques and/or sequencing labor intensive construction activities in such a way to reduce the peak construction workforce needs.

Potential mitigations outside of DoD control:

1. Adding chemical coagulants or increasing the surface overflow rate (within the normal design range) of the clarifier would improve plant operations so that the primary clarifier would be able to treat the additional 0.8 MGd (2.8 mld) without adverse effects on the NDWWTP. This should also be done with advance regulatory approval.
2. The collection system could be inspected and upgraded to minimize inflow and infiltration to reduce the demand.
3. The construction workforce housing could be located where a different WWTP would support the wastewater treatment needs. This could reduce the demand at NDWWTP by 1.47 MGd (mld). This one mitigation would reduce the peak flow to the NDWWTP to 11.3 MGd (mld), within the design capacity of the NDWWTP. GovGuam could manage this through their permitting process.
4. The Navy anticipates that special purpose entities will be formed to operate, manage, upgrade or develop utility plants and associated infrastructure such as collection or distribution systems. The precise manner in which these private business entities would operate is not known but the Navy anticipates they will receive financing from the Government of Japan under the agreement reached between the U.S. and Japan regarding relocation of Marines from Okinawa to Guam. The Navy will not exercise any authority or control over the SPEs but is committed to facilitate discussions between GOJ, the SPE and Guam to focus SPE efforts on addressing utility impacts associated with the short-term construction work force and long term population growth.

3.2.4.2 Long-Term Alternative 1

Long-term Alternative 1 consists of a phased implementation of refurbishment to the primary treatment system at the NDWWTP to address the interim wastewater treatment needs and the addition of a secondary wastewater treatment plant on DoD property with its own outfall as a long-term wastewater treatment solution. The proposed modifications to the primary treatment facilities at the NDWWTP would be the same as described in Basic Alternative 1 covered in Section 3.2.4.1 and is not repeated here. Projected interim wastewater flows to the NDWWTP are summarized in Tables 3.2-11 and 3.2-12. Tables 3.2-11 and 3.2-12 also summarizes existing Guam civilian and DoD flows, projected increases in flows from Guam civilians related to natural population growth, projected DoD increases associated with the military buildup, increases associated with the imported construction workforce, and civilian increases that could result from induced growth under Main Cantonment Alternatives 1, 2, 3, and 8.

The final phase consists of construction of a DoD only primary/secondary wastewater treatment facility at Finegayan on DoD land with its own outfall. The collection sewer would be changed to take wastewater from Finegayan directly to this new treatment plant. Should Main Cantonment Alternative 3 or 8 be chosen, the sewer modification would be expanded to extend the sewer from Barrigada to the existing GWA sewer that feeds NDWWTP all the way to this new DoD treatment plant. This final phase is a long-term alternative and will be addressed programmatically.

3.2.4.3 Summary of Impacts

Table 3.2-13 summarizes the potential impacts of the basic alternative, including the interim phase for long term alternative, shown below as impacts on NDWWTP treatment capacity and water quality. An analysis of long-term alternative was not developed because the alternative is not ready for project-specific analysis. A text summary is provided below.

Table 3.2-13. Summary of Potential Wastewater Impacts

Potentially Affected Resource	*Basic Alternative 1**
NDWWTP Treatment Capacity	SI-M
Water Quality (short/intermediate term)	LSI/BI

Legend: SI-M = Significant impact mitigable to less than significant, LSI = Less than significant impact, BI = Beneficial impact. * Preferred Alternative

Implementation of Basic Alternative 1, which is the Preferred Alternative, would accomplish the required refurbishment of the NDWWTP primary treatment system to accept the projected increase in wastewater flows such that there would be no impact on the NDWWTP ability to physically handle the increased interim wastewater flows. However, permit modifications would be required and interim increased wastewater flows would temporarily exceed the design capacity of the plant. Thus the impact to the NDWWTP from the proposed DoD buildup is deemed significant with potential mitigation of upgrades, permit modifications, and alterations of operations when the flow exceeds the design capacity.

During the time when NDWWTP would be operating only primary treatment, the ocean water quality might degrade some due to the increased flow, but that would be offset by the improved operation from the refurbishment. Thus near-term water quality is expected to be impacted in a less than significant manner. In the intermediate term, after the secondary treatment capability has been constructed and become operational, the impact to water quality would be beneficial due to the improved quality of the effluent. Impacts to water quality and the marine environment are expected to be the same as those described for Basic Alternative 1.

3.2.5 Solid Waste

3.2.5.1 Basic Alternative 1 (Preferred Alternative)

The Preferred Alternative for solid waste would be the continued use of Navy Landfill at Apra Harbor until Layon Landfill is opened, which is scheduled for July 2011. In July 2011, DoD would use GovGuam's Layon Landfill for disposal of municipal solid waste as set forth in the letter of intent (see Appendix C).

As described in Section 2.4.2, the Navy Sanitary Landfill has the potential for providing 10 years of capacity (until 2019) based on the computed demand in Table 2.4-2 (506,954 tons [459,900 metric tons]) and a capacity of 1,200,000 yd^3 (917,500 m^3) or 540,000 tons (490,000 metric tons), assuming a landfill height of 54 ft (16 m) above msl and minor operational improvements. Such operational improvements include reducing the daily cover to that which is required and using larger compaction equipment to achieve greater densities. Because the Navy Sanitary Landfill is unlined, leachate has the potential to affect the underlying groundwater. Studies are currently underway to assess whether or not the underlying groundwater has been affected by leachate. The conclusions of these studies show that further action may be required.

This alternative would also consist of using the planned new GovGuam landfill in Layon. The site selected for the Layon Landfill is approximately 317 ac (128 ha) in size, with a landfill footprint of 127.4 ac (52 ha). Based on studies of future solid waste disposal quantities in GEPA's ISWMP (GEPA 2006), GEPA and Guam DPW established a minimum design capacity of 14 million CY (11 million m^3) as an estimate of the volume required to manage Guam's municipal solid waste for a 30-year period. Based on detailed design documents completed since the ISWMP was completed, the Layon Landfill is estimated to have a capacity of 15.8 million yd^3 (12 million m^3) or 9.5 million tons (8.6 million metric tons), assuming an in-place density of 1,200 lbs/ yd^3 (TG Engineers 2009).

The landfill would be constructed in phases, with Cells 1 and 2 scheduled for construction at the same time, in July 2011. Cells 1 and 2 would cover approximately 11.1 ac (4.5 ha) and 11.3 ac (4.6 ha), respectively, with a combined waste capacity of 1.4 million yd^3 (1.1 million m^3) (GEPA 2009). Table 2.4-4 presents the projected solid waste generation rates from both the military buildup and the civilian Guam population by year. Solid waste rates are shown as two categories: DoD solid waste and Guam general population solid waste. These two categories were added together to determine total estimated solid waste in tons, which were then converted into cubic yards. In 2014, Cells 1 and 2 would have reached their capacity and would have provided approximately 4 years of useful life. The operations plan for the Layon Landfill (TG Engineers 2009) indicates that subsequent disposal cells would normally be constructed at intervals of 2-5 years. Therefore, the demand from the military buildup would not have a significant impact on the short-term capacity of the Layon Landfill.

Table 2.4-4 also provides an estimate of when the Layon Landfill would reach its ultimate capacity from solid waste generated by DoD and the Guam general population. Using a landfill airspace capacity of 15.8 million yd^3 (12.0 million m^3), the table indicates that the landfill would reach capacity in 2043, 32 years after opening. The estimated 32 years of capacity is greater than the 30 years used by Guam DPW and GEPA for planning and designing of the Layon Landfill; therefore, the military buildup would not have a significant impact on the long-term capacity of the landfill.

GovGuam completed the *Final Supplemental Environmental Impact Statement for the Siting of a Municipal Solid Waste Facility, Guam* (Guam DPW 2005) in July 2005. The report evaluated all aspects of siting a new landfill, including potential impacts on geology, groundwater, soils, air quality, noise, hydrology, water quality, wetlands, coastal zone management, vegetation, wildlife, aquatic ecology, land use, zoning, demographics, economics, recreation, sensitive receptors, utilities, road network, energy use and conservation measures, public health/safety, aesthetics, archaeological resources, and historical resources. Whenever impacts from the landfill development were identified, suitable mitigation measures were developed.

Currently two studies are being conducted regarding solid waste reduction. The first study is related to municipal solid waste recycling for long term DoD waste generation on Guam, including waste generated as part of the military buildup. The second study is related to construction and demolition debris associated with the construction phase of the military buildup. The construction and demolition debris study will estimate the quantity of material generated and what portion of the material could be potentially reused. Following completion of these studies, it is anticipated the recommendations presented in the respective study would result in a reduction in solid waste generation, thereby minimizing impacts related to solid waste disposal.

Potential Mitigation Measures

No mitigation measures are required.

3.2.5.2 Summary of Impacts

Table 3.2-14 summarizes the potential impact of the Preferred Alternative. A text summary is provided below.

Table 3.2-14. Summary of Potential Solid Waste Impacts

Potentially Affected Resource	*Preferred Alternative*
Solid Waste Disposal Capacity	LSI

Legend: LSI = Less-than-significant impact

The proposed action would result in increased solid waste generation. Implementation of the preferred solid waste alternative would provide sufficient disposal capacity for this increase. However, this would reduce the projected life of the Layon Landfill. Because this reduction would be minimal this draft EIS/OEIS concludes that impacts on solid waste disposal capacity would be less than significant.

3.2.6 Roadway Projects

3.2.6.1 Alternative 1

North

Roadway widening, pavement strengthening, and intersection improvement activities in the north region's study area would require utilities to be relocated along Routes 1, 3, 9, 15, and 28, as shown in Table 3.2-15. Utility relocation would include GPA and Navy utility system components for power, telephone, cable television, fiber optic, and GWA and Navy sanitary sewer and water.

Central

In the central region's study area, roadway widening, roadway realignment, pavement strengthening, intersection improvement, or bridge replacement projects would require utilities to be relocated along Routes 1, 7, 8, 8A, 10, 15, 16, 25, 26, and 27, as shown in Table 3.2-15. Utility relocation would include GPA and Navy utility system components for power, GPA fuel, telephone, cable television, fiber optic, and GWA and Navy sanitary sewer and water.

Apra Harbor

As shown in Table 3.2-15, utilities in the Apra Harbor region's study area would require relocation because of pavement strengthening and intersection improvement activities along Routes 1, 2A, and 11. Utility relocation would include GPA and Navy utility system components for power, telephone, cable television, fiber optic, and GWA and Navy sanitary sewer and water.

South

In the south region's study area, utility relocation would be required as a result of pavement strengthening and intersection improvement activities along Routes 2, 5, and 12, as shown in Table 3.2-15. Utility relocation would include GPA and Navy utility system components for power, telephone, cable television, and GWA and Navy sanitary sewer and water.

Table 3.2-15. Utility Relocation within Guam Road Network Routes

Region	*Route*	*Power*	*Navy Power*	*GPA Fuel*	*Telephone*	*Cable TV*	*Fiber Optic*	*GWA Sanitary Sewer*	*Navy Sanitary Sewer*	*GWA Water*	*Navy Water*
North	1	X			OH	OH	X		X	X	
	3	X	X		OH and UG	OH	X	X	X	X	X
	9	X			OH	OH and UG	X	X		X	
	15	X			OH	OH	X			X	
	28				OH			X		X	
Central	1	X	X	X	OH and UG	OH and UG	X	X	X	X	X
	7	X			OH			X		X	
	8	X			OH and UG	OH and UG	X	X		X	X
	8A	X			OH and UG	OH		X	X	X	
	10	X			OH and UG	OH	X	X		X	
	15	X			OH and UG	OH		X		X	
	16	X		X	OH and UG	OH and UG	X	X		X	X
	25*										
	26*										
	27	X			OH and UG	OH	X	X		X	X
Apra Harbor	1	X	X		OH and UG	OH and UG	X		X		X
	2A	X	X		OH and UG	OH and UG					X
	11	X	X			OH and UG	X	X	X	X	X
South	2	X			OH and UG			X		X	
	5	X	X		OH and UG	OH		X	X	X	X
	12	X			OH			X		X	

Legend: OH = overhead; UG = underground.
Note: * Utility data not currently available for Routes 25 and 26.
Source: Parsons Transportation Group

Potential Mitigation Measures

Planning and continued coordination with utility providers during the preliminary engineering and final design and the construction stages of the project would be necessary to minimize or eliminate interruption in utility service to customers. The Joint Region Marianas would coordinate with the affected service provider in each instance to ensure that work is conducted in accordance with the appropriate requirements and criteria. In addition, coordination efforts would lay out utility reroutes, identify potential conflicts, ensure that construction of the proposed project minimizes disruption to utility operations, and formulate strategies for overcoming problems that may arise. If interruptions of utility service are required, they would be restricted in duration and geographic extent. Careful scheduling of these disruptions and advance notification to occupants of the adjacent properties that would be affected by temporary service interruptions would help to avoid any critical service periods. Where feasible, utility relocations would be undertaken in advance of roadway construction activities.

3.2.6.2 Alternative 2 (Preferred Alternative)

North

Utility relocation would be similar to that described for Alternative 1.

Central

Utility relocation would be similar to that described for Alternative 1.

Apra Harbor

Utility relocation would be similar to that described for Alternative 1.

South

Utility relocation would be similar to that described for Alternative 1.

Potential Mitigation Measures

Potential mitigation measures would similar to those described for Alternative 1.

3.2.6.3 Alternative 3

North

Utility relocation would be similar to that described for Alternative 1.

Central

Utility relocation would be similar to that described for Alternative 1.

Apra Harbor

Utility relocation would be similar to that described for Alternative 1.

South

Utility relocation would be similar to that described for Alternative 1.

Potential Mitigation Measures

Potential mitigation measures would similar to those described for Alternative 1.

3.2.6.4 Alternative 8

North

Utility relocation would be similar to that described for Alternative 1.

Central

Utility relocation would be similar to that described for Alternative 1.

Apra Harbor

Utility relocation would be similar to that described for Alternative 1.

South

Utility relocation would be similar to that described for Alternative 1.

Potential Mitigation Measures

Potential mitigation measures would be similar to those described for Alternative 1.

3.2.6.5 Summary of Impacts

Table 3.2-16 summarizes the potential impacts of anticipated utility relocations under each action alternative. The types of improvements proposed under the project alternatives would not create new demand for water supplies, stormwater or wastewater transport or treatment, or solid waste disposal capacity or facilities. The potential for impact is limited to physical disruption of existing utilities, the need for relocation of utilities before construction of new transportation facilities, or unanticipated interruptions in utility services.

Table 3.2-16. Summary of Potential Roadway Projects Impacts

Potentially Affected Resource	*Alternative 1*	*Alternative 2**	*Alternative 3*	*Alternative 8*
Utility Relocations Required before Construction	LSI	LSI	LSI	LSI

*Legend: LSI = less-than-significant impact. * Preferred Alternative*

Potential mitigation measures include coordination with utility providers to minimize or eliminate interruption in utility service to customers. If interruptions of utility service are required, they would be restricted in duration and geographic extent. Careful scheduling of these disruptions and advance notification to occupants of the adjacent properties that would be affected by temporary service interruptions would help to avoid any critical service periods. When feasible, utility relocations would be undertaken in advance of roadway construction activities.

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CHAPTER 4.
ROADWAYS

4.1 INTRODUCTION

4.1.1 Definition of Resource

4.1.1.1 On Base Roadways

On base roadways herein refers to transportation roadway features that support vehicular and pedestrian traffic within the Department of Defense (DoD) military bases. This chapter describes the existing roadway conditions and known operations within Andersen Air Force Base (AFB), Andersen South, Naval Computer and Telecommunications Station (NCTS) Finegayan, Finegayan South, Navy Barrigada, Air Force Barrigada, Naval Base Guam, and the Naval Munitions Site (NMS). Additionally, off base existing road conditions and operations for features directly connected to various alternatives (such as, Former FAA lands, Harmon Annex, and Route 15 lands) have been addressed under the section of non-DoD land within each area of interest. As described in the Affected Environment subsection of Volume 2, the island is divided up into four “areas of interest”: North, Central, Apra Harbor, and South.

The possible effects on roadways within the bases as a result of the increase in the number of vehicle and vehicle movements from the proposed relocation of Marines from Okinawa to Guam are also assessed and presented in the Environmental Consequences section of this chapter.

4.1.1.2 Off Base Roadways

Off base roadways herein refers to transportation roadway features that support vehicular traffic, public transit service, pedestrian facilities and bicycle facilities outside of the DoD military bases. This section describes the existing conditions of the off base roadways within their respective Region of influence – North, Central, Apra Harbor, and South.

<u>Data Collection</u>

Traffic Volumes and Congestion

Existing traffic volumes for all of the roadways included in this study were determined by using a TransCAD model and existing traffic counts. To understand existing traffic conditions, the existing 2003 TransCAD model was calibrated for 2008 conditions. In addition, traffic counts were taken at multiple locations across the island and compared to the TransCAD results, and they were found to be within the tolerance limits for accuracy. TransCAD is a traditional three-step model that includes:

- Trip generation – where the vehicle trips are originating from
- Trip distribution – the destination to where the vehicles are traveling
- Trip assignment – the route(s) used to get to the destination

Population and employment data are used to calculate the daily to and from trips between Traffic Analysis Zones, which are areas of land that are usually residential or commercial in nature. The results of this analysis can be found in maps in each area of interest section.

Traffic congestion is measured by dividing the number of cars on the road (i.e., volume) by the number of cars the road was designed to carry (i.e., capacity). A volume-to-capacity (V/C) ratio greater than 1 indicates that the roads are carrying more vehicles than they were designed to handle – the roads are congested.

Intersection Operations

Forty-two intersections along the major street network across the island were analyzed for traffic operations for signalized and unsignalized intersections. The intersections were evaluated using the methodologies outlined in the Transportation Research Board's *Highway Capacity Manual, 2000 Edition*. Traffic counts were taken at each of the 42 intersections in 2008. The Synchro computer model, that incorporates the Highway Capacity Manual methodology, used these traffic counts to determine traffic operations for the signalized and unsignalized intersections and access points for a.m. and p.m. peak hours.

The results of the intersection operational analyses were used to assess the Level of Service (LOS) experienced by the drivers. The LOS describes the quality of traffic operating conditions, ranging from A to F, and is measured as the duration of delay that a driver experiences at a given intersection. LOS A represents free-flow movement of traffic and minimal delays to motorists. LOS F generally indicates severely congested conditions with excessive delays to motorists. Intermediate grades of B, C, D, and E reflect incremental increases in congestion.

The duration of delay was measured differently for signalized intersections compared to unsignalized intersections. Because an unsignalized intersection does not generally have as much traffic as a signalized intersection, the LOS delay is typically shorter than at a signalized intersection. In addition, studies have shown that at unsignalized intersections, drivers tend to become impatient with long delays and may use inadequate and unsafe gaps in the traffic stream to make left turns or enter the major street. Table 4.1-1 provides the delay thresholds for signalized and unsignalized intersections.

Table 4.1-1. Delay Thresholds for Level of Service

LOS	*Signalized Intersection (seconds/vehicle)*	*Unsignalized Intersection (seconds/vehicle)*
A	0.0-10.0 Seconds	0.0-10.0 Seconds
B	10.1-20.0 Seconds	10.1-15.0 Seconds
C	20.1-35.0 Seconds	15.1-25.0 Seconds
D	35.1-55.0 Seconds	25.1-35.0 Seconds
E	55.1-80.0 Seconds	35.1-50.0 Seconds
F	Greater than 80.0 Seconds	Greater than 50.0 Seconds

Source: Transportation Research Board, Highway Capacity Manual, 2000 Edition.

The LOS rating deemed acceptable varies by jurisdiction, facility type, and traffic control device. At signalized intersections, LOS D is generally recognized as the minimum desirable operating condition; however, according to the 2030 Guam Transportation Plan it is recommended that, "*All intersections and roadway segments should operate at LOS E during peak periods. Improvements undertaken by Guam DPW would be designed to alleviate substandard LOS conditions to the extent feasible, with due consideration to physical and environmental constraints*." For purposes of this study, any LOS better than LOS F would be considered acceptable.

Roadway Network

Guam's existing roadway network has developed into a multi-lane roadway system that serves commercial, retail, military, and tourist-based travel demands. Based on a preliminary classification map, roadways included in this study are classified as one of the following:

- Major Arterial – Roadways with four to six lanes, that have a high degree of mobility and limited access points
- Minor Arterial – Roadways with two to four lanes, that still have a higher degree of mobility and fewer access points, however, not to the extent of major arterials
- Major Collector – Roadways with two lanes that have lower speeds than arterials and often connect local roads to arterials.

As part of the Guam and Commonwealth of the Northern Mariana Islands Military Relocation Project, much of the roadway network would require improvements from their current conditions. The proposed improvements are discussed in the Proposed Action and Alternatives chapter, Off Base Roadways section. The roads proposed for improvement with this project include (see Project Description section for a map):

- Route 1
- Route 2A
- Route 3
- Route 5
- Route 8
- Route 8A
- Route 9
- Route 10
- Route 11
- Route 12
- Route 15
- Route 16
- Route 25
- Route 26
- Route 27
- Route 28
- Chalan Lujuna

The existing conditions of the off base roadways are described in the following sections. This includes a discussion of traffic volumes and congestion, as well as intersection operations for 42 intersections. A list of the intersections, both signalized and unsignalized, also included in this project can be found within each area of interest.

Public Transportation

Public transportation on Guam includes the following modes and service types:

- Tour buses
- Shopping buses
- Taxis
- School buses
- Special service for Navy shore leave
- Guam Mass Transit
- Fixed-route (buses on designated routes at prescribed headways)
- Demand-response (reservation-type service linking residential areas with fixed-route service or nearby activity centers)
- Paratransit

For purposes of this project, the discussion focuses on Guam Mass Transit. It describes the existing conditions for fixed-route, demand-response service (DRS) areas, and paratransit service in each of the four areas of interest. There is overlap between the routes, DRS areas, and paratransit areas in the areas of interest, so descriptions of routes and areas may be described in multiple areas.

There are currently six fixed-routes, seven DRS areas, and five paratransit areas on the island. A section of Chamorro Village, located in Hagatna, currently acts as a transit center consisting of a shared-use parking lot with two bus shelters. Only one route in the fixed system is not anchored by this location.

In addition to the fixed routes, all DRS routes originate and terminate at Chamorro Village. In this respect, the current network acts as a low-frequency "pulse" system, having most of the routes service one central location simultaneously to maximize transfer potential.

The third type of mass transit on Guam is paratransit. Paratransit service, provided by Guam Mass Transit, supplies door-to-door transportation for persons with certified disabilities and is available by advance reservation. Hours of operation are 5:30 a.m. to 7:30 p.m., Monday through Saturday, and 7:30 a.m. to 6:30 p.m. on Sundays and holidays.

There are overall scheduling issues with mass transit on the island. Buses generally run ahead of the published schedule, and they do not adhere to slower speeds or wait time to follow the schedule, that often causes passengers to miss the bus and thus does not provide a reliable public transportation system on the island.

<u>Pedestrian and Bike Facilities</u>

Guam has limited accommodations for pedestrian and bicycle travel; and the type, quantity, and quality of facilities varies throughout the island. Sidewalks and roadway shoulders comprise the existing pedestrian and bicycle system. Most of the 26 miles (mi) (42 kilometers [km]) of sidewalk is on the central western portion of the island, in the Hagatna and Tumon Bay area, as described in the Central Region. No marked or designated bicycle lanes or paths exist at this time. Where no sidewalks are present, the shoulder generally functions as a pedestrian and bicycle space and is used for running and cycling. The width and condition of roadway shoulders varies throughout the island. Shoulders are present along large segments of Route 1 and on Route 3 from Route 1 to Route 28; however, pedestrian and bicycle mobility and safety on road shoulders can be impeded by conflicting uses, such as parking.

Most of the signalized intersections included in this study contain a pedestrian indication on at least one of the intersection legs. Marked crosswalks and pedestrian safety devices are present at all signalized intersections. Crosswalks use the standard (i.e., two parallel lines) or continental marking pattern.

The condition of pedestrian facilities generally mirrors general road conditions and is deteriorated in some areas. Sidewalks often contain obstructions, such as fire hydrants, power poles, traffic signal controllers, or other utilities.

Pedestrian/auto accidents are a common occurrence on Guam. Most of these accidents occur at night in areas where street lighting levels are low and where pedestrian crosswalks do not exist, are not clearly marked, or are spaced too far apart. In addition, along village streets, there is a lack of sidewalks and, in many instances, minimal shoulder space for pedestrians.

4.1.2 North

4.1.2.1 On Base Roadways

<u>Andersen AFB</u>

Andersen AFB has two access gates. The Main Gate provides access between Route 1 and Arc Light Boulevard. Arc Light Boulevard is the main roadway on base and provides an east-west route across the base. The Back Gate is about 1.1 mi (1.8 km) southeast of the Main Gate and provides access between Route 15 and Santa Rosa Boulevard. Santa Rosa Boulevard passes through housing areas on base. All of the base roadways are two lanes (one lane in each direction) with additional separate turning lanes at major intersections. All the on base intersections are currently controlled by two- or all-way stop signs.

The *Andersen AFB Traffic and Safety Engineering Study* (December 2008) found that most of the on base intersections were operating at acceptable levels of service with the exception of several intersections along Arc Light Boulevard. The study recommended improvements for these problem intersections.

4.1.2.2 Finegayan

NCTS Finegayan is accessed by the gate between Route 3 and Bullard Avenue. South Finegayan can be accessed at two points; the intersection between Royal Palm Drive and Route 3, and the intersection between Coral Tree Drive and Route 3. All of the base roadways are two lanes (one lane in each direction).

Based on the relatively low traffic demand on Finegayan, all roadways and intersections should be operating at acceptable levels of service for both the a.m. and p.m. peak hours.

4.1.2.3 Off Base Roadways

<u>Existing Roadway Conditions</u>

Route 1

Route 1, also known as Marine Corps Drive, is a major arterial roadway that extends approximately 22.0 mi (35.4 km) from Andersen AFB in Yigo on the northeastern corner of the island down to the Naval base in Santa Rita, that is located on the central western area of the island. Route 1 from Andersen AFB to Route 29 in Yigo is a four-lane road with a raised median. The lanes are approximately 12.0 feet (ft) (3.6 meters [m]) wide. There is a shoulder on either side of the road; however, there is no curb and gutter or sidewalk. The median becomes flush at Route 29 and continues to Chalan Lujuna in Yigo. Portions of Route 1 are not structurally capable of handling heavy truck loads due to the current condition of the pavement.

Route 3

Route 3 is located on the northern end of the island in Dededo. It connects with Route 9 at the Route 3A intersection and intersects Route 1 at its southern terminus. Route 3 is 5.7 mi (9.2 km) long. From Route 1 to Route 28, it is a minor arterial that consists of four lanes with intermittent center turn lanes and shoulders and no curb and gutter or sidewalks. From Route 28 to Route 9, the roadway decreases to two lanes with no median/center lane, shoulders, curb and gutter, or sidewalk. The lanes are generally 12.0 ft (3.6 m) wide. Route 3 is not structurally capable of handling heavy truck loads due to the current condition of the pavement.

Route 9

Route 9 is located on the northern end of the island near Andersen AFB and connects Route 3 at its western terminus with Route 1 at its eastern terminus at the entrance to Andersen AFB. Route 9 is 3.1 mi (5.0 km) long and is classified as a minor collector. The road has two lanes with limited median/center turn lane, intermittent shoulders, curb and gutter, and no sidewalks. Route 9 is not structurally capable of handling heavy truck loads due to the current condition of the pavement.

Route 15

Route 15 is located on the northeastern part of the island, with its northern terminus in Yigo and southern terminus in Chalan-Pago-Ordot at Route 4. Route 15 is 14.2 mi (22.8 km) long and is classified as a minor arterial in the North Region. The portion of Route 15 in the North Region is approximately 0.75-mile (1.2 km). From Smith Quarry to just north of Chalan Lujuna, there are two lanes with no center lane, a flush median, no shoulders, curb and gutter, or sidewalk. The lanes are generally 12.0 ft (3.6 m) wide.

Route 28

Route 28 is located on the northern part of the island and connects Route 1 with Route 3 in Dededo. Route 28 is 3.9 mi (6.3 km) long and is classified as a minor arterial. The road has two lanes with intermittent median or center lane, no shoulders, curb and gutter, or sidewalks. The lanes are generally 11.0 ft (3.4 m) to 12.0 ft (3.6 m) wide.

The intersections and access points included in the North Region are listed in Table 4.1-2.

Table 4.1-2. Intersections and Access Points – North Region

Intersections and Access Points – North	
Signalized	
Route 1/9/Andersen AFB Main Gate	Route 1/29
Route 3/28	
Unsignalized	
Route 3/3A/9	Route 15/29
Access Points	
Route 3 – South Finegayan/Residential Gate	

Existing Traffic Volumes and Capacity

A summary of existing average daily traffic (ADT) volumes and capacity (2008) for the North Region can be found in Table 4.1-3.

Table 4.1-3. Existing ADT and Capacity Summary – North Region

Roadway	*Existing ADT Summary*	*Existing Volume to Capacity (V/C) Ratio*
Route 1	Route 1 ranges from 14,000 to 19,000 vehicles per day (vpd). Traffic decreases as Route 1 approaches Andersen AFB.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.80, which indicates that the roadway is not considered congested.
Route 3	Route 3 ranges from 6,800 to 15,000 vpd. Traffic increases south of the intersection with Route 28.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.80, which indicates that the roadway is not considered congested.
Route 9	Route 9 ranges from 2,700 to 4,400 vpd. There is a decrease in traffic east of the two residential developments on Route 9.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.80, which indicates that the roadway is not considered congested.
Route 15	Route 15 has 4,300 vpd.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.80, which indicates that the roadway is not considered congested.
Route 28	Route 28 ranges from 9,400 to 9,500 vpd.	The north/south portion of Route 28 has a V/C ratio of 0.81-0.99, and the east/west portion has a V/C ratio of 0.00-0.80 in the a.m. peak. The roadway is not considered congested in the a.m.. The north/south portion of Route 28 has a V/C ratio of 0.81-0.99, and the east/west (and part of the north/south) portion has a V/C ratio of 1.00-1.15 in the p.m. peak. The roadway is considered congested in the p.m. on the east/west portion.

Figure 4.1-1 and Figure 4.1-2 show existing levels of traffic congestion in the northern part of Guam for

the a.m. and p.m. peak hours, respectively. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested.

The roads serving major residential and employment centers, such as Dededo and Tamuning, are currently the most congested. These roads are also roads that would be heavily used by the military. During both the morning and afternoon peaks, the road with the greatest congestion levels in the North Region is Route 28; however, in the a.m. conditions, the ratio is still below 1, which means the road is not considered congested. This is not true for the p.m. conditions, as portions of Route 28 have a V/C ratio between 1 and 1.15, which indicates the road is congested.

Existing Intersection Operations

In the existing conditions, all intersections in the North Region operate at acceptable LOS E or better except for the following intersection:

- Route 1/29 (a.m. peak hour only)

Table 4.1-4 displays the LOS and delay results for the study intersections in the North Region.

Table 4.1-4. Existing Level of Service and Delay Results – North Region

	a.m. Peak Hour		*p.m. Peak Hour*	
	LOS	*Delay (Seconds)*	*LOS*	*Delay (Seconds)*
Signalized*				
Route 1/9	C	25.8	D	46.1
Route 1/29	F	97.4	C	24.0
Route 3/28	C	26.8	B	17.4
Unsignalized**				
Route 3/3A/9	B	10.1	A	9.6
Route 15/29	D	30.7	C	18.3
Access Points**				
Route 3 - Main Cantonment/Commercial Gate**	C	17.9	B	13.0
Route 3 - Main Cantonment/Main Gate**	D	25.7	C	15.9
Route 3 – South Finegayan/ Residential Gate	C	23.9	D	30.0

Notes: *Signalized intersection LOS based on average delay for the overall intersection.
**Unsignalized intersection LOS based on approach delay on STOP-controlled approach.

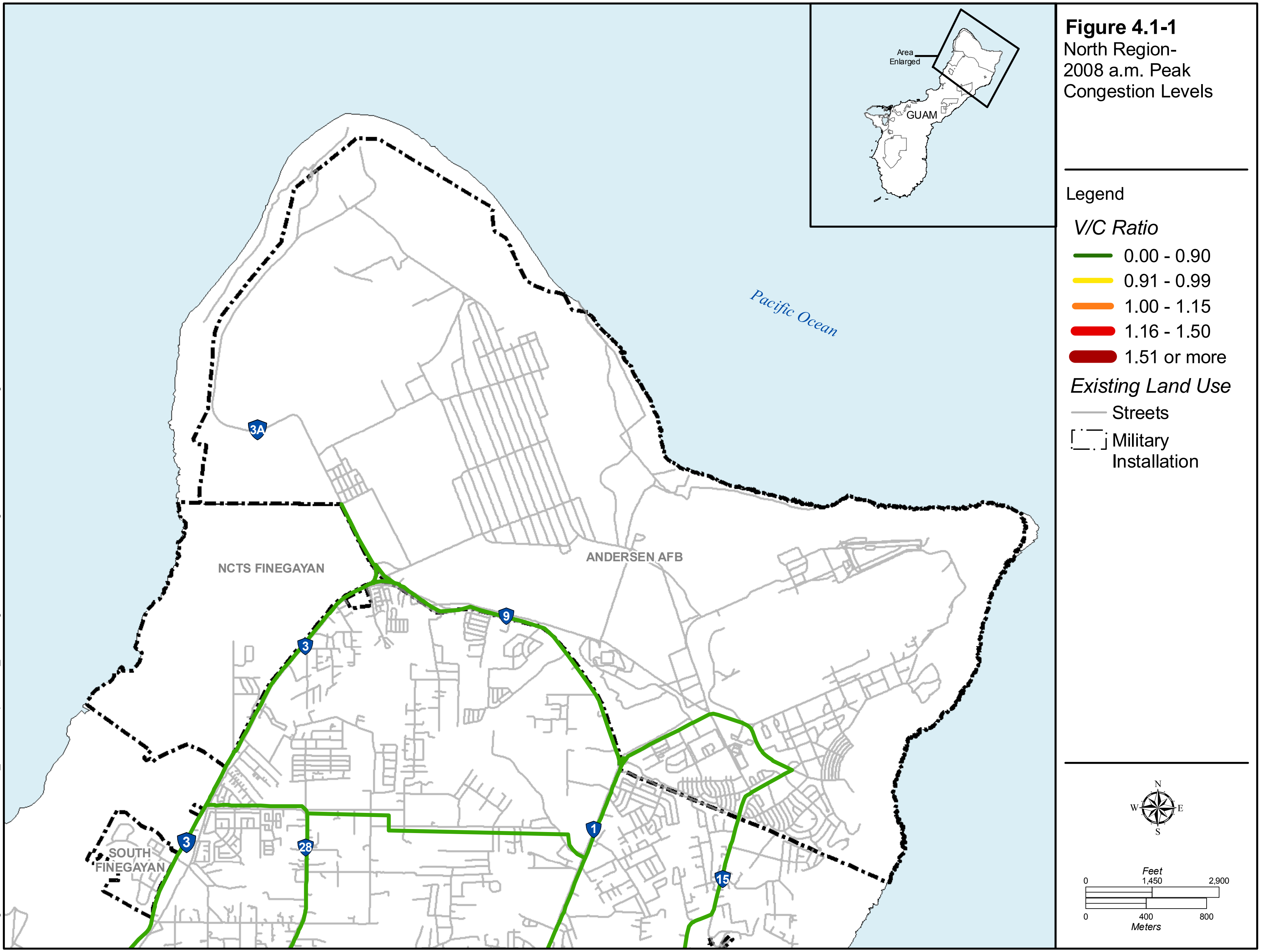

Figure 4.1-1
North Region-
2008 a.m. Peak
Congestion Levels

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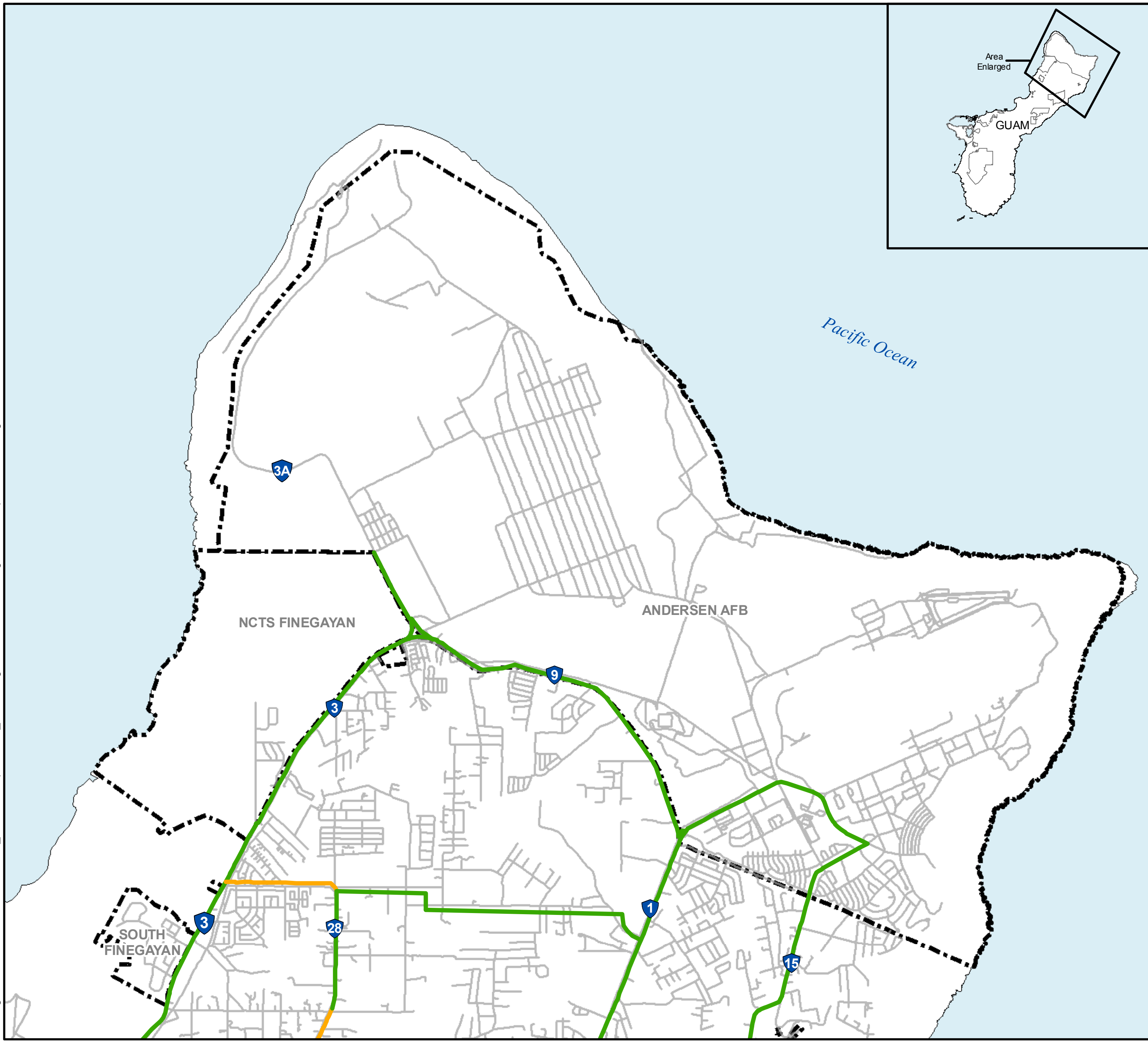


Figure 4.1-2
North Region-
2008 p.m. Peak
Congestion Levels

Legend

V/C Ratio

- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use

- Streets
- Military Installation

N W E S

Feet 0 1,450 2,900

0 400 800 *Meters*

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.1-2. North Region - 2008 p.m Peak Congestion Levels.mxd

Existing Public Transportation

The discussion of existing conditions in this section would focus on the Guam Mass Transit System in the North Region.

- Figure 4.1-3 illustrates the fixed routes and DRS areas for the North Region. A demand-response area is a geographical area that is served by the demand-response type of bus service described earlier. Note that all of the Monday through Friday fixed routes originate at Chamorro Village, which is located in Hagatna and is not shown on this map. The Grey Line 4, which only runs on Sundays and holidays, is the only bus route that is partially included in the North Region. The DRS areas located in the North Region are Grey 1, Grey 2, and Grey 3. These routes provide service on Monday through Saturday only, and they all observe the normal 5:30 a.m. to 7:30 p.m. hours of service. DRS is available on call and normally provides transportation to the nearest fixed-route. Table 4.1-5 shows details about the fixed route and DRS areas in the North Region.

Table 4.1-5. Fixed Route and DRS Areas – North Region

Route	*Areas Served*	*Headway (hours)*	*Trips per Day, Monday-Saturday*	*Trips per Day, Sunday/Holiday*	*Scheduled Run Time Outbound (minutes)*	*Scheduled DR Time (minutes)*	*Scheduled Run Time Inbound (minutes)*
Fixed Route							
Grey Line 4*	Micronesia Mall—Yigo (Loop)	2	0	5	39 to 40	20 to 21	48 to 49
DRS Area							
Grey Line 1	Dededo, Agafa Gumas, Santa Ana, and vicinity	NA	NA	NA	NA	NA	NA
Grey Line 2	Yigo, Latte Heights, and vicinity	NA	NA	NA	NA	NA	NA
Grey Line 3	Tamuning, Tumon, Harmon, and vicinity	NA	NA	NA	NA	NA	NA

Legend: NA = Not Applicable.
Notes: *Hours of service are 5:30 a.m. to 7:30 p.m. Monday through Saturday and 7:30 a.m. to 5:30 p.m. Sundays and Holidays.

The paratransit services partially located in the North Region are:

- Freedom 1 (northern area) serving Yigo, Agafa Gumas, NCS, Santa Ana Subdivision, Astumbo, Dededo, Harmon, and Tamuning
- Freedom 5 serving the entire island

The 12-month (2006-2007) ridership for the fixed route, DRS, and paratransit routes in the North Region can be found in Table 4.1-6. Note that there is overlap between several of the routes and service areas between the areas of interest for this project. Because the Freedom 5 serves the entire island, ridership is not included here.

Table 4.1-6. Monthly and Total Fiscal Year 2007 Guam Mass Transit Ridership (Passengers Boarding Each Route)

Service Type	*Route Name*	*12-Month Totals*
DRS	Grey 1	30,823
	Grey 2	25,431
	Grey 3	11,826
Fixed Route	Grey 4	562
Paratransit	Freedom 1	8,129
	Total	**76,771**

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs Figure 4.1-3. North Region - Existing Transit Service.mxd

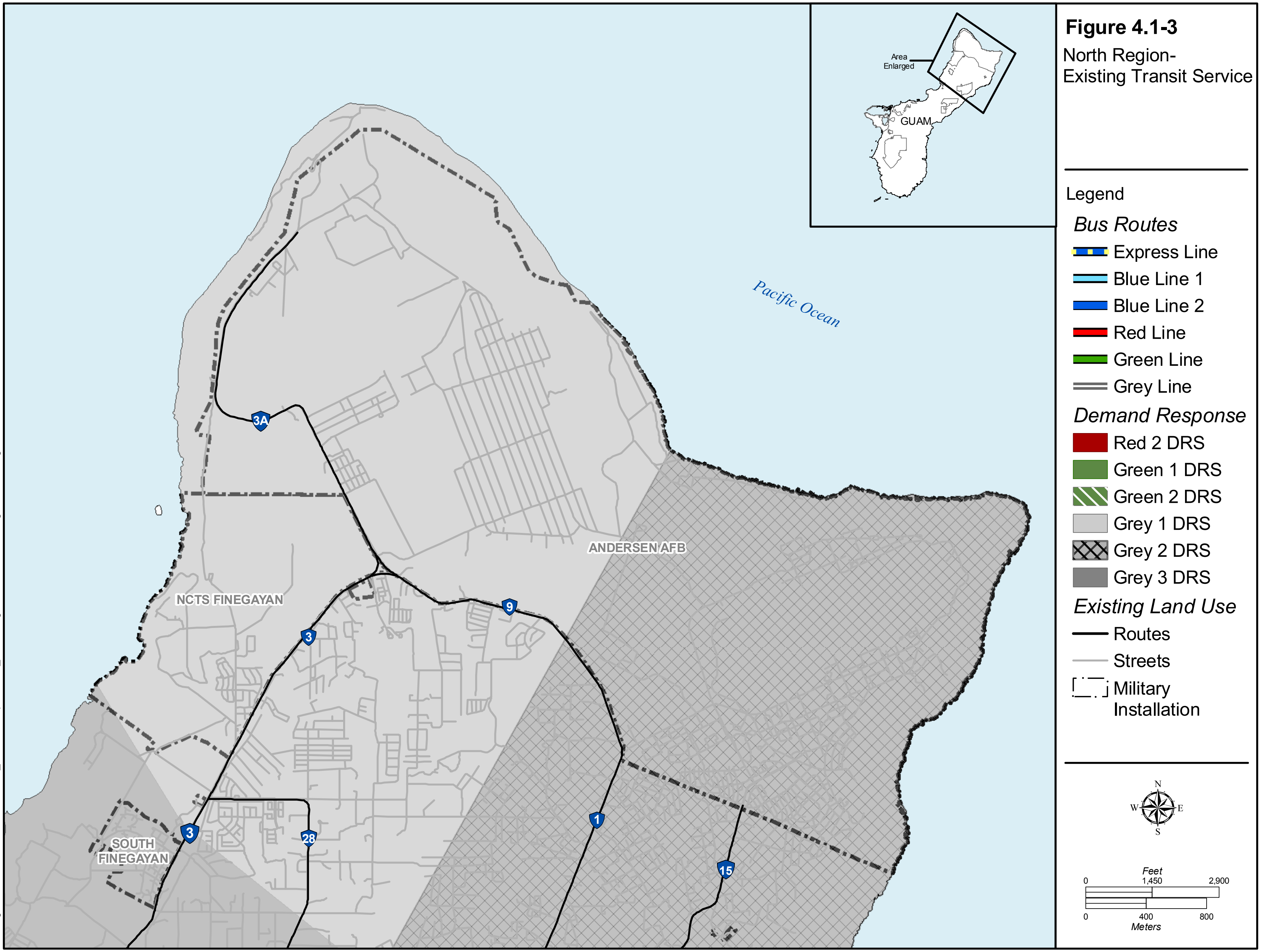


Figure 4.1-3
North Region-
Existing Transit Service

Existing Pedestrian and Bicycle Facilities

The northern tip of the island does not contain any dedicated pedestrian or bicycle facilities. Shoulders exist along Route 1 and on Route 3 south of Route 28. In these areas, the outside lane or shoulder, which are generally unpaved, function as the pedestrian/bicycle space. Figure 4.1-4 illustrates the existing pedestrian and bicycle facilities.

4.1.3 Central

4.1.3.1 On Base Roadways

Andersen South

Existing roadways and abandoned right–of-ways within areas in Andersen South were originally constructed in the 1950s timeframe and have varying levels of existing use. Air Force operations except training at Andersen South have stopped and the roadway facilities in the area are in a general state of disrepair. Andersen South is bounded on the north side by Route 1 and on the south side by Route 15. The Andersen South Base can be accessed from the southern side at the intersection of Rissi Street and Route 15. The base is accessible from the northern side at the intersection of Turner Street and Route 1 near the northeastern corner of the site. Also, there are other potential access points along Route 1. Manha Street intersects Route 1 at the northwestern edge of the site. Three other unnamed streets intersect Route 1 between Turner Street in the northeast and Manha Street in the northwest. These roads (Turner Street, Manha Street, and the three unnamed streets) run perpendicular to Route 1 and Route 15 in a north-south route across the base.

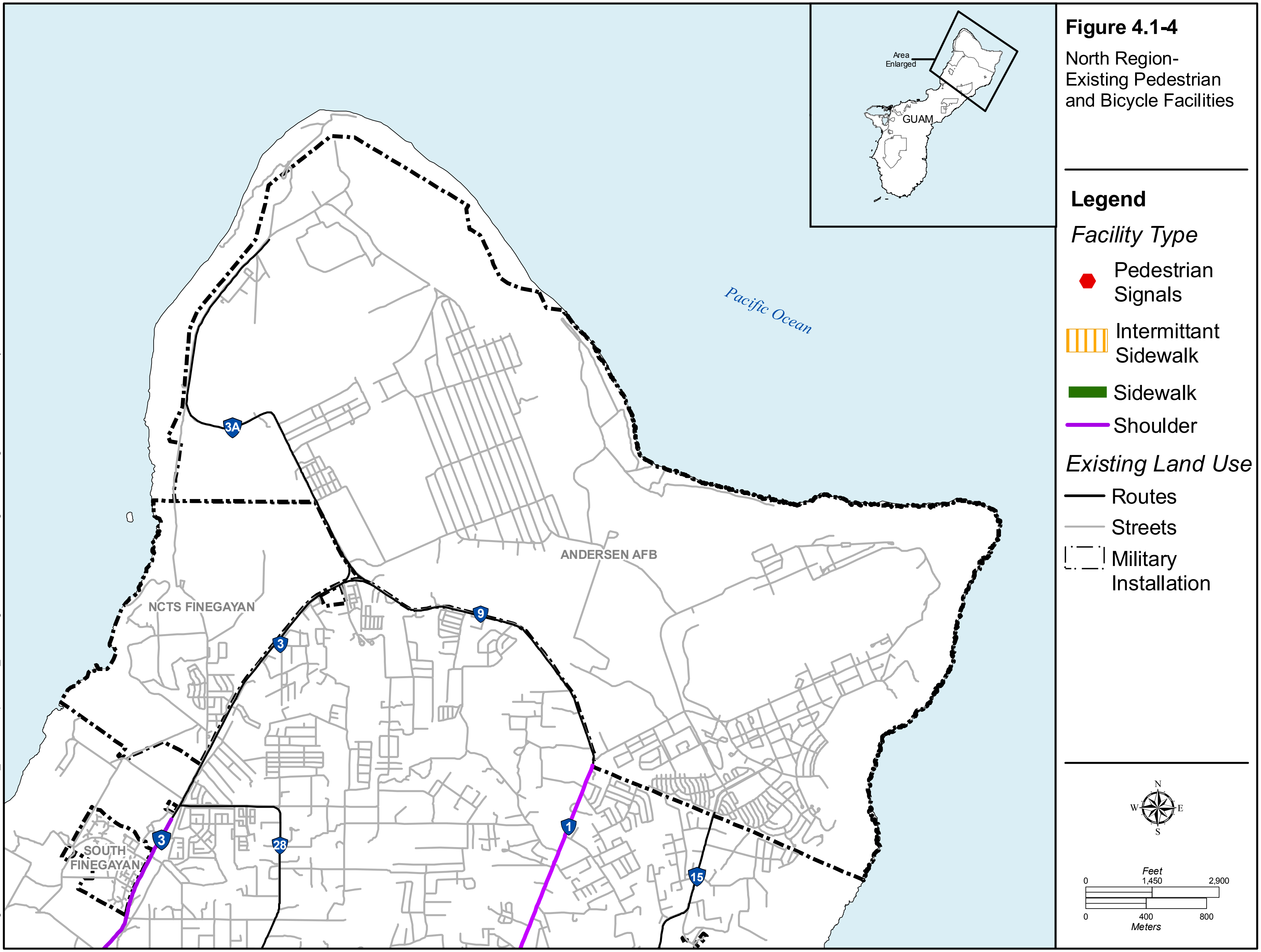
Based on the relatively low roadway utilization on Andersen South, all roadways and intersections are most likely operating at acceptable levels of service for both the a.m. and p.m. peak hours.

Barrigada

Route 15 forms the eastern bounding edge and Route 16 forms the western bounding edge of the Navy Barrigada parcel. The Navy Barrigada can be accessed by Route 8A. Route 8A approaches Navy Barrigada parcel from the western side and ends at the central part of the Navy Barrigada parcel. Route 8A provides the most direct access point to the golf course within the Navy Barrigada site. The Navy Barrigada golf course abuts the northeastern edge of the Air Force Barrigada parcel. The Navy Barrigada site also has gated access at Route 16 and Sabana Barrigada Drive.

Route 15 forms the southern edge of the Air Force Barrigada parcel. The primary point of entry into Air Force Barrigada site is from the south side where an unnamed access street from Air Force Barrigada intersects Route 15. This access point is located at the intersection of Chada Street and Route 15. Chada Street is an off base road that intersect Route 15 from the southern side. The Air Force Barrigada parcel could also potentially be accessed from the western side from Route 10 by heading into Lalo Street

Based on the relatively low traffic demand on Navy and Air Force Barrigada, all roadways and intersections should be operating at acceptable levels of service for both the a.m. and p.m. peak hours.



Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.1-4. North Region - Existing Pedestrian and Bicycle Facilities.mxd

4.1.3.2 Off Base Roadways

Existing Roadway Conditions

Route 1

Route 1, also known as Marine Corps Drive, is a major arterial roadway that extends approximately 22.0 mi (35.4 km) from Andersen AFB in Yigo on the northeastern corner of the island down to the Naval base in Santa Rita, which is located on the central western area of the island. Route 1 from Chalan Lujuna to Route 28 in Dededo is a four-lane road with a flush median. The lanes are approximately 12.0 ft (3.6 m) wide. There is a shoulder on either side of the road; however, there is no curb and gutter or sidewalk.

South of Route 28 in Dededo, the roadway becomes six lanes with a raised median. The six-lane portion of Route 1 extends to Route 6 in Hagatna, at which point it becomes four lanes again. The lanes are generally 12.0 ft (3.6 m) wide. There are left-turn queuing (stacking) lanes at intersections and at other access points along Route 1. There are curb and gutter and sidewalks along this section of the roadway.

Just south of the Route 6 intersection in Hagatna, the road becomes four lanes again to where it ends near the Naval base in Santa Rita. There is a raised median from Route 6 to Route 11 in Piti. Portions of Route 1 are not structurally capable of handling heavy truck loads due to the current condition of the pavement.

Route 3

Route 3 is located on the northern end of the island in Dededo. It connects with Route 9 at the Route 3A intersection and intersects Route 1 at its southern terminus. Route 3 is 5.7 mi (9.2 km) long. From Route 1 to Route 28, it is a minor arterial that consists of four lanes with intermittent center turn lanes and shoulders and no curb and gutter or sidewalks. From Route 28 to Route 9, the roadway decreases to two lanes with an intermittent left-turn lane, shoulders, curb and gutter, or sidewalk. The lanes are generally 11.0 ft (3.4 m) wide. Route 3 is not structurally capable of handling heavy truck loads due to the current condition of the pavement.

Route 8/8A

Route 8 is located in the center of the island, with its eastern terminus at the Admiral Nimitz Golf Course in Barrigada and western terminus in Hagatna. Route 8 is 4.3 mi (6.9 km) long and is a major arterial between Route 10/16 and Route 1 and a major collector east of the Route 10/16 intersection. The road has four lanes with a two-way center turn lane, intermittent shoulders and sidewalks, and curb and gutter between Route 10/16 and Route 1. The lanes are generally 12.0 ft (3.6 m) wide. Route 8/8A is not structurally capable of handling heavy truck loads due to the current condition of the pavement.

Route 10

Route 10 is located in the center of the island, with its northern terminus in Barrigada at Route 8/16 and southern terminus in Chalan-Pago-Ordot at Route 4. Route 10 is 3.2 mi (5.1 km) long and is classified as a major arterial. Generally, the road has four lanes with a two-way center turn lane, shoulders, curb and gutter, and sidewalks. The lanes are generally 12.0 ft (3.6 m) wide. Route 10 is not structurally capable of handling heavy truck loads due to the current condition of the pavement.

Route 15

Route 15 is located on the northeastern part of the island, with its northern terminus in Yigo and southern terminus in Chalan-Pago-Ordot at Route 4. Route 15 is 14.2 mi (22.8 km) long and is classified as both a minor arterial (north of Route 10) and a major collector (south of Route 10). The portion of Route 15 in this study is approximately 9.0 mi (14.5 km) and extends from Route 10 to Chalan Lujuna on the north. From Chalan Lujuna to Route 26, there are two lanes with no center lane, a flush median, no shoulders, curb and gutter, or sidewalk. From Route 26 to Route 10, the road has two lanes with an intermittent center lane, a flush median, no shoulders, curb and gutter, or sidewalks. The lanes are generally 12.0 ft (3.6 m) wide. Route 15 is not structurally capable of handling heavy truck loads due to the current condition of the pavement.

Route 16

Route 16 is located on the east side of Guam International Airport and extends from Route 1 to Route 8 in Barrigada. This section of Route 16 is approximately 3.0 mi (4.8 km) long and is classified as a major arterial. From Route 8 to Route 10A, the road has four lanes with a center lane, intermittent raised and flush medians, shoulders, curb and gutter, and no sidewalks. The lanes are generally 12.0 ft (3.6 m) wide in this section. At the intersection with Route 10A, Route 16 continues below-grade under Route 10A, with four through lanes. There are two lanes that exit to the at-grade intersection with Route 10A. From Route 10A to Route 27A, the road has six lanes, a center turn lane, an intermittent raised median, shoulders, no curb and gutter, and no sidewalks. The lanes are generally 12.0 ft (3.6 m) wide in this section. Route 16 is not structurally capable of handling heavy truck loads due to the current condition of the pavement.

Route 25

Route 25 is located in the north-central part of the island and connects Route 16 with Route 26 in Dededo. Route 25 is approximately 1.4 mi (2.3 km) long and is classified as a minor arterial. The road generally has two lanes with a two-way center turn lane, shoulders, and no sidewalks or curb and gutter for approximately 0.5-mile (0.8-km) west of Route 16. The road then decreases in width and has no center lane or median, no curb and gutter, sidewalks, or shoulders for the remainder of the route. The lanes are generally 12.0 ft (3.6 m) wide. Route 25 is not structurally capable of handling heavy truck loads due to the current condition of the pavement.

Route 26

Route 26 is located in the north-central part of the island and connects Route 1 in Dededo with Route 15 in Mangilao. Route 26 is approximately 2.3 mi (3.7 km) long and is classified as a minor arterial. The road has two lanes with no median, intermittent shoulders, no curb and gutter, and intermittent sidewalks in the Latte Heights Estates area. The lanes are generally 12.0 ft (3.6 m) wide. Route 26 is not structurally capable of handling heavy truck loads due to the current condition of the pavement.

Route 27

Route 27 is located in the north-central part of the island and connects Route 16 with Route 1 in Dededo. Route 27 is approximately 1.1 mi (1.8 km) long and is classified as a major arterial. The road has six lanes with a raised median and left-turn queuing lanes at intersections, curb and gutter, sidewalks, and no shoulders. The lanes are generally 12.0 ft (3.6 m) wide. Route 27 is not structurally capable of handling heavy truck loads due to the current condition of the pavement.

Route 28

Route 28 is located on the northern part of the island and connects Route 1 with Route 3 in Dededo. Route 28 is 3.9 mi (6.3 km) long and is classified as a minor arterial. The road has two lanes with intermittent median or center lane, no shoulders, curb and gutter, or sidewalks. The lanes are generally 12.0 ft (3.6 m) wide.

Chalan Lujuna

Chalan Lujuna is located on the northern part of the island and connects Route 1 and Route 15, just south of Route 29 in Yigo. Chalan Lujuna is approximately 0.83-mile (1.3 km) long and is classified as a major collector. The road has two lanes with no median or center lane, no shoulders, curb and gutter, or sidewalks. The lanes are generally 12.0 ft (3.6 m) wide. Chalan Lujuna is not structurally capable of handling heavy truck loads due to the current condition of the pavement.

The intersections and access points included in the Central Region are listed in Table 4.1-7.

Table 4.1-7. Intersections and Access Points – Central Region

Intersections and Access Points – Central Region	
Signalized	
Route 1/28	Route 1/4
Route 1/26	Route 1/6 (Adelup)
Route 1/27	Route 1/6 (West)
Route 1/27A	Route 4/7A
Route 1/3	Route 4/10
Route 1/16	Route 4/17
Route 1/14 (North San Vitoris)	Route 8/33 (East)
Route 1/14A	Route 8/10
Route 1/10A	Route 10/15
Route 1/14B	Route 16/27A
Route 1/14 International Trade Center (ITC)	Route 16/27
Route 1/30	Route 16/10A
Route 1/8	
Unsignalized	
Route 7/7A	Route 26/15
Route 26/25	Route 28/27A
Access Points	
Route 1 - South Andersen Main Gate/(Turner Street)	Route 15 - South Andersen/Second Gate

<u>Existing Traffic Volumes and Capacity</u>

A summary of existing ADT volumes and capacity (2008) for the Central Region can be found in Table 4.1-8.

Table 4.1-8. Existing ADT and Capacity Summary – Central Region

Roadway	*Existing ADT Summary*	*Existing V/C Ratio*
Route 1	Route 1 ranges from 32,000 to 73,000 vpd. Traffic decreases significantly south of the intersection with Route 4.	The V/C ratio is generally 0.00-0.80 in both the a.m. and p.m. peak conditions; however, there are small segments that have a V/C ratio of 0.81-0.99. The roadway is not considered congested.
Route 3	Route 3 ranges from 6,800 to 15,000 vpd. Traffic increases south of the intersection with Route 28.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.80, which indicates that the roadway is not congested.
Route 8	Route 8 ranges from 37,000 to 39,000 vpd. There is generally no change in volume along the route.	In the a.m. peak hours, Route 8 has a V/C ratio of 0.00-0.80; however, in the p.m. peak hours, the portion of Route 8 between Route 33 and Route 1 has a V/C ratio of 0.81-0.99. The roadway is not considered congested.
Route 10	Route 10 has 30,000 vpd between Route 8 and Route 15.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.80, which indicates that the roadway is not congested.
Route 15	Route 15 ranges from 6,900 to 16,000 vpd. There is a significant increase in traffic south of the intersection with Route 26.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.80, which indicates that the roadway is not congested.
Route 16	Route 16 ranges from 37,000 to 49,000 vpd.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.80, which indicates that the roadway is not congested.
Route 25	Route 25 ranges from 12,000 to 16,000 vpd.	The eastern portion of Route 25 has a V/C ratio of 1.00-1.15 in both the a.m. and p.m. peak hours. The western portion has a V/C ratio of 1.16-1.50 in both the a.m. and p.m. peak hours. The roadway is considered congested in both the a.m. and p.m..
Route 26	Route 26 ranges from 6,900 to 15,000 vpd. There is a decrease in traffic south of the large residential development just north of the intersection with Route 15.	The V/C ratio is generally 0.81-0.99 in both the a.m. and p.m. peak conditions; however, there are small segments that have a V/C ratio of 0.00-0.80. The roadway is not considered congested.
Route 27	Route 27 has 32,000 vpd between Route 16 and Route 1.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.80, which indicates that the roadway is not congested.
Route 28	Route 28 ranges from 12,000 to 15,000 vpd. Traffic increases at the intersection with Route 1.	Route 28 has several V/C ratios in the Central Region. In the a.m., the worst portion of the roadway is north of the intersection with Route 1, with a V/C ratio greater than 1.50. The V/C ratio in the p.m. is the worst at the intersection with Route 1, with a V/C ratio greater than 1.50.
Chalan Lujuna	Chalan Lujuna ranges from 3,600 to 4,000 vpd.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.80, which indicates that the roadway is not congested.

Figure 4.1-5 and Figure 4.1-6 show existing levels of traffic congestion in Central Guam for the a.m. and p.m. peak hours, respectively. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested.

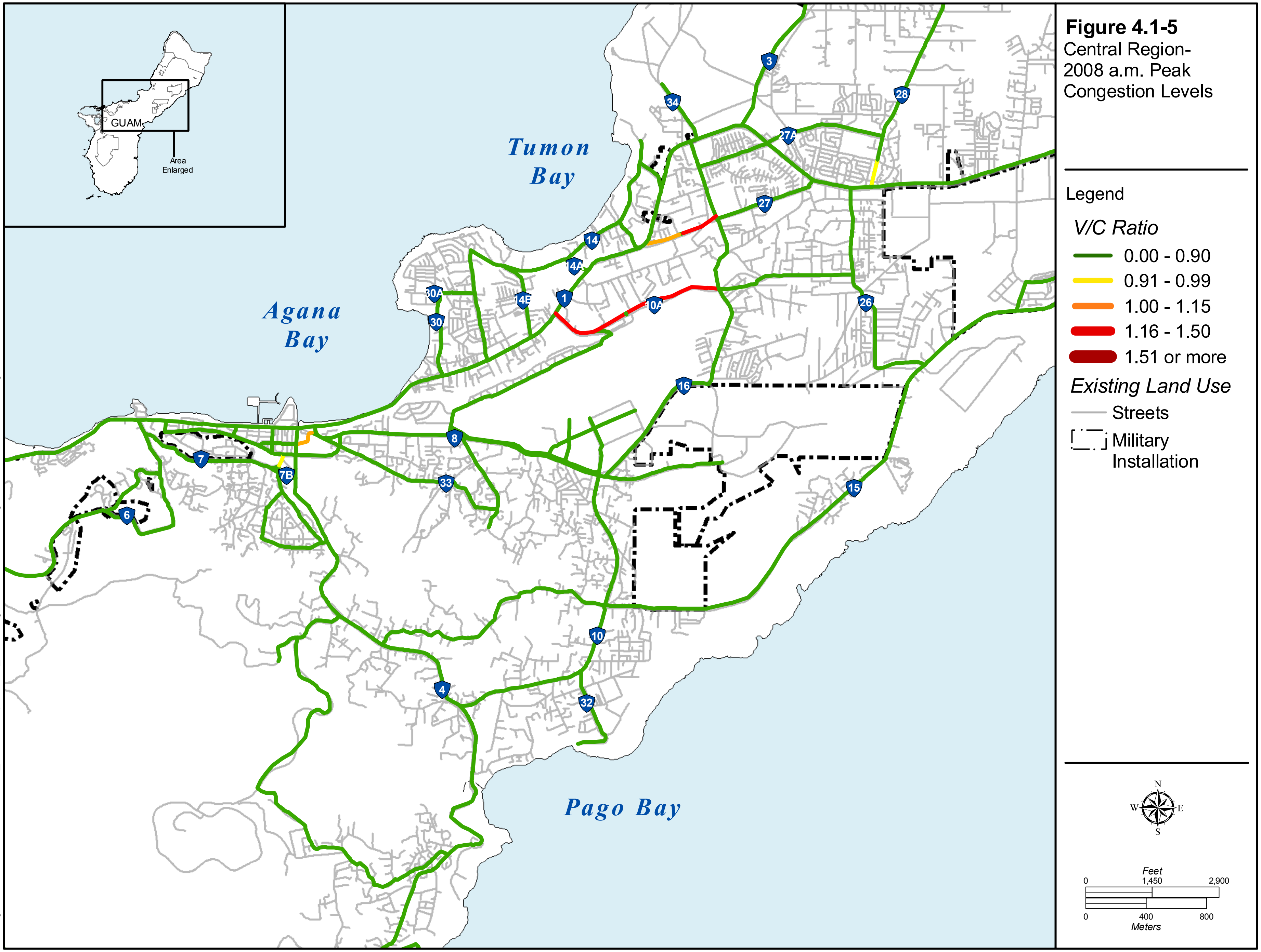


Figure 4.1-5
Central Region-2008 a.m. Peak Congestion Levels

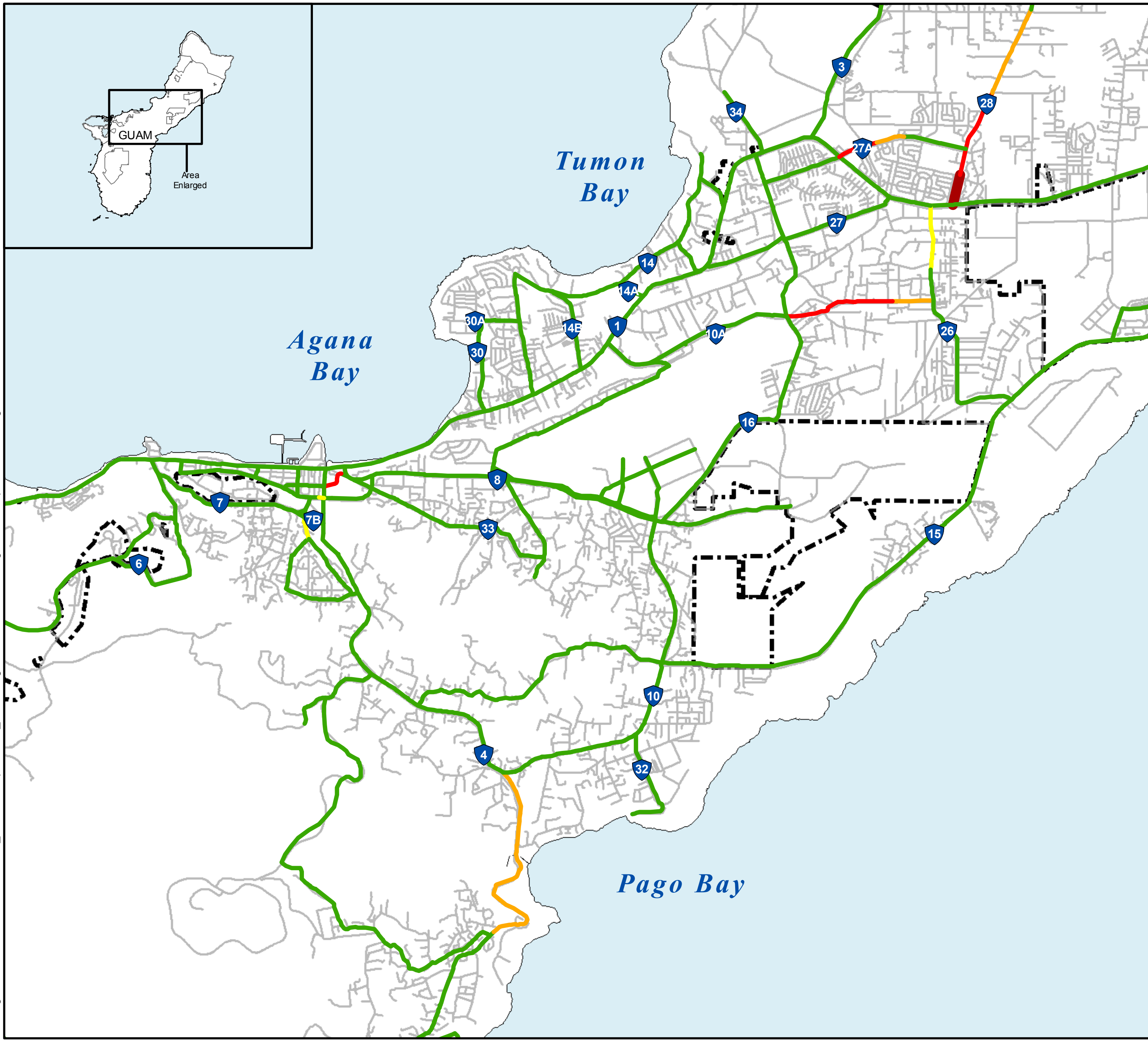


Figure 4.1-6
Central Region-
2008 p.m. Peak
Congestion Levels

Legend

V/C Ratio
- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use
- Streets
- Military Installation

N
W E
S

Feet
0 1,450 2,900
0 400 800
Meters

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.1-6. Central Region - 2008 p.m. Peak Congestion Levels.mxd

The roads serving major residential and employment centers, such as Dededo and Tamuning, are currently the most congested. These roads are also roads that would be heavily used by the military. During both the morning and afternoon peaks, the roads with the greatest congestion levels in the Central Region are Routes 28 and 25. They both have an LOS F in both the a.m. and p.m. peak hours, that is considered congested. Route 28 has the highest level of congestion (V/C ratio greater than 1.50), north of the Route 1 intersection in the a.m. and at the Route 1 intersection in the p.m..

Of particular note is that the model does not show congestion along Route 1 through Tamuning even though many vehicles travel this roadway. This is because the roadway segments are designed to handle the high volume of traffic they presently serve. Even though there are many cars on the road, it does not exceed its design capacity; therefore, it is not technically "congested" (Figure 4.1-5 and Figure 4.1-6). The delay that drivers experience on Route 1 results from poor operations, such as traffic signal timing.

Existing Intersection Operations

In the existing conditions, all intersection in the Central Region operate at acceptable LOS E or better except for the following intersections:

- Route 1/27A (p.m. peak hour only)
- Route 1/3 (a.m. peak hour only)
- Route 1/10A
- Route 1/14 (ITC) (p.m. peak hour only)
- Route 8/33
- Route 8/10 (a.m. peak hour only)
- Route 10/15 (a.m. peak hour only)
- Route 16/27
- Route 16/10A
- Route 26/25
- Route 26/15 (a.m. peak hour)
- Route 28/27A (a.m. peak hour)
- Access Point at Route 16 – Navy Barrigada Residential Gate

Table 4.1-9 displays the LOS and delay results for the study intersections in the Central Region.

Table 4.1-9. Existing Level of Service and Delay Results – Central Region

	a.m. Peak Hour		*p.m. Peak Hour*	
	LOS	*Delay (Second)*	*LOS*	*Delay (Second)*
Signalized*				
Route 1/28	C	33.9	D	48.6
Route 1/26	C	33.8	E	58.5
Route 1/27	E	74.6	E	51.8
Route 1/27A	D	37.1	F	91.5
Route 1/3	F	165.9	E	71.0
Route 1/16	C	32.6	E	58.6
Route 1/14 (North San Vitoris)	C	33.1	F	92.9
Route 1/14A	D	52.1	E	59.6
Route 1/10A	F	96.2	F	81.9
Route 1/14B	D	43.3	C	33.6
Route 1/14 (ITC)	D	51.7	F	116.2
Route 1/30	E	67.8	D	51.5

Table 4.1-9. Existing Level of Service and Delay Results – Central Region

	a.m. Peak Hour		*p.m. Peak Hour*	
	LOS	*Delay (Second)*	*LOS*	*Delay (Second)*
Route 1/8	B	19.3	C	34.1
Route 1/4	C	23.2	C	20.4
Route 1/6 (west)	B	10.0	C	23.1
Route 1/6 (Adelup)	B	19.9	E	59.9
Route 4/7A	C	23.2	E	57.8
Route 4/10	E	64.5	E	59.5
Route 4/17	C	24.9	C	21.2
Route 8/33	F	81.6	F	162.8
Route 8/10	F	140.1	E	67.5
Route 10/15	F	83.8	E	56.3
Route 16/27A	C	34.4	C	25.9
Route 16/27	F	112.4	F	89.4
Route 16/10A	F	125.4	F	89.3
Unsignalized**				
Route 7/7A	C	15.1	C	19.9
Route 26/25	F	81.5	F	400.4
Route 26/15	F	202.4	E	39.5
Route 28/27A	F	152.9	F	37.4
Access Points				
Route 1 - South Andersen Main Gate/(Turner Street)**	B	11.5	D	34.9
Route 15 - South Andersen/Second Gate ***	-	-	-	-
Route 16 - Navy Barrigada Residential Gate *	F	75.5.	F	63.4
Route 8A – Navy Barrigada/(Residential Gate)***	-	-	-	-
Route 15 - Barrigada Air Force/(Chada Point Drive)**	E	37.4	C	18.2

Notes: *Signalized intersection LOS based on average delay for the overall intersection.
**Unsignalized intersection LOS based on approach delay on STOP-controlled approach.
***The access is not built in existing conditions.

Existing Public Transportation

The discussion of existing conditions in this section would focus on the Guam Mass Transit System in the Central Region.

Figure 4.1-7 illustrates the fixed routes and DRS areas for the Central Region. Note that all of the Monday through Friday fixed routes originate at Chamorro Village, that is located in Hagatna. The fixed routes included in the Central Region are Blue Line, Blue Line 2, Red Line 1, Express Line, Green Line 1, and Grey Line 4. The DRS areas located in the Central Region are Grey 2, Grey 3, Red 1, Red 2, Green 1, and Green 2. These routes provide service Monday through Saturday only, and all observe the normal 5:30 a.m. to 7:30 p.m. hours of service. DRS is available on call and normally provides transportation to the nearest fixed-route. Table 4.1-10 shows details about the fixed route and DRS areas in the Central Region.

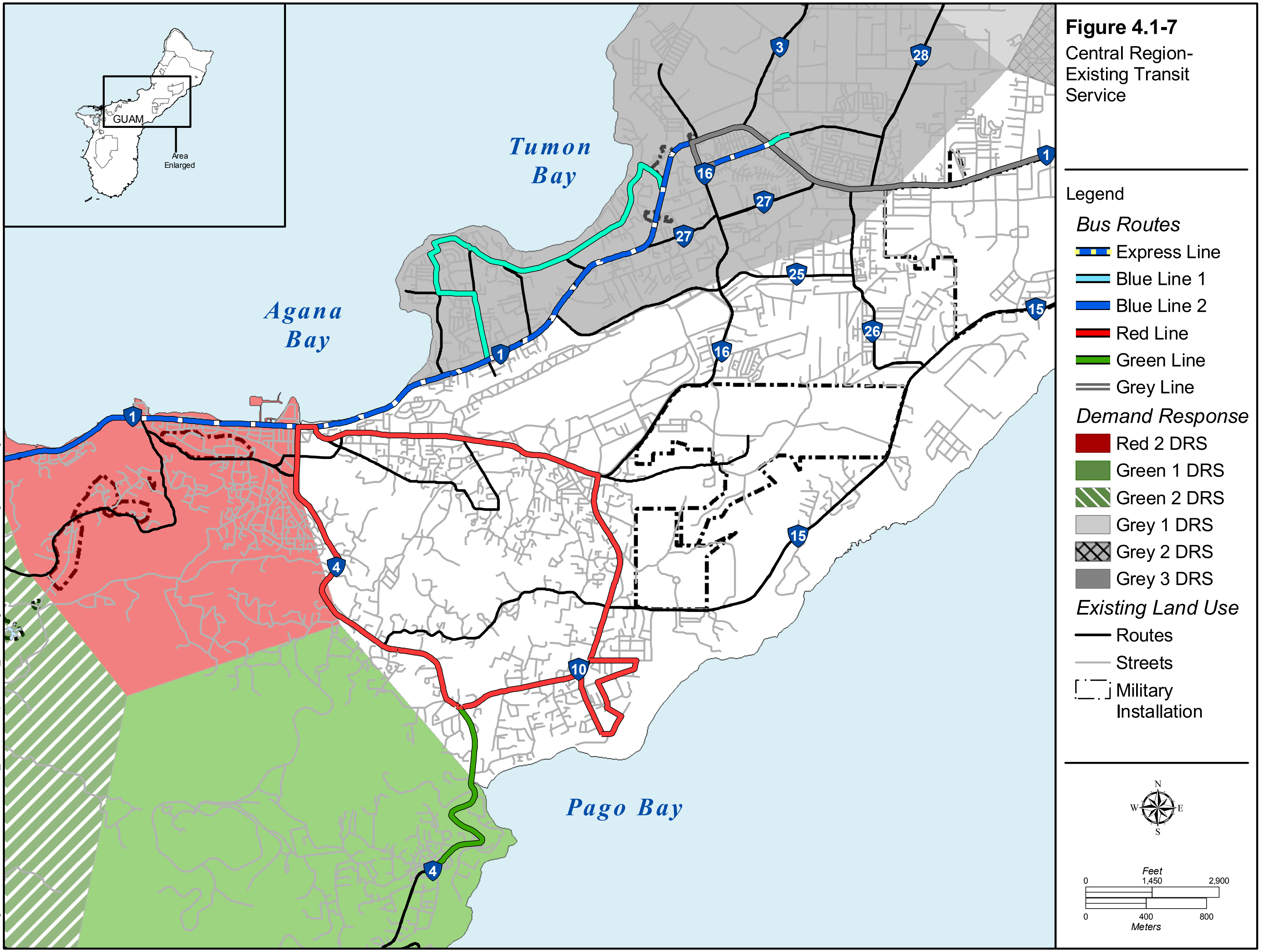


Figure 4.1-7
Central Region-
Existing Transit
Service

Table 4.1-10. Fixed Route and DRS Areas – Central Region

Route	*Areas Served*	*Headway (hours)*	*Trips per Day, Monday-Saturday*	*Trips per Day, Sunday/Holiday*	*Scheduled Run Time Outbound (minutes)*	*Scheduled DR Time (minutes)*	*Scheduled Run Time Inbound (minutes)*
Fixed Route							
Blue Line 1	Hagatna –Tumon – Micronesia Mall (Shuttle)	2	8 OB, 6 IB	6	41 to 52		44 to 54
Blue Line 2	Hagatna – Agat (Shuttle)	2	8 OB, 6 IB	5 OB, 4 IB	35 to 37		32 to 35
Red Line 1	Hagatna – Mangilao (Loop)	1	14	9	22 to 28		28 to 37
Express Line	Hagatna – Micronesia Mall (Loop)	1	13.5	9	25 to 37		28
Green Line 1*	Chamorro Village – Yona (Loop)	2	8	0	10	80	20
Grey Line 4*	Micronesia Mall – Yigo (Loop)	2	0	5	39 to 40	20 to 21	48 to 49
DRS Area							
Grey Line 2	Yigo, Latte Heights, and vicinity	NA	NA	NA	NA	NA	NA
Grey Line 3	Tamuning, Tumon, Harmon, and vicinity	NA	NA	NA	NA	NA	NA
Red Line 1	Hagatna and Asan.	NA	NA	NA	NA	NA	NA
Red Line 2	Hagatna, Anigua, Maina, and vicinity	NA	NA	NA	NA	NA	NA
Green Line 1	Hagatna, Yona, Talofofo, Malojloj, and Inarajan	NA	NA	NA	NA	NA	NA
Green Line 2	Agat, Santa Rita, Umatac, and Merizo	NA	NA	NA	NA	NA	NA

Legend: OB=Outbound; IB = Inbound; NA = Not Applicable.
Notes: *Hours of service are 5:30 a.m. to 7:30 p.m. Monday through Saturday and 7:30 a.m. to 5:30 p.m. Sundays and Holidays.
Source: Government of Guam, Department of Administration, Division of Public Transportation Services..

The paratransit service partially located in the Central Region is:

- Freedom 1 (northern area) serving Yigo, Agafa Gumas, NCS, Santa Ana Subdivision, Astumbo, Dededo, Harmon, and Tamuning
- Freedom 2 (central area) serving Hagatna, Hagatna Heights, Sinajano, Chalan Pago, Pago Bay, Mong Mong, and Tamuning
- Freedom 3 (southern area) serving Inarajan, Malojloj, Talofofo, and Yona
- Freedom 4 (southern area) serving Umatac, Agat, Piti, Asan, Maina, Hagatna Heights, and Hagatna
- Freedom 5 serving the entire island

The 12-month (2006-2007) ridership for the fixed route, DRS, and paratransit routes in the Central Region can be found in Table 4.1-11. Note that there is overlap between several of the routes and service areas between the "areas of interest" for this project. Because the Freedom 5 serves the entire island, ridership is not included here.

Table 4.1-11. Monthly and Total Fiscal Year 2007
Guam Mass Transit Ridership (Passengers Boarding Each Route)

Service Type	*Route Name*	*12-Month Totals*
DRS	Grey 2	25,431
	Grey 3	11,826
	Red 1	NA
	Red 2	21,308
	Green 1	13,050
	Green 2	9,669
Fixed Route	Blue Line 1	30,005
	Blue Line 2	14,870
	Red Line 1	26,620
	Express Line	39,310
	Green Line 1	NA
	Grey Line 4	562
Paratransit	Freedom 1	8,129
	Freedom 2	7,846
	Freedom 3	6,728
	Freedom 4	8,892
All	**Totals**	**224,246**

<u>Existing Pedestrian and Bicycle Facilities</u>

There are sidewalks on both sides of Route 1 (Marine Corps Drive) from the intersection with Route 28 in Dededo, through Tamuning, Mongmong-Toto-Maite, and Hagatna, to the intersection with Route 6 in Asan. Table 4.1-12 and Table 4.1-13 list roads with existing and intermittent sidewalks in the Central Region. Note that these are not all of the sidewalks in the Central Region, only the ones on roadways included in this study. Figure 4.1-8 shows the existing bicycle and pedestrian facilities in the Central Region.

Table 4.1-12. Roads with Existing Sidewalks

Route	*Length (miles)*
Route 1	9.42
Route 10	3.73
Route 27	2.52
Total Length	**15.67**

Table 4.1-13. Roads with Intermittent Sidewalks

Route	*Length (miles)*
Route 8	3.29
Route 26	0.97
Route 28	1.12
Total Length	**5.38**

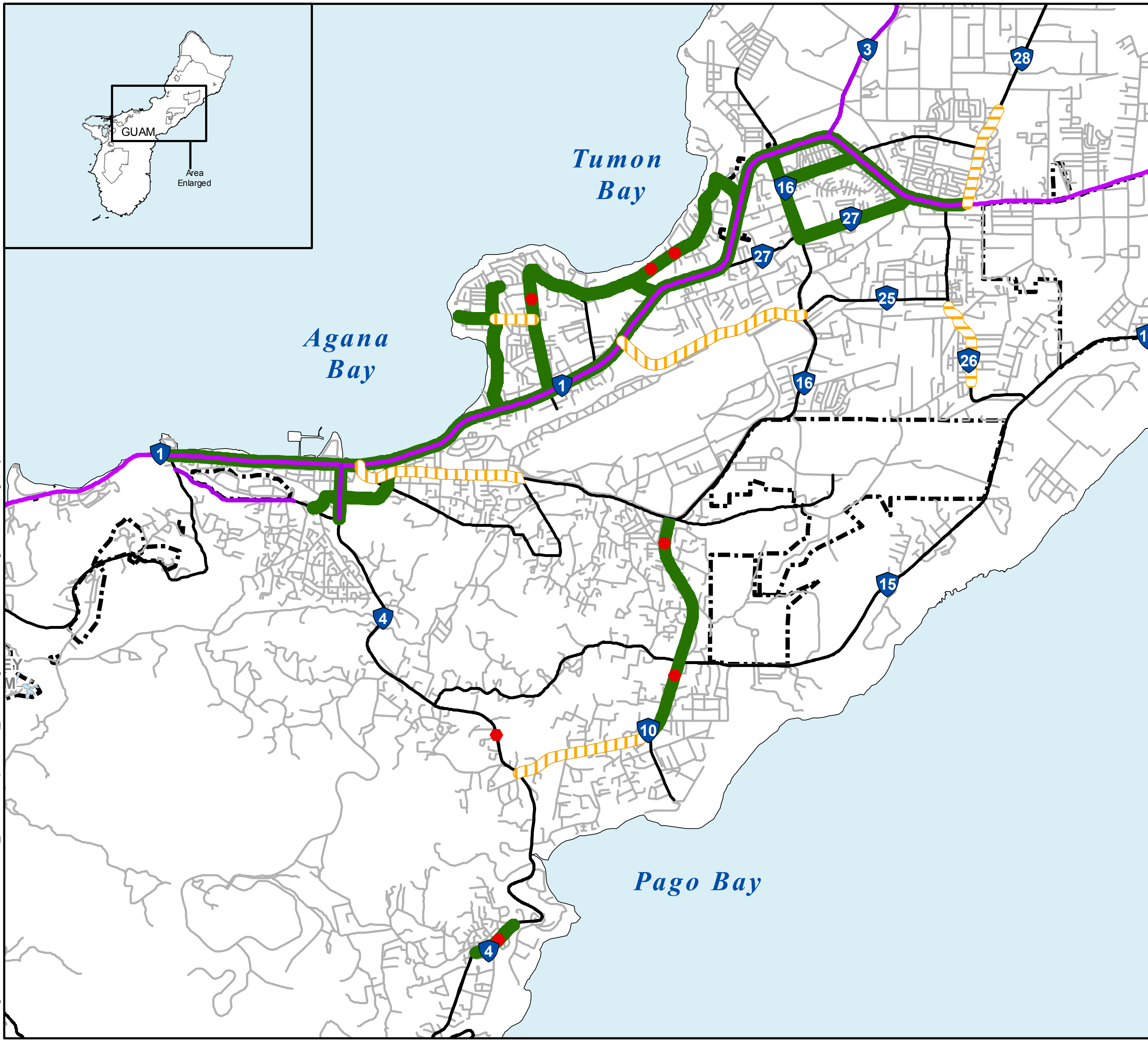


Figure 4.1-8
Central Region-
Existing Bicycle and
Pedestrian Facilities

Legend

Facility Type
- Pedestrian Signals
- Intermittant Sidewalk
- Sidewalk
- Shoulder

Existing Land Use
- Routes
- Streets
- Military Installation

N
W E
S

Feet
0 1,450 2,900

0 400 800
Meters

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.1-8. Central Region - Existing Bicycle and Pedestrian Facilities.mxd

4.1.4 Apra Harbor

4.1.4.1 On Base Roadways

Naval Base Guam

The Naval base main gate is accessed by Marine Corps Drive. Marine Corps Drive is a north-south four-lane arterial roadway that serves as a primary arterial on the base.

The *Traffic Impact Study for Proposed Residential Housing Development (BEQ) Naval Base, Guam* (NAVFAC MAR 2008) analyzed the level of service for several intersections along Marine Corps Drive (Route 1) within the Naval base and found them all to be operating at a very acceptable level of service in both the a.m. and p.m. peak hours.

4.1.4.2 Off Base Roadways

Route 1

Route 1, also known as Marine Corps Drive, is a major arterial roadway and extends approximately 22.0 mi (35.4 km) from Andersen AFB in Yigo on the northeastern corner of the island down to the Naval base in Santa Rita, that is located on the central western area of the island. From Route 11 in Piti to Route 2A in Santa Rita, the road has four lanes. There is a combination of raised and flush median, shoulders, no curb and gutter, and no sidewalks.

Route 2A

Route 2A is located near the Naval base in Santa Rita and connects Route 1 to Route 2. The portion of the road included in this study is from Route 1 to Route 5. This section of Route 2A is approximately 1.0-mile (1.6 km) long and is a two-lane minor arterial with no median, shoulders, curb and gutter, or sidewalk. The lanes are generally 12.0 ft (3.6 m) wide.

Route 11

Route 11 is located on the central west side of the island and serves as the entrance to the Port Authority and Family Beach in Piti. Route 11 is 2.9 mi (4.7 km) long and is classified as a minor arterial. The road has two lanes with no median, and intermittent shoulders, curb and gutter and sidewalks. The lanes are generally 12.0 ft (3.6 m) wide.

The intersections included in the Apra Harbor Region are listed in Table 4.1-14.

Table 4.1-14. Intersections and Access Points – Apra Harbor Region

Intersections and Access Points – Apra Harbor	
Signalized	
Route 1/11	Route 5/2A
Route 1/2A	Route 1/Polaris Point

Existing Traffic Volumes and Capacity

A summary of existing ADT volumes and capacity (2008) for the Apra Harbor Region can be found in Table 4.1-15.

Table 4.1-15. Existing ADT and Capacity Summary – Apra Harbor Region

Roadway	*Existing ADT Summary*	*Existing V/C Ratio*
Route 1	Route 1 ranges from 19,000 to 30,000 vpd. The traffic decreases into the entrance of the Naval base, which is at the Route 1/2A intersection.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.80, which indicates that the roadway is not considered congested.
Route 2A	Route 2A ranges from 16,000 to 24,000 vpd. The traffic decreases after the intersection with Route 5.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.80, which indicates that the roadway is not considered congested.
Route 11	Route 11 has 9,100 vpd.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.80, which indicates that the roadway is not considered congested.

Figure 4.1-9 and Figure 4.10 show existing levels of traffic congestion in the Apra Harbor Region for the a.m. and p.m. peak hours, respectively. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested. Although there are numerous intersections with capacity issues, there are not currently many roadways included in this study with a high existing V/C ratio.

Existing Intersection Operations

In the existing conditions, all of the intersections in the Apra Harbor Region operate at acceptable LOS. Table 4.1-16 displays the LOS and delay results for the study intersections in the Apra Harbor Region.

Table 4.1-16. Level of Service and Delay Results – Apra Harbor Region

	a.m. Peak Hour		*p.m. Peak Hour*	
	LOS	*Delay Seconds*	*LOS*	*Delay Seconds*
Signalized*				
Route 1/11	B	14.5	C	22.2
Route 1/2A	B	15.9	C	29.1
Route 1/Polaris Point	A	2.1	A	3.9
Route 5/2A	D	37.6	C	33.9

*Note: *Signalized intersection LOS based on average delay for the overall intersection.*

Existing Public Transportation

This discussion of existing conditions would focus on the Guam Mass Transit System in the Apra Harbor Region. Figure 4.1-11 illustrate the fixed routes and DRS areas for the Apra Harbor Region. A demand-response area is a geographical area that is served by the demand-response type of bus service as described earlier.

Note that all of the Monday through Friday fixed routes originate at Chamorro Village, which is located in Hagatna and is not shown on this map. The Blue Line 2 is the only bus route that is partially included in the Apra Harbor Region. The DRS area located in the Apra Harbor Region is Green 1. This route provides service on Monday through Saturday only, and all observe the normal 5:30 a.m. to 7:30 p.m. hours of service. DRS is available on call and normally provides transportation to the nearest fixed-route.

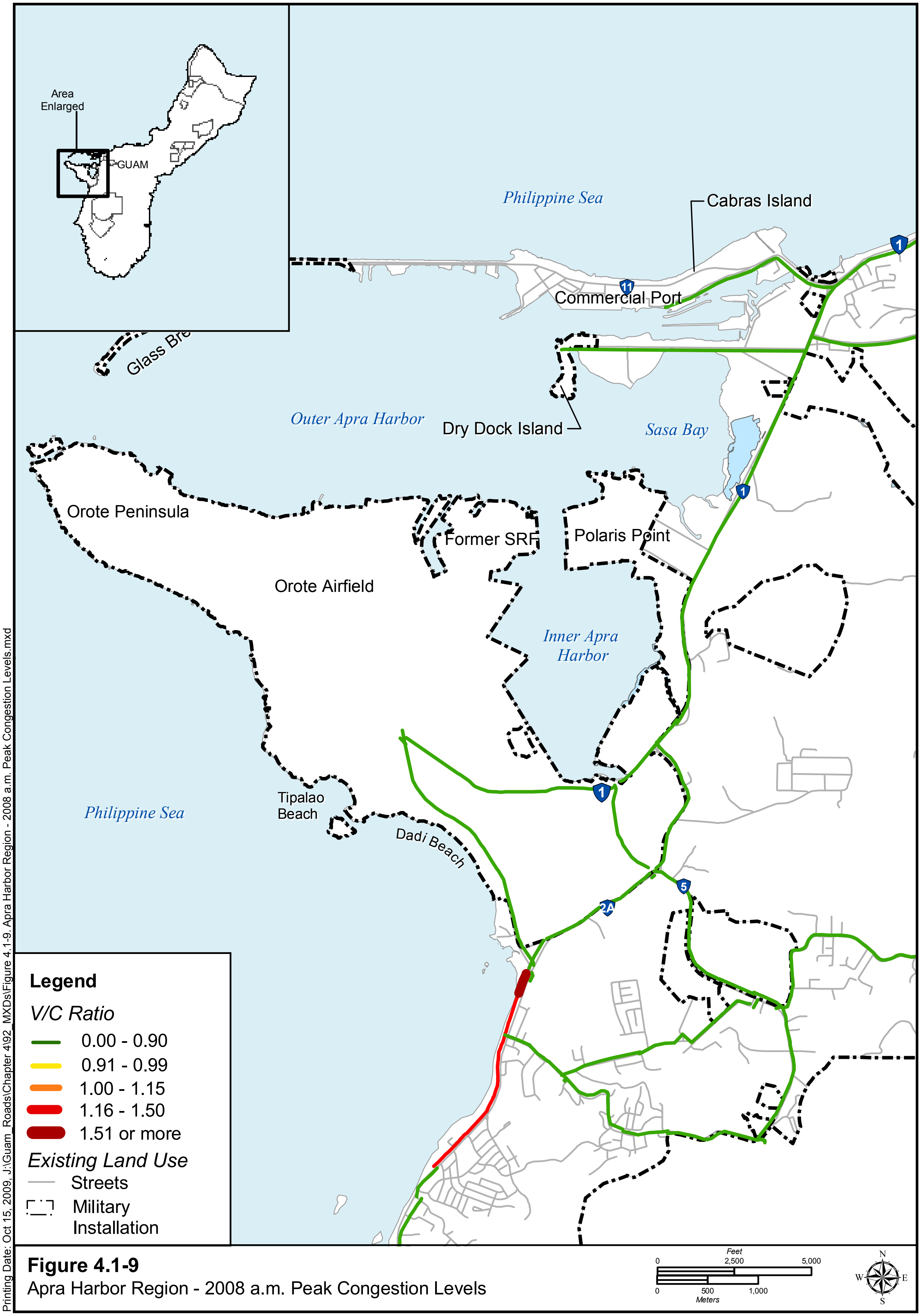


Figure 4.1-9
Apra Harbor Region - 2008 a.m. Peak Congestion Levels

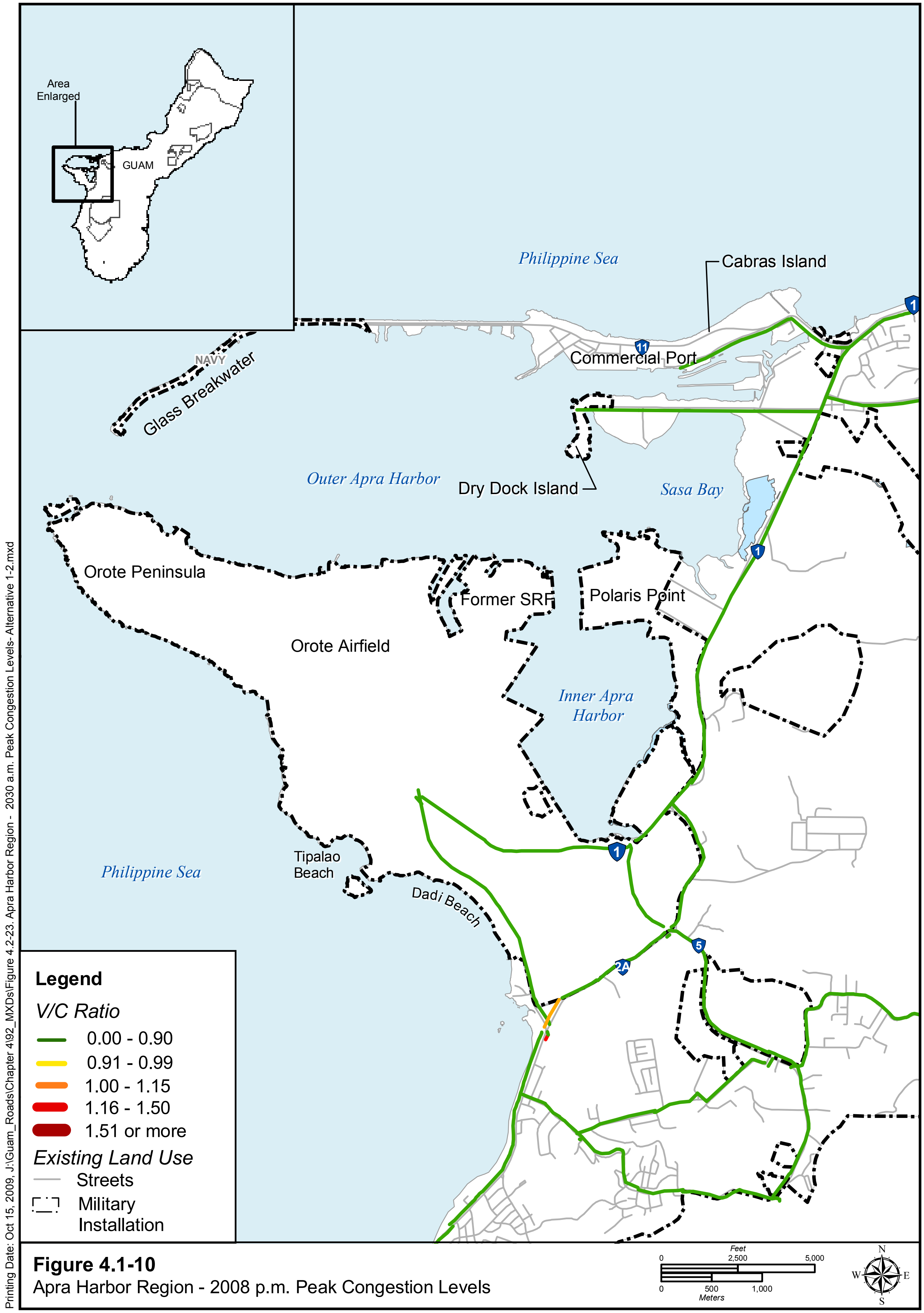
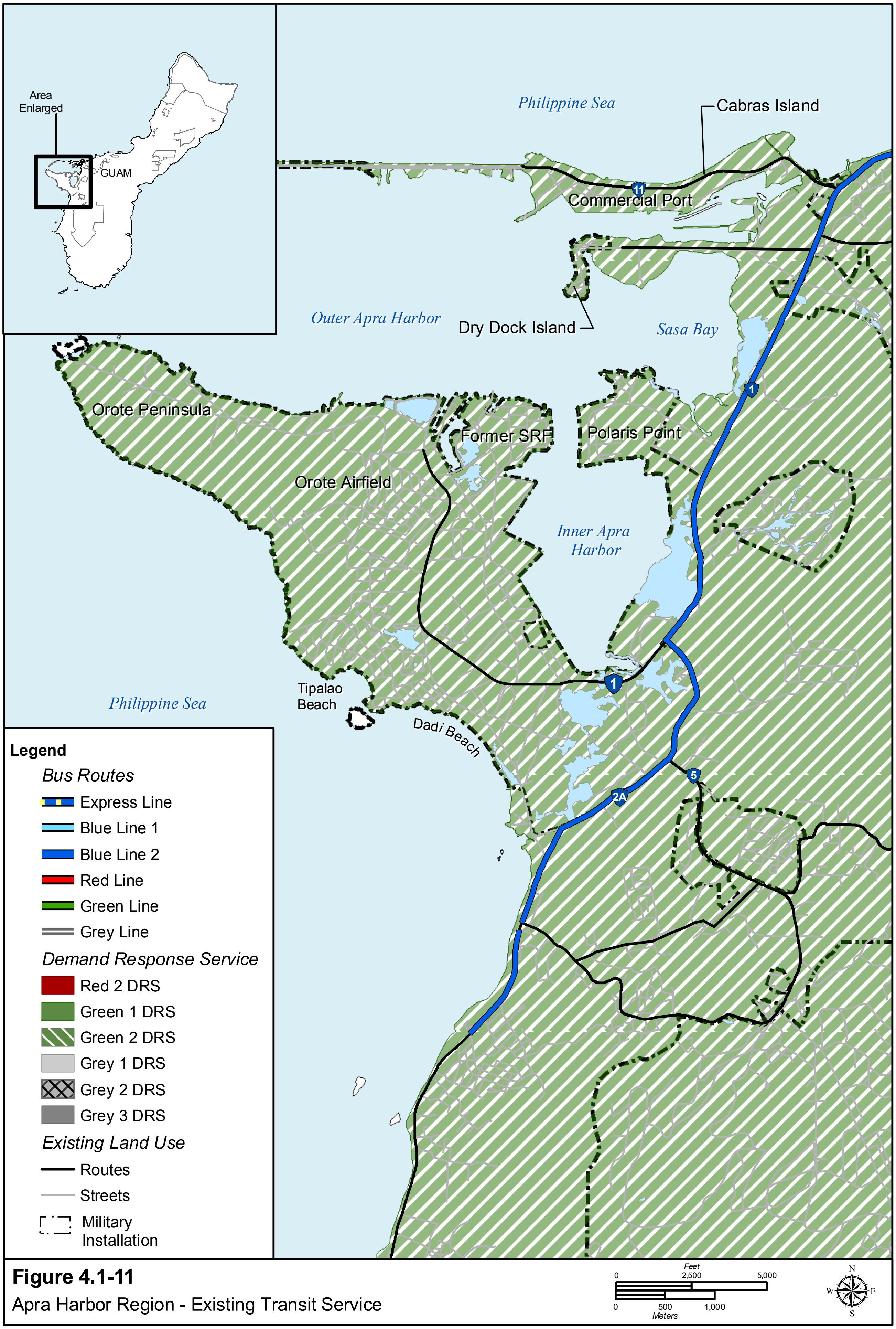


Figure 4.1-10
Apra Harbor Region - 2008 p.m. Peak Congestion Levels



Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.1-11. Apra Harbor Region - Existing Transit Service.mxd

Figure 4.1-11

Apra Harbor Region - Existing Transit Service

Table 4.1-17 shows details about the fixed route and DRS areas in the Apra Harbor Region.

Table 4.1-17. Fixed Route and DRS Areas – Apra Harbor Region

Route	*Areas Served*	*Headway (hours)*	*Trips per Day, Monday-Saturday*	*Trips per Day, Sunday/Holiday*	*Scheduled Run Time Outbound (minutes)*	*Scheduled DR Time (minutes)*	*Scheduled Run Time Inbound (minutes)*
Fixed Route							
Blue Line 2	Hagatna – Agat (Shuttle)	2	8 OB, 6 IB	6	41 to 52		44 to 54
DRS Area							
Green 2	Agat, Santa Rita, Umatac, and Merizo	NA	NA	NA	NA	NA	NA

Legend: OB=Outbound; IB = Inbound; NA = Not Applicable.
Source: Government of Guam, Department of Administration, Division of Public Transportation Services 2008.

The paratransit services partially located in the Apra Harbor Region are:

- Freedom 4 (southern area) serving Umatac, Agat, Piti, Asan, Maina, Hagatna Heights, and Hagatna
- Freedom 5 serving the entire island

The 12-month (2006-2007) ridership for the fixed route, DRS, and paratransit routes in the Apra Harbor Region can be found in Table 4.1-18. Note that there is overlap between several of the routes and service areas between the areas of interest for this project. Because the Freedom 5 serves the entire island, ridership is not included here.

Table 4.1-18. Monthly and Total Fiscal Year 2007
Guam Mass Transit Ridership (Passengers Boarding Each Route)

Service Type	*Route Name*	*12-Month Totals*
DRS	Green 2	9,669
Fixed Route	Blue Line 2	14,870
Paratransit	Freedom 4	8,892
	Totals	**33,431**

Existing Pedestrian and Bicycle Facilities

The only sidewalks in the Apra Harbor Region are intermittent and are located on Route 11. There are approximately 2.27 mi (3.70 km) of sidewalk along Route 11 (Figure 4.1-12). In addition, there are existing shoulders on Route 1 up to the entrance of the Naval base.

4.1.5 South

4.1.5.1 On Base Roadways

Naval Munitions Site

The NMS can be accessed through the gate at the intersection of Harmon Road and Route 12 in Santa Rita. Harmon Road and Lower Harmon Road provide access to the Fena Valley Reservoir within the NMS, which is the primary source of potable water for the Navy water system.

Based on the relatively low traffic demand on the NMS, all roadways and intersections should be operating at acceptable levels of service for both the a.m. and p.m. peak hours.

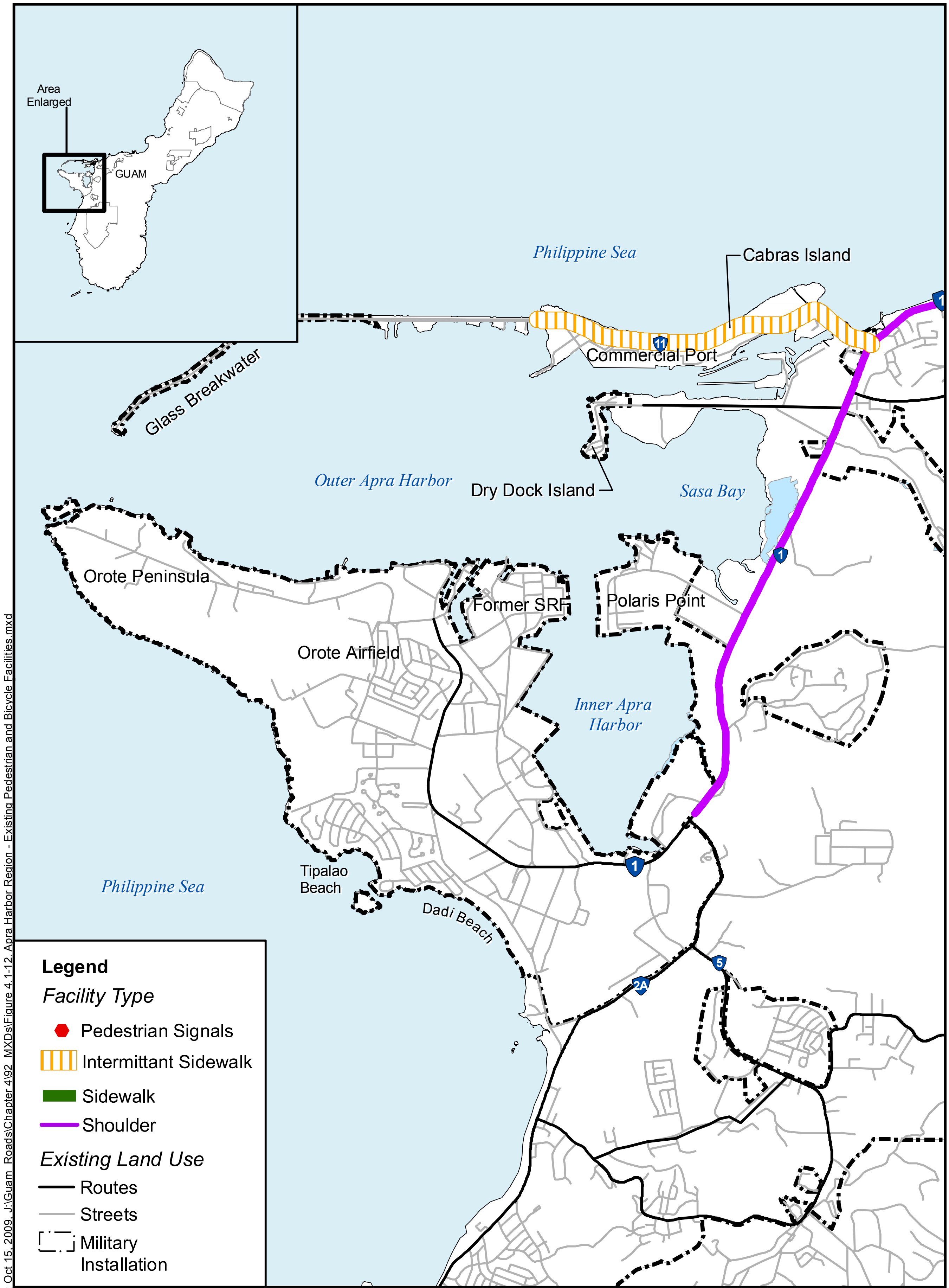


Figure 4.1-12
Apra Harbor Region - Existing Pedestrian and Bicycle Facilities

4.1.5.2 Off Base Roadways

Existing Roadway Conditions

Route 5

Route 5 is located near the Naval base in Santa Rita and intersects with Route 2A at its northern terminus. It loops around to join Route 12 at its southern terminus. The portion of Route 5 included in this study is the section between Route 2A and Route 17. The road is approximately 0.5-mile (0.8-km) long and is considered a minor arterial for the portion in this project. Route 5 has two lanes with an intermediate raised median and queuing left-turn lane at intersections and no shoulders, curb and gutter, or sidewalks. The lanes are generally 12.0 ft (3.6 m) wide.

Route 12

Route 12 is located in the southern part of the island and connects with Route 5 at its eastern terminus in Santa Rita and Route 2 at the western terminus in Agat. Route 12 is 2.7 mi (4.3 km) long and is classified as a major collector; however, the only portion included in this project is the intersection with Route 2. The road has two lanes, intermittent shoulders, and no curb and gutter or sidewalks. The lanes are generally 12.0 ft (3.6 m) wide.

The intersections and access points included in the South Region are listed in Table 4.1-19.

Table 4.1-19. Intersections and Access Points – South Region

Intersections and Access Points - South
Signalized
Route 2/12
Unsignalized
Route 5/17
Route 17/4A
Route 4/4A
Access Points
Route 5 – Naval Munitions Site / Harmon Road

Existing Traffic Volumes and Capacity

A summary of existing ADT volumes (2008) for the South Region can be found in Table 4.1-20.

Table 4.1-20. Existing ADT Summary and Capacity – South Region

Roadway	*Existing ADT Summary*	*Existing V/C Ratio*
Route 5	Route 5 ranges from 7,200 to 12,000 vpd.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.80, which indicates that the roadway is not considered congested.
Route 12	Route 12 ranges from 1,000 to 4,100 vpd. The traffic increases toward the intersection with Route 2.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.80, which indicates that the roadway is not considered congested.

Figure 4.1-13 and Figure 4.1Figure 4.1-14 show existing levels of traffic congestion in the South Region for the a.m. and p.m. peak hours, respectively. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested.

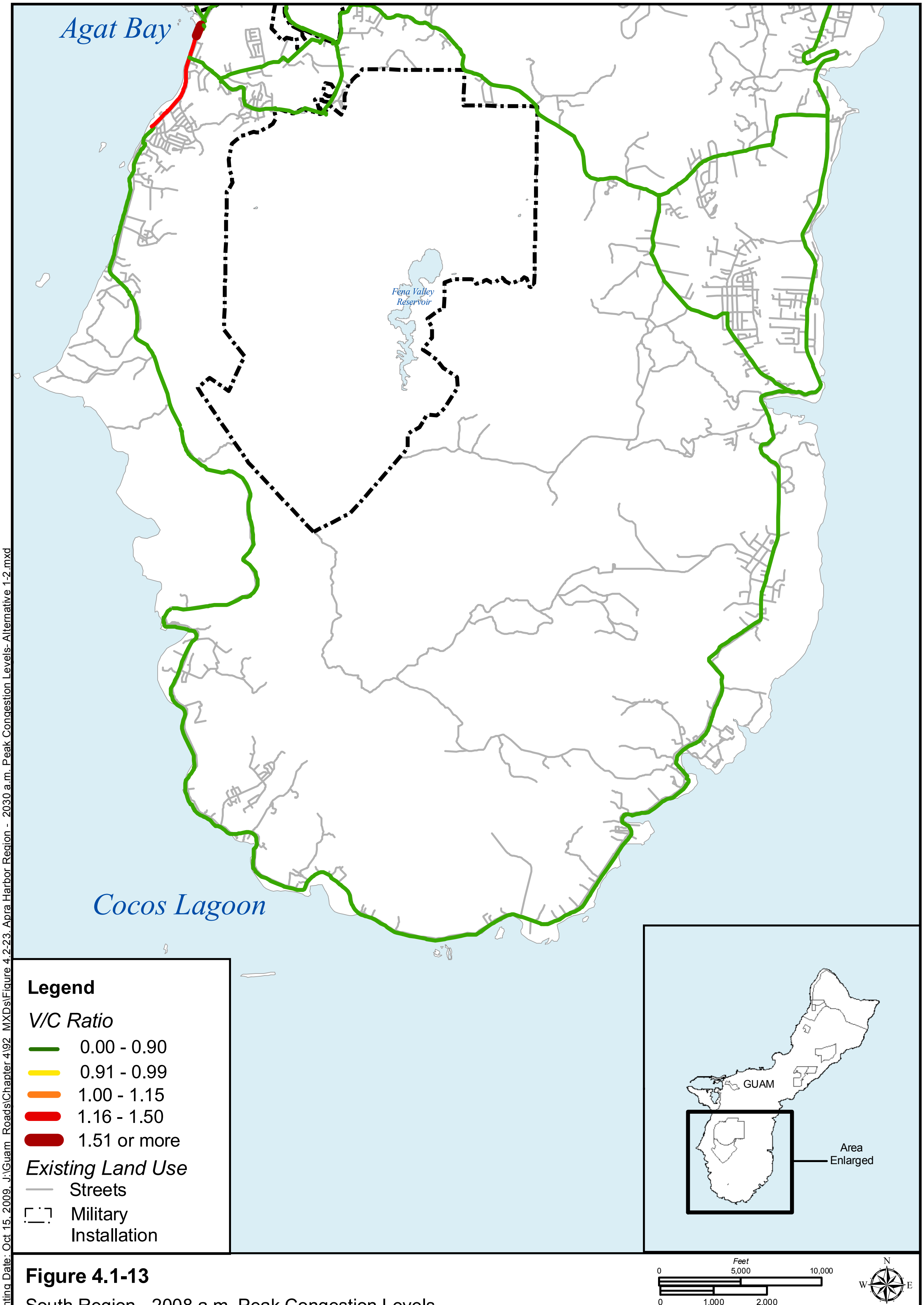


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Figure 4.1-13

South Region - 2008 a.m. Peak Congestion Levels

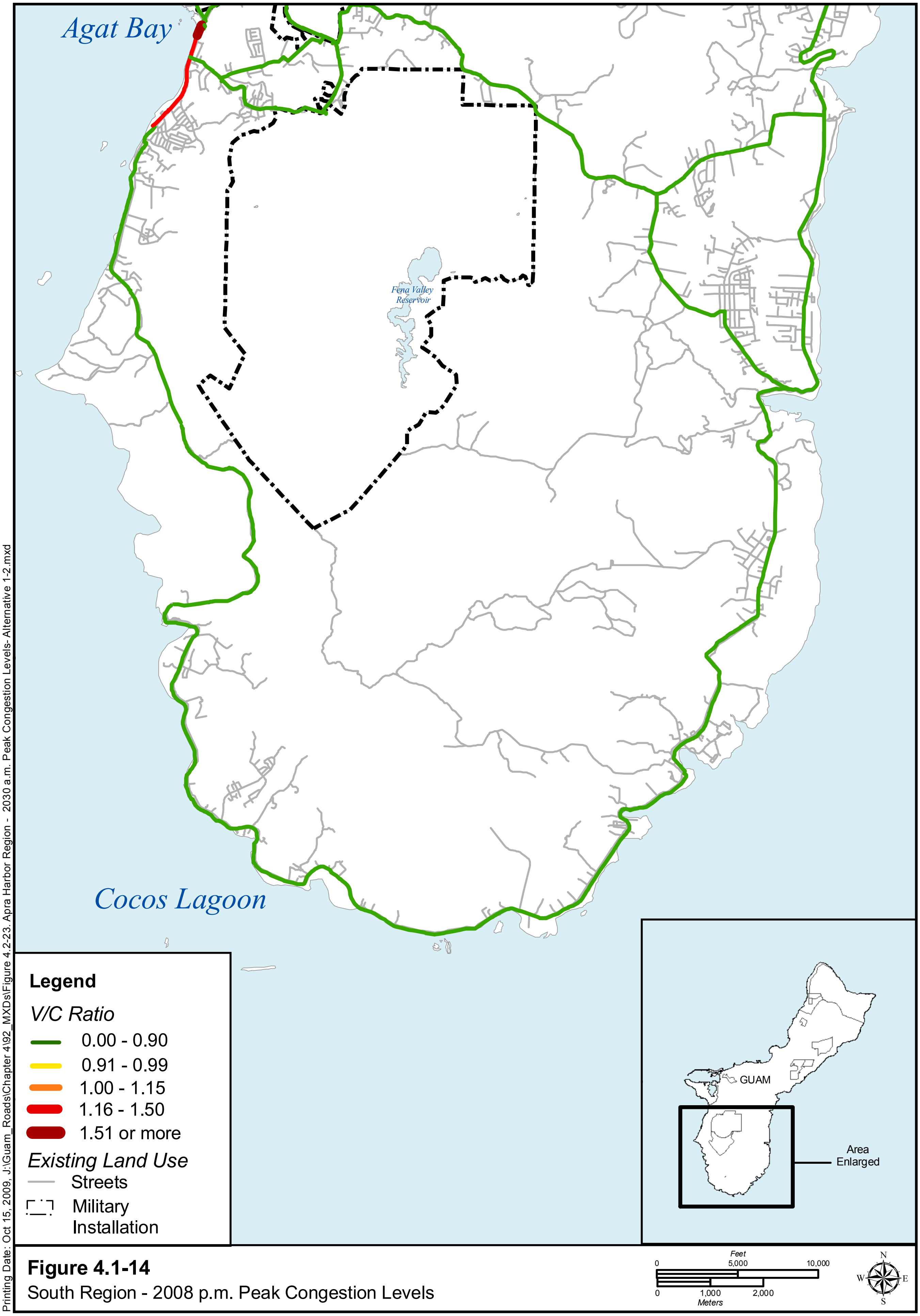

Figure 4.1-14
South Region - 2008 p.m. Peak Congestion Levels

Although there are numerous intersections with capacity issues, there are not currently many roadways included in this study with a high existing V/C ratio. During both the morning and afternoon peaks, the roadways included in this area of interest are all considered not congested in both the a.m. and p.m. peak hours.

Existing Intersection Operations

In the existing conditions, all intersections in the South Region operate at LOS C or better. Table 4.1 displays the LOS and delay results for the study intersections in the South Region.

Table 4.1-21. Existing Level of Service and Delay Results – South Region

	a.m. Peak Hour		*p.m. Peak Hour*	
	LOS	*Delay Seconds*	*LOS*	*Delay Seconds*
Signalized*				
Route 2/12	C	26.3	B	19.2
Unsignalized**				
Route 5/17	B	12.1	B	11.0
Route 4/4A	C	16.8	B	11.4
Route 17/4A	B	14.0	B	11.4
Access Points				
Route 5 – Naval Ordnance Annex/Harmon Road.**	A	8.8	B	10.2

*Notes: *Signalized intersection LOS based on average delay for the overall intersection.*
***Unsignalized intersection LOS based on approach delay on STOP-controlled approach.*

During both the morning and afternoon peaks, the roadways included in this study area are all considered not congested in both the a.m. and p.m. peak hours.

Existing Public Transportation

The discussion of existing conditions in this section would focus on the Guam Mass Transit System in the South Region. Figure 4.1-15 illustrates the fixed routes and DRS areas for the South Region. Note that all of the Monday through Friday fixed routes originate at Chamorro Village, which is located in Hagatna and is not shown on this map. The bus route partially included in the South Region is Blue Line 2. The DRS areas located in the South Region are Green 1 and Green 2. These routes provide service Monday through Saturday only, and all observe the normal 5:30 a.m. to 7:30 p.m. hours of service. DRS is available on call and normally provides transportation to the nearest fixed-route. Table 4.1 shows details about the fixed route and DRS areas in the South Region.

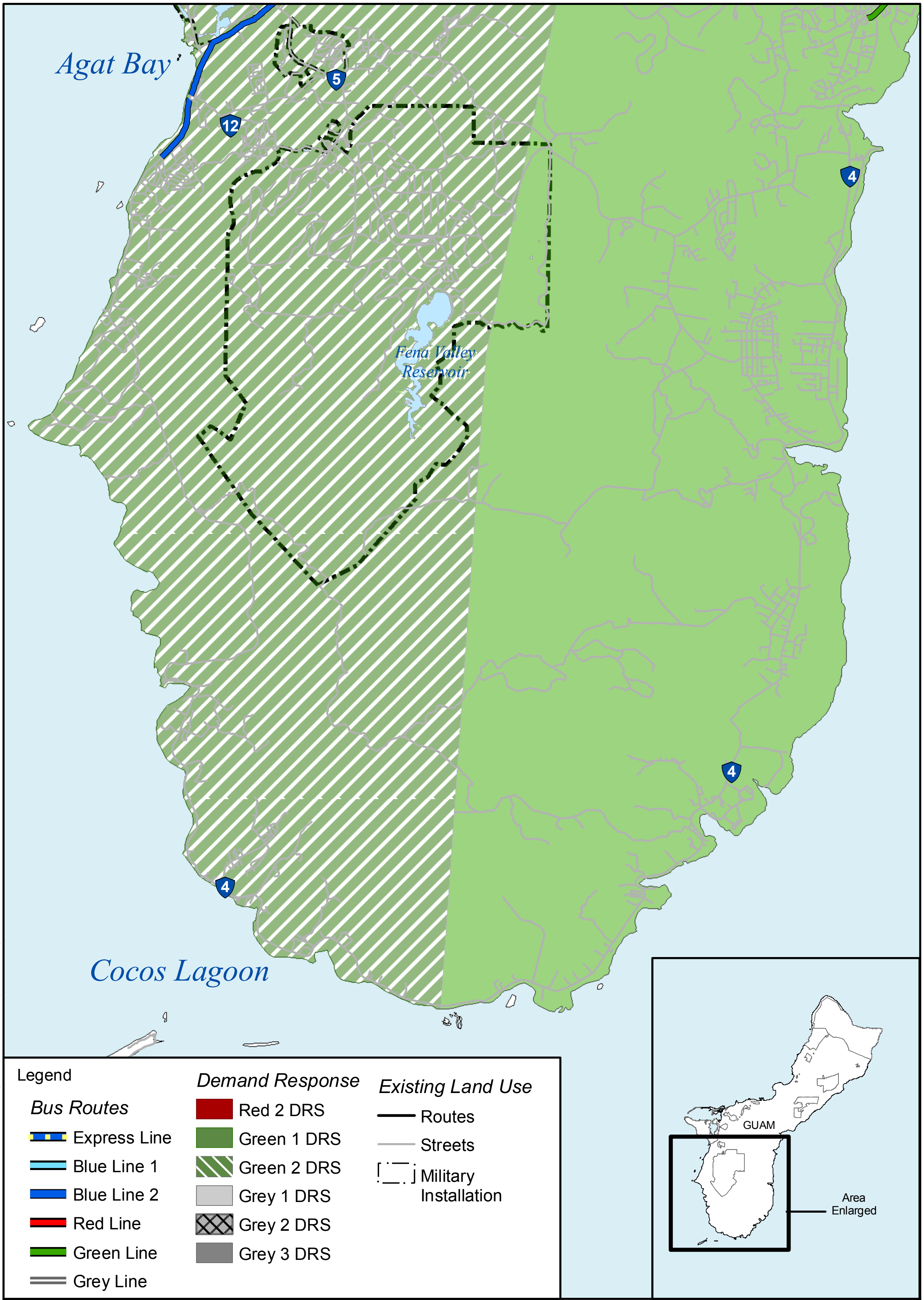

Figure 4.1-15
South Region - Existing Transit Service

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Table 4.1-22. Fixed Route and DRS Areas – South Region

Route	*Areas Served*	*Headway (hours)*	*Trips per Day, Monday-Saturday*	*Trips per Day, Sunday/Holiday*	*Scheduled Run Time Outbound (minutes)*	*Scheduled Time (minutes)*	*Scheduled Run Time Inbound (minutes)*
Fixed Route							
Blue Line 2	Hagatna —Agat (Shuttle)	2	8 OB, 6 IB	5 OB, 4 IB	35 to 37		32 to 35
Green Line 1*	Chamorro Village—Yona (Loop)	2	8	0	10	80	20
DRS Area							
Green Line 1	Hagatna, Yona, Talofofo, Malojloj, and Inarajan	NA	NA	NA	NA	NA	NA
Green Line 2	Agat, Santa Rita, Umatac, and Merizo	NA	NA	NA	NA	NA	NA

Legend: OB=Outbound; IB=Inbound; NA=Not Applicable.
Note: *Hours of service are 5:30 a.m. to 7:30 p.m. Monday through Saturday and 7:30 a.m. to 5:30 p.m. Sundays and Holidays.
Source: Government of Guam, Department of Administration, Division of Public Transportation Services 2008.

The paratransit service partially located in the South Region is:

- Freedom 3 (southern area) serving Inarajan, Malojloj, Talofofo, and Yona
- Freedom 4 (southern area) serving Umatac, Agat, Piti, Asan, Maina, Hagatna Heights, and Hagatna
- Freedom 5 serving the entire island

The 12-month (2006-2007) ridership for the fixed route, DRS, and paratransit routes in the South Region can be found in Table 4.1-23. Note that there is overlap between several of the routes and service areas between the "areas of interest" for this project. Because the Freedom 5 serves the entire island, ridership is not included here.

Table 4.1-23. Monthly and Total Fiscal Year 2007

Guam Mass Transit Ridership (Passengers Boarding Each Route)

Service Type	*Route Name*	*12-Month Totals*
DRS	Green 1	13,050
	Green 2	9,669
Fixed Route	Blue Line 2	14,870
	Green Line 1	NA
Paratransit	Freedom 3	6,728
	Freedom 4	8,892
	Totals	**53,209**

<u>Existing Pedestrian and Bicycle Facilities</u>

The southern portion of the island does not contain any pedestrian or bicycle facilities. In addition, there are no shoulders that can function as pedestrian or bicycle lanes. As stated earlier, no formal bike lanes or paths exist on Guam.

4.2 ENVIRONMENTAL CONSEQUENCES

4.2.1 Approach to Analysis

On Base Roadways

For Andersen AFB and Navy base, on base roadway analysis approach was based on the TransCAD traffic model volumes and available traffic study data. General baseline and operating conditions were taken from the *Andersen AFB Traffic and Safety Engineering Study* (Andersen AFBDecember 2008) for Andersen AFB and the *Traffic Impact Study for Proposed Residential Housing Development (BEQ) Naval Base, Guam* for Navy base. The TransCAD 2008 and 2030 traffic volumes at Andersen Air Force and Navy base gates were compared to determine the anticipated increase in traffic entering and exiting the base. This index provides a relative measure of traffic impact and is intended to be a gauge of the general level of traffic on the base. This index does not measure the traffic impact at critical intersections.

For Andersen South, Finegayan, Polaris Point and Naval Munitions Site, the current base land use was compared to the traffic anticipated to be generated by the proposed action. A qualitative analysis based on roadway capacities and project trips were compared to determine level of significance.

An on base traffic study is currently being conducted and results from that report will be incorporated in the FEIS.

Off Base Roadways

This section describes the future condition of off base roadways as a result of roadway improvements needed to support the military buildup on Guam. The results are discussed for the four major alternatives of Volume 2: Alternative 1, Alternative 2, Alternative 3, and Alternative 8, all of which are described in detail in Chapter 2. However, the analysis includes the alternatives associated with the aircraft carrier berthing action (Volume 4) and the Army AMDTF action (Volume 5). As described in the Affected Environment subsection of Volume 2, the island is divided up into four “areas of interest”: North, Central, Apra Harbor, and South. The future conditions of the off base roadways are discussed in their respective area of interest, as listed above.

The traffic impacts of the alternatives were determined through an analysis of future traffic volumes and intersection operations. The alternatives that were modeled are as follows:

- 2014 Peak Construction/Full Military Expansion – Alternative 1
- 2014 Peak Construction/Full Military Expansion – Alternative 2
- 2014 Peak Construction/Full Military Expansion – Alternative 3
- 2014 Peak Construction/Full Military Expansion – Alternative 8
- 2014 – No-Action Alternative
- 2030 Full Military Expansion – Alternative 1
- 2030 Full Military Expansion – Alternative 2
- 2030 Full Military Expansion – Alternative 3
- 2030 Full Military Expansion – Alternative 8
- 2030 – No-Action Alternative

Forecasting of future traffic volumes involved a three-step process (trip generation, trip distribution and assignment). All modeling efforts used the 2008 TransCAD model, as discussed in the Affected Environment section, along with several population and employment assumptions. The assumptions included:

- Population related to the military buildup would peak in 2014 with approximately 268,000 construction and military personnel and general population of Guam. By 2030, the population would slightly decrease to approximately 255,000 because of the loss in off-island construction personnel (see Figure 4.2-1).

- All military loading, housing location, and military workplace location information was provided by the Navy. Most of the military personnel are housed in the northwest area of the island (see Figure 4.2-1 and Table 4.2-1 and Figure 4.2-2).
- Off-island construction personnel associated with the military actions are housed in community housing close to the construction sites and bused to work during off-peak hours during the construction years.
- Transient personnel (CVN, Marines, Air Force) visit periodically, do not have access to personally owned vehicles, and would have designated shuttle service to on-island locations; therefore, traffic was assumed to be negligible and subsequently not included in model.
- Off-island indirect workers associated with the military actions would live in zones concentrated around the north and central parts of the island.
- New indirect and direct jobs that result from the military actions would be concentrated around the north and central parts of the island.
- Roadway construction workers were included in the model as "Other" indirect workers. The employment at these locations would attract workers during the trip distribution step.
- Construction materials being delivered to the construction sites were also modeled.
- Including roadway construction employment delivery of construction materials in the model accounts for the impact of roadway work during the construction peak phase.
- Traffic congestion was measured by dividing the number of cars on the road (i.e., volume) by the number of cars the road was designed to carry (i.e., capacity). A V/C ratio greater than 1 indicates that the roads are carrying more vehicles than they were designed to handle—the roads are congested.

4.2.1.1 Methodology

<u>On Base Roadways</u>

For Andersen AFB and Navy base, a percent increase of traffic between 2030 with and without project was used to determine the level of significance. Typically, a 2% increase of a critical movement at an intersection operating at LOS D or worse would be considered significant. For the purpose of this analysis, 5% increase in total traffic was use as the significance threshold regardless of level of service.

For on base construction, Andersen South, Finegayan, Polaris Point and Naval Munitions Site, the current traffic demand on the roadway system was compared to the traffic anticipated to be generated by the proposed action. Typically, a two lane roadway has a capacity of approximately 5,000 vehicles per day. This capacity was compared to projected traffic of the project and current traffic demand to determine the level of significance.

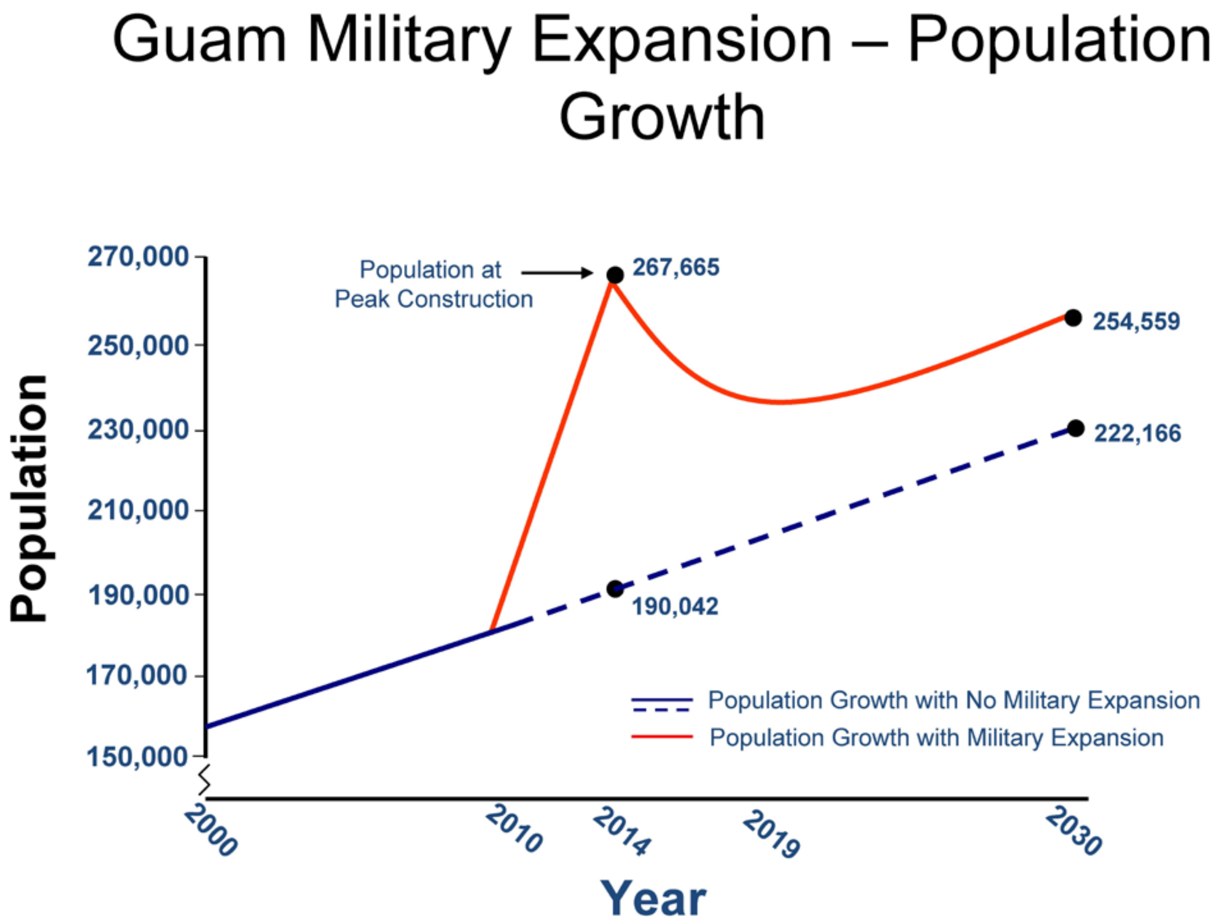


Figure 4.2-1. Island Population Growth

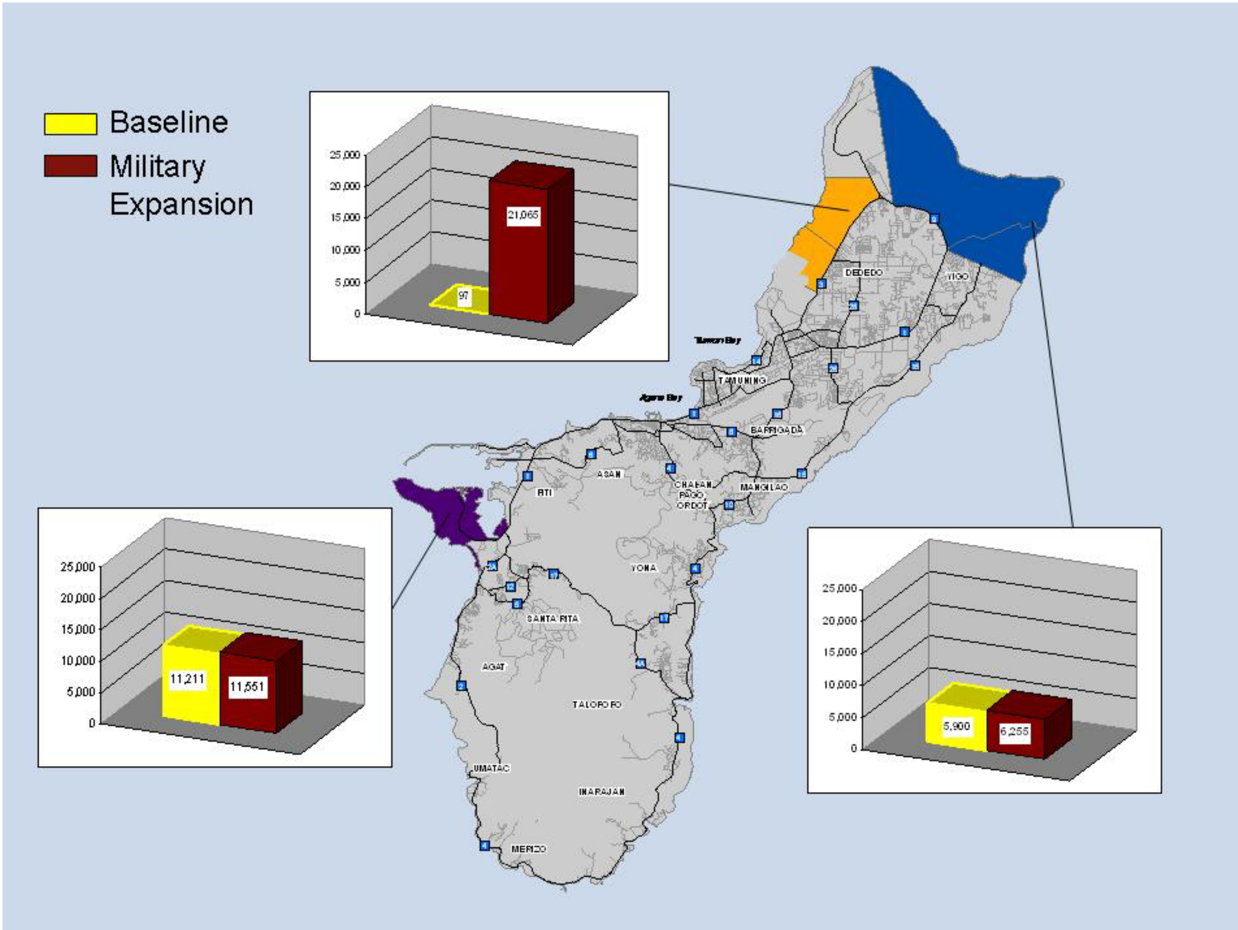


Figure 4.2-2. Military Base Population Growth

Off Base Roadways

As the first step, traffic volumes were modeled for each alternative to understand the impacts of the military buildup on the existing roadway network, including already programmed roadway improvements. With current capacities, this initial modeling effort showed severe military-related congestion along several routes in the northern and central portions of the island. The results formed the roadway improvements needed to improve traffic congestion and improve safety of the system. The proposed projects, as described in Volume 6, Chapter 2, included roadway widening to improve the congestion levels and strengthening to improve structural capacity of roads. These projects are shown in Table 4.2-1.

Table 4.2-1. Roadway Widening Projects

Route	*Limits*	*Description*	*Alternative 1/2*	*Alternative 3*	*Alternative 8*
Route 3	NCTS Finegayan to Route 28	Widen from 2 to 4 lanes, add median and shoulders.	X	X	X
Route 3	NCTS Finegayan to Route 9	Widen from 2 to 4 lanes, add median and shoulders.	X	X	X
Route 8	Route 33 (east) to Route 1	Widen from 4/6 lanes to 6 lanes, with a median.	X	X	X
Route 8A	Route 16 to Air Force Barrigada	Widen to provide median and shoulders.		X	
Route 9	Route 3 to Andersen AFB (ACE Gate)	Widen from 2 to 4 lanes, add median.	X	X	X
Route 9	Andersen AFB ACE Gate to Route 1 (Andersen AFB Main Gate)	Add median and shoulders	X	X	X
Route 16	Route 10A to Sabana Barrigada	Widen from 4 to 6 lanes, with a median.		X	
Route 25	Route 16 to Route 26	Widen from 2 to 4 lanes	X	X	X
Route 26	Route 1 to Route 15	Widen from 2 to 4 lanes	X	X	X
Route 28	Route 1 to Route 3	Add median and 4 shoulders	X	X	X

The existing roads are not structurally capable of handling heavy traffic due to the current condition of pavement. By improving the structural capacity of the roadways and widening selected roads to account for additional traffic, the safety and stability of the roadways would also be improved for other drivers, transit patrons, pedestrians, and bicyclists. As discussed in Chapter 2, the following roads are included in the proposed improvements for this project:

- Route 1
- Route 2a
- Route 3
- Route 5
- Route 8
- Route 8a
- Route 9
- Route 10
- Route 11
- Route 12
- Route 15
- Route 16
- Route 25
- Route 26
- Route 27
- Route 28
- Chalan Lujuna

The second step included modeling the traffic volumes for each alternative with the roadway projects. After incorporating the new capacities with the proposed roadway segment improvements, the results reveal decreased congestion on the routes in the north; however, some military-related congestion still exists in the Central Region, leading to the identification of two additional roadway improvement projects on Routes 25 and 26. The remaining congested areas are existing concerns and would be present regardless of military buildup.

The third step included adding the widening of Routes 25 and 26 to the TransCAD model for 2030. These results, along with the rest of the roadway volume results, were incorporated into Synchro, along with the proposed improvements at 27 intersections. The intersection improvements were evaluated for both 2014 and 2030. LOS modeling and geometric requirements/design were completed for the access points based on the long-term steady-state condition in 2030. The 2014 analysis should be completed for the "preferred" alternative as part of a future traffic management plan during the peak construction period.

The results of this analysis are shown in the *Future Traffic Impacts* sections in this chapter.

Figure 4.2-3 through Figure 4.2-14 present the different congestion levels for each alternative. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested. The congestion levels for Alternative 2 are the same as that of Alternative 1; therefore, Figure 4.2-3 through Figure4.2-6 are applicable to both Alternatives 1 and 2.

The turning movements calculated using the methods and assumptions described above were then used to forecast the LOS at the 42 intersections. The traffic volumes from the revised TransCAD model, including the roadway widening projects associated with each alternative, were used to analyze intersection operations. The future conditions for the 42 intersections were calculated using Synchro, which is described earlier in this chapter.

4.2.1.2 Determination of Significance

<u>On Base Roadways</u>

See On base Approach to Analysis and Methodology of this Chapter.

<u>Off Base Roadways</u>

The desired threshold for acceptable operating conditions at intersections is LOS E or better. Intersections operating at LOS F would be considered unacceptable.

4.2.1.3 Issues Identified during Public Scoping Process

<u>On Base Roadways</u>

Although there were many traffic related comments received during the public scoping process, on base traffic related comments were not received.

<u>Off Base Roadways</u>

During the public scoping meeting, 33 comments were received regarding the increase in traffic and roadway conditions. Several comments were received indicating that studies must be conducted to identify needs, synchronize signals, upgrade roads to federal standards, and identify impacts to primary, secondary, and tertiary roadways. The Bureau of Planning and Statistics had several comments and questions regarding the impact of population growth on existing off base roadways, the capacity of the existing system, and the interface between the planning efforts with the Guam Highway Master Plan(s). In addition, there were comments received on wanting the mitigation measures for traffic impacts identified in this EIS/OEIS.

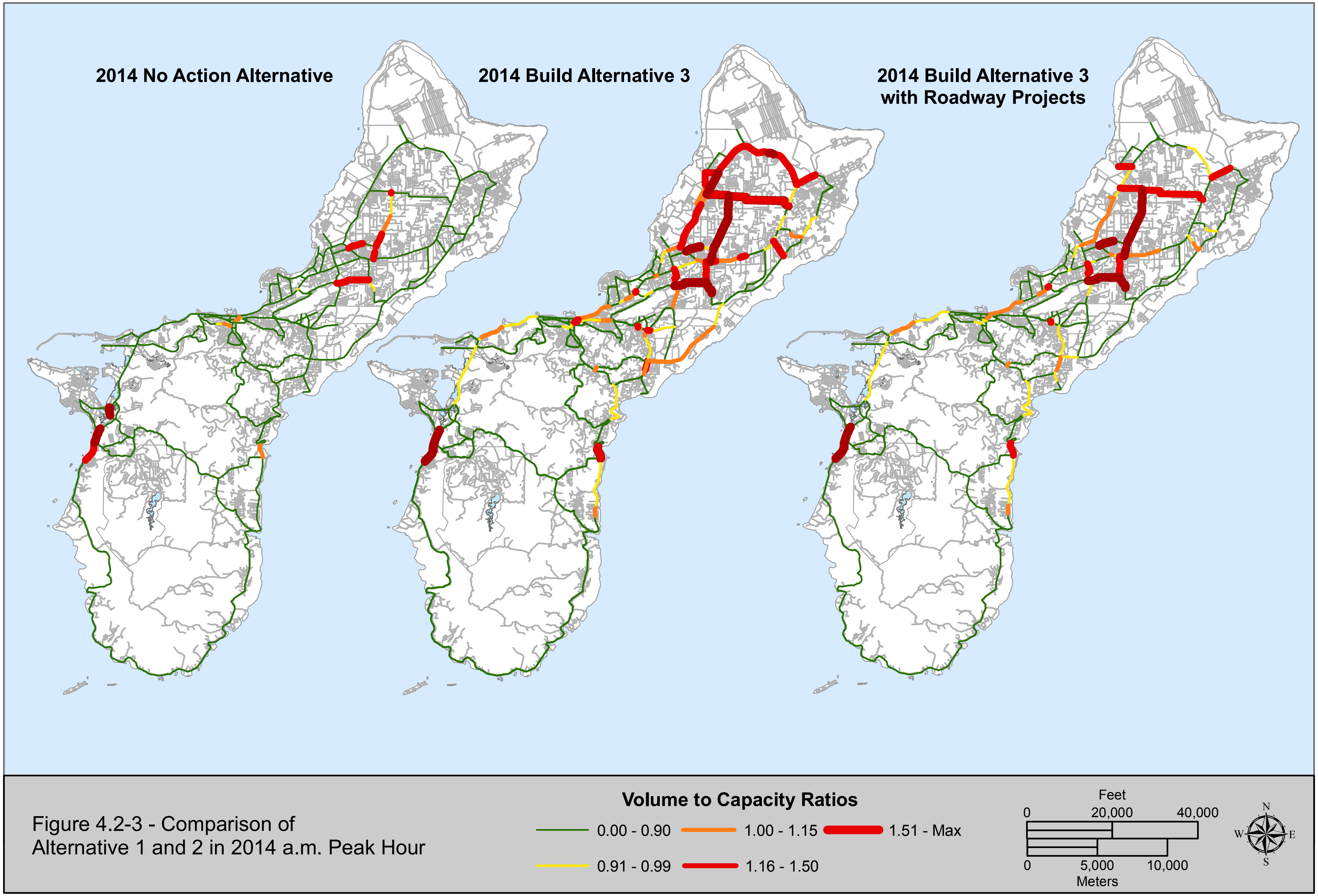


Figure 4.2-3 - Comparison of
Alternative 1 and 2 in 2014 a.m. Peak Hour

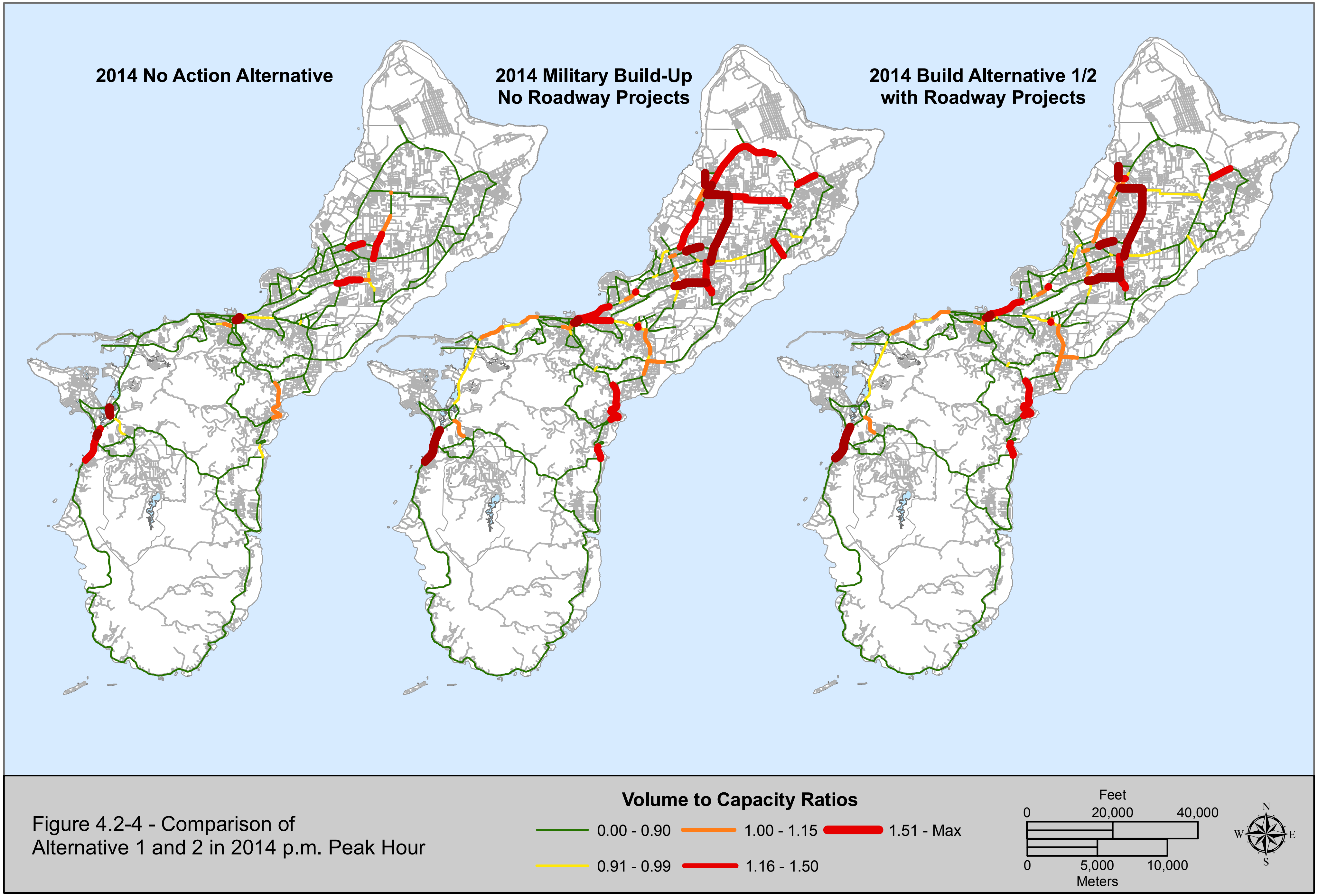


Figure 4.2-4 - Comparison of Alternative 1 and 2 in 2014 p.m. Peak Hour

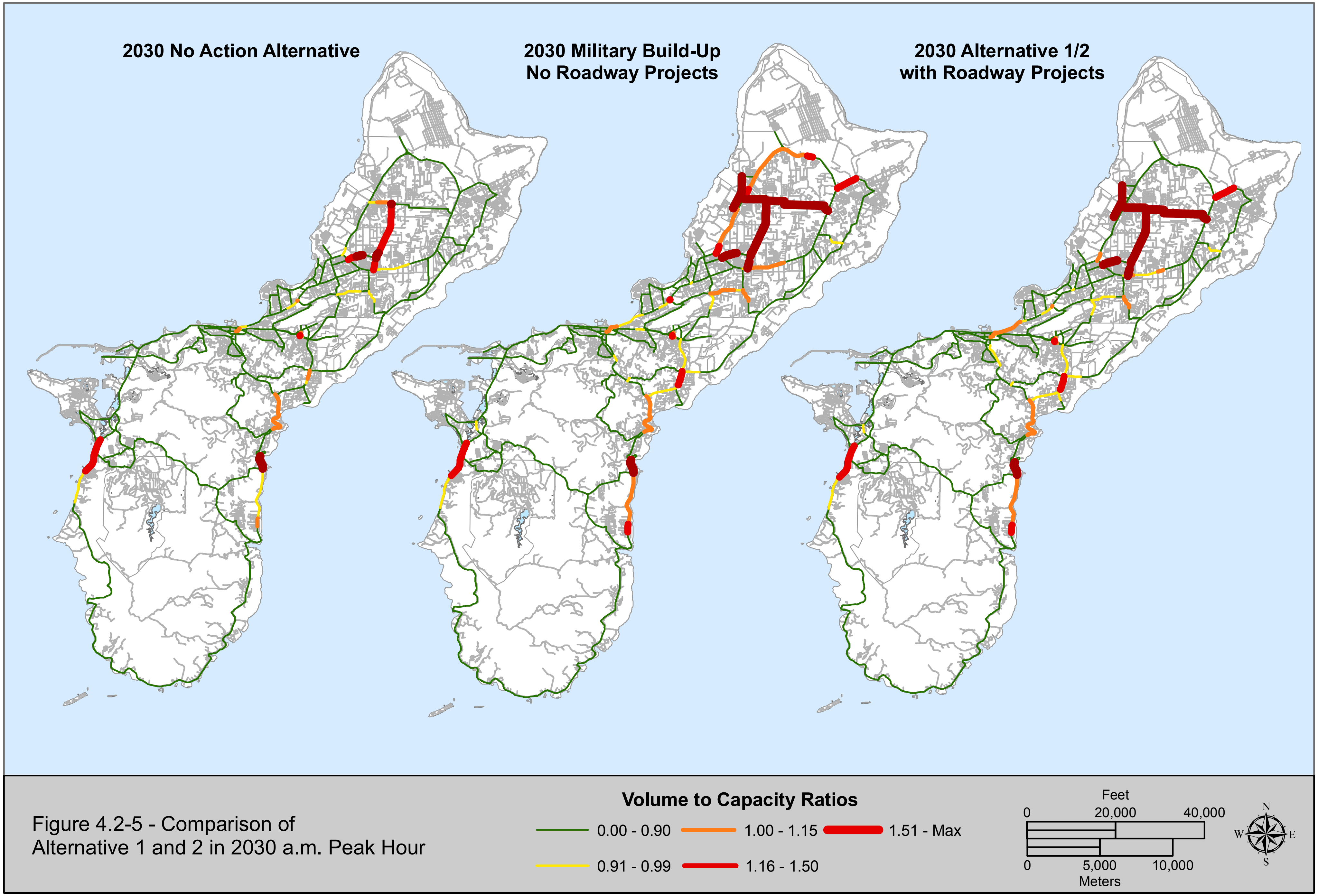


Figure 4.2-5 - Comparison of Alternative 1 and 2 in 2030 a.m. Peak Hour

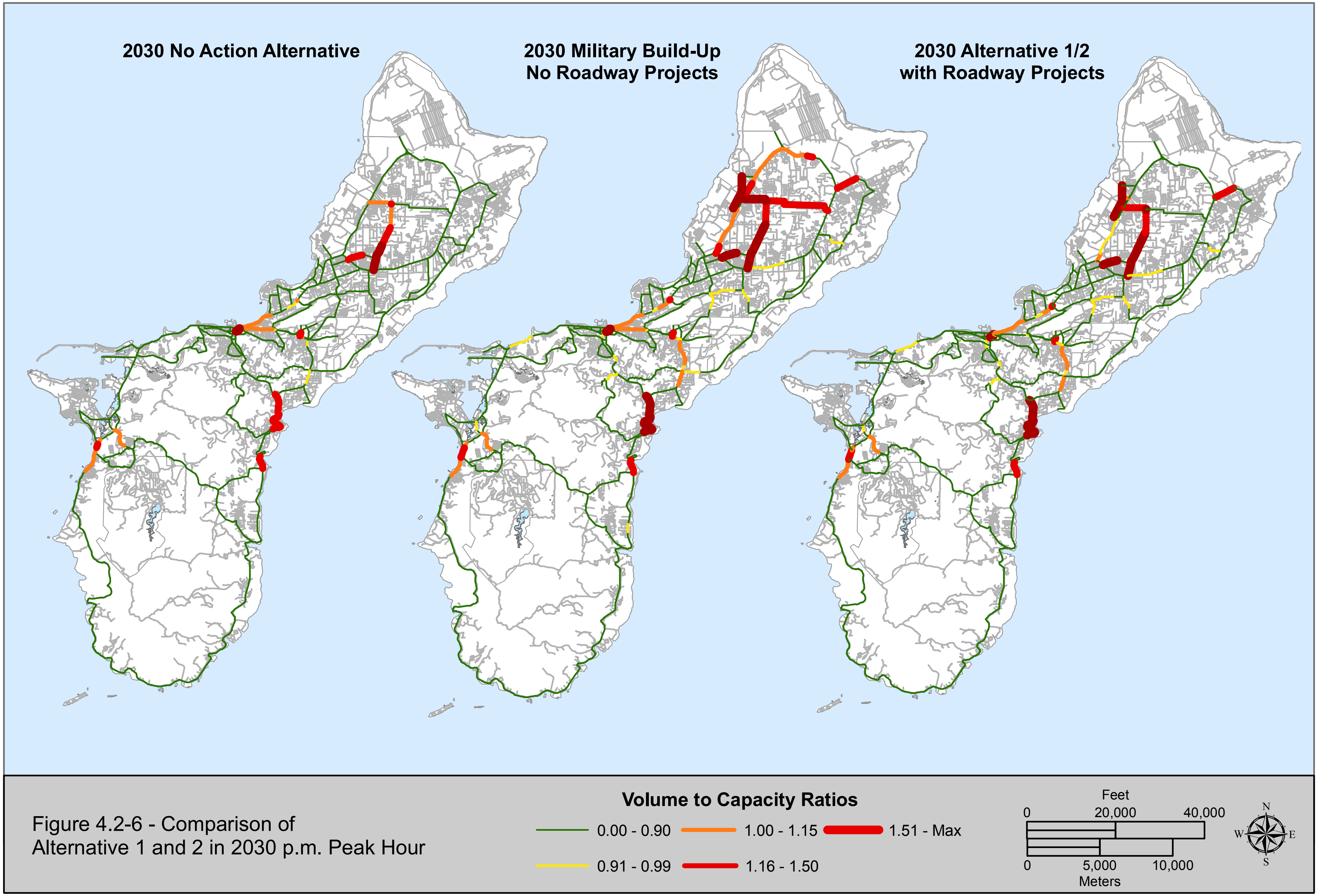


Figure 4.2-6 - Comparison of Alternative 1 and 2 in 2030 p.m. Peak Hour

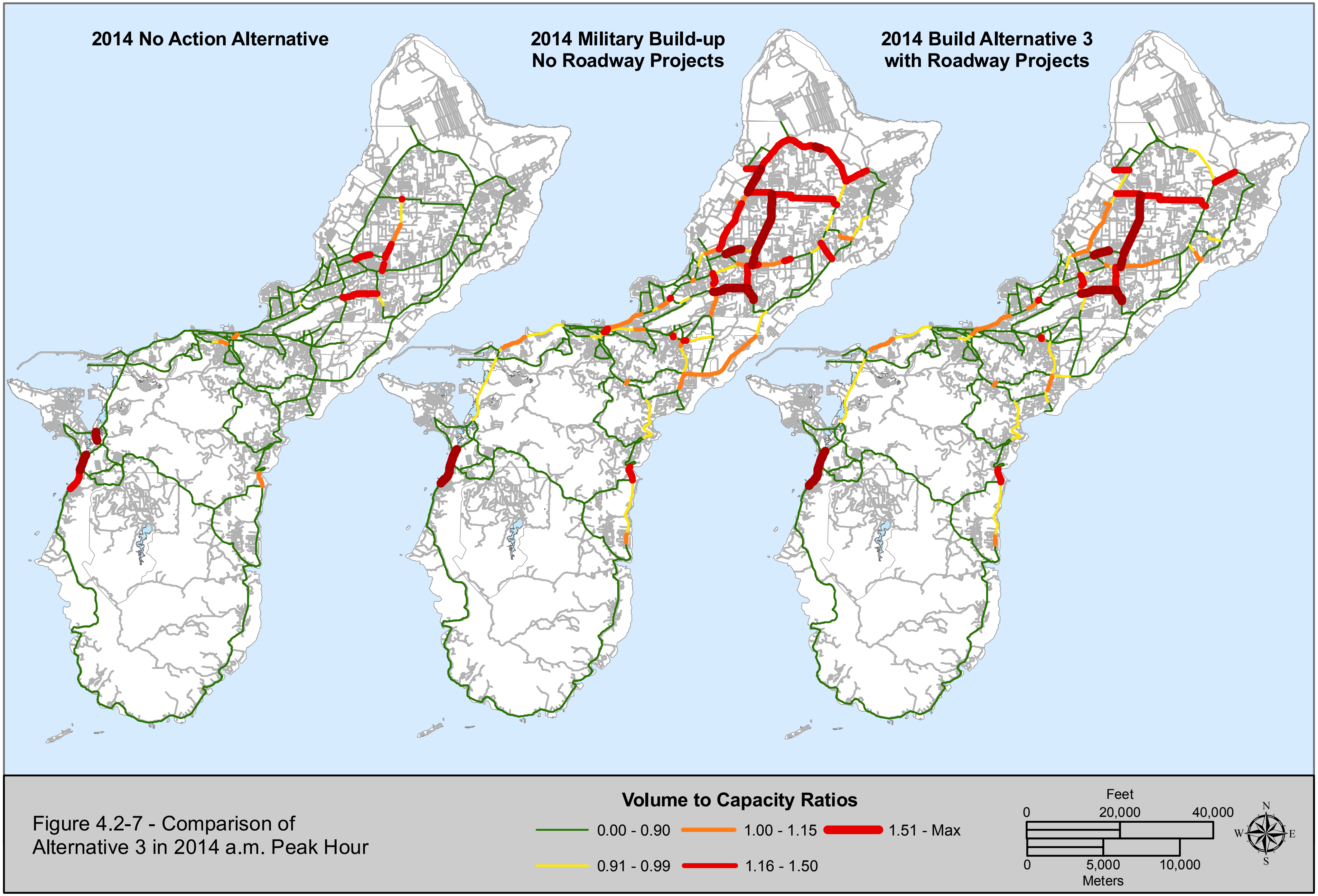


Figure 4.2-7 - Comparison of Alternative 3 in 2014 a.m. Peak Hour

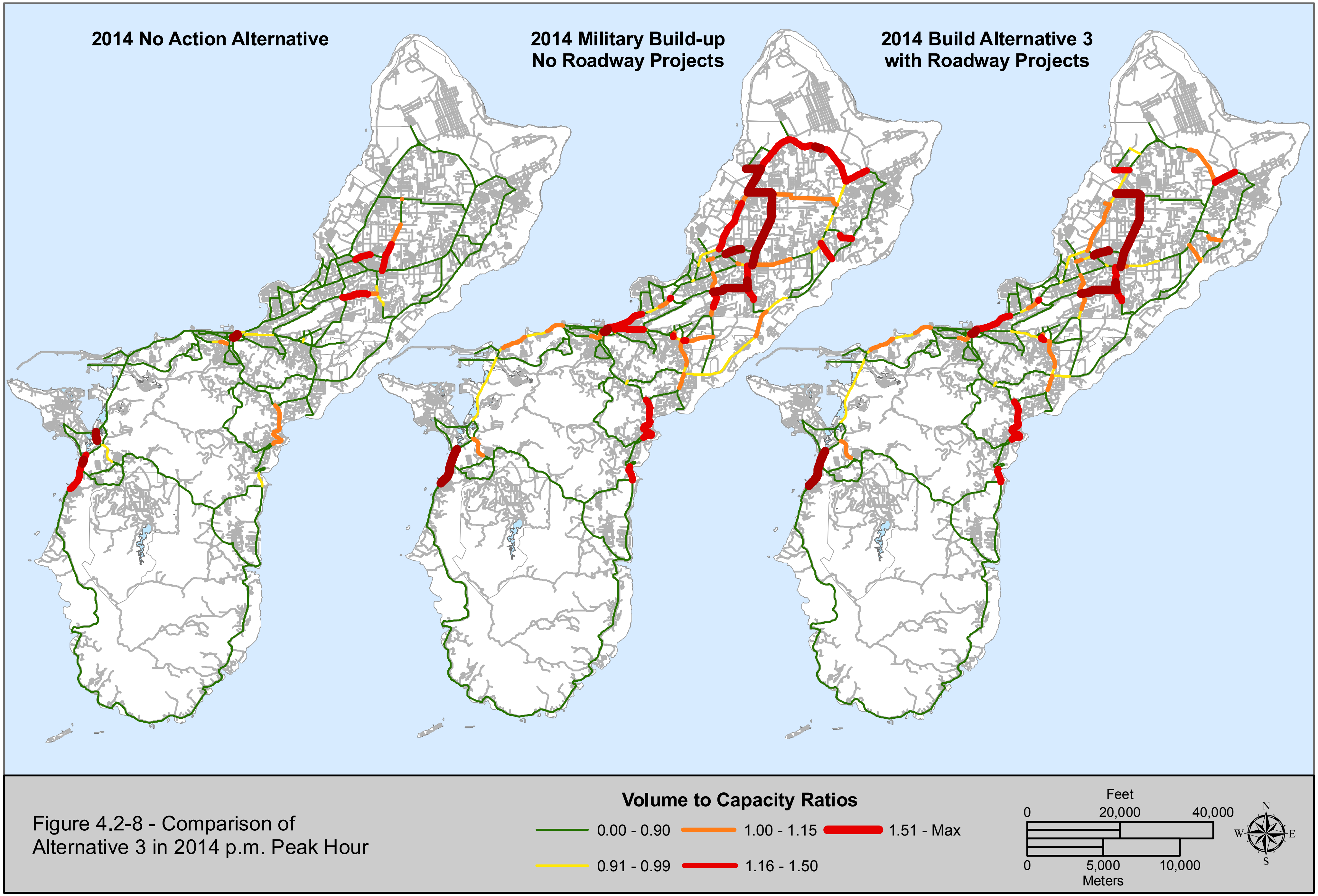


Figure 4.2-8 - Comparison of Alternative 3 in 2014 p.m. Peak Hour

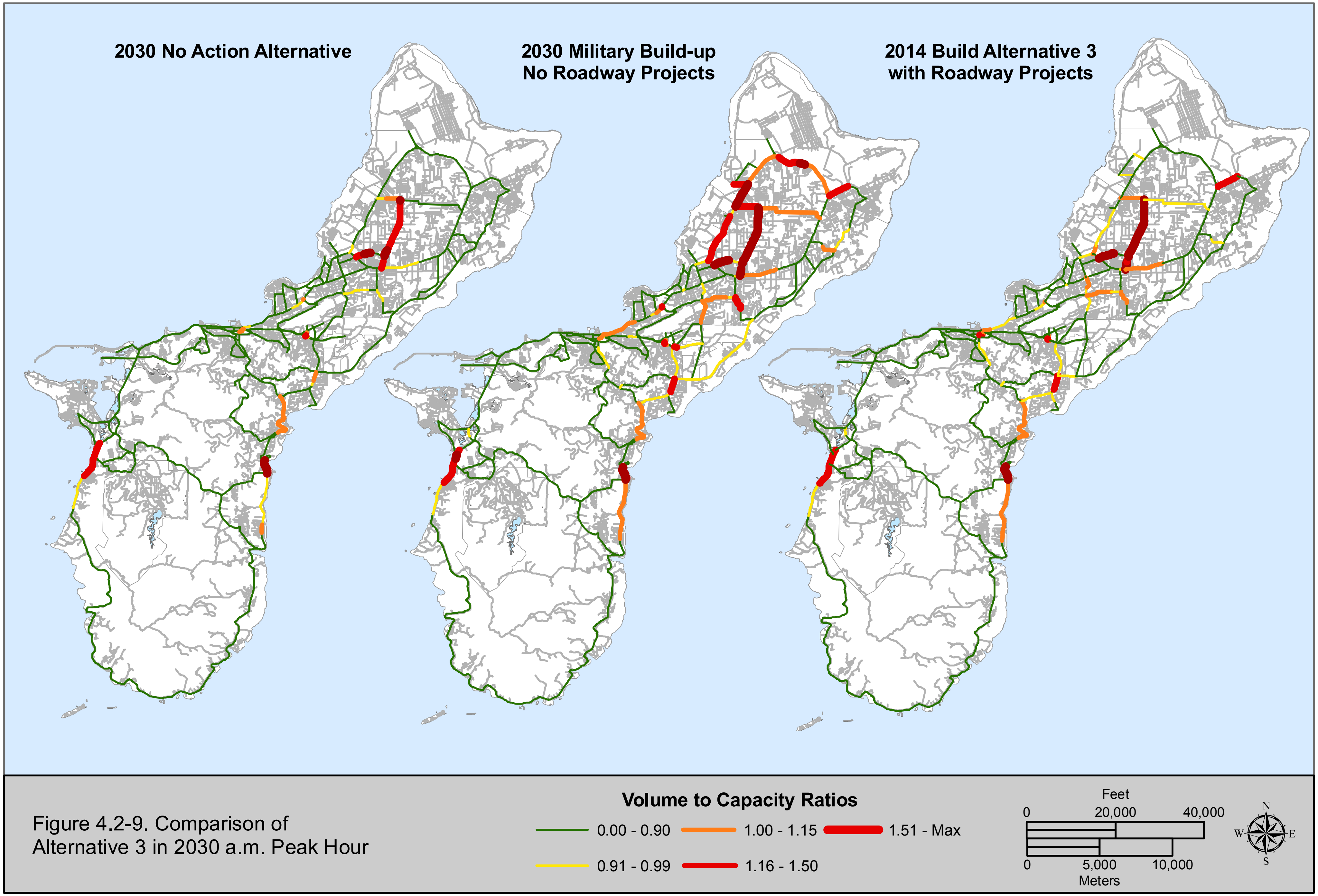


Figure 4.2-9. Comparison of Alternative 3 in 2030 a.m. Peak Hour

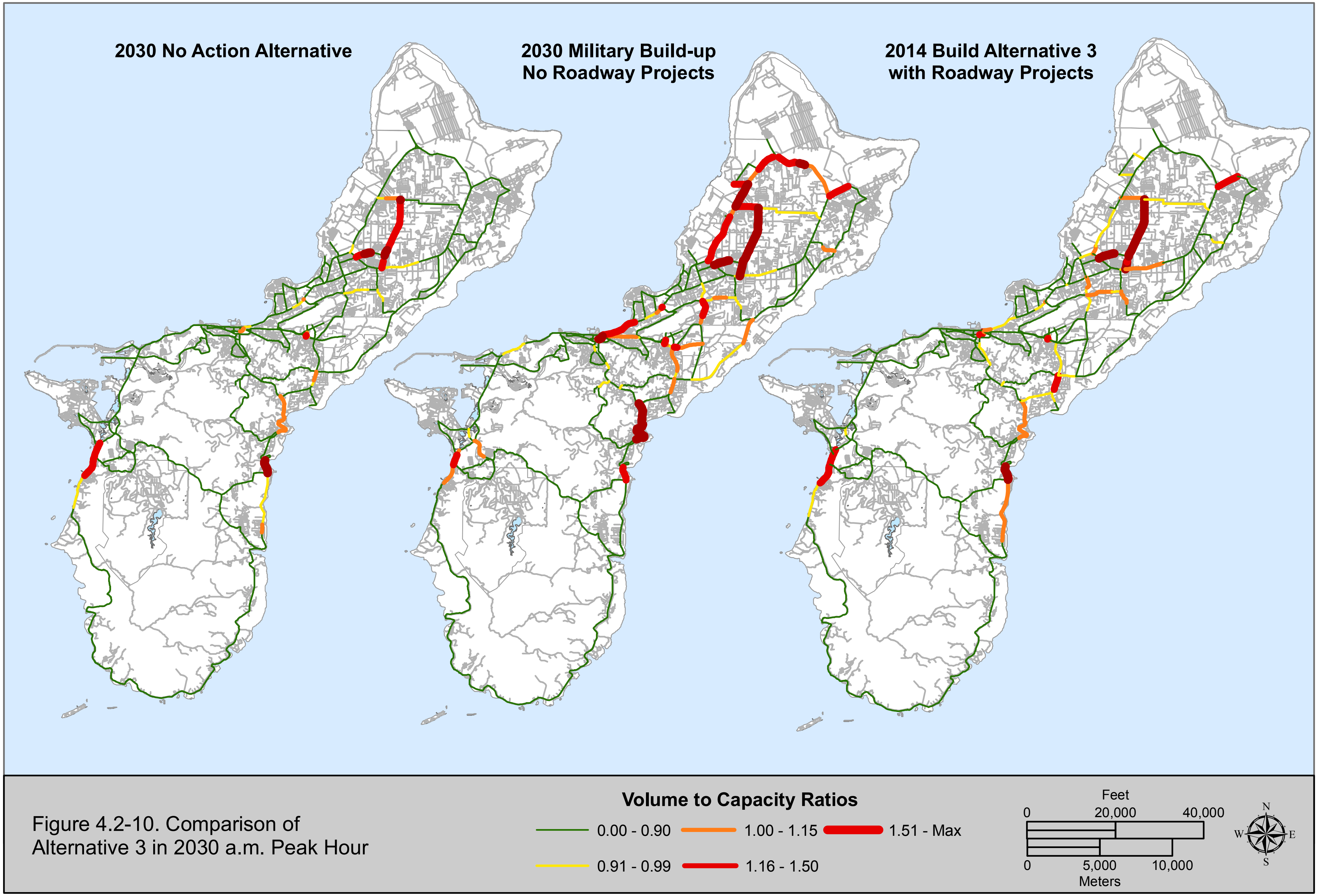


Figure 4.2-10. Comparison of Alternative 3 in 2030 a.m. Peak Hour

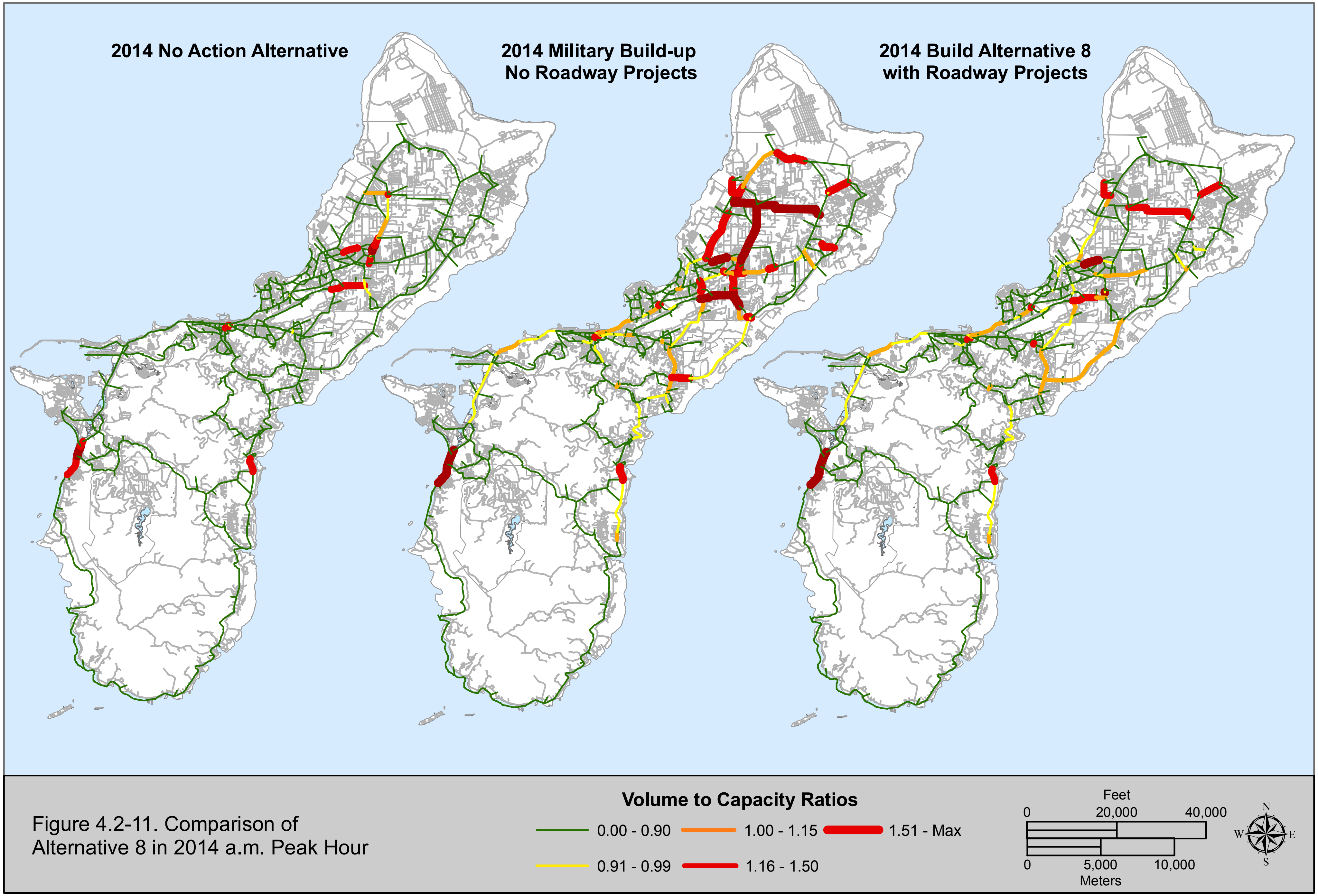


Figure 4.2-11. Comparison of Alternative 8 in 2014 a.m. Peak Hour

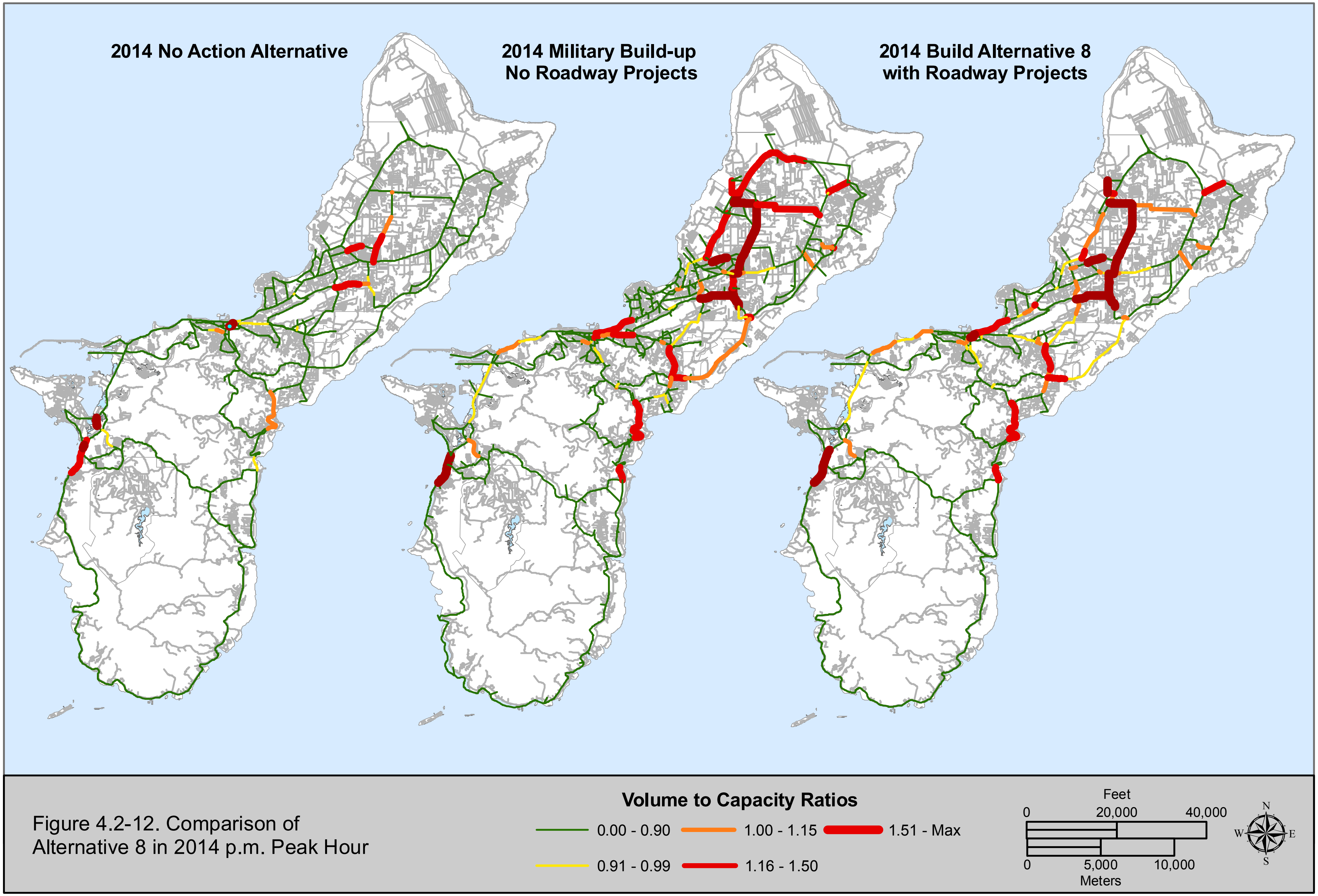


Figure 4.2-12. Comparison of Alternative 8 in 2014 p.m. Peak Hour

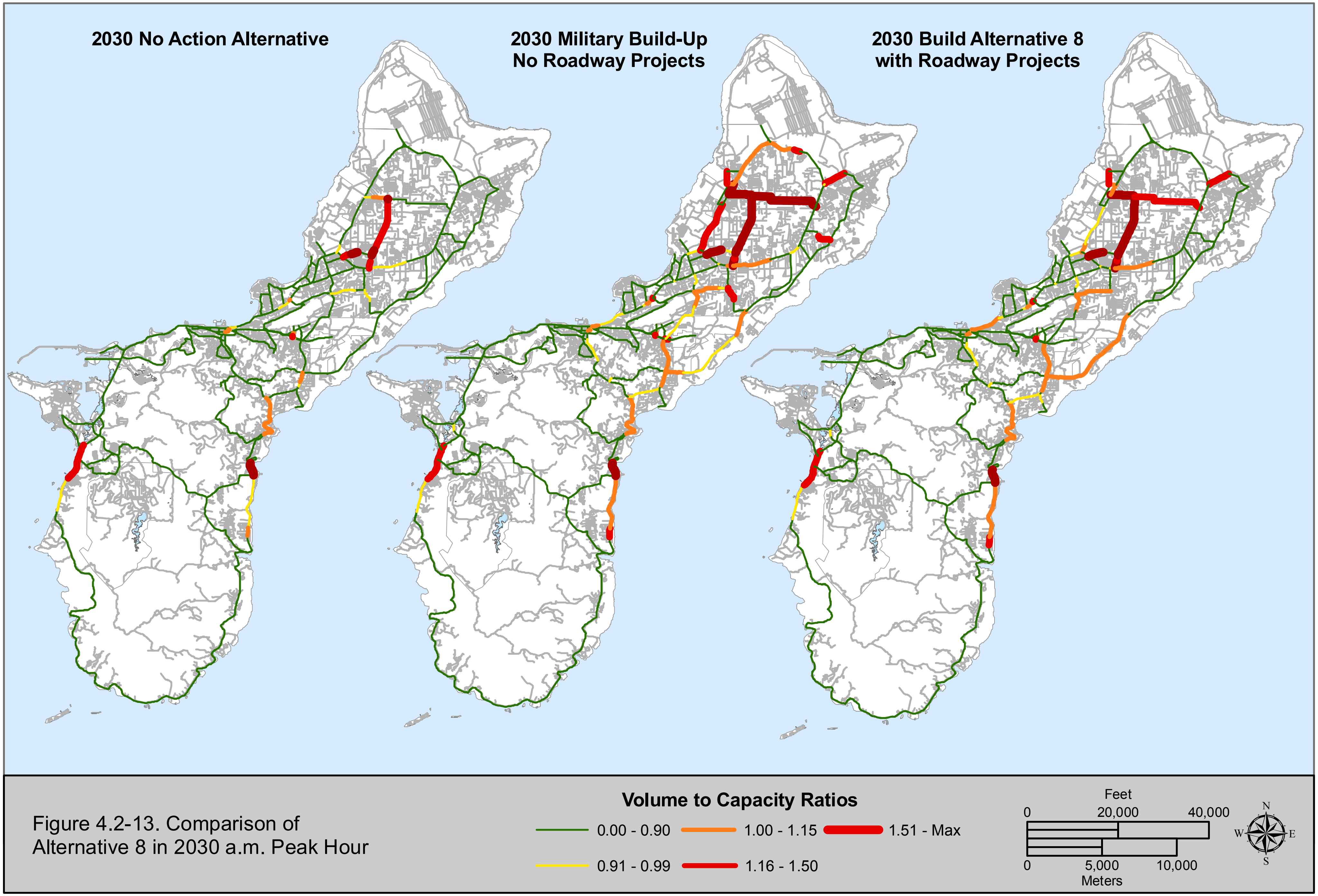


Figure 4.2-13. Comparison of Alternative 8 in 2030 a.m. Peak Hour

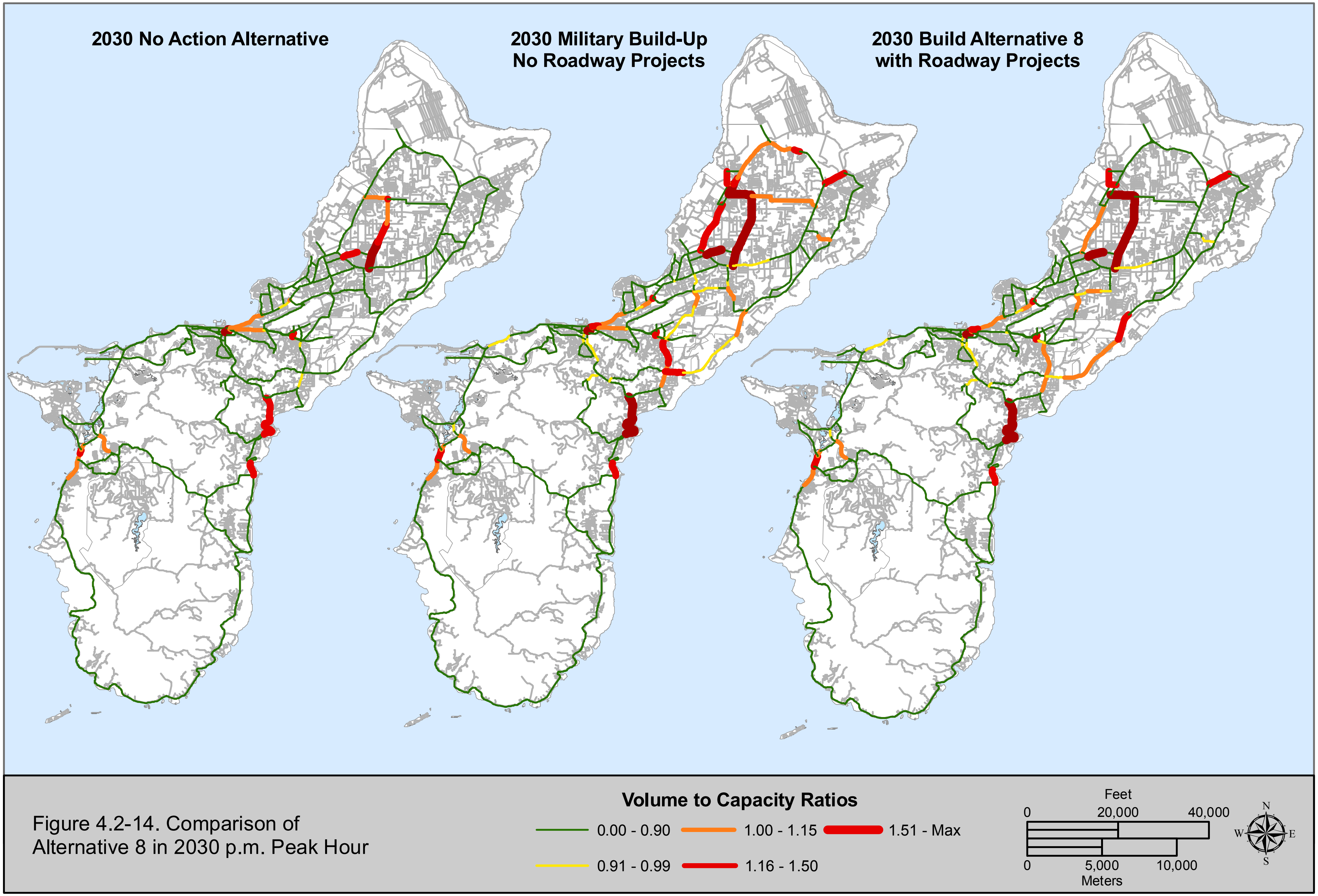


Figure 4.2-14. Comparison of Alternative 8 in 2030 p.m. Peak Hour

4.2.2 Roadways

4.2.2.1 Alternative 1

North

On Base Roadways

Andersen AFB

Construction. Construction at the Andersen AFB are the same for Alternative 1, 2, 3 and 8 and would include a new access road and a new access gate (North Gate) on Route 9. The access road would serve as the main access to the North Ramp area where the support facilities would be constructed.

New construction associated with the access road would include the following:

- Two new lanes would be constructed on Route 9 to allow for WB-33D Turnpike-Double Combination Trucks to turn into and out of the new base access road.
- The project includes a 12 ft (3.7 m) wide access road to intersect Route 9 approximately 10,561 ft (3,219 m) north of existing Andersen AFB Entry Control Point and extend into Andersen AFB approximately 6,561.66 ft (2,000 m) until it terminates at 5th Avenue. Roadway paving, street lighting, and drainage would be constructed for the entire length of the alignment. No curbs or sidewalks are proposed along the roadway. Improvements at the new intersection would include two dedicated turn lanes per AASHTO WB 33D (i.e., Minimum Turning Path for Turnpike-Double Combination), and traffic signals with demand left turn signals and pavement detectors.
- A new traffic signal is proposed at the new gate access road and Route 9, subject to Government of Guam approval.

Marianas Boulevard has relatively low traffic with an existing ADT of 1064 trips near the proposed North Ramp area. Marianas Boulevard has a capacity of approximately 5,000 vehicles per day. With the construction of a new North Gate, construction activities related to the North Ramp area would be isolated to roadways with relatively low traffic. Therefore, the construction activities at the North Ramp area would have less than significant impact if the construction traffic is restricted to the North Gate and new access road.

Operation. Andersen AFB has two existing access gates, Main and Back Gate, and a new North Gate that would be constructed prior to the Marine relocation. The North Gate would be the primary access for the North Ramp area.

In 2008, there were 1,637 morning peak hour trips, 1,816 afternoon peak hour trips, and 21,984 daily trips through the Main and Back Gates. These volumes are expected to increase by Year 2030 due to the increase in base population and the proposed action. In 2030, traffic is anticipated to increase by 457 trips (28%) in a.m. peak hour, 469 trips (26%) in p.m. peak hour and 5,144 trips (23%). daily. The *Andersen AFB Traffic and Safety Engineering Study* (Andersen AFB December 2008) conducted a base-wide road survey and recommended roadway improvements. It forecast a 25% increase in on base traffic volumes based on an expected 1,000 increase in base population from the current 4,000. This 25% growth rate agrees with the 2030 baseline growth rates shown on Table 4.2-2 from the 2008 TransCAD traffic model.

For 2030 with project, the morning peak hour traffic is forecasted to increase by 1,676 mostly inbound trips (80%), the afternoon peak hour traffic by 1,719 mostly outbound trips (75%), and daily traffic by 7,058 trips (28%). The peak hour growth rates being much higher than the daily growth rates would indicate that the traffic generated by the proposed actions would primarily be work oriented and made during the major commuter periods. The proposed project would increase traffic in excess of 5% (significance threshold), except for a.m. outbound period. Hence, traffic impact at Andersen AFB would be significant but mitigable.

Table 4.2-2. 2030 Baseline Growth Rates

	2008	*2030 BASELINE*			*2030 W/PROJECT*		
			2030 BASE/2008			*2030 PROJ/BASE*	
Time Period	*Volume*	*Volume*	*Number Increase*	*Percentage Increase*	*Volume*	*Number Increase*	*Percentage Increase*
Andersen AFB: Alternatives 1, 2, 3 and 8							
a.m. Inbound	869	1227	358	41%	2,869	1642	134%
a.m. Outbound	768	867	99	13%	901	34	4%
a.m. Total	1,637	2,094	457	28%	3,770	1,676	80%
p.m. Inbound	864	993	129	15%	1,064	71	7%
p.m. Outbound	952	1,292	340	36%	2,940	1,648	128%
p.m. Total	1,816	2,285	469	26%	4,004	1,719	75%
Daily	21,984	27,128	5,144	23%	34,186	7,058	26%

Finegayan

Construction. In Alternative 1, NCTS Finegayan, Former FAA Land, South Finegayan, and Harmon Annex land parcels would be utilized for constructing the Main Cantonment, family housing, and community support structures for the Marines. The alternative proposes three access gates. A new Commercial Gate would be constructed on Route 3 about 0.2 mi (0.32 km) due east from the present intersection of Van Meter Street and Courtney Street. A new Main Gate would be constructed close to the point where presently Bullard Avenue meets Route 3. The present access gate to South Finegayan at Coral Tree Drive and Route 3 intersection would be upgraded to form the Residential Gate for Alternative 1. New roads, intersections, curbs, pedestrian walkways, signage, lighting, and landscaped areas would be constructed to support the constructed facilities.

Due to the reconstruction of the roadway system at Finegayan, impact is significant but mitigable to existing motorist on Finegayan.

Operation. The new transportation roadway network on the Main Cantonment is intended to accommodate the proposed relocation of Marines from Okinawa to Guam. The new base would be designed to Navy planning criteria and the features would be designed and sized to accommodate the expected future conditions.

The traffic impact from operations at the Main Cantonment would be less than significant to existing motorists on Finegayan.

Off Base Roadways

Future Traffic Impacts. Alternative 1 of the Army AMDTF proposed action involves collocation of facilities with the Marine Corps at NCTS Finegayan. Thus, effects of Army AMDTF Alternative 1 are captured in the following analysis.

A summary of future ADT volumes and the V/C ratio for 2014 and 2030 for Alternative 1 can be found in Table 4.2-3. Generally, there is a substantial increase in volumes on roadways from 2008 to 2014, and then a modest decrease in volumes on roadways from 2014 to 2017. This can be attributed to the increase in construction traffic and coinciding military expansion during peak construction time, which is in 2014, and then a reduction in traffic once off-island construction workers leave the island. These changes are most noticeable on roadways with direct access to DoD property, such as the Main Cantonment area located on Route 3.

Table 4.2-3. Alternatives 1 and 2 Future ADT and Volume to Capacity Ratio Summary – North Region

Roadway	2014		2030	
	ADT Summary	V/C Ratio	ADT Summary	V/C Ratio
Route 1	Route 1 ranges from 24,000 to 44,000 vpd. Traffic decreases as Route 1 approaches Andersen AFB.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.90, which indicates that the roadway is not considered congested.	Route 1 ranges from 23,000 to 37,000 vpd. Traffic decreases as Route 1 approaches Andersen AFB.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.90, which indicates that the roadway is not considered congested.
Route 3	Route 3 ranges from 23,000 to 46,000 vpd. Traffic decreases north of the intersection with Route 28.	The portion of Route 3 south of the Residential Gate, as well as between Route 28 and the Main Gate, have a V/C ratio of 1.00-1.15 in the a.m. and p.m. peak. This portion of the roadway is considered congested. North of the Commercial Gate, Route 3 has a V/C ratio of 0.00-0.90 during peak hours, which indicates that this part of the roadway is not considered congested.	Route 3 ranges from 20,000 to 37,000 vpd. Traffic decreases north of the intersection with Route 28.	The portion of Route 3 south of the Residential Gate has a V/C ratio of 0.91-0.99 in both the a.m. and p.m. peak hours. Aside from a stretch between Route 28 and the Main Gate, Route 3 north of the Residential Gate has a V/C ratio of 0.00-0.90 during peak hours. The roadway is considered congested.
Route 9	Route 9 ranges from 12,000 to 20,000 vpd. There is a decrease in traffic east of the two residential developments on Route 9.	The western portion of Route 9 has a V/C ratio of 0.00-0.90 in both the a.m. and p.m. peak hours. The eastern portion has a V/C ratio of 0.91-0.99 in both the a.m. and p.m. peak hours. The roadway is not considered congested.	Route 9 ranges from 10,000 to 16,000 vpd. There is a decrease in traffic east of the two residential developments on Route 9.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.90, which indicates that the roadway is not considered congested.
Route 15	Route 15 has 6,900 vpd in the North.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.90, which indicates that the roadway is not considered congested.	Route 15 has 7,600 vpd in the North.	The V/C ratio in both the a.m. and p.m. peak conditions is 0.00-0.90, which indicates that the roadway is not considered congested.
Route 28	Route 28 ranges from 21,000 to 22,000 vpd. Traffic increases closer to the intersection with Route 1.	Route 28 has a V/C ratio greater than 1.51 in both the a.m. and p.m. peak hours, which indicates the roadway is considered congested.	Route 28 ranges from 16,000 to 17,000 vpd. Traffic increases closer to the intersection with Route 1.	In the a.m. peak, Route 29 has a V/C ratio greater than 1.15. In the p.m. peak, Route 28 has a V/C ratio of 1.15-1.50. The roadway is considered congested during peak hours.

Figure 4.2-15 through Figure 4.2-18 show existing levels of traffic congestion in the North Region for the a.m. and p.m. peak hours, respectively. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested. The roads serving the DoD lands are expected to be the most congested. During both the morning and afternoon peaks, the roads with the greatest congestion levels in the North Region are Routes 3 and 28, south of the Main Gate. Route 28 has the highest level of congestion (V/C ratio greater than 1.50). They both have an LOS F in both the a.m. and p.m. peak hours, which is considered severely congested. The results of the future operational analysis are shown in Table 4.2-4 for both the 2014 a.m. and p.m. and 2030 a.m. and p.m. conditions.

For most of the intersections, the LOS in both 2014 and 2030 was below the minimum acceptable LOS E. It is important to note that in many cases, the proposed intersection improvements do not improve the LOS level; however, they do decrease the amount of delay a driver would experience at an intersection. As stated previously, each LOS has a range of seconds of delay. Anything greater than 80.0 seconds of delay at signalized intersections or 50.0 seconds of delay at unsignalized intersections is considered LOS F. There is no upper end for delay for LOS F, which is why an intersection could greatly decrease in the amount of delay while still being LOS F. For the North Region, there are three intersections for which the traffic is worse in 2014 than in 2030 in both the a.m. and p.m. peak hours. This can be attributed to an increase in traffic associated with construction activity and military personnel in 2014.

As shown in Table 4.2-4, there are four intersections and one access point with LOS F for at least one peak hour, which is considered unacceptable; however, none of the intersections are operating at LOS F in both the a.m. and p.m. for 2030. The worst intersection in the North Region is Route 15/29, which is operating at LOS F with heavy delays in the a.m. peak hour in 2014.

Table 4.2-4. Alternative 1/2 Future Level of Service and Delay Results – North Region

	2014				*2030*			
	a.m. Peak Hour		*p.m. Peak Hour*		*a.m. Peak Hour*		*p.m. Peak Hour*	
	LOS	*Delay Seconds*	*LOS*	*Delay Seconds*	*LOS*	*Delay Seconds*	*LOS*	*Delay Seconds*
Signalized*								
Route 1/9	C	27.6	D	39.8	C	22.5	D	52.2
Route 1/29	F	256.2	F	138.7	E	65.5	E	67.7
Route 3/28	F	85.1	F	227.1	C	26.0	D	36.9
Route 15/29**	F	NA	F	838.9	C	27.7	C	25.4
Unsignalized**								
Route 3/3A/9	C	19.7	F	74.3	B	11.6	F	79.0
Access Points*								
Route 3 – Main Cantonment/Commercial Gate**	-	-	-	-	B	12.5	C	28.3
Route 3 - Main Cantonment/Main Gate**	-	-	-	-	C	33.5	E	58.6
Route 3 – South Finegayan/Residential Gate**	-	-	-	-	C	26.7	B	18.5
Route 9 – Andersen AFB/ Andersen AFB North Gate***	-	-	-	-	F	NA****	F	NA****

Legend: NA = Not Applicable.
Notes: *Signalized intersection LOS based on average delay for the overall intersection.
**Intersection is proposed to be signalized in future build conditions.
***Unsignalized intersection LOS based on approach delay on STOP-controlled approach.
****Delay exceeded maximum calculated value.

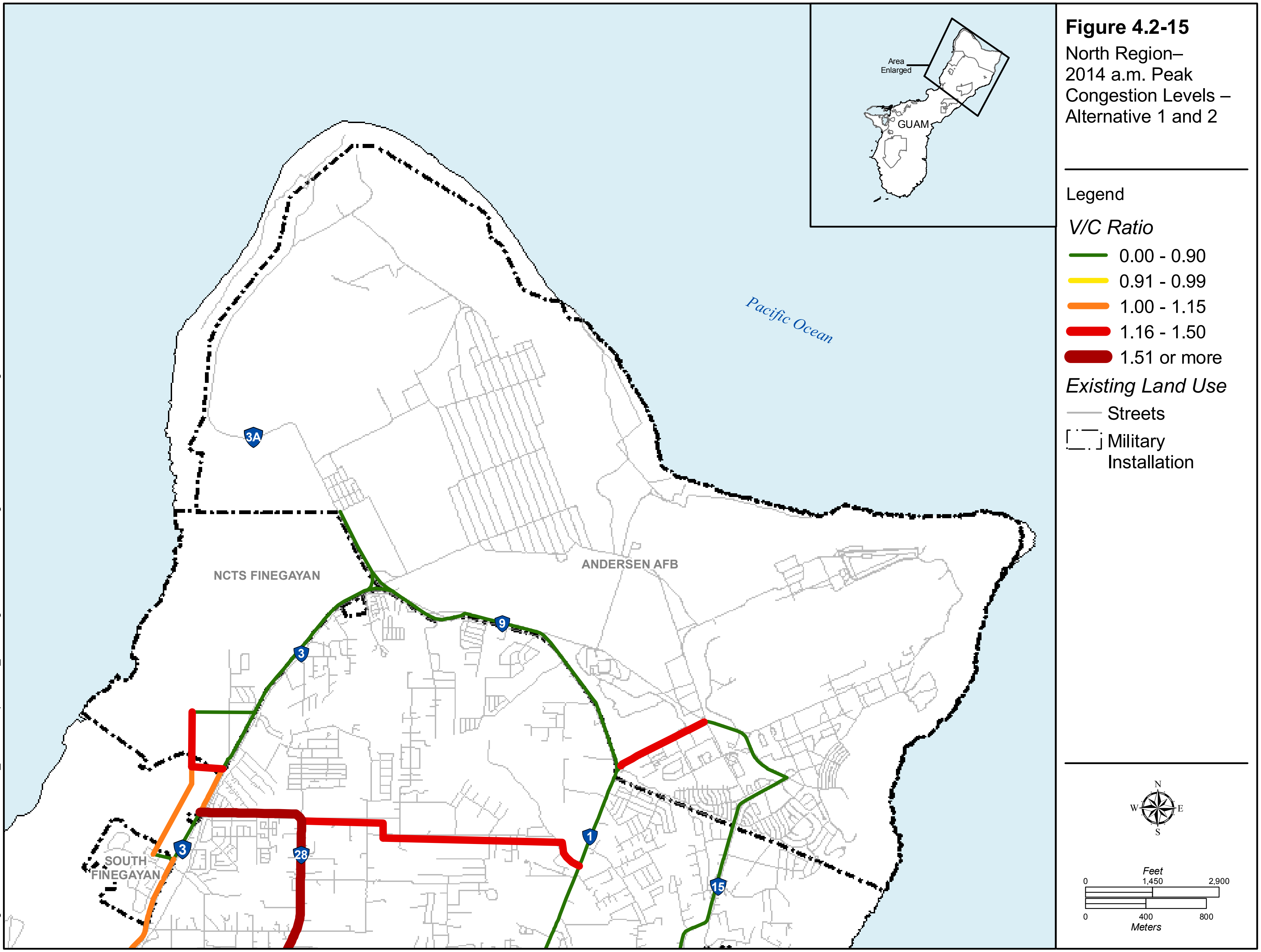
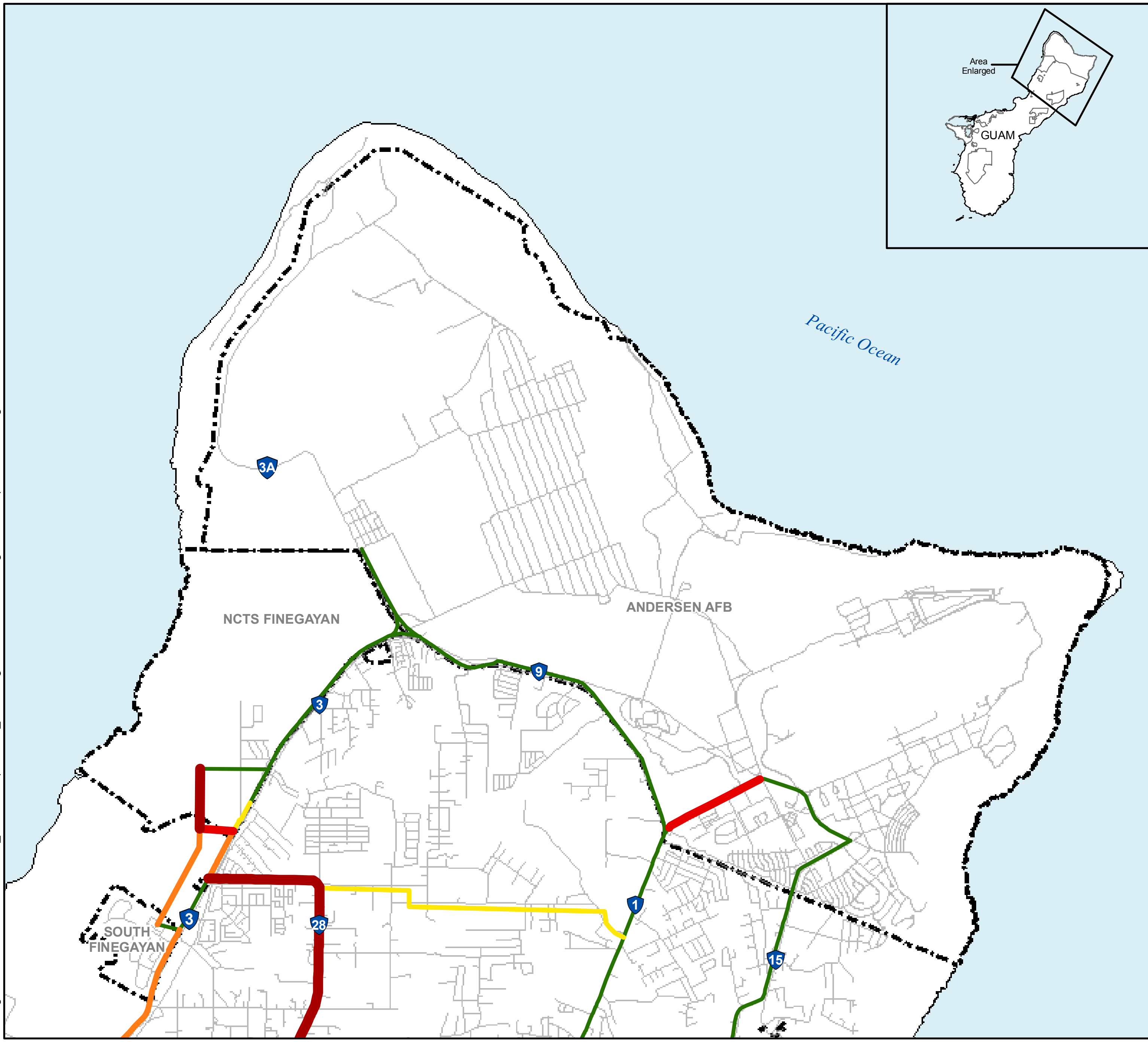


Figure 4.2-15
North Region–
2014 a.m. Peak
Congestion Levels –
Alternative 1 and 2

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-15. North Region - 2014 a.m. Peak Congestion Levels- Alternative 1-2.mxd

Figure 4.2-16

North Region–
2014 p.m. Peak
Congestion Levels –
Alternative 1 and 2



Legend

V/C Ratio

- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use

- Streets
- Military Installation

N
W E
S

Feet
0 1,450 2,900

0 400 800
Meters

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-16. North Region - 2014 p.m. Peak Congestion Levels- Alternative 1-2.mxd

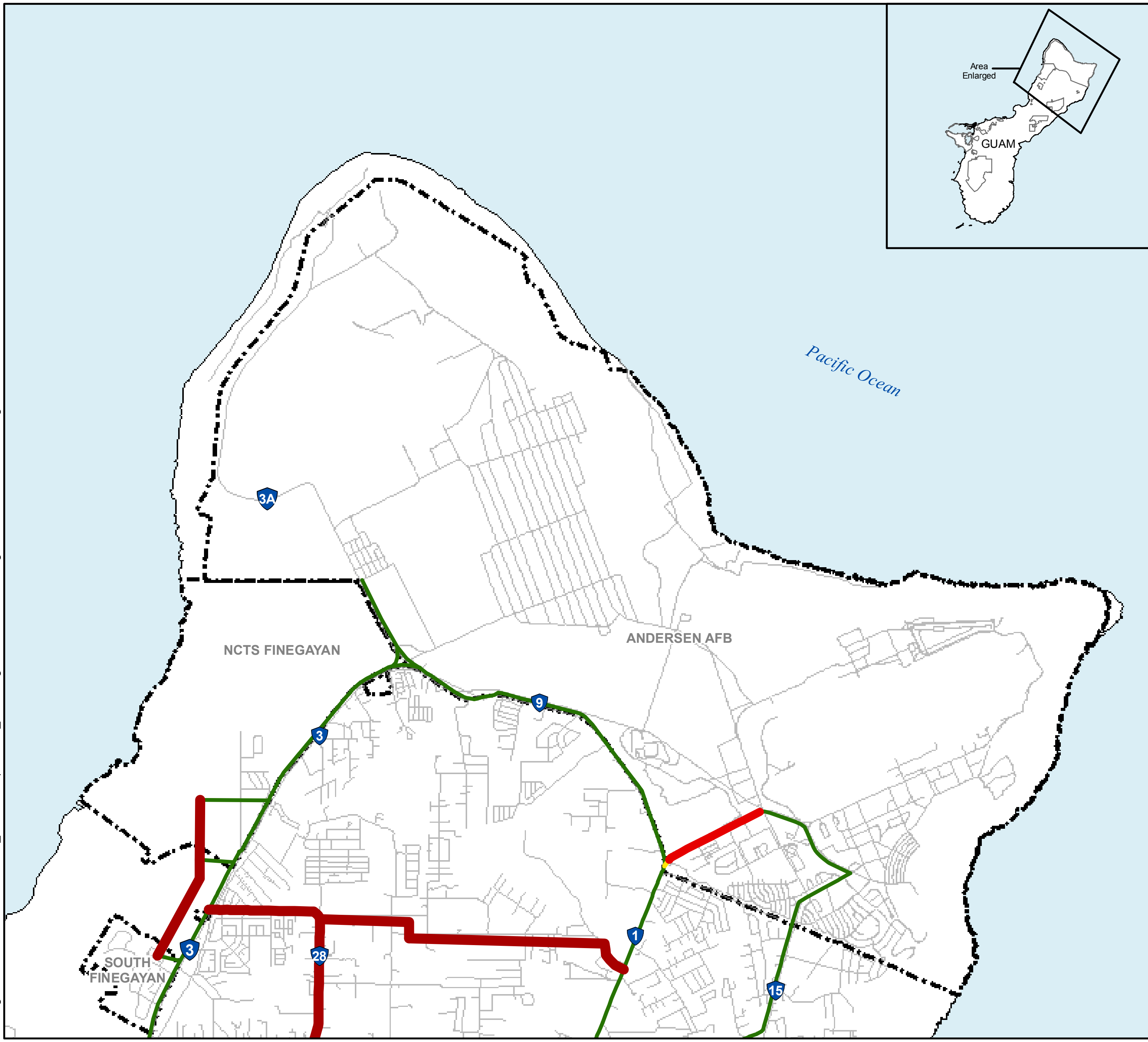


Figure 4.2-17
North Region–
2030 a.m. Peak
Congestion Levels –
Alternative 1and 2

Legend

V/C Ratio

- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use

- Streets
- Military Installation

N
W E
S

Feet
0 1,450 2,900
0 400 800
Meters

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-18. North Region - 2030 p.m. Peak Congestion Levels- Alternative 1-2.mxd

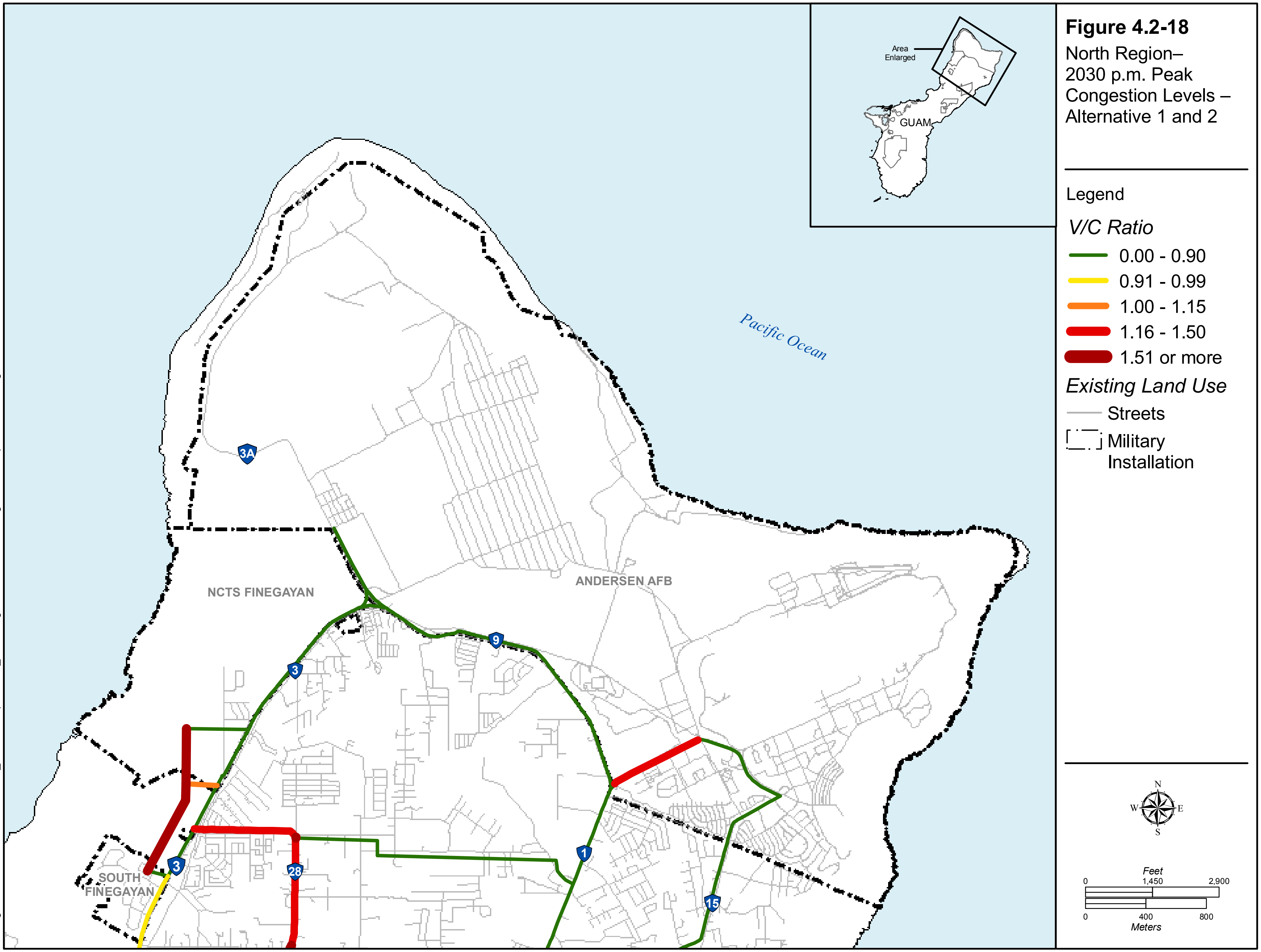


Figure 4.2-18
North Region–
2030 p.m. Peak
Congestion Levels –
Alternative 1 and 2

Public Transportation Impacts. Impacts to the public transportation system relate to the delays caused by increased levels of congestion on roadways and at intersections. This would affect the demand response and paratransit services, increasing passenger wait times and missed transfers. While there is no existing fixed-route service in the North Region, planning efforts have proposed new routes along Routes 1 and 3. Implementation of new transit services should take into consideration the impacts of the military relocation.

Pedestrian and Bicycle Impacts. There are no impacts to pedestrian and bicycle facilities in the North Region. Along Route 1, future traffic volumes and congestion should not negatively affect the experience or safety of the pedestrian or cyclist using the shoulder as a running or biking lane. Any future planning for pedestrian and bicycle facilities needs to consider the impacts of the military relocation.

<u>Central</u>

On Base Roadways

Andersen South

Construction. Proposed construction at Andersen South are independent of Alternatives 1, 2, 3, and 8. The proposed constructions are geared towards constructing the Military Operations in Urban Terrain complex for providing maneuver training to the relocated marines. The proposed constructions include:

- Construction of a new road segment to connect existing roads into a complete convoy course loop.
- Two access gates are proposed for the new base that would upgrade existing gates at the base. The proposed Main Gate would be located at the present intersection of Turner Street and Route 1. The Proposed Secondary Gate would be located at the present intersection of Rissi Street and Route 15.
- The construction of the roadway improvements on Andersen South would have a less than significant impact to traffic because of the base operations have been abandoned in exception of training.
- Based on the relatively low traffic demand on Andersen South, traffic impact would be less than significant for construction activities.

Operation. Convoy operations, Military operations in Urban Terrain-related maneuver training, and general maneuver and air-ground operations would vary from small unit to company-level exercises. They would occur 5 days a week, 45 weeks per day, day and night. The upward estimate is that approximately 250-300 Marines would participate in maneuver training at Andersen South each week, for a total annual throughput of 11,250-13,500 Marines. The convoy operations would typically consist of 7-10 vehicles.

The two lane roadways on Andersen South have a capacity of approximately 5,000 vehicles per day and can accommodate the anticipated increase in traffic. Therefore, traffic impact would be less than significant for operation impact.

Barrigada

Construction. In Alternative 1, Barrigada is not utilized.

Operation. In Alternative 1, Barrigada is not utilized.

Off Base Roadways

Future Traffic Impacts. A summary of future ADT volumes and the V/C ratio for 2014 and 2030 for Alternative 1 can be found in Table 4.2-5. Generally, there is a substantial increase in volumes on roadways from 2008 to 2014, and then a modest decrease in volumes on roadways from 2014 to 2017.

This can be attributed to the increase in construction traffic and coinciding military expansion during peak construction time, which is in 2014, and then a reduction in traffic once off-island construction workers leave the island.

Table 4.2-5. Alternative 1 and 2 Future ADT and Volume to Capacity Ratio Summary – Central Region

Roadway	*2014*		*2030*	
	ADT Summary	*V/C Ratio*	*ADT Summary*	*V/C Ratio*
Route 1	Route 1 ranges from 59,000 to 100,000 vpd. Traffic decreases significantly south of the intersection with Route 4.	The V/C ratio is generally less than 1.00 in both the a.m. and p.m. condition; however, there are small segments near the intersections with 14A, and 30 that have a V/C ratio of more than 1, which indicates the roadway is congested in Tamuning.	Route 1 ranges from 51,000 to 95,000 vpd. Traffic decreases significantly south of the intersection with Route 4.	The V/C ratio is generally less than 1.00 in both the a.m. and p.m. condition; however, there are small segments near the intersections with 14A, and 30 that have a V/C ratio of more than 1, which indicates the roadway is considered congested in Tamuning.
Route 3	Route 3 ranges from 46,000 to 68,000 vpd. Traffic increases toward the Route 1 intersection.	The V/C ratio in both the a.m. and p.m. peak is 1.00-1.15. This indicates the roadway is considered congested.	Route 3 ranges from 37,000 to 54,000 vpd. Traffic increases toward the Route 1 intersection.	The V/C ratio is between 1.00-1.15, indicating that the roadway is considered congested at this location.
Route 8/8A	Route 8 ranges from 51,000 to 65,000 vpd. There is a decrease in traffic west of the intersection with Sunset Boulevard. Route 8A has 3,500 vpd.	During peak hours, the V/C ratio is 0.00-0.90 east of Tiyan Parkway, 0.91-0.99 west of Tiyan Parkway, and 0.00-0.80 west of Route 16. The roadway is not considered congested.	Route 8 ranges from 50,000 to 59,000 vpd. There is a decrease in traffic west of the intersection with Sunset Boulevard. Route 8A has 3,400 vpd.	During the a.m. peak, the V/C ratio is 0.00-0.90. During the p.m. peak, the V/C ratio is 0.00-0.80 east of Tiyan Parkway, 0.81-0.99 west of Tiyan Parkway, and 0.00-0.90 west of Route 16. The roadway is not considered congested.
Route 10	Route 10 ranges from 56,000 to 58,000 vpd between Routes 8 and 15.	In the a.m. peak, a small segment south of the intersection with Route 15 has a V/C ratio between 1.15-1.50. During the p.m. peak, Route 10 has a V/C ratio of 1.00-1.15 north of Route 32 to Route 8. The roadway is primarily congested during the p.m. peak.	Route 10 ranges from 54,000 to 56,000 vpd between Routes 8 and 15.	In the a.m. peak, Route 10 has a V/C ratio of 1.00-1.15 north of Route 32 to Route 15. During the p.m. peak, Route 10 has a V/C ratio of 1.00-1.15 north of Route 32 to Route 8. The roadway is primarily congested during the p.m. peak.

Table 4.2-5. Alternative 1 and 2 Future ADT and Volume to Capacity Ratio Summary – Central Region

Roadway	*2014*		*2030*	
	ADT Summary	*V/C Ratio*	*ADT Summary*	*V/C Ratio*
Route 15	Route 15 ranges from 13,000 to 24,000 vpd. There is an increase in traffic south of the intersection with Route 26.	North of Route 26 and west of Route 10, Route 15 has a V/C ratio of 0.00-0.90 during peak hours. The middle section of Route 15 has a V/C ratio of 0.91-0.99, with a V/C ratio of 1.00-1.15 at Route 10. The roadway is only congested near the intersection with Route 10.	Route 15 ranges from 7,500 to 13,000 vpd. There is an increase in traffic south of the intersection with Route 26.	The V/C ratio is less than 1.00 during peak hours. The roadway is not considered congested.
Route 16	Route 16 ranges from 59,000 to 91,000 vpd. There is a decrease in traffic south of the residential developments south of Route 25.	The V/C ratio is less than 1.00 in the a.m. and p.m., except at the intersection with Route 27 where the V/C ratio is 1.00-1.15. The roadway is considered congested at this location.	Route 16 ranges from 40,000 to 77,000 vpd. There is a decrease in traffic south of the residential developments south of Route 25.	The V/C ratio is less than 1.00 during peak hours. The roadway is not considered congested.
Route 25	Route 25 ranges from 24,000 to 28,000 vpd.	Route 25 has a V/C ratio greater than 1.50, indicating that the roadway is considered congested.	Route 25 ranges from 29,000 to 33,000 vpd.	The V/C ratio is less than 1.00 during peak hours. The roadway is not considered congested.
Route 26	Route 26 ranges from 10,000 to 25,000 vpd. There is a decrease in traffic south of the large residential development just north of the intersection with Route 15.	Route 26 primarily has a V/C ratio greater than 1.00 during both the a.m. and p.m. peak. The roadway is considered congested.	Route 26 ranges from 10,000 to 30,000 vpd. There is a decrease in traffic south of the large residential development just north of the intersection with Route 15.	The V/C ratio is less than 1.00 during peak hours, except for south of Route 25, where the V/C ratio is 1.00-1.15 in the a.m. peak. The roadway is considered congested at this location.
Route 27	Route 27 ranges from 58,000 to 61,000 vpd between Routes 16 and 1.	The V/C ratio is 0.00-0.90 during peak hours, except for the portion between Routes 16 and 1, which has a V/C ratio of 0.81-0.99 during the a.m. peak. This roadway is not considered congested.	Route 27 ranges from 49,000 to 51,000 vpd between Routes 16 and 1.	The V/C ratio is 0.00-0.90 during peak hours, indicating the roadway is not considered congested.

Table 4.2-5. Alternative 1 and 2 Future ADT and Volume to Capacity Ratio Summary – Central Region

Roadway	*2014*		*2030*	
	ADT Summary	*V/C Ratio*	*ADT Summary*	*V/C Ratio*
Route 28	Route 28 ranges from 21,000 to 26,000 vpd. Traffic generally decreases south of the Route 7A intersection.	The V/C ratio is greater than 1.50 in both the a.m. and p.m. peak, indicating the roadway is congested.	Route 28 ranges from 19,000 to 23,000 vpd. Traffic generally decreases south of the Route 7A intersection.	The V/C ratio is greater than 1.50 in both the a.m. and p.m. peak, indicating the roadway is considered congested.
Chalan Lujuna	Chalan Lujuna has 9,000 vpd.	The V/C ratio is 0.91-0.99, indicating it is not considered congested.	Chalan Lujuna ranges from 6,300 to 7,100 vpd.	The V/C ratio is 0.00-0.90 during peak hours, indicating the roadway is not considered congested.

Figure 4.2-19 through Figure 4.2-22 show existing levels of traffic congestion in the Central Region for the a.m. and p.m. peak hours, respectively. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested.

There are a few areas of congestion in the Central Region, primarily on roads that serve the DoD lands to the north. During both the morning and afternoon peaks, the roads with the greatest congestion levels in the Central Region are parts of Route 1 and 10 and Route 28. All have an LOS F in both the a.m. and p.m. peak hours, which is considered congested. Route 28 has the highest level of congestion (V/C ratio greater than 1.50) north of the Route 1 intersection in the a.m..

As shown in Table 4.2-6, 24 out of 28 intersections have LOS F for at least one peak hour, which is considered unacceptable. The following intersections are operating at LOS F in the a.m. and p.m. peak hours in both 2014 and 2030:

- Route 1/28
- Route 1/27
- Route 1/14A
- Route 1/10A
- Route 1/14 (ITC)
- Route 1/30
- Route 1/8
- Route 4/7A
- Route 8/10
- Route 10/15
- Route 16/27
- Route 16/10A

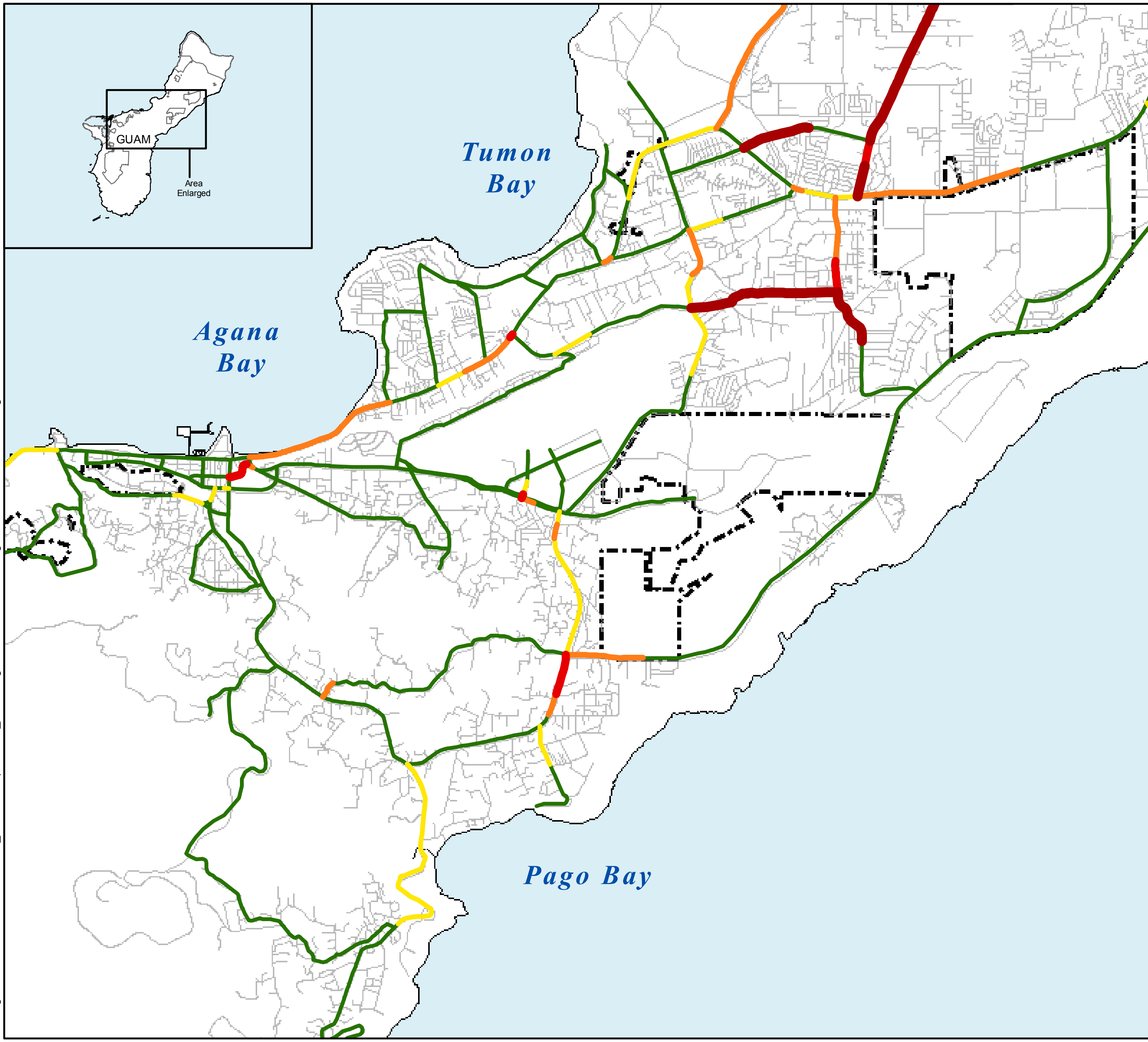


Figure 4.2-19
Central Region–2014 a.m. Peak Congestion Levels – Alternative 1 and 2

Legend

V/C Ratio
- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use
- Streets
- Military Installation

N E S W

Feet 0 1,450 2,900
0 400 800 *Meters*

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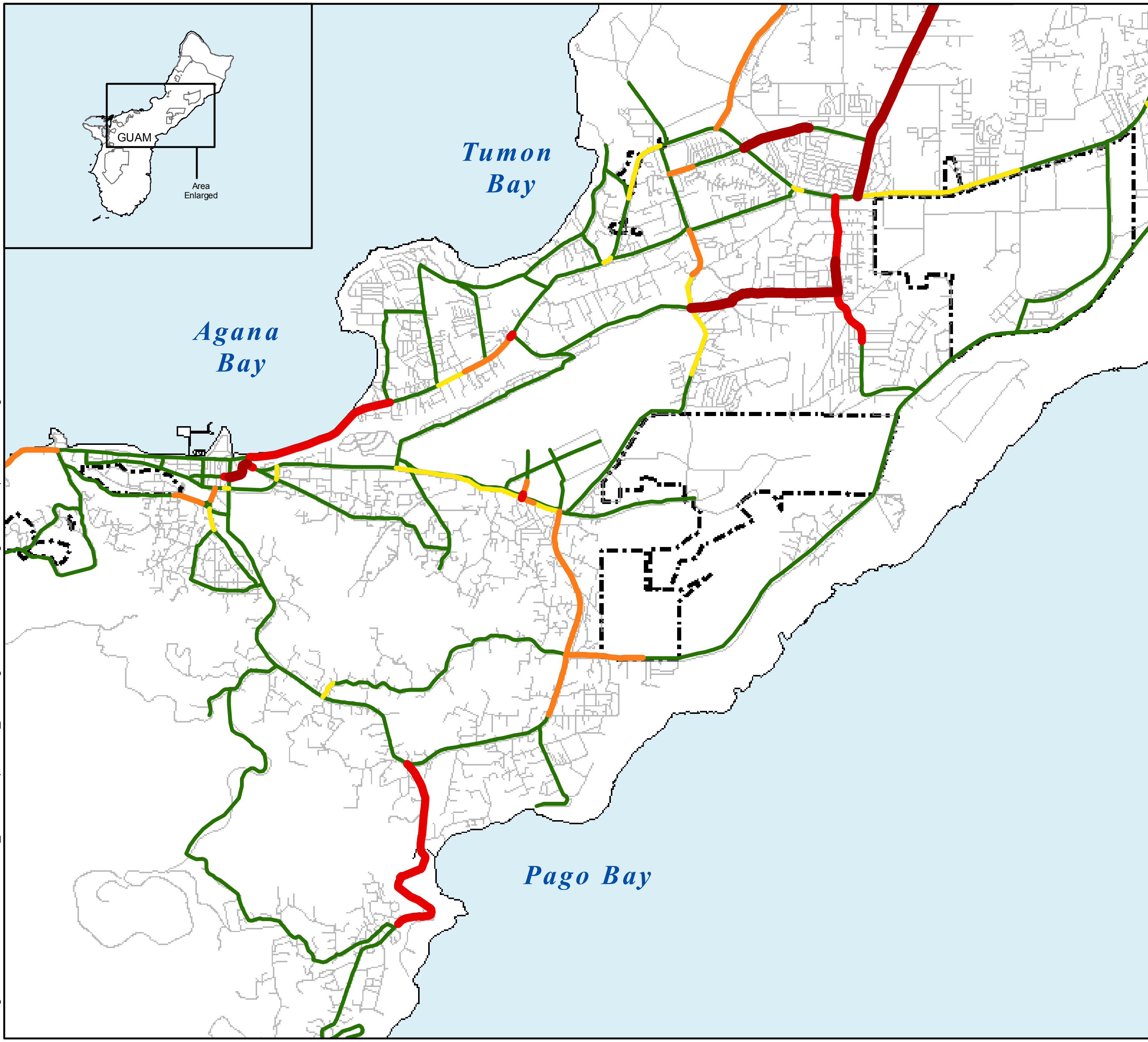


Figure 4.2-20
Central Region–
2014 p.m. Peak
Congestion Levels –
Alternative 1 and 2

Legend

V/C Ratio
- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use
- Streets
- Military Installation

N W E S

Feet
0 1,450 2,900

0 400 800
Meters

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-20. Central Region - 2014 p.m. Peak Congestion Levels- Alternative 1-2.mxd

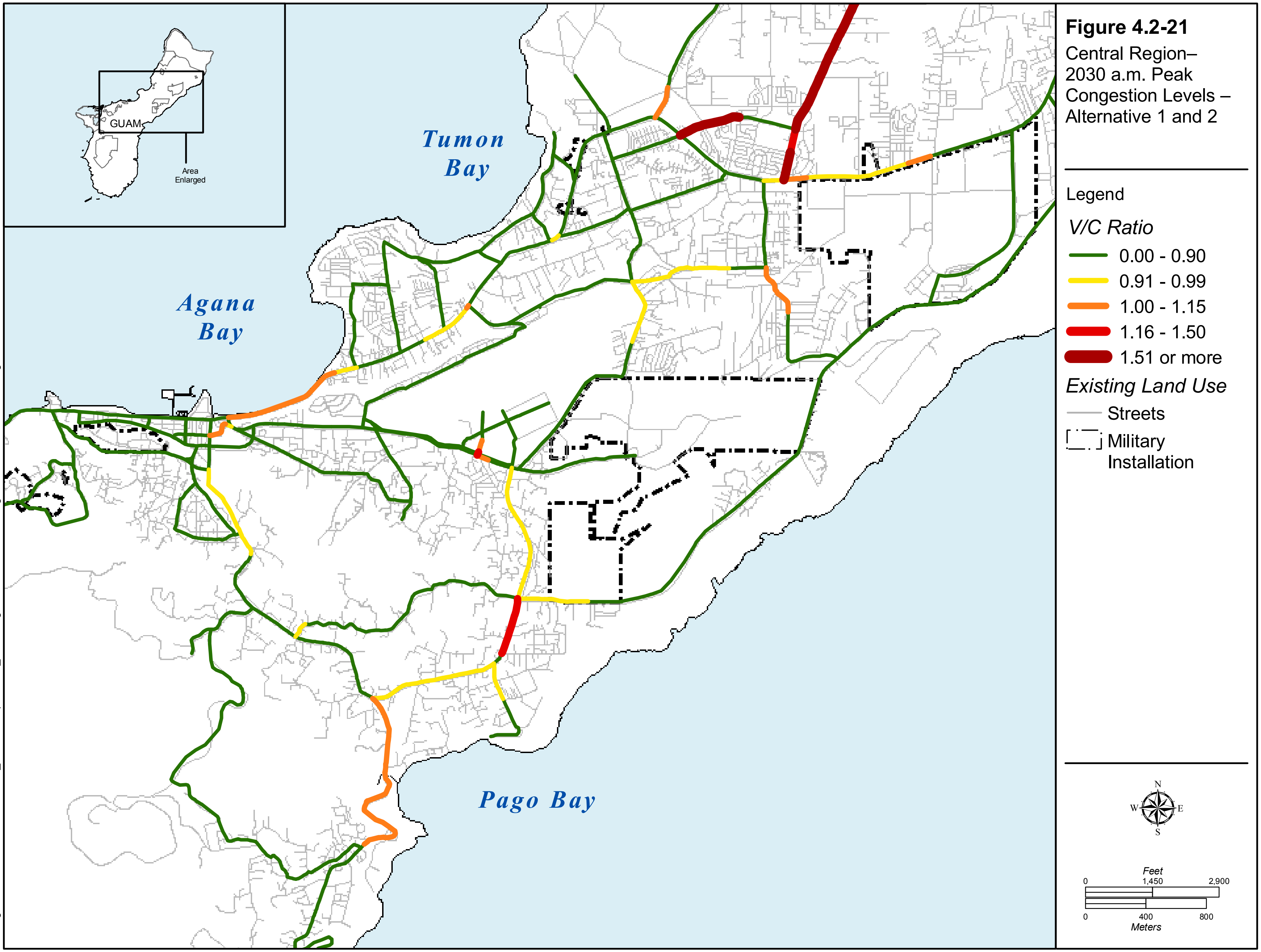
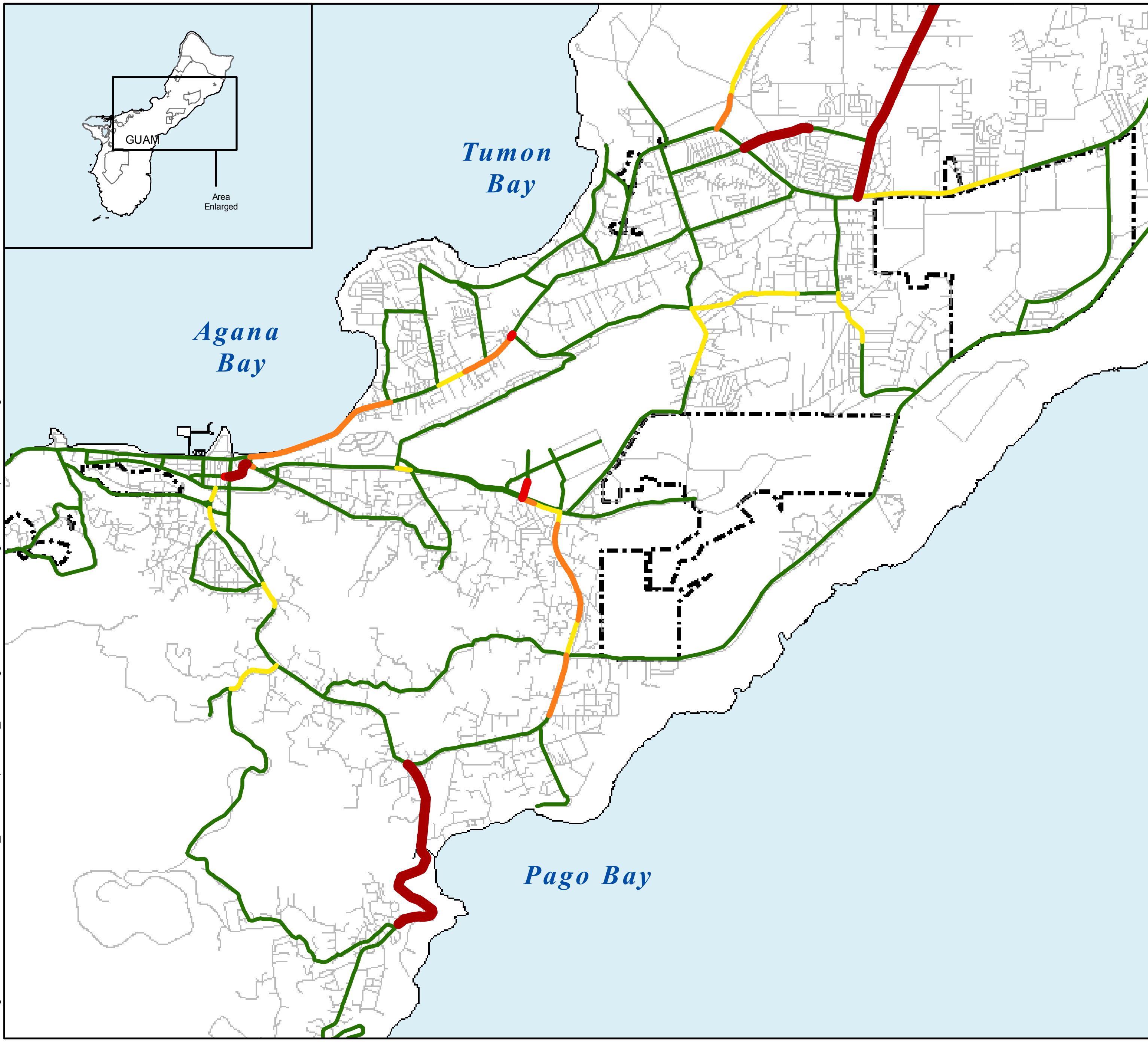


Figure 4.2-21
Central Region–2030 a.m. Peak Congestion Levels – Alternative 1 and 2

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-21. Central Region - 2030 a.m. Peak Congestion Levels- Alternative 1-2.mxd

Figure 4.2-22
Central Region–2030 p.m. Peak Congestion Levels – Alternative 1 and 2



Legend

V/C Ratio
- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use
- Streets
- Military Installation

N
W E
S

Feet
0 1,450 2,900
0 400 800
Meters

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-22. Central Region - 2030 p.m. Peak Congestion Levels- Alternative 1-2.mxd

Table 4.2-6. Alternative 1/2 Future Level of Service and Delay Results – Central Region

	2014				*2030*			
	a.m. Peak Hour		*p.m. Peak Hour*		*a.m. Peak Hour*		*p.m. Peak Hour*	
	LOS	*Delay Seconds*	*LOS*	*Delay Seconds*	*LOS*	*Delay Seconds*	*LOS*	*Delay Seconds*
Signalized*								
Route 1/28	F	360.8	F	331.8	F	216.8	F	104.5
Route 1/26	F	109.8	F	278.1	E	75.8	F	156.6
Route 1/27	F	1830.9	F	928.9	F	137.4	F	374.3
Route 1/27A	E	77.8	F	204.7	D	44.4	E	75.7
Route 1/3	F	495.1	F	523.8	D	48.5	D	50.6
Route 1/16	F	126.4	F	336.2	E	65.3	F	87.5
Route 1/14 (North San Vitoris)	F	176.5	F	134.8	E	68.0	F	82.0
Route 1/14A	F	313.6	F	326.8	F	112.2	F	131.5
Route 1/10A	F	241.5	F	376.7	F	118.1	F	102.0
Route 1/14B	F	168.4	F	159.1	F	83.9	E	78.2
Route 1/14 (ITC)	F	234.7	F	428.6	F	182.5	F	275.1
Route 1/30	F	488.1	F	568.6	F	134.7	F	267.2
Route 1/8	F	216.2	F	143.5	F	97.6	F	127.5
Route 1/4	C	24.3	D	44.6	C	32.4	F	140.2
Route 1/6 (Adelup)	D	36.2	F	108.9	D	40.6	E	61.8
Route 4/7A	F	270.5	F	989.8	F	607.3	F	534.1
Route 4/10	F	190.2	F	165.1	F	199.5	E	65.1
Route 4/17	C	35.0	D	42.6	D	39.6	E	57.7
Route 8/33	E	64.8	F	145.2	D	54.6	F	81.7
Route 8/10	F	273.7	F	315.0	F	96.9	F	172.7
Route 10/15	F	166.4	F	144.7	F	196.9	F	152.3
Route 16/27A	C	26.3	D	51.9	C	27.4	C	34.2
Route 16/27	F	389.3	F	601.5	F	345.0	F	288.7
Route 16/10A	F	260.1	F	566.1	F	123.1	F	123.5
Route 26/25**	F	94.9	E	70.1	C	31.2	D	41.0
Route 26/15**	F	2554.1	F	3440.9	C	27.9	C	32.1
Route 28/27A**	C	31.8	F	402.8	D	35.6	D	36.6
Unsignalized***								
Route 7/7A	F	167.7	F	285.7	D	29.2	F	105.1
Access Points								
Route 1 - South Andersen Main Gate/(Turner Street)*	-	-	-	-	C	32.4	E	79.1
Route 15 - South Andersen/Second Gate*	-	-	-	-	C	22.1	C	22.6
Route 16 - Navy Barrigada/(Sabana Barrigada) Residential Gate	-	-	-	-	NA	NA	NA	NA

Table 4.2-7. Alternative 1/2 Future Level of Service and Delay Results – Central Region

	2014				2030			
	a.m. Peak Hour		p.m. Peak Hour		a.m. Peak Hour		p.m. Peak Hour	
	LOS	Delay Seconds	LOS	Delay Seconds	LOS	Delay Seconds	LOS	Delay Seconds
Route 8A - Navy Barrigada/(Residential Gate)	-	-	-	-	NA	NA	NA	NA
Route 15 - Barrigada Air Force/(Fadian Point Drive)***	-	-	-	-	NA	NA	NA	NA

Legend: NA = Not Applicable.
Notes: *Signalized intersection LOS based on average delay for the overall intersection.
**Intersection is proposed to be signalized in future build conditions.
***Unsignalized intersection LOS based on approach delay on STOP-controlled approach.

Public Transportation Impacts. Impacts to the public transportation system relate to the delays caused by increased levels of congestion on roadways and at intersections. In the Central Region, this would affect the fixed-route service along Routes 1 and 10, as well as the demand response and paratransit services. Delays on the roadways increase passenger travel times, with longer headways and missed transfers. This would also affect the fixed-route services proposed for Routes 16 and 26. Implementation of new transit services should take into consideration the impacts of the military relocation.

Pedestrian and Bicycle Impacts. There are limited impacts to the pedestrian and bicycle facilities in the Central Region. Along Routes 1 and 10, future traffic volumes and congestion should not negatively affect the experience or safety of the pedestrian using the existing sidewalk; however, it could impact a cyclist wanting to use the outside lane when unable to use the sidewalk. Future improvements to Routes 8 and 26 would also impact the intermittent sidewalk along these roadways and provide an opportunity to fully complete the facility. In addition, any future planning for pedestrian and bicycle facilities needs to consider the impacts of the military relocation.

Apra Harbor

On Base Roadways

Naval Base Guam

Construction. Construction at the Naval base are independent of the Alternatives 1, 2, 3, and 8. Construction of necessary facilities to support the MEU are located at the inner harbor at Apra. Marine and roadway traffic volumes associated with transport of dredge materials during construction are described in Volume 4 Chapter 14. Due to the expected increase of construction traffic, the impact of the construction of the facilities would be significant but mitigable. An on base traffic study is currently being conducted and results from the study will be provided for the FEIS to determine the exact level of impact.

Operation. The MEU training would bring approximately 2,000 additional military personnel to Guam as a transient population. They would not be provided family housing or be using on or off base amenities (except during periods of leave and liberty). Personnel, cargo, and equipment arriving at Apra Harbor would travel in trucks, buses, and High Mobility Multipurpose Wheeled Vehicle on civilian roads to bivouac/expeditionary camp site Andersen South or other training venue. It is anticipated that these transport events would occur during evening hours or other non-peak travel hours to avoid peak traffic periods. Approximately 15 trucks would travel as a group, with distance and time between caravans to minimize interruptions to civilian traffic flow. The number of trips varies with the mission. On return to the wharf, the vehicles and equipment would be inspected and washed prior to being loaded onto the ships carrying amphibious vehicles.

In 2008, the Naval base had approximately 1,343 morning peak hour trips, 1,540 afternoon peak hour trips, and 19,286 daily trips through its Main Gate. These volumes are expected to increase by 2030 with expected increases in base activities. In 2030 without project, the morning peak hour traffic is forecasted to increase by 232 trips (17%), the afternoon peak hour traffic by 303 trips (20%), and daily traffic by 4,182 trips (22%).

Traffic generated by the proposed actions at the Naval base is summarized on Table 4.2-8. For 2030 with project, the morning peak hour traffic is forecasted to increase by 213 (14%), the afternoon peak hour traffic by 225 trips (12%), and daily traffic by 3010 trips (13%). Due to the percent increase of traffic in excess of 5% (significance threshold), impact at Navy base would be significant but mitigable.

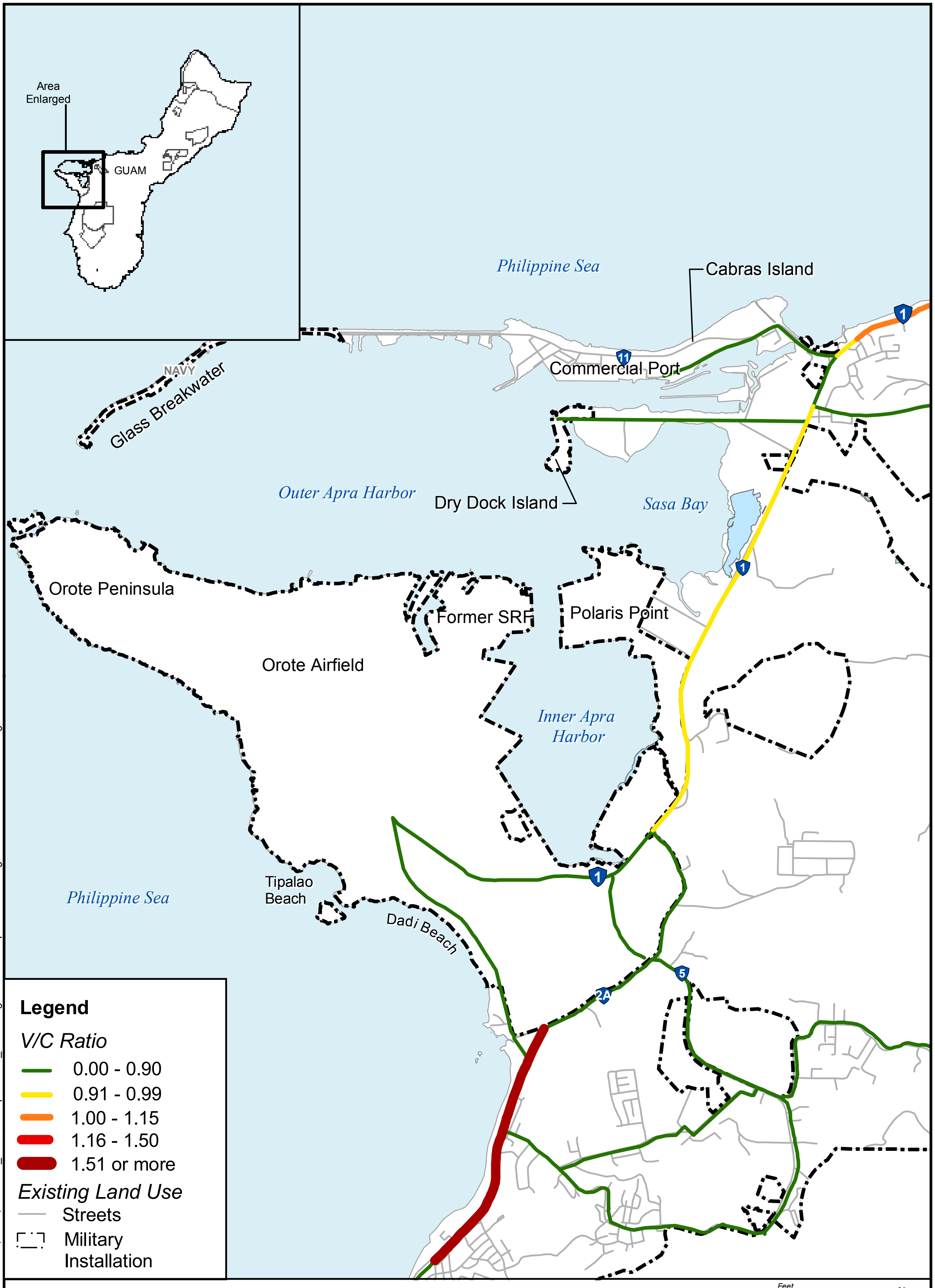
Table 4.2-8. Traffic Generated by the Proposed Actions at the Navy Base

	2008	*2030 BASELINE*			*2030 W/PROJECT*		
			2030 BASE/2008			*2030 PROJ/BASE*	
Time Period	*Volume*	*Volume*	*Number Increase*	*Percentage Increase*	*Volume*	*Number Increase*	*Percentage Increase*
Naval Base: Alternative 1, 2, 3 & 8							
a.m. Inbound	883	999	116	13%	1066	67	7%
a.m. Outbound	460	576	116	25%	722	146	25%
a.m. Total	1343	1575	232	17%	1788	213	14%
p.m. Inbound	603	754	151	25%	880	126	17%
p.m. Outbound	937	1089	152	16%	1188	99	9%
p.m. Total	1540	1843	303	20%	2068	225	12%
Daily	19286	23468	4182	22%	26478	3010	13%

Off Base Roadways

Future Traffic Impacts. A summary of future ADT volumes and the V/C ratio for 2014 and 2030 for Alternative 1 can be found in Table 4.2-9. Generally, there is a substantial increase in volumes on roadways from 2008 to 2014, and then a modest decrease in volumes on roadways from 2014 to 2017. This can be attributed to the increase in construction traffic and coinciding military expansion during peak construction time, which is in 2014, and then a reduction in traffic once off-island construction workers leave the island. The magnitude of decrease is especially noticeable on Route 11, which decreases from approximately 14,000 vpd to 8,900 vpd. This can be attributed to the high volume of construction traffic.

Figure 4.2-23 through Figure 4.2-26 show future levels of traffic congestion in the Apra Harbor Region for the a.m. and p.m. peak hours, respectively. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested.



Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4192_MXDs\Figure 4.2-23. Apra Harbor Region - 2014 a.m. Peak Congestion Levels- Alternative 1-2.mxd

Figure 4.2-23
Apra Harbor Region - 2014 a.m. Peak Congestion Levels- Alternative 1 and 2

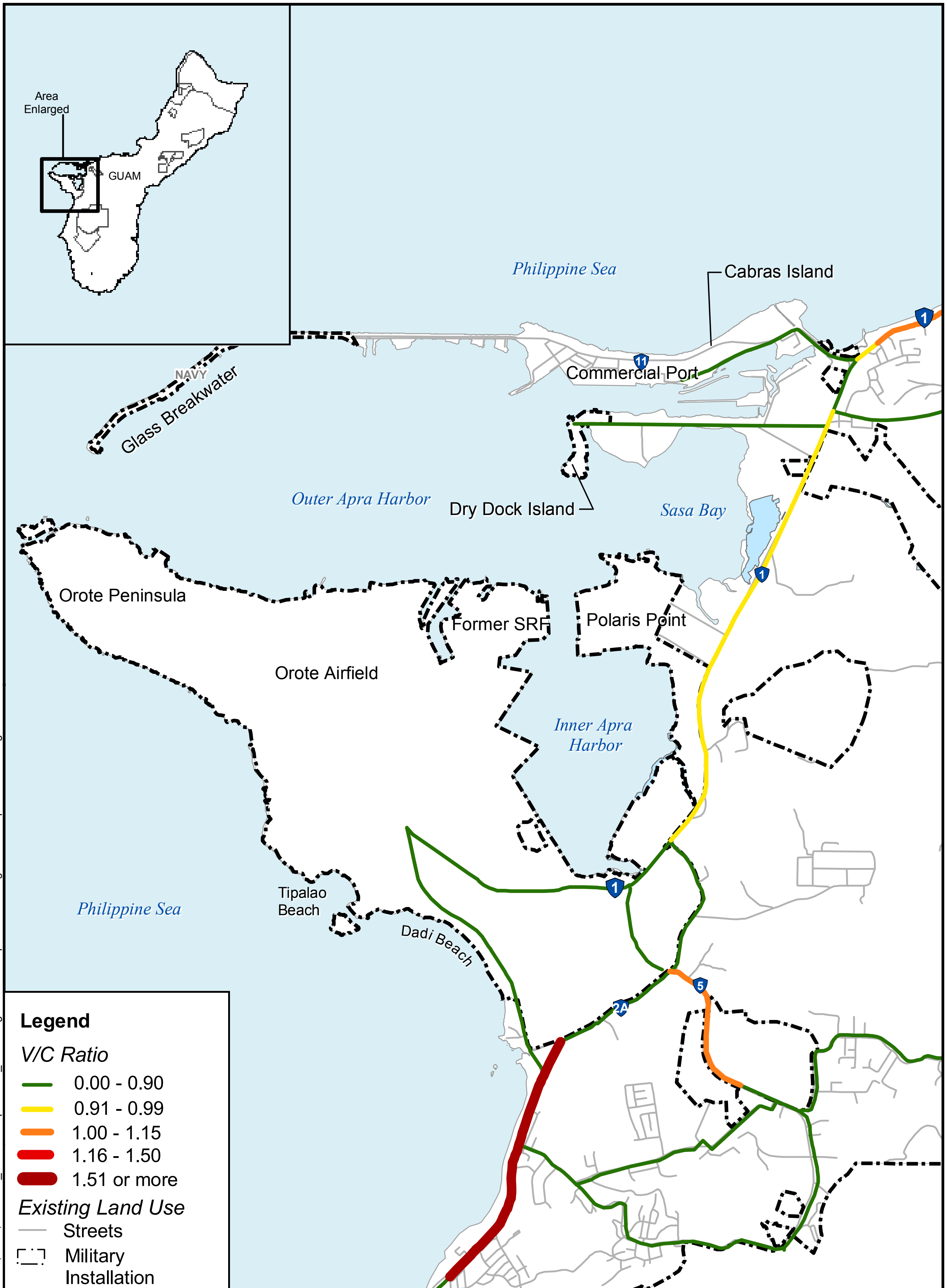


Figure 4.2-24
Apra Harbor Region 2014 p.m. Peak Congestion Levels – Alternative 1 and 2

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4192_MXDs\Figure 4.2-24. Apra Harbor Region - 2014 p.m. Peak Congestion Levels- Alternative 1-2.mxd

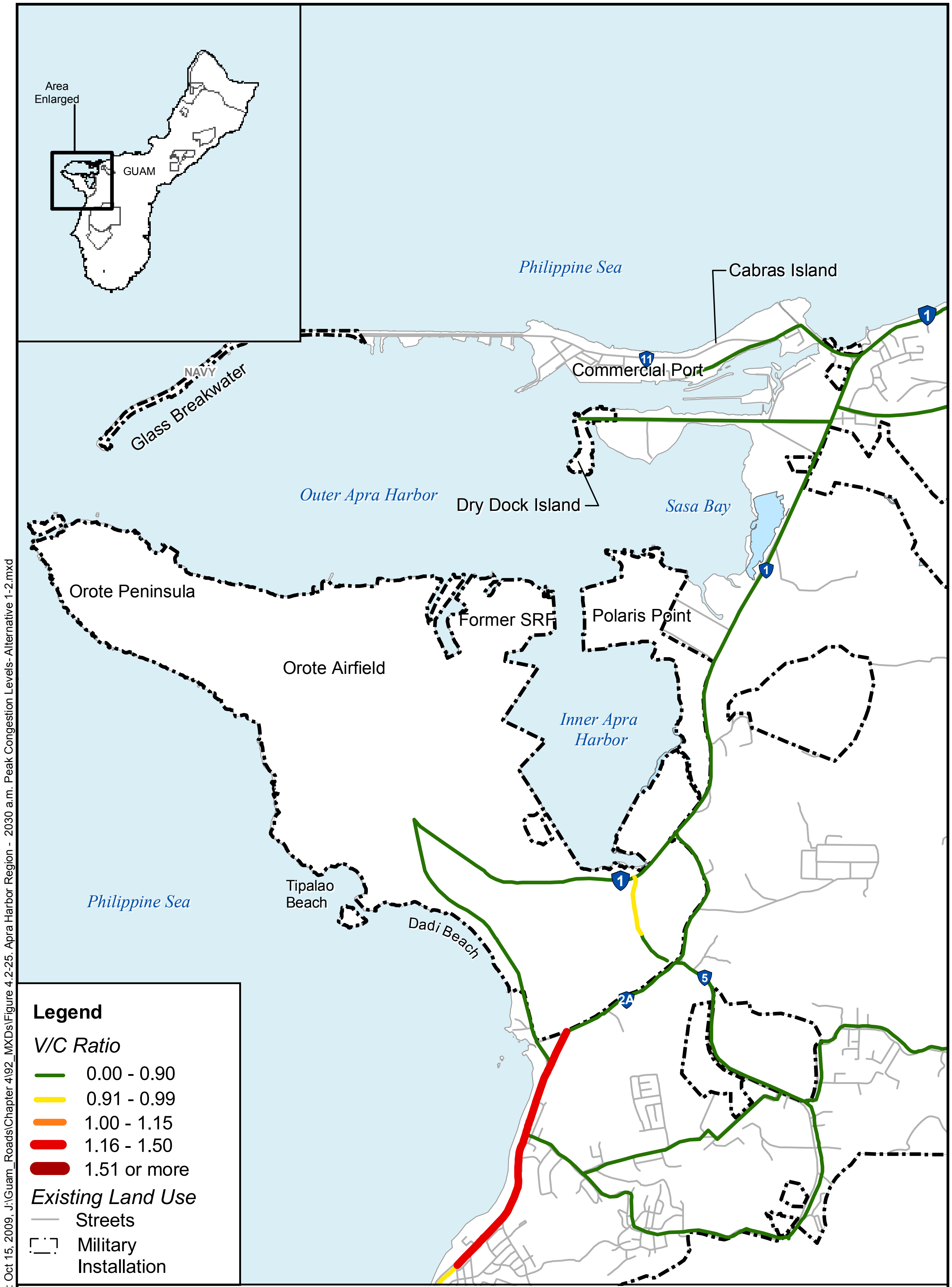


Figure 4.2-25
Apra Harbor Region – 2030 a.m. Peak Congestion Levels – Alternative 1 and 2

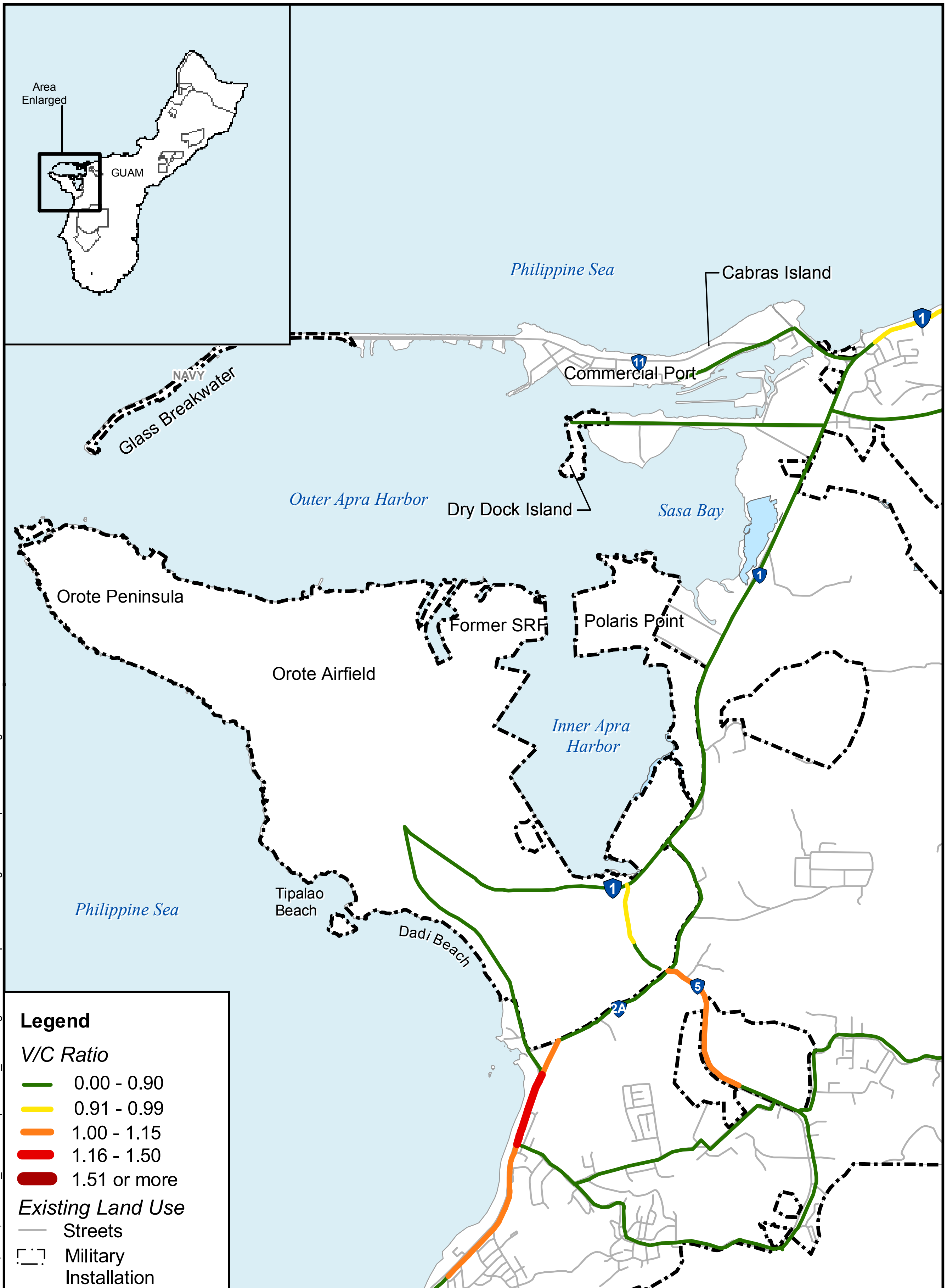


Figure 4.2-26

Apra Harbor Region – 2030 p.m. Peak Congestion Levels – Alternative 1 and 2

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-26. Apra Harbor Region - 2030 p.m. Peak Congestion Levels - Alternative 1-2.mxd

The proposed aircraft carrier berthing project would occur in the Apra Harbor Region. While in port, it is estimated that an average of four busses per hour would travel between the Navy base and Tumon Bay. Under Alternative 1 (Polaris Point), an additional 2 busses per hour would travel between Polaris Point and the Main base. An identical number (unknown) of taxis and car rentals would be used for each alternative. Thus, for the two aircraft carrier berthing alternatives, the amount of vehicle activity would be virtually identical. However, existing traffic conditions at the off base roadways providing access to Polaris Point (Alternative 1) are better than existing roadway conditions at the off base roadways providing access to Former SRF (Alternative 2). Traffic associated with Alternative 1 (Polaris Point) would have access to the Guam roadway system at the existing signalized access point at Route 1/Polaris Point access road intersection. In the future, this signalized intersection operates at LOS A during weekday morning and afternoon peak hours and has adequate capacity for infrequent traffic events such as berthing of ships. Therefore, for Alternative 1 (Polaris Point), any additional traffic (e.g., rental cars, busses, taxis, etc) during berthing operations at peak hours would impact the LOS A condition on Route 1/Route 2a.

In the future condition, Route 1/Route 2A is anticipated to operate at LOS E both in the a.m. and p.m. peak hour without the aircraft carrier berthing project. Therefore, for Alternative 2 (Former SRF), any additional traffic (e.g., rental cars, busses, taxis, etc) during berthing operations for Alternative 2 during peak hours would impact the LOS E condition on Route 1/Route 2a.

Table 4.2-9. Alternatives 1 and 2 Future ADT and Volume to Capacity Ratio Summary – Apra Harbor Region

Roadway	*2014*		*2030*	
	ADT Summary	*V/C Ratio*	*ADT Summary*	*V/C Ratio*
Route 1	Route 1 ranges from 23,000 to 47,000 vpd. The traffic decreases into the entrance into the Naval base, which is at the Route 1/2A intersection.	The V/C ratio is less than 1. The roadway is not considered congested.	Route 1 ranges from 24,000 to 56,000 vpd. The traffic decreases into the entrance into the Naval base, which is at the Route 1/2A intersection.	The V/C ratio is less than 1, indicating the roadway is not considered congested.
Route 2A	Route 2A has 36,000 vpd. The traffic decreases after the intersection with Route 5.	The V/C ratio is 0.00-0.90, indicating the roadway is not considered congested.	Route 2A has 35,000 vpd. The traffic decreases after the intersection with Route 5.	The V/C ratio is 0.00-0.90, indicating the roadway is not considered congested.
Route 11	Route 11 has 14,000 vpd.	The V/C ratio is 0.00-0.90, indicating the roadway is not considered congested.	Route 11 has 8,900 vpd.	The V/C ratio is 0.00-0.90, indicating the roadway is not considered congested.

As shown in Table 4.2-10, Route 1/2A would operate at LOS F in the a.m. peak hour for 2014, which is considered unacceptable. The intersection would operate more efficiently in terms of delay in 2030, with LOS E in the a.m.. This change can be attributed to a decrease in construction traffic in 2030. Route 5/2A is operating at LOS F in the p.m. peak hour for 2030, which is considered unacceptable.

Table 4.2-10. Alternatives 1 and 2 Future Level of Service and Delay Results – Apra Harbor Region

	2014				*2030*			
	a.m. Peak Hour		*p.m. Peak Hour*		*a.m. Peak Hour*		*p.m. Peak Hour*	
	LOS	*Delay Seconds*	*LOS*	*Delay Seconds*	*LOS*	*Delay Seconds*	*LOS*	*Delay Seconds*
Signalized*								
Route 1/11	C	25.4	E	67.1	C	20.7	D	43.5
Route 1/Polaris Point	A	3.8	A	4.3	A	8.2	A	7.4
Route 1/6 (west)	D	53.2	C	23.6	B	18.4	C	22.0
Route 1/2A	F	94.1	F	82.1	E	66.8	E	57.2
Route 5/2A	E	79.4	D	36.9	F	96.3	C	26.2

*Notes: *Signalized intersection LOS based on average delay for the overall intersection.*

Public Transportation Impacts. Impacts to the public transportation system in the Apra Harbor Region should be minimal and would relate to the delays caused by increased levels of congestion on Route 5 or at intersections near DoD lands. This would possibly affect the fixed-route service along Route 1, as well as any demand response and paratransit services. Implementation of new transit services should take into consideration the impacts of the military relocation.

Pedestrian and Bicycle Impacts. There are no impacts to the pedestrian and bicycle facilities in the Apra Harbor Region. Along Route 1, future traffic volumes and congestion should not negatively affect the experience or safety of the pedestrian and cyclist using the shoulder as a running or biking lane. Any future planning for pedestrian and bicycle facilities needs to consider the impacts of the military relocation.

<u>South</u>

On Base Roadways

Naval Munitions Site

Construction. Construction at the NMS associated with maneuver training operations, not connected to Main Cantonment Alternatives 1, 2, 3, and 8. A new access road to the southern end of NMS would be required to avoid the Explosive Safety Quantity Distance arcs generated by the ammunitions storage area that overlap the existing access to NMS (the proposed maneuver area itself would not be within the safety arcs). This access road would be approximately 16-ft (5-m) wide for one way travel by a maximum of 10 7-ton trucks in a convoy.

Alternative A: This existing hiking trail is 0.4 mi (0.6 km), would cover 0.8 acres at a 16 ft (5 m) width, and includes no stream crossings.

Alternative B: Under this alternative, the road would be the same length but would not be improved. It would be used by foot traffic and by all-terrain vehicles (ATVs).

The new access roadway would be new and located away from the existing roadways in the NMS. Therefore, construction of the new access road would have no impact to traffic in the NMS.

Operation.

The training operations would utilize a new access road that is located away from the existing roadways in the NMS. Therefore, the training operations would have a no impact to existing traffic in the NMS.

Off Base Roadways

Future Traffic Impacts. A summary of future ADT volumes and the V/C ratio for 2014 and 2030 for Alternative 1 can be found in Table 4.2-11. Route 12 decreases in volume from 2014 to 2017. This can be attributed to the increase in construction traffic and coinciding military expansion during peak construction time, which is in 2014, and then a reduction in traffic once off-island construction workers leave the island.

Table 4.2-11. Alternatives 1 and 2 Future ADT and Volume to Capacity Ratio Summary – South Region

Roadway	*2014*		*2030*	
	ADT Summary	*V/C Ratio*	*ADT Summary*	*V/C Ratio*
Route 5	Route 5 ranges from 9,800 to 17,000 vpd. Traffic decreases as Route 5 approaches the intersection with Route 17.	The V/C ratio is 0.91-0.99 in the a.m. peak and 1.00-1.15 in the p.m. peak. The roadway is congested during the p.m. peak hours.	Route 5 ranges from 11,000 to 18,000 vpd. Traffic decreases as Route 5 approaches the intersection with Route 17.	The V/C ratio is 0.91-0.99 in the a.m. peak and 1.00-1.15 in the p.m. peak. The roadway is congested during the p.m. peak hours.
Route 12	Route 12 ranges from 1,800 to 5,600 vpd. The traffic increases toward the intersection with Route 2.	The V/C ratio is 0.00-0.90 during both the a.m. and p.m. peak, indicating the roadway is not considered congested.	Route 12 ranges from 2,300 to 6,000 vpd. The traffic increases toward the intersection with Route 2.	The V/C ratio is 0.00-0.90 during both the a.m. and p.m. peak, indicating the roadway is not considered congested.

Figure 4.2-27 through Figure 4.2-30 show future levels of traffic congestion in the South Region for the a.m. and p.m. peak hours, respectively. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested.

The roads in the South Region do not exhibit high levels of congestion. During the afternoon peak in 2030, Route 5 between the Naval base and the NMS has an LOS F.

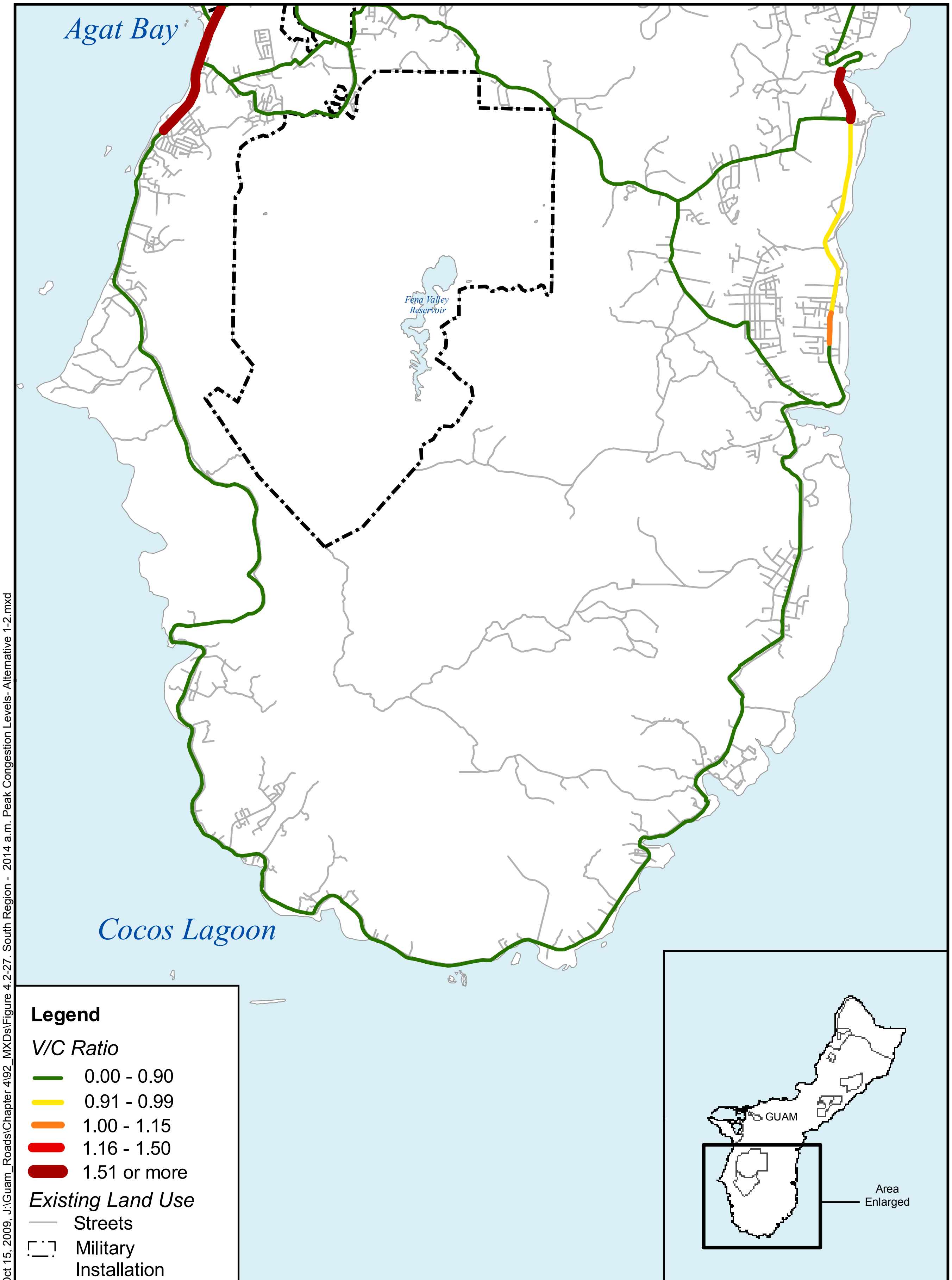


Figure 4.2-27
South Region – 2014 a.m. Peak Congestion Levels – Alternative 1 and 2

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4192_MXDs\Figure 4.2-27. South Region - 2014 a.m. Peak Congestion Levels- Alternative 1-2.mxd

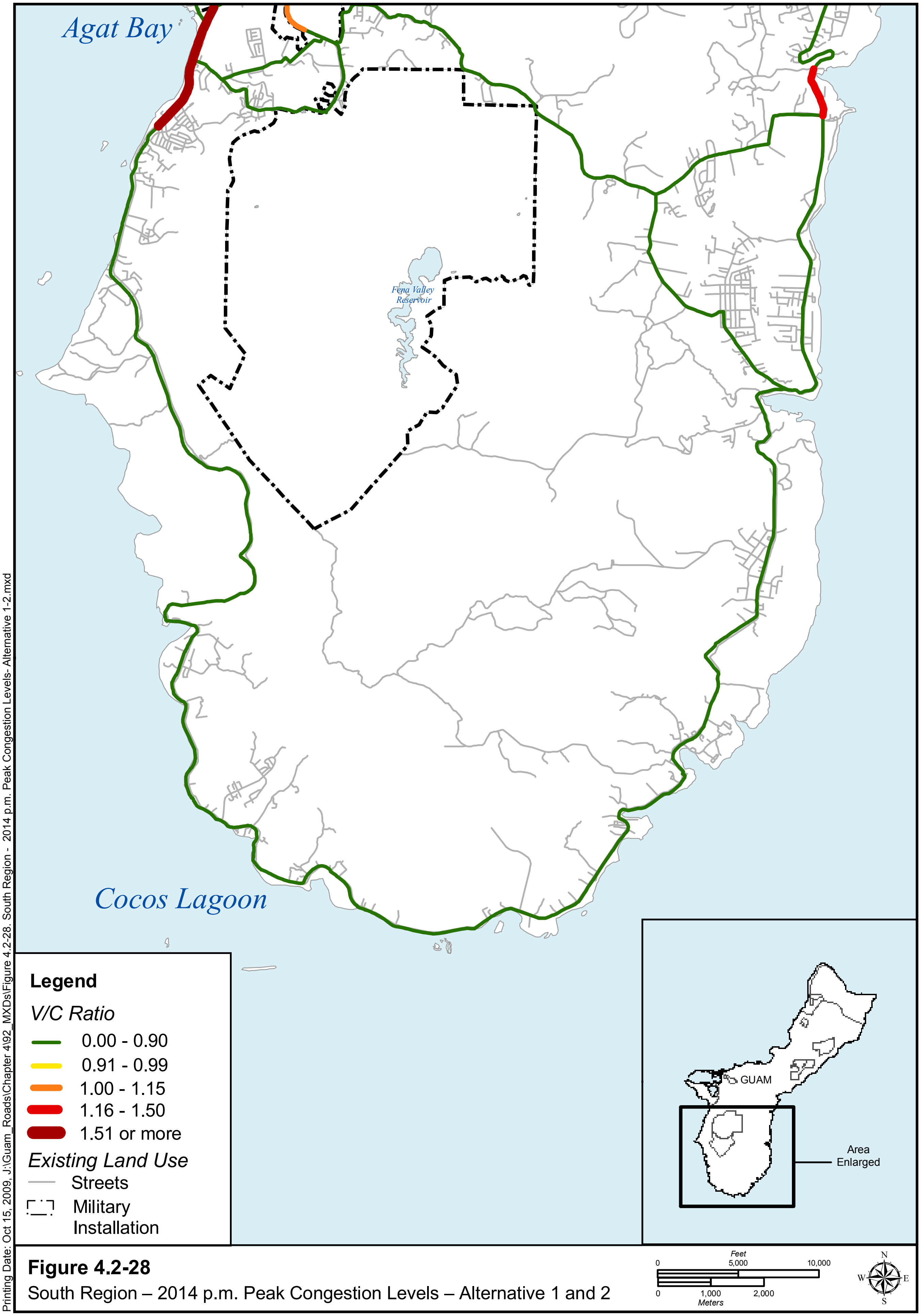


Figure 4.2-28
South Region – 2014 p.m. Peak Congestion Levels – Alternative 1 and 2

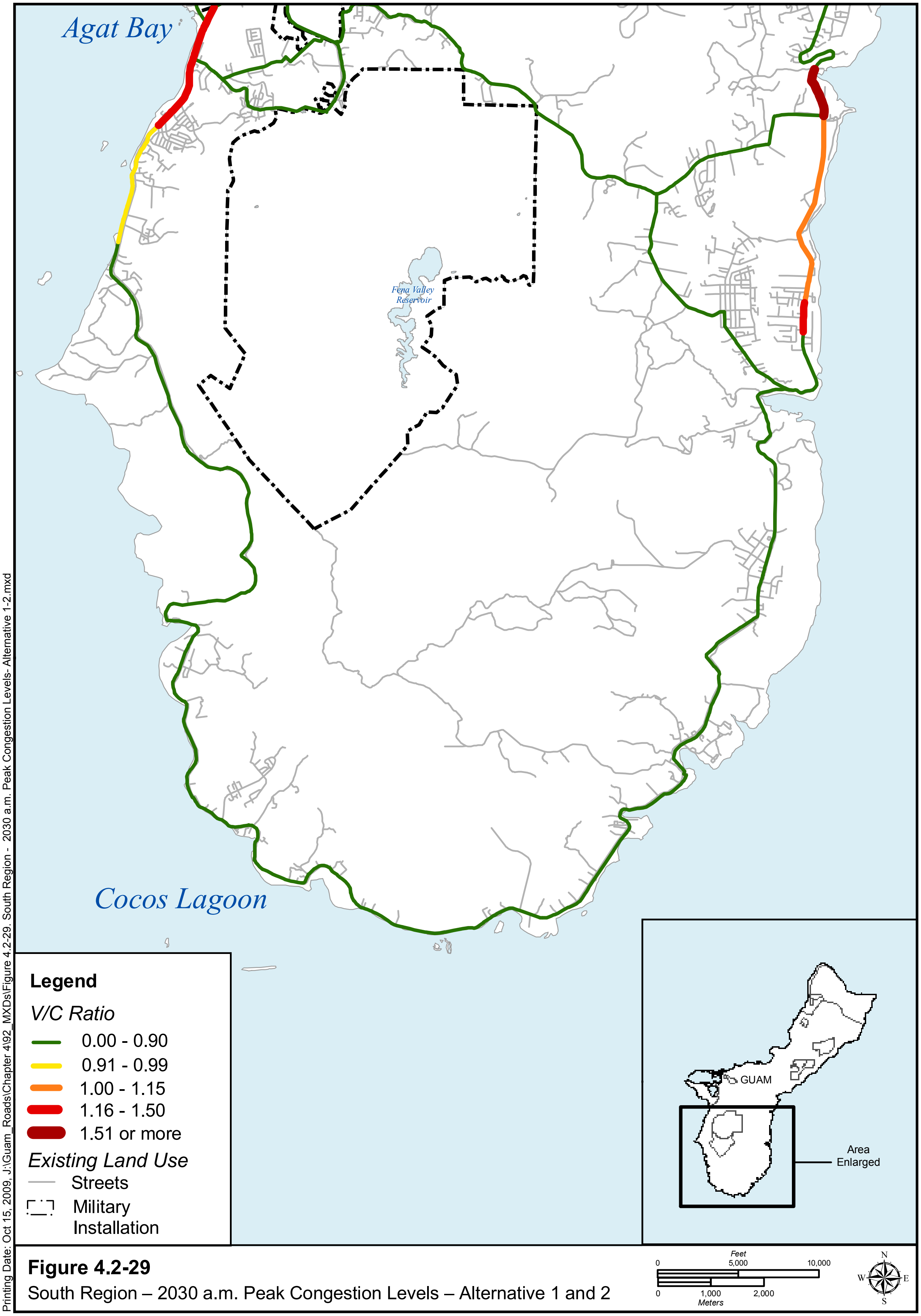


Figure 4.2-29
South Region – 2030 a.m. Peak Congestion Levels – Alternative 1 and 2

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4192_MXDs\Figure 4.2-29. South Region - 2030 a.m. Peak Congestion Levels- Alternative 1-2.mxd

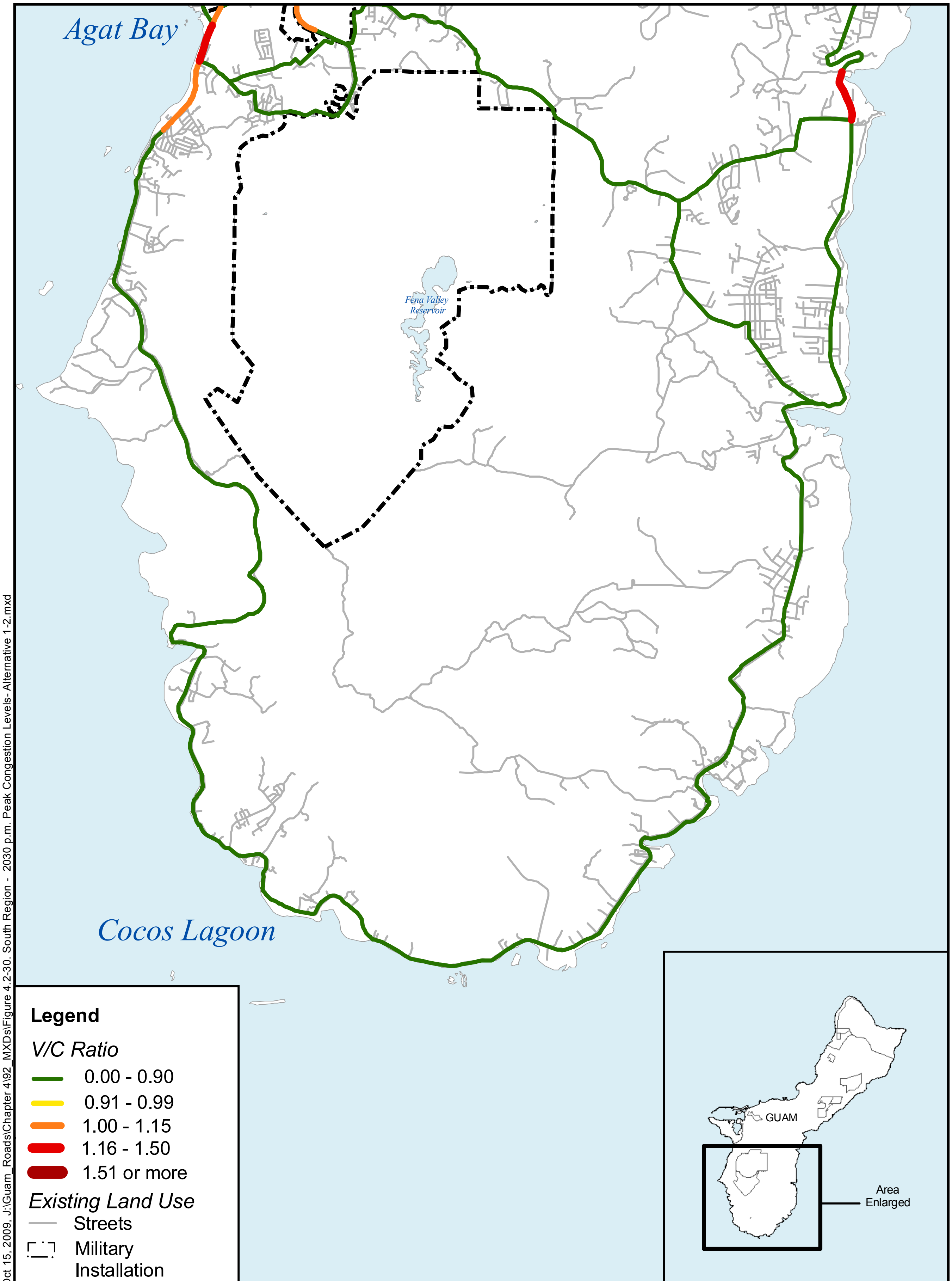


Figure 4.2-30
South Region – 2030 p.m. Peak Congestion Levels – Alternative 1 and 2

Feet 0 5,000 10,000
0 1,000 2,000 Meters

As shown in Table 4.2-12, two intersections have LOS F for at least one peak hour, which is considered unacceptable: Route 2/12, Route 5/17, and Route 4/4A. Route 4/4A and Route 5/17 have fairly free-flowing conditions in 2014 and become significantly more congested in 2030.

Table 4.2-12. Alternatives 1 and 2 Future Level of Service and Delay Results – South Region

	2014				*2030*			
	a.m. Peak Hour		*p.m. Peak Hour*		*a.m. Peak Hour*		*p.m. Peak Hour*	
	LOS	*Delay Seconds*	*LOS*	*Delay Seconds*	*LOS*	*Delay Seconds*	*LOS*	*Delay Seconds*
Signalized*								
Route 2/12	F	135.0	C	26.0	C	27.8	C	27.1
Unsignalized**								
Route 5/17	C	13.1	D	29.3	F	56.8	F	149.6
Route 4/4A	C	23.9	C	17.1	E	49.7	F	484.3
Route 17/4A	B	12.9	B	14.0	B	13.6	C	18.7
Access Points								
Route 5 - Naval Ordnance Annex/Harmon Road.**	-	-	-	-	A	9.5	A	10.6

*Notes: *Signalized intersection LOS based on average delay for the overall intersection.*
***Unsignalized intersection LOS based on approach delay on STOP-controlled approach.*

Public Transportation Impacts. Impacts to the demand response and paratransit that service the South Region are minimal. Implementation of new transit services should take into consideration the impacts of the military relocation.

Pedestrian and Bicycle Impacts. There are no impacts to pedestrian and bicycle facilities in the South Region. Any future planning for pedestrian and bicycle facilities needs to consider the impacts of the military relocation.

Potential Mitigation Measures

On Base Roadways

Due to increase of traffic due to the proposed action, the impact would be significant but mitigable at Andersen AFB and at the Navy base. The traffic impact is less than significant at Andersen South, Barrigada, and NMS. Potential mitigation measures for Andersen AFB and the Naval base may include road widening, restriping, traffic signal and other traffic control devices to help improve traffic operations. An on base traffic study is currently being conducted, and the results of the detailed traffic analyses will be provided in the FEIS on specific improvements.

Off Base Roadways

Mitigation for the impacts described for Alternative 1 would be under the control of FHWA and could include the creation of a Traffic Management Plan that may incorporate the following:

- Travel demand management
- Encourage moped and motorcycle use
- Develop transportation demand measures to discourage single-occupant vehicle use
- Stagger work hours
- Provide corporate shuttles for local circulation
- Better delivery system for purchases
- Flextime – compressed work weeks

- Promote trip reduction planning
- Traffic management would follow the Manual on Uniform Traffic Control Devices, as deemed necessary and applicable
- The Manual on Uniform Traffic Control Devices provides several examples on dealing with traffic through many different types of roadway construction activities
- Whenever possible, construction would be phased to allow two lanes of traffic to remain open
- If two lanes of traffic are not permissible, traffic would be reduced to one lane
- Should it be required for all lanes of traffic to be closed, a detour route would be clearly signed
- Appropriate measures would be taken to maintain access to businesses
- Should construction require a business access to be closed, the business owner would be given reasonable notice of the construction activities and the estimated duration of closure
- Pedestrian routes would remain open and clear of any debris
- Should a pedestrian route be closed, a detour route would be clearly signed and maintained throughout construction to ensure pedestrian safety
- All emergency services would be given sufficient notice of construction activities and relative detour routes as to not affect their response times

4.2.2.2 Alternative 2 (Preferred Alternative)

<u>North</u>

On Base Roadways

Andersen AFB

Construction. The impacts for Alternative 2 are the same as Alternative 1.

Operation. The impacts for Alternative 2 are the same as Alternative 1.

Finegayan

Construction. The impacts for Alternative 2 are the same as Alternative 1.

Operation. The impacts for Alternative 2 are the same as Alternative 1.

Off Base Roadways

The impacts for Alternative 2 are the same as Alternative 1.

<u>Central</u>

On Base Roadways

Andersen South

Construction. The impacts for Alternative 2 are the same as Alternative 1.

Operation. The impacts for Alternative 2 are the same as Alternative 1.

Barrigada

Construction. The impacts for Alternative 2 are the same as Alternative 1.

Operation. The impacts for Alternative 2 are the same as Alternative 1.

Off Base Roadways

The impacts for Alternative 2 are the same as Alternative 1.

Apra Harbor

On Base Roadways

Naval Base Guam

Construction. The impacts for Alternative 2 are the same as Alternative 1.

Operation. The impacts for Alternative 2 are the same as Alternative 1.

Off Base Roadways

The impacts for Alternative 2 are the same as Alternative 1.

South

On Base Roadways

Naval Munitions Site

Construction. The impacts for Alternative 2 are the same as Alternative 1.

Operation. The impacts for Alternative 2 are the same as Alternative 1.

Off Base Roadways

The impacts for Alternative 2 are the same as Alternative 1.

Potential Mitigation Measures

On Base Roadways

The proposed mitigation measures would be the same as for Alternative 1.

Off Base Roadways

The proposed mitigation measures would be the same as for Alternative 1.

4.2.2.3 Alternative 3

North

On Base Roadways

Andersen AFB

Construction. The impacts for Alternative 3 are the same as Alternative 1.

Operation. The impacts for Alternative 3 are the same as Alternative 1.

Finegayan

Construction. The construction in Finegayan remains similar to that explained in Alternatives 1 and 2. In this alternative, the Former FAA Land and Harmon Annex are not utilized. The alternative includes utilizing Navy and Air Force Barrigada bases for constructing the family housing and community support facilities that would not be constructed on FAA Land and Harmon Annex. The Commercial Gate, Main Gate, and Residential Gate remain at the same location. Facilities that would be constructed remain same as explained in Alternatives 1 and 2 earlier.

However, the impacts for Alternative 3 would be similar to Alternative 1.

Operation. As there is no inter-connectivity between NCTS Finegayan and South Finegayan bases in Alternative 3; the traffic between these two neighboring bases would have to pass through Route 3. This would result in higher traffic congestion on Route 3 and impacts are discussed in the Off Base Roadway section of this chapter.

The impacts for Alternative 3 to on base roadways are the same as Alternative 1.

Off Base Roadways

Future Traffic Impacts. Alternative 3 of the Army AMDTF proposed action involves collocation of facilities with the Marine Corps at NCTS Finegayan, Navy Barrigada, and Air Force Barrigada. Alternative 2 of the Army AMDTF is similar in that Army facilities would be located at Navy Barrigada. Thus, effects of Army AMDTF Alternatives 2 and 3 are captured in the following analysis.

A summary of future ADT volumes and the V/C ratio for 2014 and 2030 for Alternative 3 is presented in Table 4.2-13. Generally, there is a substantial increase in volumes on roadways from 2008 to 2014, and then a modest decrease in volumes on roadways from 2014 to 2017. This can be attributed to the increase in construction traffic and coinciding military expansion during peak construction time, which is in 2014, and then a reduction in traffic once off-island construction workers leave the island. Overall, there would be increased traffic as compared to Alternative 1 due to traffic from off-base housing.

Table 4.2-13. Alternative 3 Future ADT and Volume to Capacity Ratio Summary – North Region

Roadway	*2014*		*2030*	
	ADT Summary	*V/C Ratio*	*ADT Summary*	*V/C Ratio*
Route 1	Route 1 ranges from 32,000 to 41,000 vpd. Traffic decreases as Route 1 approaches Andersen AFB.	The V/C ratio is 0.00-0.90 during the a.m. and p.m. peak hours, indicating the roadway is not considered congested.	Route 1 ranges from 24,000 to 40,000 vpd. Traffic decreases as Route 1 approaches Andersen AFB.	The V/C ratio is 0.00-0.90 during the a.m. and p.m. peak hours, indicating the roadway is not considered congested.
Route 3	Route 3 ranges from 23,000 to 68,000 vpd. Traffic decreases north of the intersection with Route 28.	During the a.m. and p.m. peak, Route 3 south of the Residential Gate has a V/C ratio of 1.00-1.15. North of the Residential Gate, the V/C ratio is less than 1. The roadway is considered congested south of the military installation.	Route 3 ranges from 13,000 to 53,000 vpd. Traffic decreases north of the intersection with Route 28.	During peak hours, Route 3 has a V/C ratio of less than 1 and is not considered congested.

Table 4.2-13. Alternative 3 Future ADT and Volume to Capacity Ratio Summary – North Region

Roadway	2014		2030	
	ADT Summary	V/C Ratio	ADT Summary	V/C Ratio
Route 9	Route 9 ranges from 12,000 to 20,000 vpd. There is a decrease in traffic east of the two residential developments on Route 9.	The western portion has a V/C ratio of 0.00-0.90 during peak hours; however, the eastern portion has a V/C ratio of 0.81-0.99 during the a.m. peak and 1.00-1.15 during the p.m. peak. This section is congested during the p.m. peak.	Route 9 ranges from 9,200 to 16,000 vpd. There is a decrease in traffic east of the two residential developments on Route 9.	The western portion of Route 9 has a V/C ratio of 0.00-0.90 during peak hours, while the eastern portion has a V/C ratio of 0.91-0.99. The roadway is not considered congested.
Route 15	Route 15 has 6,900 vpd in the North Region.	The V/C ratio is 0.00-0.90 during the a.m. and p.m. peak hours, indicating the roadway is not considered congested.	Route 15 has 7,600 vpd in the North Region.	The V/C ratio is 0.00-0.90 during the a.m. and p.m. peak hours, indicating the roadway is not considered congested
Route 28	Route 28 ranges from 21,000 to 26,000 vpd. Traffic increases closer to the intersection with Route 1.	The north/south portion of Route 28 has a V/C ratio greater than 1.50 during peak hours. The east/west portion has a V/C of 1.16-1.50 during the a.m. and greater than 1.50 during the p.m.. The roadway is considered congested.	Route 28 ranges from 16,000 to 18,000 vpd. Traffic increases closer to the intersection with Route 1.	The north/south portion of Route 28 has a V/C ratio greater than 1.50 during peak hours. The east/west portion has a V/C of 1.00-1.15 during the a.m. and 1.16-1.50 during the p.m.. The roadway is considered congested.

Figure 4.2-31 through Figure 4.2-34 show future levels of traffic congestion in the North Region for the a.m. and p.m. peak hours, respectively. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested.

The road indirectly serving the DoD lands is the most congested. During both the morning and afternoon peaks, the road with the greatest congestion levels in the North Region is Route 28 with LOS F.

The results of the future operational analysis are shown in Table 4.2-14 for both the 2014 a.m. and p.m. and 2030 a.m. and p.m. conditions.

For the North Region, there are three intersections for which traffic is worse in 2014 than in 2030 in both the a.m. and p.m. peak hour. This can be attributed to an increase in construction equipment and personnel in addition to the first military deployment that would occur in 2010.

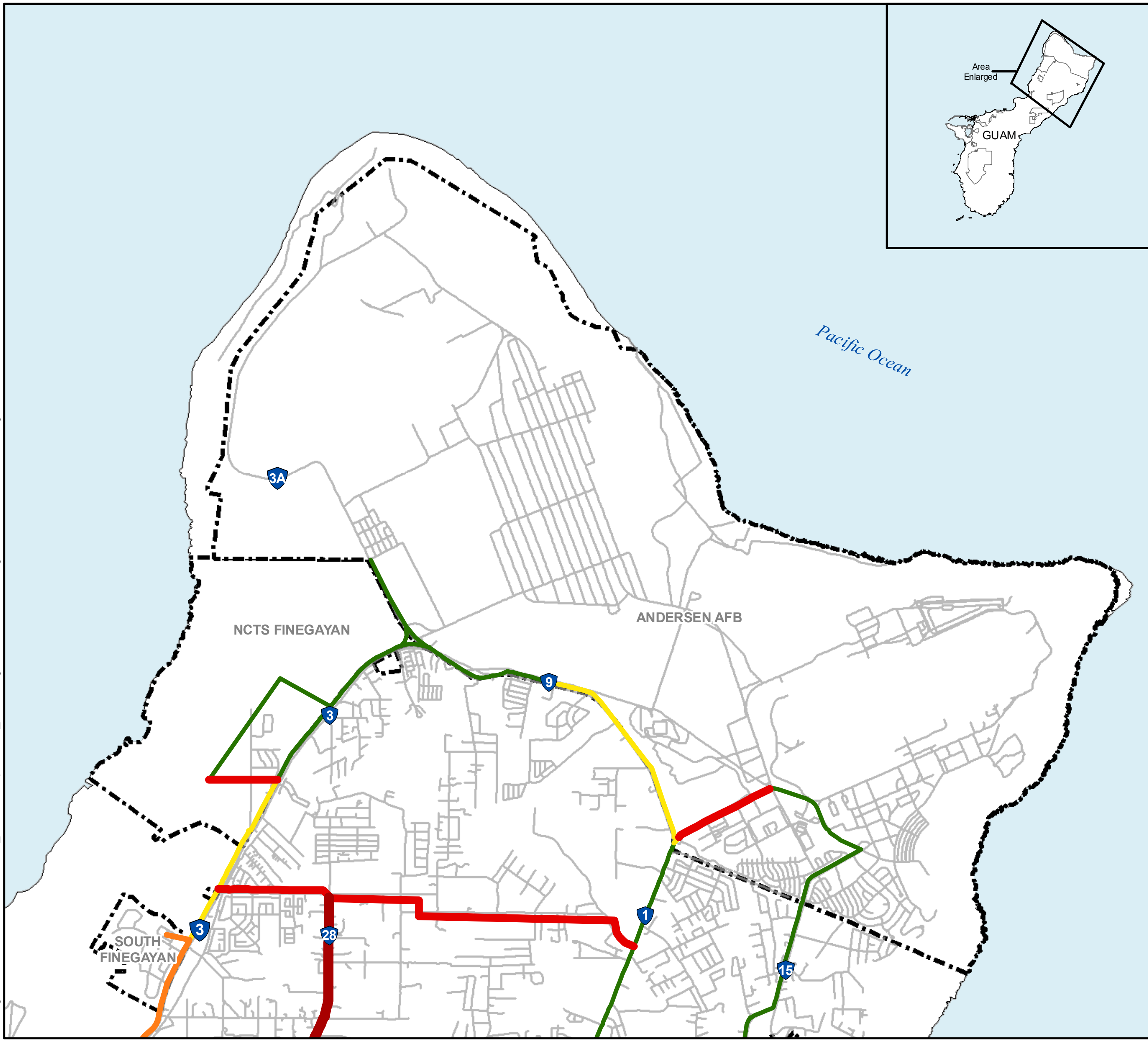


Figure 4.2-31
North Region–
2014 a.m. Peak
Congestion Levels –
Alternative 3

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-31 North Region - 2014 a.m. Peak Congestion Levels- Alternative 3.mxd

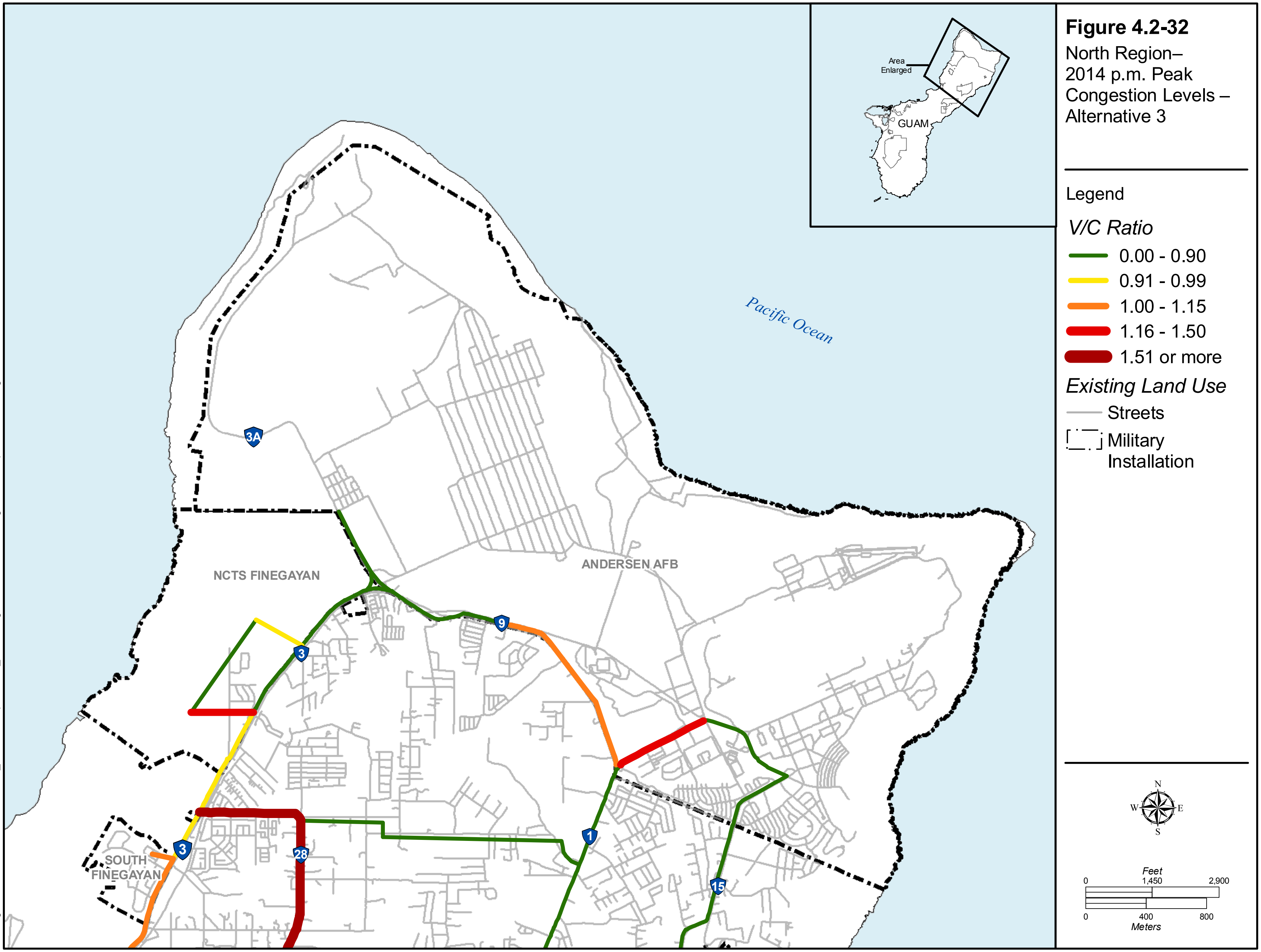


Figure 4.2-32
North Region–
2014 p.m. Peak
Congestion Levels –
Alternative 3

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-32 North Region - 2014 p.m. Peak Congestion Levels- Alternative 3.mxd

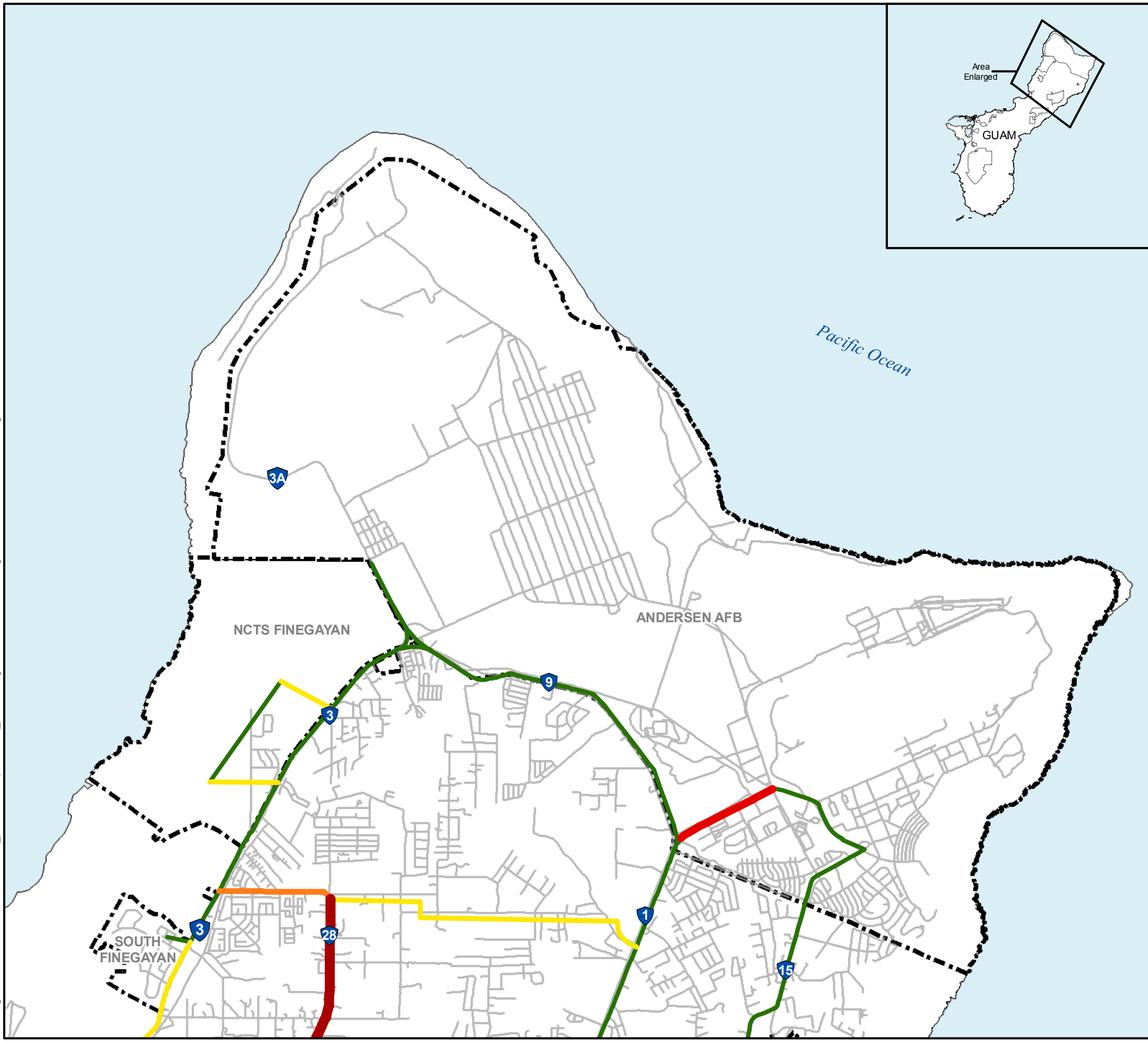


Figure 4.2-33
North Region–
2030 a.m. Peak
Congestion Levels –
Alternative 3

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-33 North Region - 2030 a.m. Peak Congestion Levels- Alternative 3.mxd

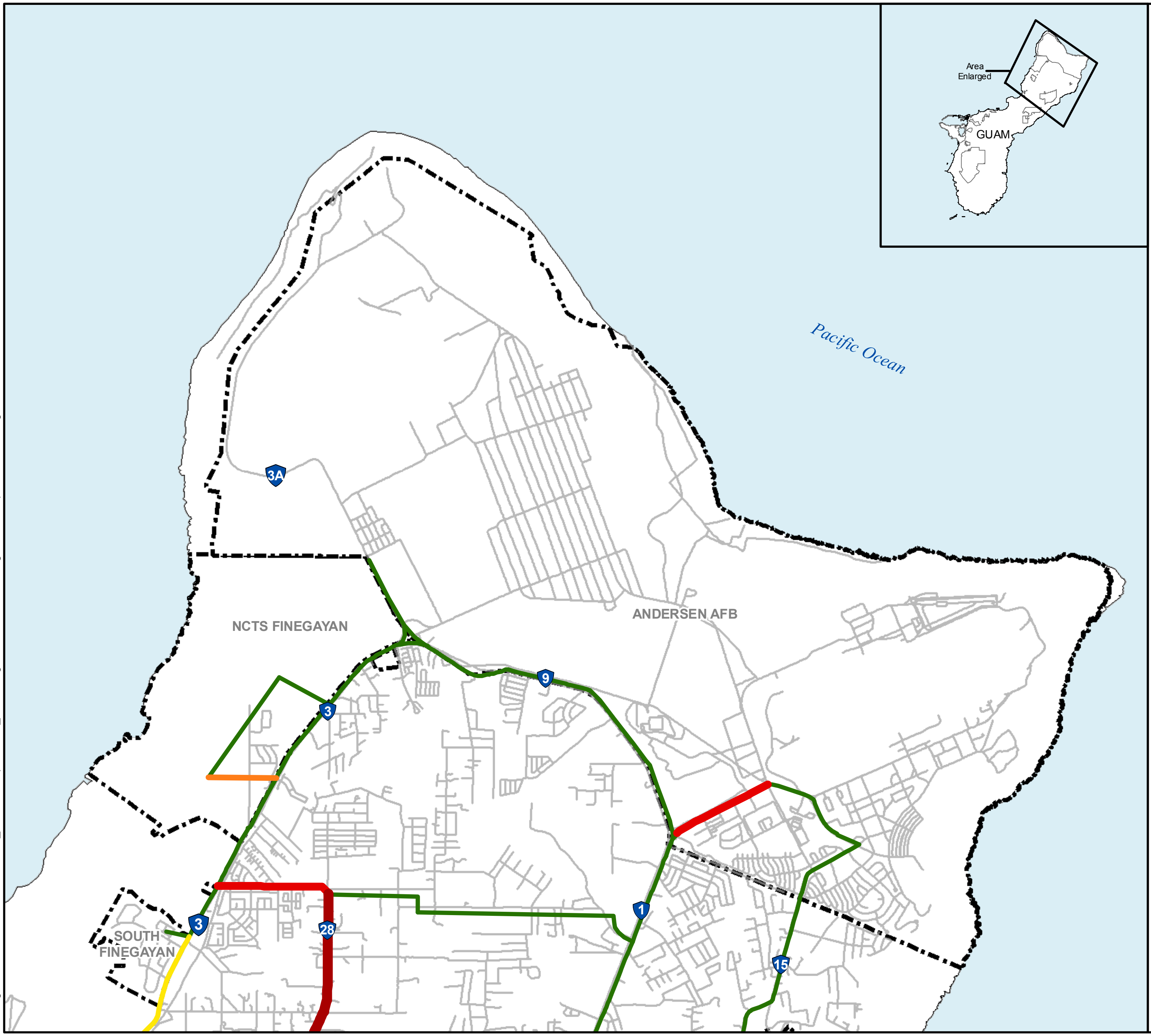


Figure 4.2-34
North Region–
2030 p.m. Peak
Congestion Levels –
Alternative 3

Legend

V/C Ratio
0.00 - 0.90
0.91 - 0.99
1.00 - 1.15
1.16 - 1.50
1.51 or more

Existing Land Use
Streets
Military Installation

N W E S

Feet
0 1,450 2,900
0 400 800
Meters

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-34 North Region - 2030 p.m. Peak Congestion Levels- Alternative 3.mxd

As shown in Table 4.2-14, there are three intersections and three access points with LOS F for at least one peak hour, which is considered unacceptable. The Route 1/29 intersection is operating at LOS F in the a.m. and p.m. peak hours in both 2014 and 2030.

Table 4.2-14. Alternative 3 Future Level of Service and Delay Results – North Region

	2014				*2030*			
	a.m. Peak Hour		*p.m. Peak Hour*		*a.m. Peak Hour*		*p.m. Peak Hour*	
	LOS	*Delay Seconds*	*LOS*	*Delay Seconds*	*LOS*	*Delay Seconds*	*LOS*	*Delay Seconds*
Signalized*								
Route 1/9	C	25.9	D	38.2	C	24.4	D	53.0
Route 1/29	F	347.0	F	278.8	F	85.3	F	90.5
Route 3/28	F	95.2	F	92.8	F	90.2	D	53.9
Route 15/29**	C	27.0	C	22.8	F	161.4	C	26.2
Unsignalized***								
Route 3/3A/9	F	142.3	F	565.0	E	47.2	F	100.7
Access Points								
Route 3 - Main Cantonment/Commercial Gate	-	-	-	-	F	91.6	D	39.9
Route 3 - Main Cantonment/Main Gate	-	-	-	-	D	51.6	F	155.9
Route 3 - South Finegayan/Residential Gate	-	-	-	-	F	141.7	D	50.1
Route 9 – Andersen AFB/ Andersen AFB North Gate****	-	-	-	-	F	1031.0	F	9051.1

Notes: *Signalized intersection LOS based on average delay for the overall intersection.
**Intersection is proposed to be signalized in future build conditions.
***Unsignalized intersection LOS based on approach delay on STOP-controlled approach.
****Delay exceeded maximum calculated value.

Public Transportation Impacts. Impacts to the public transportation system relate to the delays caused by increased levels of congestion on roadways and at intersections. This would affect the demand response and paratransit services, increasing passenger wait times and missed transfers. While there is no existing fixed-route service in the North Region, planning efforts have proposed new routes along Routes 1 and 3.

Implementation of new transit services should take into consideration the impacts of the military relocation.

Pedestrian and Bicycle Impacts. There are no impacts to the pedestrian and bicycle facilities in the North Region. Along Route 1, future traffic volumes and congestion should not negatively affect the experience or safety of the pedestrian and cyclist using the shoulder as a running or biking lane. Any future planning for pedestrian and bicycle facilities needs to consider the impacts of the military relocation.

<u>Central</u>

On Base Roadways

Andersen South

Construction. The impacts for Alternative 3 are the same as Alternative 1.

Operation. The impacts for Alternative 3 are the same as Alternative 1.

Barrigada

Construction. Alternative 3 proposes to utilize Navy and Air Force Barrigada bases for construction of family housing and community support structures to accommodate the relocation of marines from Okinawa to Guam. The Residential Gate in Navy Barrigada would be located near the present intersection of Sabana Barrigada and Route 16 in the Northern portion of the site. The Residential Gate for the Air Force Barrigada base would be located near the intersection of Route 15 and Fadian Point Road. The two bases (Navy Barrigada and Air Force Barrigada) would be connected through an approximately 1.5 mile long (2.5 km) Connector road that is proposed to run alongside the eastern edge of the Admiral Nimitz Golf Course.

Based on the relatively low traffic demand on Barrigada, the construction traffic impact would be less than significant for Alternative 3.

Operation. The existing two lane roadways in Barrigada have a daily capacity of approximately 5,000 cars per day. The expected increase in traffic and the current traffic demand is well below that capacity. Therefore, the impact would be less than significant for Alternative 3.

Off Base Roadways

Future Traffic Impacts. Alternative 3 of the Army AMDTF proposed action involves collocation of facilities with the Marine Corps at NCTS Finegayan, Navy Barrigada, and Air Force Barrigada. Alternative 2 of the Army AMDTF is similar in that Army facilities would be located at Navy Barrigada. Thus, effects of Army AMDTF Alternatives 2 and 3 are captured in the following analysis.

A summary of future ADT volumes and the V/C ratio for 2014 and 2030 for Alternative 3 can be found in Table 4.2-15. Generally, there is a substantial increase in volumes on roadways from 2008 to 2014, and then a modest decrease in volumes on roadways from 2014 to 2017. This can be attributed to the increase in construction traffic and coinciding military expansion during peak construction time, which is in 2014, and then a reduction in traffic once off-island construction workers leave the island.

Table 4.2-15. Alternative 3 Future ADT and Volume to Capacity Ratio Summary – Central Region

Roadway	*2014*		*2030*	
	ADT Summary	*V/C Ratio*	*ADT Summary*	*V/C Ratio*
Route 1	Route 1 ranges from 59,000 to 100,000 vpd. Traffic decreases significantly south of the intersection with Route 4.	The V/C ratio is generally less than 1.00 in both the a.m. and p.m. condition; however, there are small segments near the intersections with 14A, and 30 that have a V/C ratio of greater than 1, which indicates the roadway is congested in Tamuning.	Route 1 ranges from 52,000 to 93,000 vpd. Traffic decreases significantly south of the intersection with Route 4.	The V/C ratio is generally less than 1.00 in both the a.m. and p.m. condition; however, there is a segment south of Route 30 that has a V/C ratio of greater than 1 in the p.m. peak. The roadway is congested in Tamuning.
Route 3	Route 3 ranges from 57,000 to 70,000 vpd. Traffic increases toward the intersection with Route 1.	The V/C ratio in both the a.m. and p.m. peak is 1.00-1.15. This indicates the roadway is considered congested.	Route 3 ranges from 48,000 to 60,000 vpd. Traffic increases toward the intersection with Route 1.	The V/C ratio is between 1.00-1.15, indicating the roadway is considered congested at this location.
Route 8/8A	Route 8 ranges from 51,000 to 65,000 vpd. There is a decrease in traffic west of the intersection with Sunset Boulevard. Route 8A has 3,500 vpd.	During peak hours, the V/C ratio is 0.00-0.90 east of Tiyan Parkway, 0.91-0.99 west of Tiyan Parkway, and 0.00-0.90 west of Route 16. Other than a small section near the intersection of Route 10, the roadway is not considered congested.	Route 8 ranges from 52,000 to 60,000 vpd. There is a decrease in traffic west of the intersection with Sunset Boulevard. Route 8A has 2,500 vpd.	During the a.m. peak, the V/C ratio is 0.00-0.90. During the p.m. peak, the V/C ratio is 0.00-0.90 east of Tiyan Parkway, 0.81-0.99 west of Tiyan Parkway, and 0.00-0.90 west of Route 16. The roadway is not considered congested.
Route 10	Route 10 ranges from 56,000 to 58,000 vpd between Routes 8 and 15.	In the a.m. peak, a small segment south of the intersection with Route 15 has a V/C ratio between 1.15-1.50. During the p.m. peak, Route 10 has a V/C ratio of 1.00-1.15 north of Route 32 to Route 8. The roadway is primarily congested during the p.m. peak.	Route 10 ranges from 56,000 to 58,000 vpd between Routes 8 and 15.	In the a.m. peak, Route 10 has a V/C ratio of 1.16-1.50 between Route 32 and Route 15. During the p.m. peak, Route 10 has a V/C ratio of 1.00-1.15 north of Route 32 to Route 8. The roadway is primarily congested during the p.m. peak.

Table 4.2-15. Alternative 3 Future ADT and Volume to Capacity Ratio Summary – Central Region

Roadway	*2014*		*2030*	
	ADT Summary	*V/C Ratio*	*ADT Summary*	*V/C Ratio*
Route 15	Route 15 ranges from 13,000 to 24,000 vpd. There is an increase in traffic south of the intersection with Route 26.	North of Route 26 and west of Route 10, Route 15 has a V/C ratio of 0.00-0.90 during peak hours. The middle section of Route 15 has a V/C ratio of 0.91-0.99, with a V/C ratio of 1.00-1.15 at Route 10. The roadway is only congested near the intersection with Route 10.	Route 15 ranges from 8,100 to 23,000 vpd. There is an increase in traffic south of the intersection with Route 26.	The V/C ratio is less than 1.00 during peak hours. The roadway is not considered congested.
Route 16	Route 16 ranges from 59,000 to 91,000 vpd. There is a decrease in traffic south of the residential developments south of Route 25.	The V/C ratio is generally less than 1.00 in the a.m. and p.m. for the segment of the road south of Route 25. North of Route 25, the V/C level is greater than 1, indicating the roadway is considered congested at this location.	Route 16 ranges from 49,000 to 91,000 vpd. There is a decrease in traffic south of the residential developments south of Route 25.	The V/C ratio is less than 1.00 during peak hours, except for near the intersection with Route 27. The roadway is considered congested at this location.
Route 25	Route 25 ranges from 24,000 to 28,000 vpd.	Route 25 has a V/C ratio greater than 1.50, indicating that the roadway is considered congested.	Route 25 ranges from 27,000 to 30,000 vpd.	The V/C ratio is 1.00-1.15 during peak hours, indicating congestion.
Route 26	Route 26 ranges from 10,000 to 25,000 vpd. There is a decrease in traffic south of the large residential development just north of the intersection with Route 15.	Route 26 primarily has a V/C ratio greater than 1.00 during both the a.m. and p.m. peak. The roadway is considered congested.	Route 26 ranges from 9,000 to 27,000 vpd. There is a decrease in traffic south of the large residential development just north of the intersection with Route 15.	The V/C ratio is less than 1.00 during peak hours, except for south of Route 25 where the V/C ratio is 1.00-1.15 in the a.m. peak. The roadway is considered congested at this location.
Route 27	Route 27 ranges from 58,000 to 61,000 vpd between Routes 16 and 1.	The V/C ratio of 0.91-0.99 during the a.m. peak. This roadway is not considered congested.	Route 27 ranges from 53,000 to 56,000 vpd between Routes 16 and 1.	The V/C ratio is 0.00-0.90 during peak hours, indicating the roadway is not considered congested.
Route 28	Route 28 ranges from 21,000 to 24,000 vpd.	The V/C ratio is greater than 1.50 in both the a.m. and p.m. peak, indicating the roadway is considered congested.	Route 28 ranges from 22,000 to 24,000 vpd.	The V/C ratio is greater than 1.50 in both the a.m. and p.m. peak, indicating the roadway is considered congested.

Table 4.2-15. Alternative 3 Future ADT and Volume to Capacity Ratio Summary – Central Region

Roadway	*2014*		*2030*	
	ADT Summary	*V/C Ratio*	*ADT Summary*	*V/C Ratio*
Chalan Lujuna	Chalan Lujuna ranges from 22,000 to 23,000 vpd.	The V/C ratio is 1.00-1.15 during the peak hours, indicating the roadway is considered congested.	Chalan Lujuna ranges from 7,100 to 7,800 vpd.	The V/C ratio is 0.00-0.90 during peak hours, indicating the roadway is not considered congested.

Figure 4.2-35 through Figure 4.2-38 show future levels of traffic congestion in the Central Region for the a.m. and p.m. peak hours, respectively. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested.

There are a few areas of congestion in the Central Region, primarily on roads that serve the DoD lands to the north and the commercial districts in Tamuning and Hagatna. During both the morning and afternoon peaks, the road with the greatest congestion levels in the Central Region is Route 28. Segments of Routes 1, 10 16, and 25 also exhibit failing congestion levels. All have an LOS F in both the a.m. and p.m. peak hours.

For the Central Region, there are 16 intersections for which the traffic is worse in 2014 than in 2030 for both the a.m. and p.m. peak hour. As shown in Table 4.2-16, there are 23 out of 28 intersections and one out of five access points with LOS F for at least one peak hour, which is considered unacceptable. The following intersections would operate at LOS F in the a.m. and p.m. peak hours in both 2014 and 2030:

- Route 1/28
- Route 1/26
- Route 1/27
- Route 1/3
- Route 1/16
- Route 1/10A
- Route 1/14 (ITC)
- Route 1/30
- Route 1/8
- Route 4/7A
- Route 8/10
- Route 10/15
- Route 16/27
- Route 16/10A

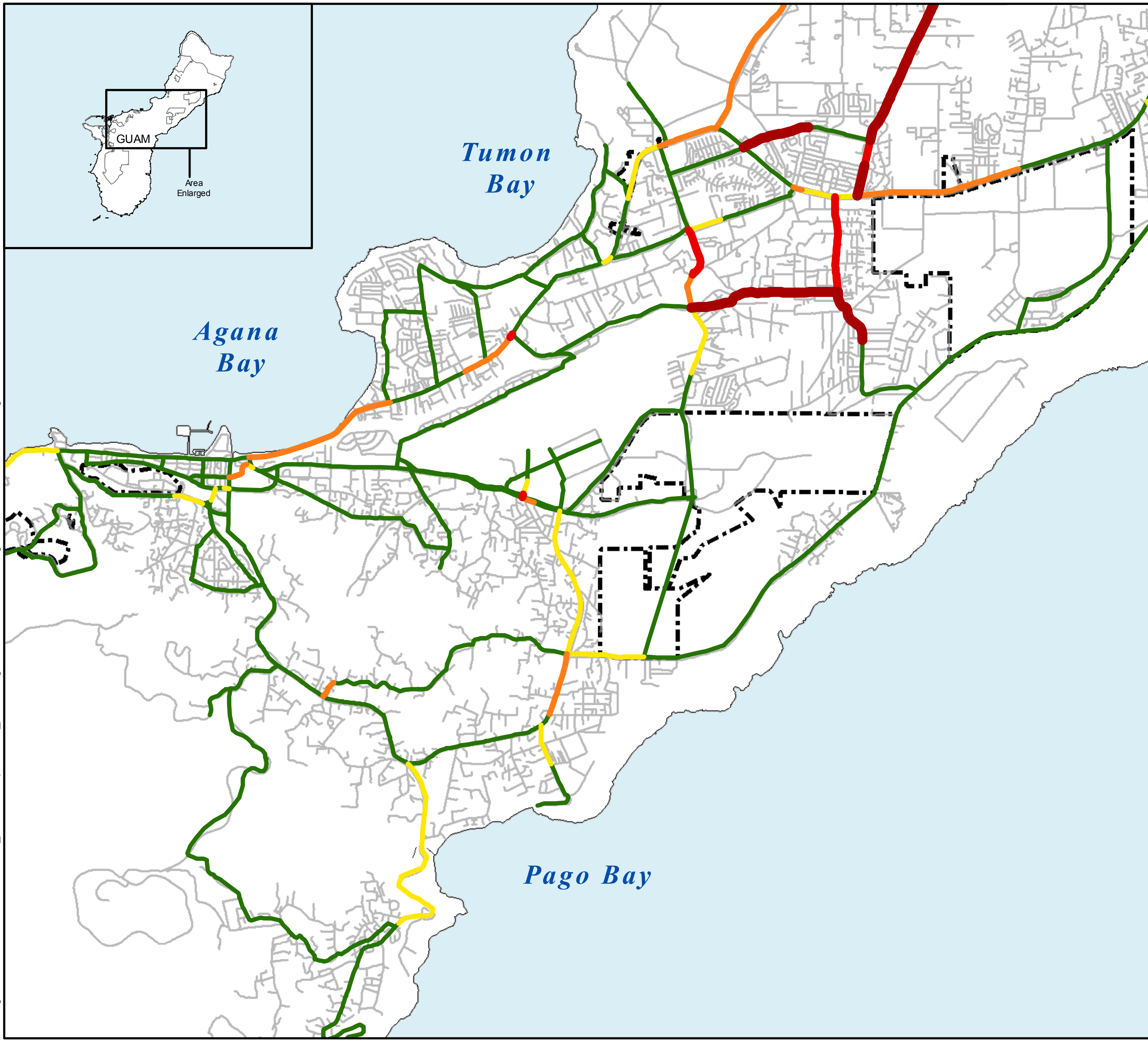


Figure 4.2-35
Central Region– 2014 a.m. Peak Congestion Levels – Alternative 3

Legend

V/C Ratio
- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use
- Streets
- Military Installation

N W E S

Feet 0 1,450 2,900
0 400 800 Meters

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-35. Central Region - 2014 a.m. Peak Congestion Levels- Alternative 3.mxd

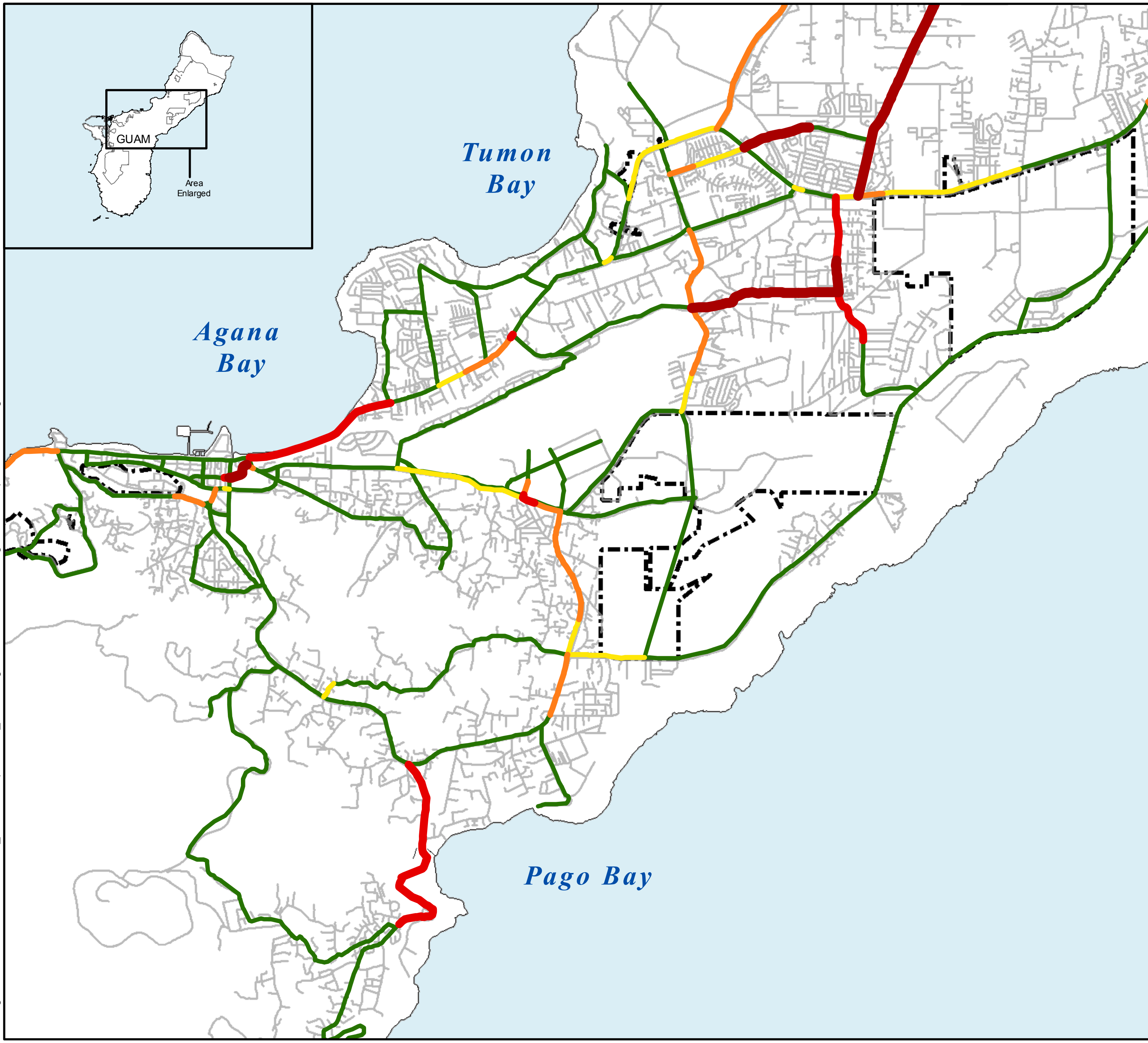


Figure 4.2-36
Central Region–2014 p.m. Peak Congestion Levels – Alternative 3

Legend

V/C Ratio
- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use
- Streets
- Military Installation

N W E S

Feet 0 1,450 2,900
Meters 0 400 800

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-36. Central Region - 2014 p.m. Peak Congestion Levels- Alternative 3.mxd

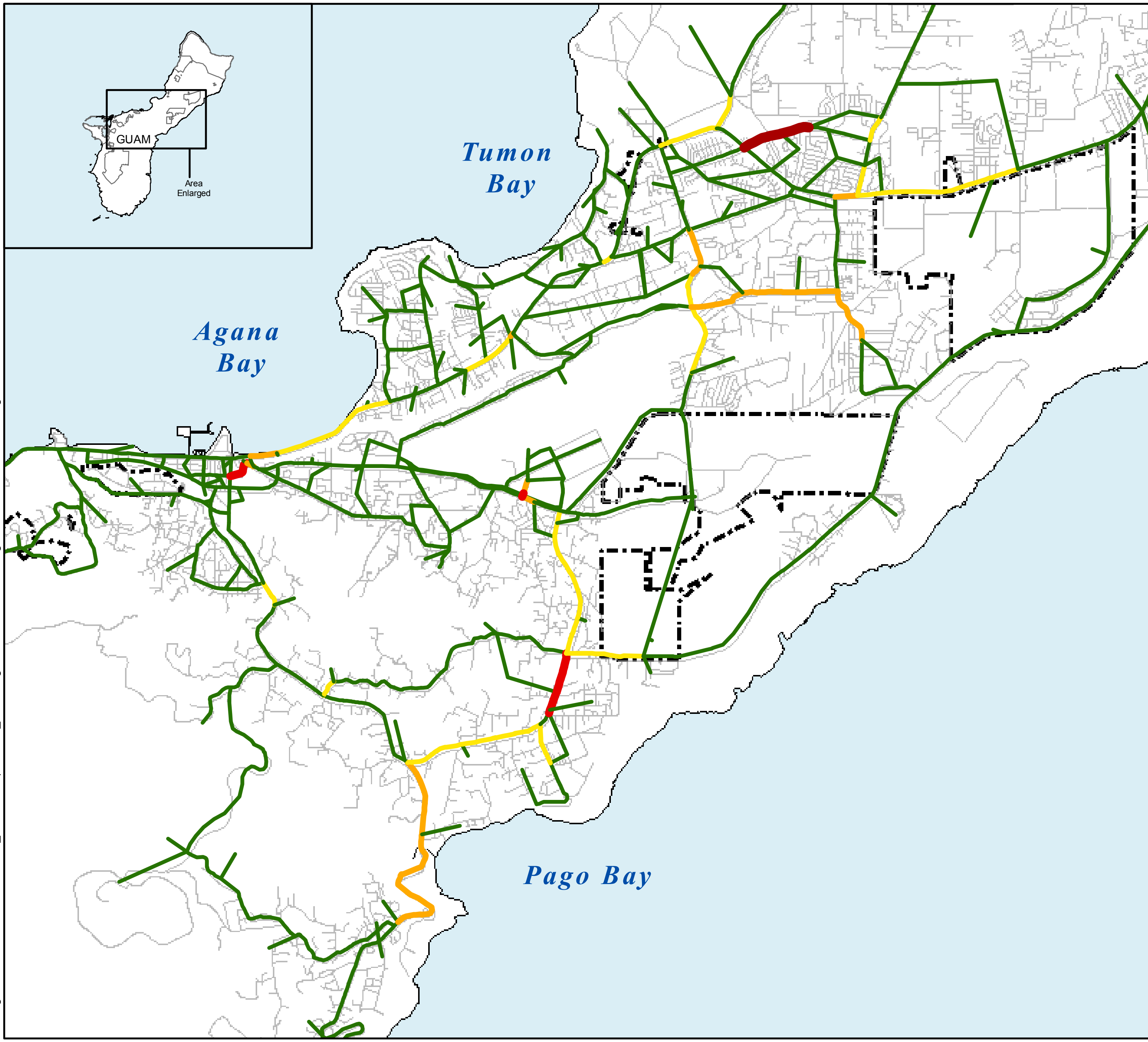


Figure 4.2-37
Central Region–
2030 a.m. Peak
Congestion Levels –
Alternative 3

Legend

V/C Ratio
- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use
- Streets
- Military Installation

N
W E
S

Feet
0 1,450 2,900
0 400 800
Meters

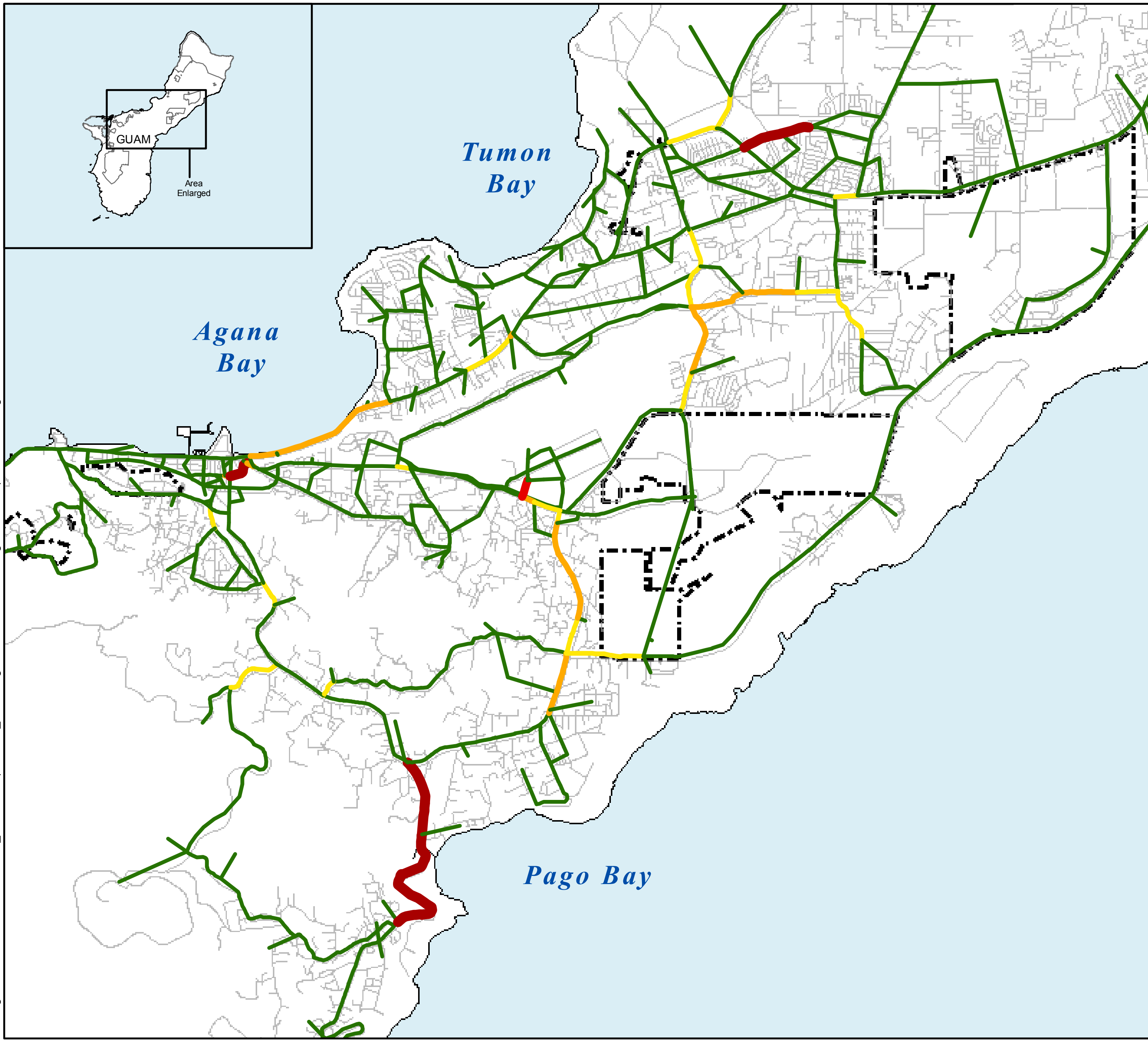


Figure 4.2-38
Central Region–2030 p.m. Peak Congestion Levels – Alternative 3

Legend

V/C Ratio
- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use
- Streets
- Military Installation

N
W E
S

Feet
0 1,450 2,900
0 400 800
Meters

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-38. Central Region - 2030 p.m. Peak Congestion Levels- Alternative 3.mxd

Table 4.2-16. Alternative 3 Future Level of Service and Delay Results – Central Region

	2014				2030			
	a.m. Peak Hour		p.m. Peak Hour		a.m. Peak Hour		p.m. Peak Hour	
	LOS	Delay Seconds	LOS	Delay Seconds	LOS	Delay Seconds	LOS	Delay Seconds
Signalized*								
Route 1/28	F	255.0	F	275.6	F	198.5	F	139.5
Route 1/26	F	135.1	F	278.1	F	89.4	F	209.1
Route 1/27	F	1937.3	F	1013.1	F	151.1	F	399.6
Route 1/27A	F	82.5	E	78.7	F	120.2	F	157.1
Route 1/3	F	417.1	F	357.1	F	341.3	F	474.4
Route 1/16	F	277.0	F	386.7	F	232.2	F	340.3
Route 1/14 (North San Vitoris)	F	157.5	F	96.2	E	66.6	E	71.5
Route 1/14A	F	307.3	F	338.1	E	71.0	F	112.3
Route 1/10A	F	188.1	F	196.7	F	129.6	F	193.6
Route 1/14B	F	149.4	F	144.0	E	79.8	E	78.5
Route 1/14 (ITC)	F	127.0	F	294.6	F	176.8	F	315.8
Route 1/30	F	348.3	F	406.2	F	148.5	F	253.3
Route 1/8	F	162.2	F	164.3	F	102.7	F	155.5
Route 1/4	C	24.8	D	40.1	C	30.5	F	107.2
Route 1/6 (Adelup)	C	34.9	F	110.7	C	29.7	F	958.7
Route 4/7A	F	274.6	F	1007.5	F	586.7	F	339.2
Route 4/10	F	164.5	E	61.4	F	199.7	E	65.9
Route 4/17	C	34.5	D	39.4	D	39.6	E	55.9
Route 8/33	C	32.6	D	46.2	D	52.9	C	29.1
Route 8/10	F	227.5	F	317.6	F	137.9	F	171.8
Route 10/15	F	175.5	F	139.6	F	197.9	F	147.2
Route 16/27A	F	126.0	F	175.8	D	44.9	F	80.6
Route 16/27	F	534.1	F	685.7	F	455.3	F	470.0
Route 16/10A	F	232.4	F	149.5	F	210.3	F	692.7
Route 26/25**	F	165.5	D	43.1	F	85.4	E	62.3
Route 26/15**	F	3444.5	F	3416.0	C	30.2	C	25.4
Route 28/27A**	D	38.5	E	60.5	D	41.3	E	65.2
Unsignalized* **								
Route 7/7A	F	173.9	F	280.0	D	28.3	F	87.7
Access Points								
Route 1 - South Andersen Main Gate/(Turner Street)**	-	-	-	-	C	32.4	E	79.5
Route 15 - South Andersen/Second Gate	-	-	-	-	C	22.1	C	21.1
Route 16 - Navy Barrigada/(Sabana Barrigada) Residential Gate	-	-	-	-	D	37.1	F	84.5
Route 8A - Navy Barrigada/(Residential Gate) (on base)	-	-	-	-	NA	NA	NA	NA
Route 15 - Barrigada Air Force/(Chada Street)**	-	-	-	-	E	64.4	C	25.9

Legend: NA=Not Applicable.

Notes: *Signalized intersection LOS based on average delay for the overall intersection.

**Intersection is proposed to be signalized in future build conditions.

***Unsignalized intersection LOS based on approach delay on STOP-controlled approach.

****Delay exceeded maximum calculated value.

Public Transportation Impacts. Impacts to the public transportation system relate to the delays caused by increased levels of congestion on roadways and at intersections. In the Central Region, this would affect the fixed-route service along Routes 1 and 10, as well as the demand response and paratransit services. Delays on the roadways would increase passenger travel times, longer headways, and missed transfers. This would also affect the fixed-route services proposed for Routes 16 and 26. Implementation of new transit services should take into consideration the impacts of the military relocation.

Pedestrian and Bicycle Impacts. There are limited impacts to the pedestrian and bicycle facilities in the Central Region. Along Routes 1 and 10, future traffic volumes and congestion should not negatively affect the experience or safety of the pedestrian using the existing sidewalk; however, it could impact a cyclist wanting to use the outside lane when unable to use the sidewalk. Future improvements to Routes 8 and 26 would also impact the intermittent sidewalk along these roadways and provide an opportunity to fully complete the facility. In addition, any future planning for pedestrian and bicycle facilities needs to consider the impacts of the military relocation.

Apra Harbor

On Base Roadways

Naval Base Guam

Construction. The impacts for Alternative 3 are the same as Alternative 1.

Operation. The impacts for Alternative 3 are the same as Alternative 1.

Off Base Roadways

Future Traffic Impacts. A summary of future ADT volumes and the V/C ratio for 2014 and 2030 for Alternative 3 can be found in Table 4.2-17. Generally, there is a substantial increase in volumes on roadways from 2008 to 2014, and then a modest decrease in volumes on roadways from 2014 to 2017. This can be attributed to the increase in construction traffic and coinciding military expansion during peak construction time, which is in 2014, and then a reduction in traffic once off-island construction workers leave the island.

Table 4.2-17. Alternative 3 Future ADT and Volume to Capacity Ratio Summary – Apra Harbor Region

Roadway	*2014*		*2030*	
	ADT Summary	*V/C Ratio*	*ADT Summary*	*V/C Ratio*
Route 1	Route 1 ranges from 23,000 to 47,000 vpd. The traffic decreases into the entrance into the Naval base, which is at the Route 1/2A intersection.	Route 1 has a V/C ratio less than 1.00. This roadway is not considered congested.	Route 1 ranges from 24,000 to 56,000 vpd. The traffic decreases into the entrance into the Naval base, which is at the Route 1/2A intersection.	Route 1 has a V/C ratio less than 1.00. This roadway is not considered congested.
Route 2A	Route 2A has 36,000 vpd.	The V/C ratio is 0.00-0.90 during peak hours, indicating the roadway is not considered congested.	Route 2A has 36,000 vpd.	The V/C ratio is 0.00-0.90 during peak hours, indicating the roadway is not considered congested.

Roadway	2014		2030	
	ADT Summary	V/C Ratio	ADT Summary	V/C Ratio
Route 11	Route 11 has 14,000 vpd.	The V/C ratio is 0.00-0.90 during peak hours, indicating the roadway is not considered congested.	Route 11 has 8,800 vpd.	The V/C ratio is 0.00-0.90 during peak hours, indicating the roadway is not considered congested.

Figure 4.2-39 through Figure 4.2-42 show future levels of traffic congestion in the Apra Harbor Region for the a.m. and p.m. peak hours for 2014 and 2030, respectively. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested.As shown in Table 4.2-18, Route 1/2A is operating at LOS F in the a.m. peak hour for 2014, which is considered unacceptable.

Table 4.2-18. Alternative 3 Future Level of Service and Delay Results – Apra Harbor Region

	2014				2030			
	a.m. Peak Hour		p.m. Peak Hour		a.m. Peak Hour		p.m. Peak Hour	
	LOS	Delay Seconds	LOS	Delay Seconds	LOS	Delay Seconds	LOS	Delay Seconds
Signalized*								
Route 1/11	C	25.4	E	63.1	B	18.4	D	40.1
Route 1/Polaris Point	A	3.2	A	2.4	A	5.8	A	7.4
Route 1/6 (west)	D	50.7	B	17.1	C	27.4	C	23.0
Route 1/2A	F	89.7	E	58.3	E	67.5	D	54.1
Route 5/2A	E	69.4	C	21.5	E	55.1	C	22.8

*Note: *Signalized intersection LOS based on average delay for the overall intersection.*

Public Transportation Impacts. Impacts to the public transportation system in the Apra Harbor Region should be minimal and would relate to the delays caused by increased levels of congestion on Route 5 or at intersections near DoD lands. This would possibly affect the fixed-route service along Route 1, as well as any demand response and paratransit services. Implementation of new transit services should take into consideration the impacts of the military relocation.

Pedestrian and Bicycle Impacts. There are no impacts to the pedestrian and bicycle facilities in the Apra Harbor Region. Along Route 1, future traffic volumes and congestion should not negatively affect the experience or safety of the pedestrian and cyclist using the shoulder as a running or biking lane. Any future planning for pedestrian and bicycle facilities needs to consider the impacts of the military relocation.

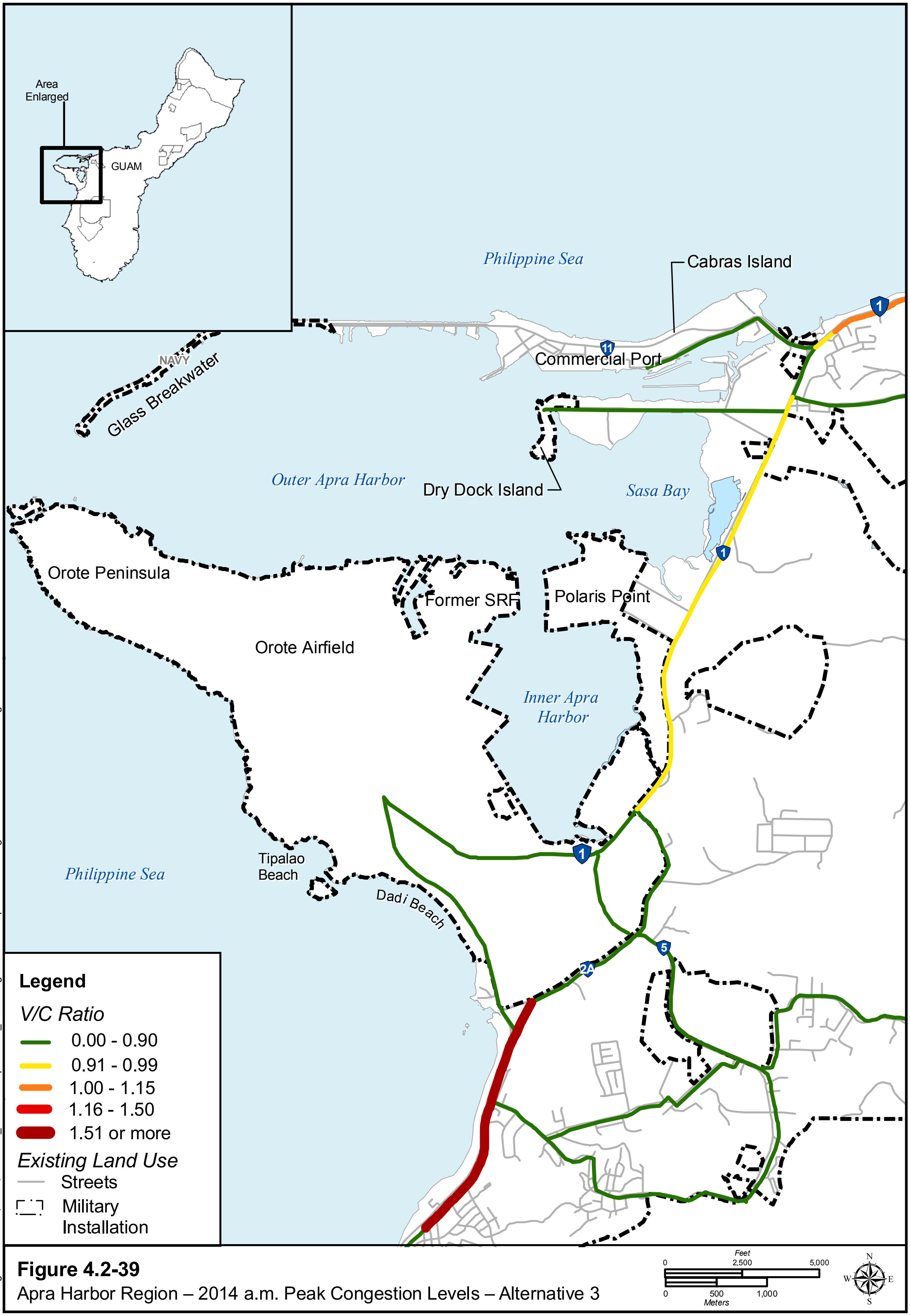
<u>South</u>

On Base Roadways

Naval Munitions Site

Construction. The impacts for Alternative 3 are the same as Alternative 1.

Operation. The impacts for Alternative 3 are the same as Alternative 1.



Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4192_MXDs\Figure 4.2-39. Apra Harbor Region - 2014 a.m. Peak Congestion Levels- Alternative 3.mxd

Figure 4.2-39
Apra Harbor Region – 2014 a.m. Peak Congestion Levels – Alternative 3

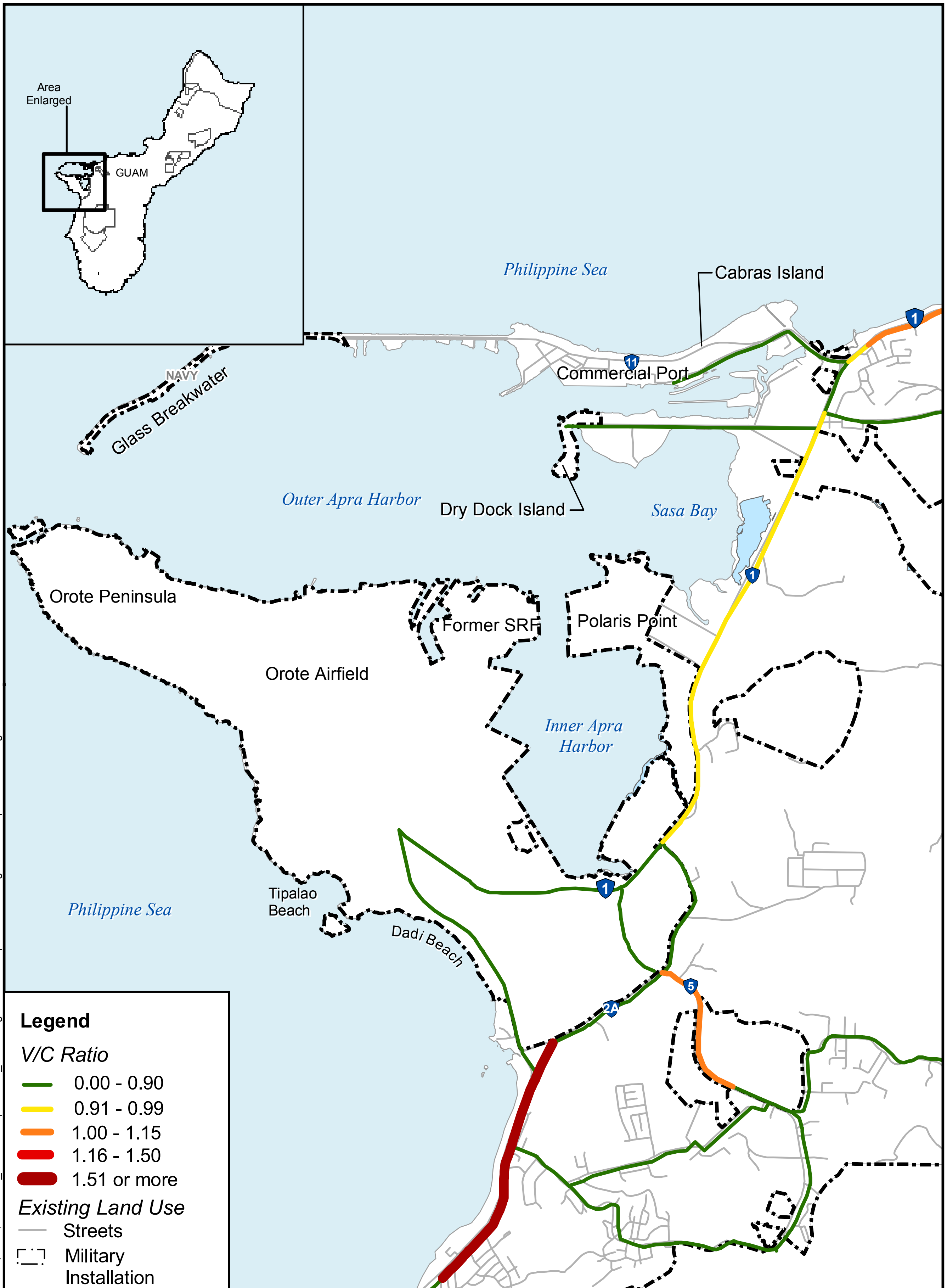


Figure 4.2-40
Apra Harbor Region – 2014 p.m. Peak Congestion Levels – Alternative 3

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4192_MXDs\Figure 4.2-41. Apra Harbor Region - 2014 p.m. Peak Congestion Levels- Alternative 3.mxd

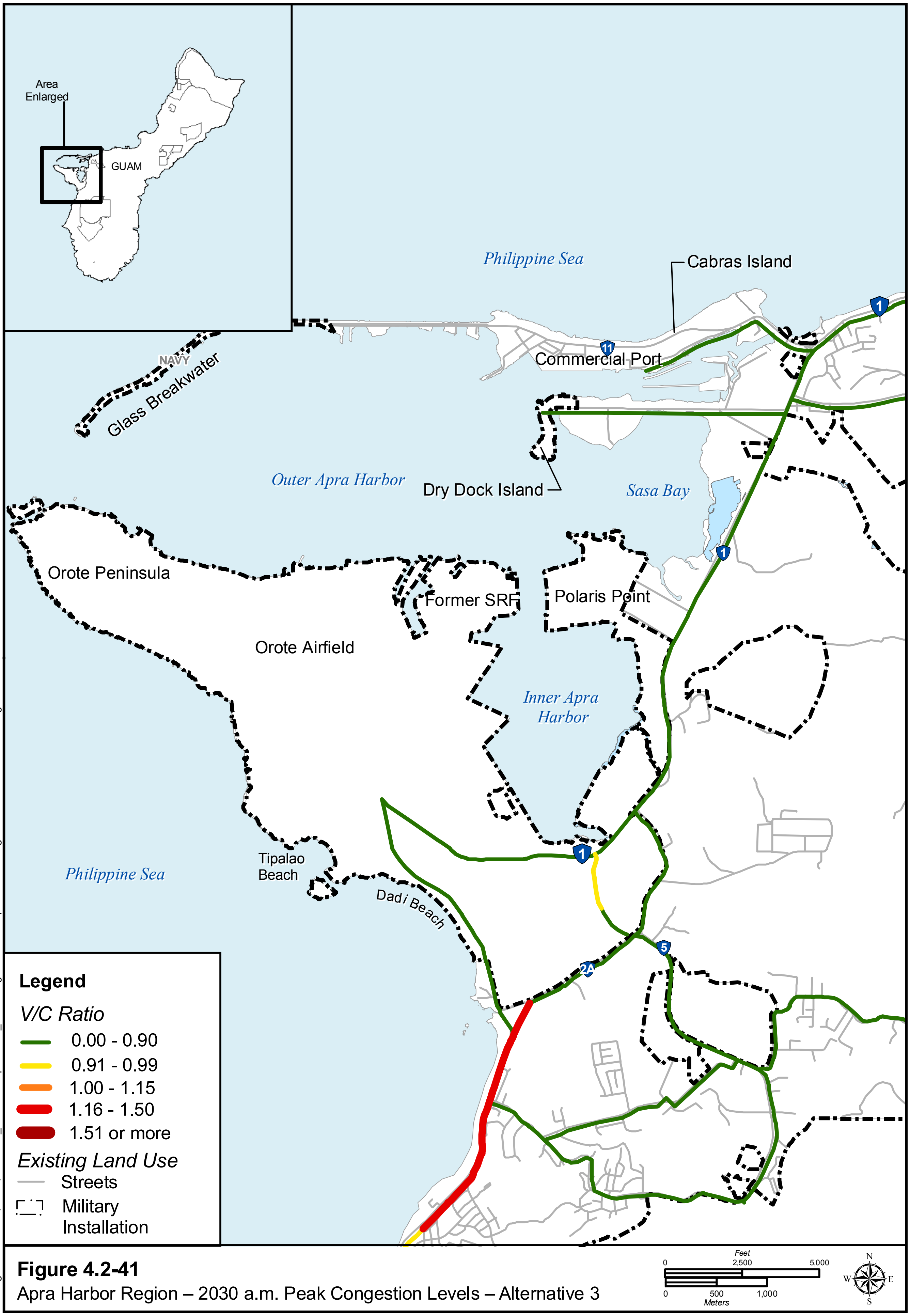


Figure 4.2-41
Apra Harbor Region – 2030 a.m. Peak Congestion Levels – Alternative 3

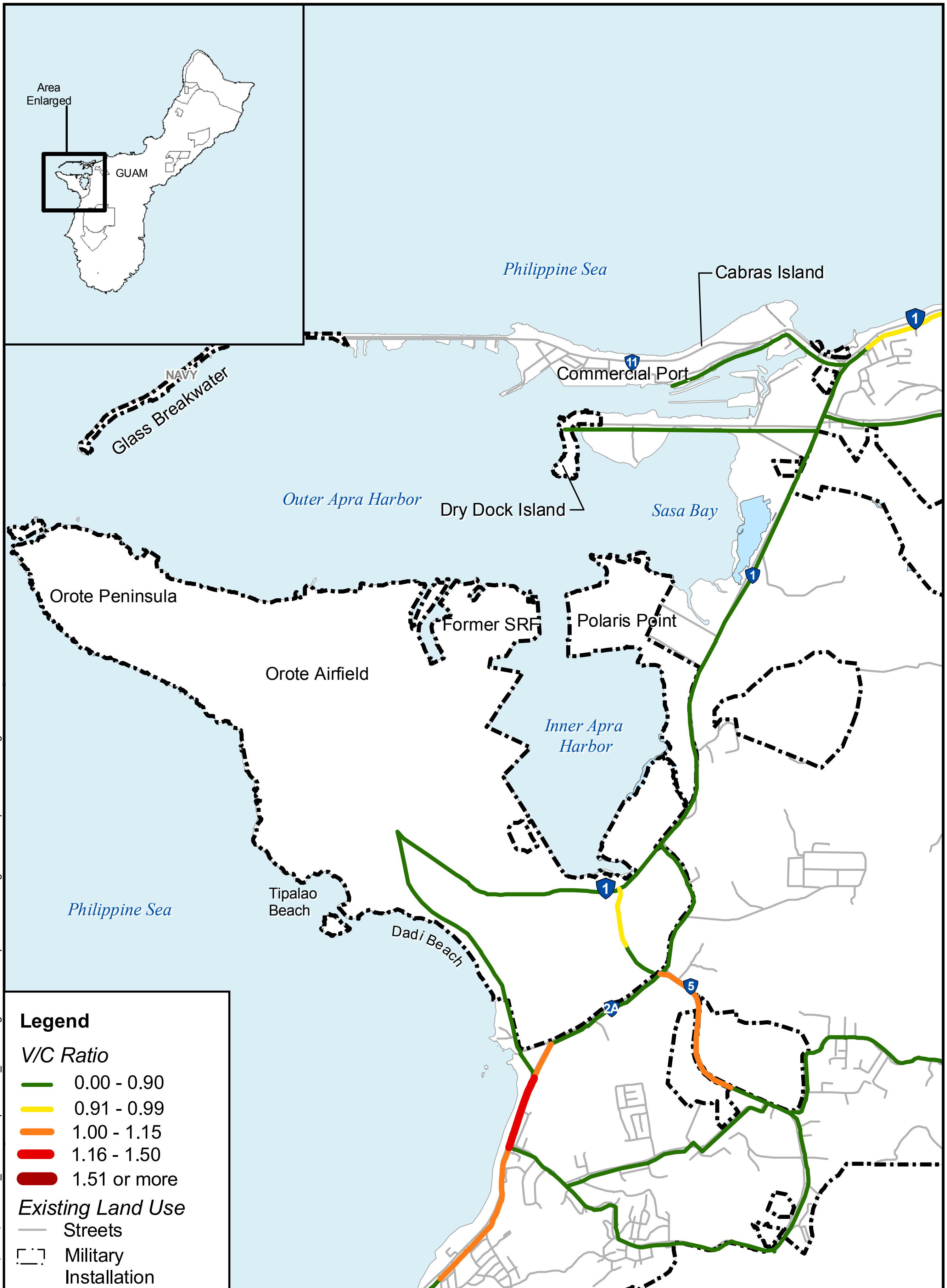


Figure 4.2-42
Apra Harbor Region – 2030 p.m. Peak Congestion Levels – Alternative 3

Feet
0 2,500 5,000
0 500 1,000
Meters

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4192_MXDs\Figure 4.2-42. Apra Harbor Region - 2030 p.m. Peak Congestion Levels- Alternative 3.mxd

Off Base Roadways

Future Traffic Impacts. A summary of future ADT volumes and the V/C ratio for 2014 and 2030 for Alternative 3 can be found in Table 4.2-19. Generally, there is a substantial increase in volumes on roadways from 2008 to 2014, and then a modest decrease in volumes on roadways from 2014 to 2017. This can be attributed to the increase in construction traffic and coinciding military expansion during peak construction time, which is in 2014, and then a reduction in traffic once off-island construction workers leave the island.

Table 4.2-19. Alternative 3 Future ADT and Volume to Capacity Ratio Summary - South Region

Roadway	*2014*		*2030*	
	ADT Summary	*V/C Ratio*	*ADT Summary*	*V/C Ratio*
Route 5	Route 5 ranges from 9,800 to 17,000 vpd. Traffic decreases as Route 5 approaches the intersection with Route 17.	The V/C ratio is 0.91-0.99 in the a.m. peak and 1.00-1.15 in the p.m. peak. The roadway is congested during the p.m. peak hours.	Route 5 ranges from 11,000 to 17,000 vpd. Traffic decreases as Route 5 approaches the intersection with Route 17.	The V/C ratio is 0.91-0.99 in the a.m. peak and 1.00-1.15 in the p.m. peak. The roadway is congested during the p.m. peak hours.
Route 12	Route 12 ranges from 1,800 to 5,600 vpd. The traffic increases toward the intersection with Route 2.	The V/C ratio is 0.00-0.90 during both the a.m. and p.m. peak, indicating the roadway is not considered congested.	Route 12 ranges from 2,300 to 6,100 vpd. The traffic increases toward the intersection with Route 2.	The V/C ratio is 0.00-0.90 during both the a.m. and p.m. peak, indicating the roadway is not considered congested.

Figure 4.2-43 through Figure 4.2-46 show future levels of traffic congestion in the South Region for the a.m. and p.m. peak hours for 2014 and 2030, respectively. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested. Although there are numerous intersections with capacity issues, there are not currently many roadways included in this study with a high existing V/C ratio.

The roads in the South Region do not exhibit high levels of congestion. During both the afternoon peaks, Route 5 between the Naval base and the NMS has an LOS F.

As shown in Table 4.2-20, the Route 5/17 intersection has LOS F for the p.m. peak hour in 2030, which is considered unacceptable. Route 4/4A and Route 5/17 have fairly free-flowing conditions in 2014 and become significantly more congested in 2030.

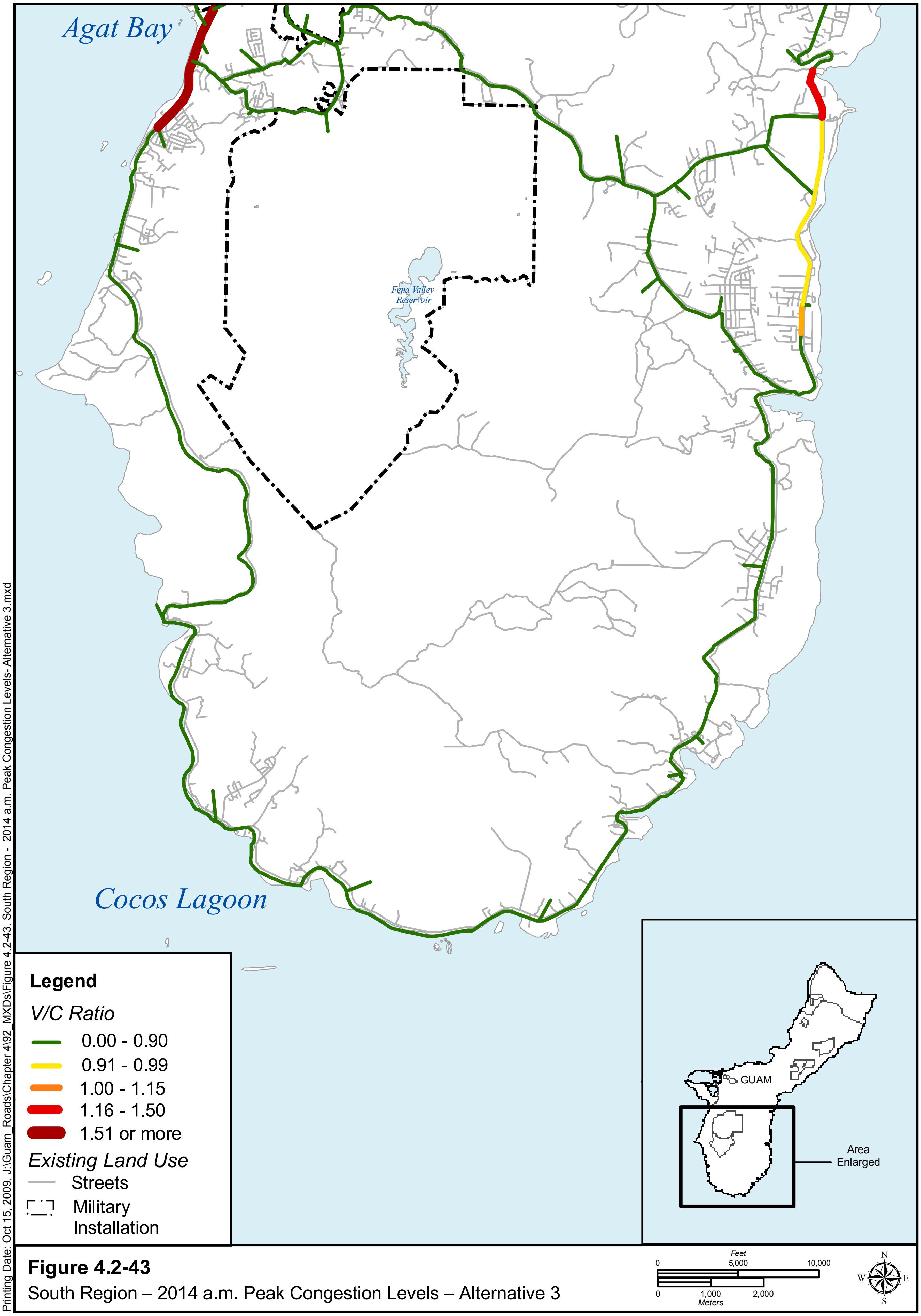


Figure 4.2-43
South Region – 2014 a.m. Peak Congestion Levels – Alternative 3

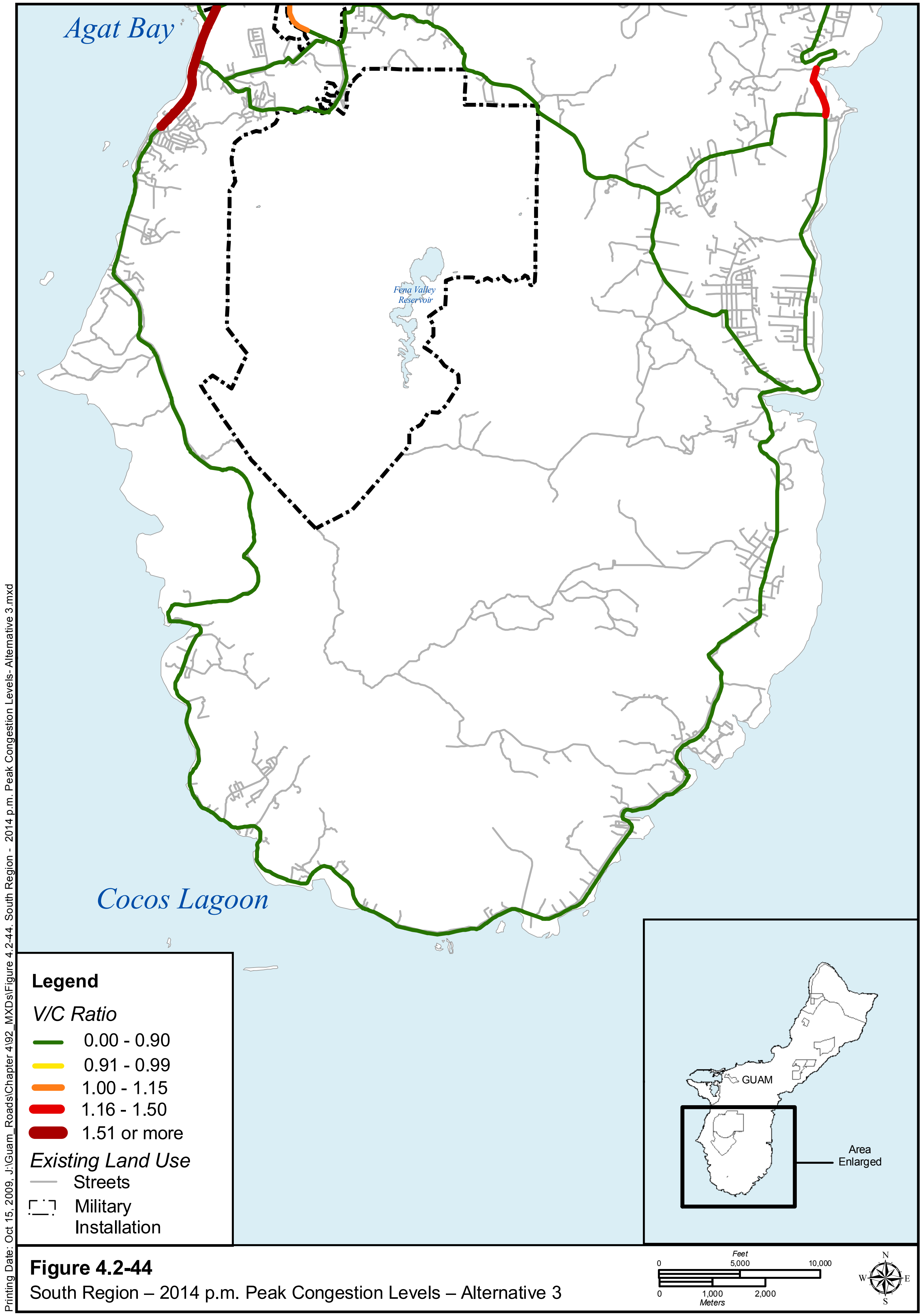


Figure 4.2-44
South Region – 2014 p.m. Peak Congestion Levels – Alternative 3

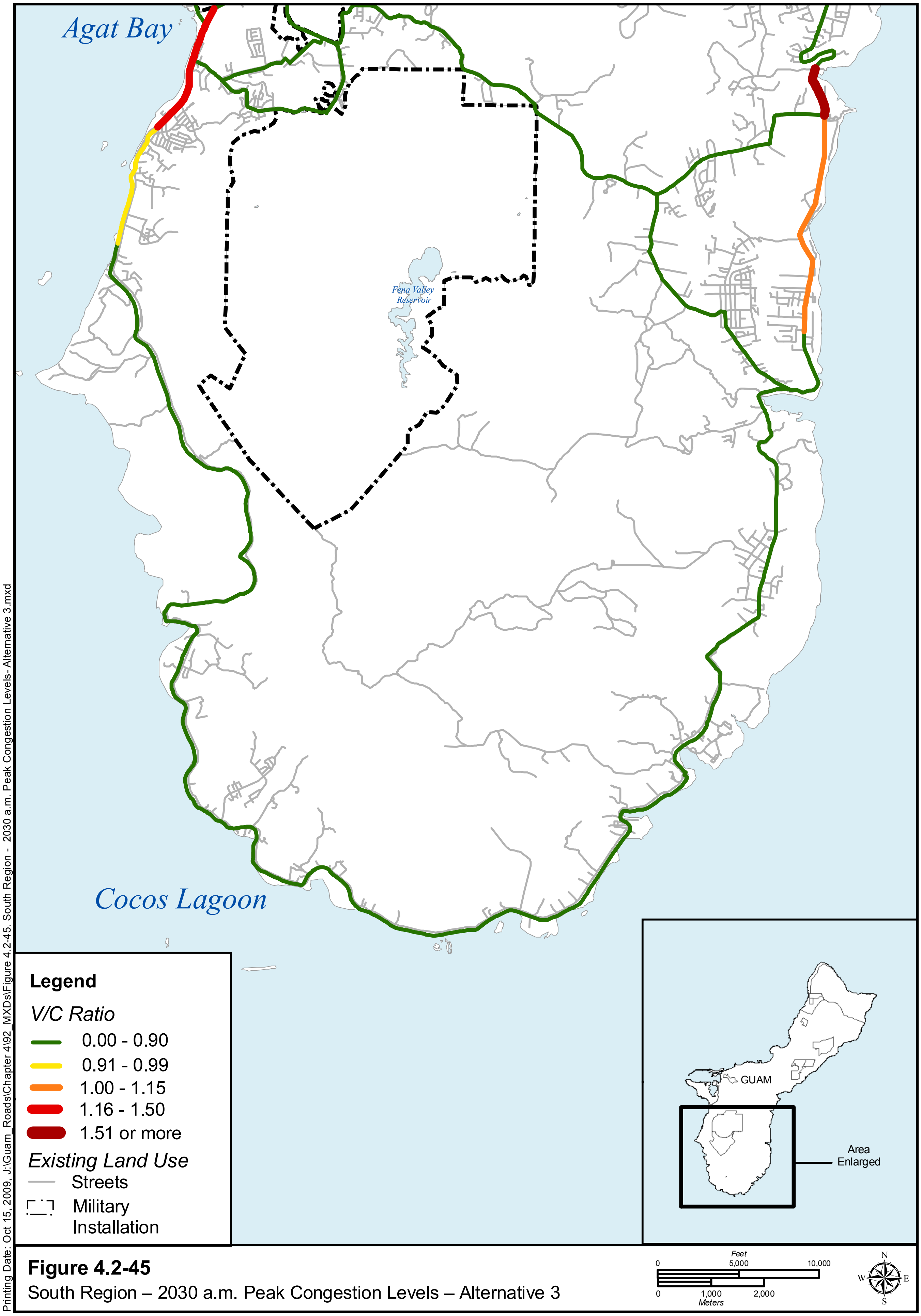


Figure 4.2-45
South Region – 2030 a.m. Peak Congestion Levels – Alternative 3

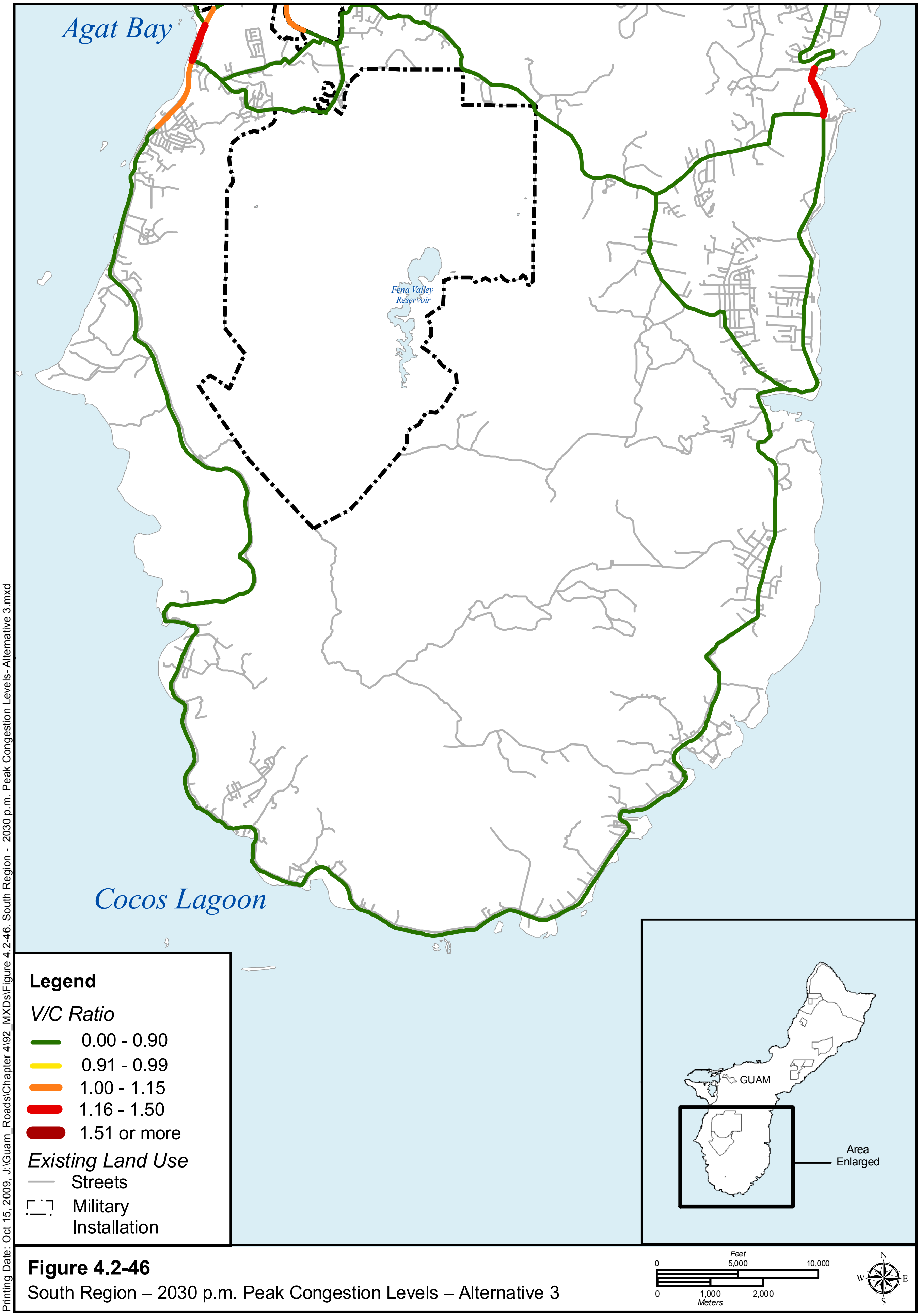


Figure 4.2-46
South Region – 2030 p.m. Peak Congestion Levels – Alternative 3

Table 4.2-20. Alternative 3 Future Level of Service and Delay Results – South Region

	2014				*2030*			
	a.m. Peak Hour		*p.m. Peak Hour*		*a.m. Peak Hour*		*p.m. Peak Hour*	
	LOS	*Delay Seconds*	*LOS*	*Delay Seconds*	*LOS*	*Delay Seconds*	*LOS*	*Delay Seconds*
Signalized*								
Route 2/12	C	29.0	C	25.5	C	30.6	C	24.9
Unsignalized*								
Route 5/17	B	13.3	C	18.3	E	42.5	F	128.5
Route 4/4A	C	21.7	B	17.0	E	44.3	C	21.9
Route 17/4A	B	13.2	B	14.0	C	16.5	C	18.5
Access Points								
Route 5 - Naval Ordnance Annex/Harmon Road.**	-	-	-	-	A	9.5	A	10.6

*Notes: *Signalized intersection LOS based on average delay for the overall intersection.*
***Unsignalized intersection LOS based on approach delay on STOP-controlled approach.*

Public Transportation Impacts. Impacts to the demand response and paratransit that service the South Region are minimal. Implementation of new transit services should take into consideration the impacts of the military relocation.

Pedestrian and Bicycle Impacts. There are no impacts to pedestrian and bicycle facilities in the South Region. Any future planning for pedestrian and bicycle facilities needs to consider the impacts of the military relocation.

Potential Mitigation Measures

On Base Roadways

The proposed mitigation measures would be the same as for Alternative 1.

Off Base Roadways

The proposed mitigation measures would be the same as for Alternative 1.

4.2.2.4 Alternative 8

North

On Base Roadways

Andersen AFB

Construction. The impacts for Alternative 8 are the same as Alternative 1.

Operation. The impacts for Alternative 8 are the same as Alternative 1.

Finegayan

Construction. In this Alternative, the Former FAA land is utilized but Harmon Annex is not used. Additional housing is constructed at Air Force Barrigada. The alternative has very similar construction in Finegayan as explained in Alternative 2.

The impacts for Alternative 8 are the same as Alternative 1

Operation. The impacts for Alternative 8 are the same as Alternative 1

Off Base Roadways

Future Traffic Impacts. A summary of future ADT volumes and the V/C ratio for 2014 and 2030 for Alternative 8 can be found in Table 4.2-21. Generally, there is a substantial increase in volumes on roadways from 2008 to 2014, and then a modest decrease in volumes on roadways from 2014 to 2017. This can be attributed to the increase in construction traffic and coinciding military expansion during peak construction time, which is in 2014, and then a reduction in traffic once off-island construction workers leave the island. Overall, traffic is comparable to Alternative 1.

Figure 4.2-47 through Figure 4.2-50 show future levels of traffic congestion in the North Region for the a.m. and p.m. peak hours, respectively. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested.

The road indirectly serving the DoD lands is the most congested. During both the morning and afternoon peaks, the road with the greatest congestion levels in the North Region is Route 28 with LOS F.

Table 4.2-21. Alternative 8 Future ADT and Volume to Capacity Ratio Summary – North Region

Roadway	*2014*		*2030*	
	ADT Summary	*V/C Ratio*	*ADT Summary*	*V/C Ratio*
Route 1	Route 1 ranges from 27,000 to 48,000 vpd. Traffic decreases as Route 1 approaches Andersen AFB.	The V/C ratio is 0.00-0.90 during the a.m. and p.m. peak hours, indicating the roadway is not considered congested.	Route 1 ranges from 20,000 to 40,000 vpd. Traffic decreases as Route 1 approaches Andersen AFB.	The V/C ratio is 0.00-0.90 during the a.m. and p.m. peak hours, indicating the roadway is not considered congested.
Route 3	Route 3 ranges from 22,000 to 69,000 vpd. Traffic decreases north of the intersection with Route 28.	During the a.m. and p.m. peak, Route 3 south of the Residential Gate has a V/C ratio greater than 1. North of the Residential Gate, the V/C ratio is less than 1. The roadway is congested south of the military installation.	Route 3 ranges from 19,000 to 53,000 vpd. Traffic decreases north of the intersection with Route 28.	During peak hours, Route 3 has a V/C ratio of less than 1 and is not considered to be congested, with the exception of a small portion north of the intersection with Route 28.
Route 9	Route 9 ranges from 12,000 to 19,000 vpd. There is a decrease in traffic east of the two residential developments on Route 9.	The V/C ratio is 0.00-0.90 during the a.m. and p.m. peak hours, indicating the roadway is not considered congested.	Route 9 ranges from 10,000 to 16,000 vpd. There is a decrease in traffic east of the two residential developments on Route 9.	The V/C ratio is 0.00-0.90 during the a.m. and p.m. peak hours, indicating the roadway is not considered congested.
Route 15	Route 15 has 6,000 vpd in the North.	The V/C ratio is 0.00-0.90 during the a.m. and p.m. peak hours, indicating the roadway is not considered congested.	Route 15 has 7,500 vpd in the North.	The V/C ratio is 0.00-0.90 during the a.m. and p.m. peak hours, indicating the roadway is not considered congested.
Route 28	Route 28 ranges from 22,000 to 26,000 vpd. Traffic increases closer to the intersection with Route 1.	The V/C ratio is greater than 1.51 in the a.m. and p.m. peak hours. The roadway is considered congested.	Route 28 ranges from 16,000 to 21,000 vpd. Traffic increases closer to the intersection with Route 1.	The V/C ratio is greater than 1.51 in the a.m. and p.m. peak hours. The roadway is considered congested.

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-47. North Region - 2014 a.m. Peak Congestion Levels- Alternative 8.mxd

Figure 4.2-47
North Region–
2014 a.m. Peak
Congestion Levels –
Alternative 8

Legend

V/C Ratio
- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use
- Streets
- Military Installation

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-48. North Region - 2014 p.m. Peak Congestion Levels- Alternative 8.mxd

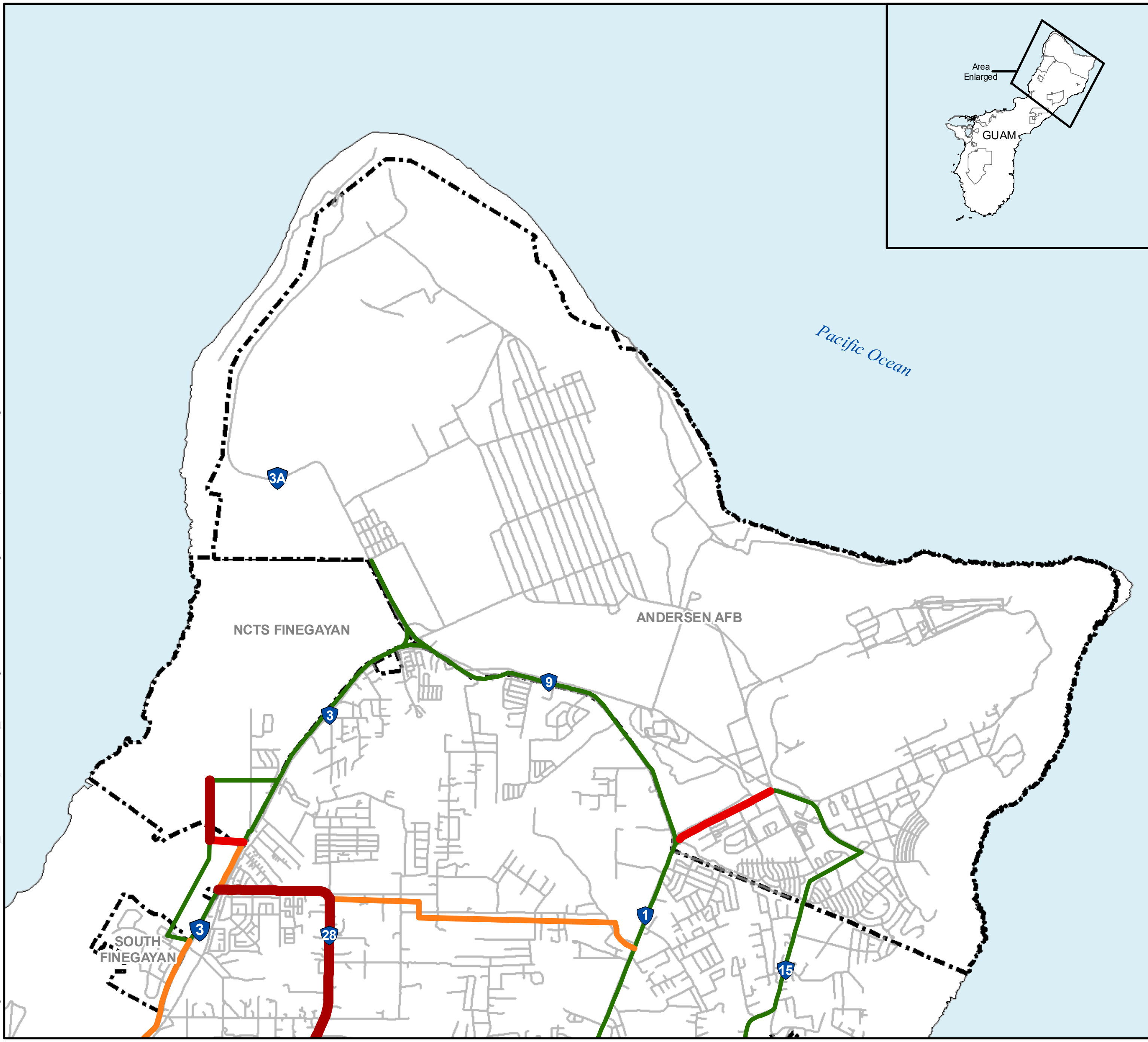


Figure 4.2-48
North Region–
2014 p.m. Peak
Congestion Levels –
Alternative 8

Legend

V/C Ratio
- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use
- Streets
- Military Installation

N
W E
S

Feet
0 1,450 2,900
0 400 800
Meters

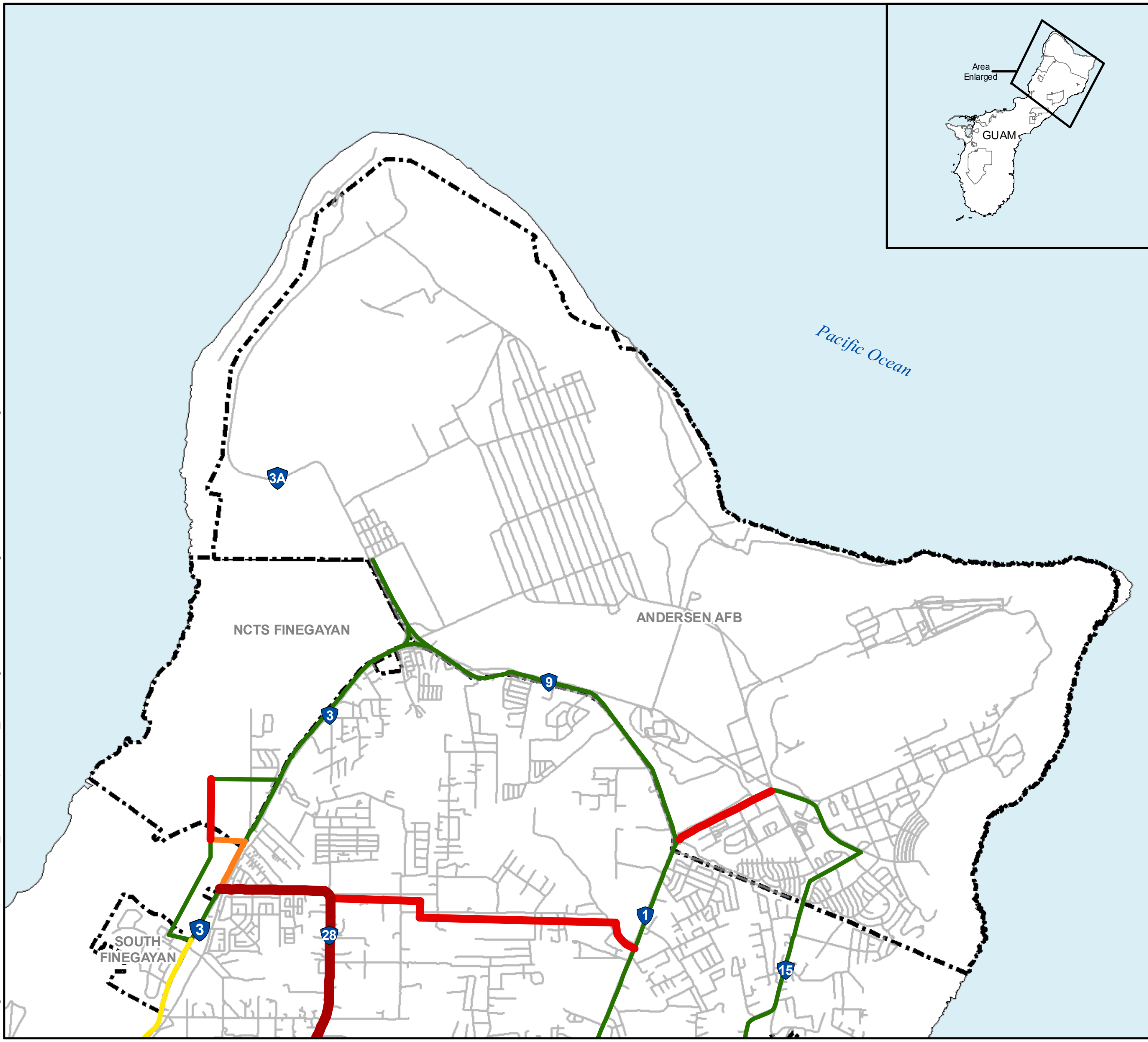


Figure 4.2-49
North Region–
2030 a.m. Peak
Congestion Levels –
Alternative 8

Legend

V/C Ratio
- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use
- Streets
- Military Installation

N
W E
S

Feet
0 1,450 2,900
0 400 800
Meters

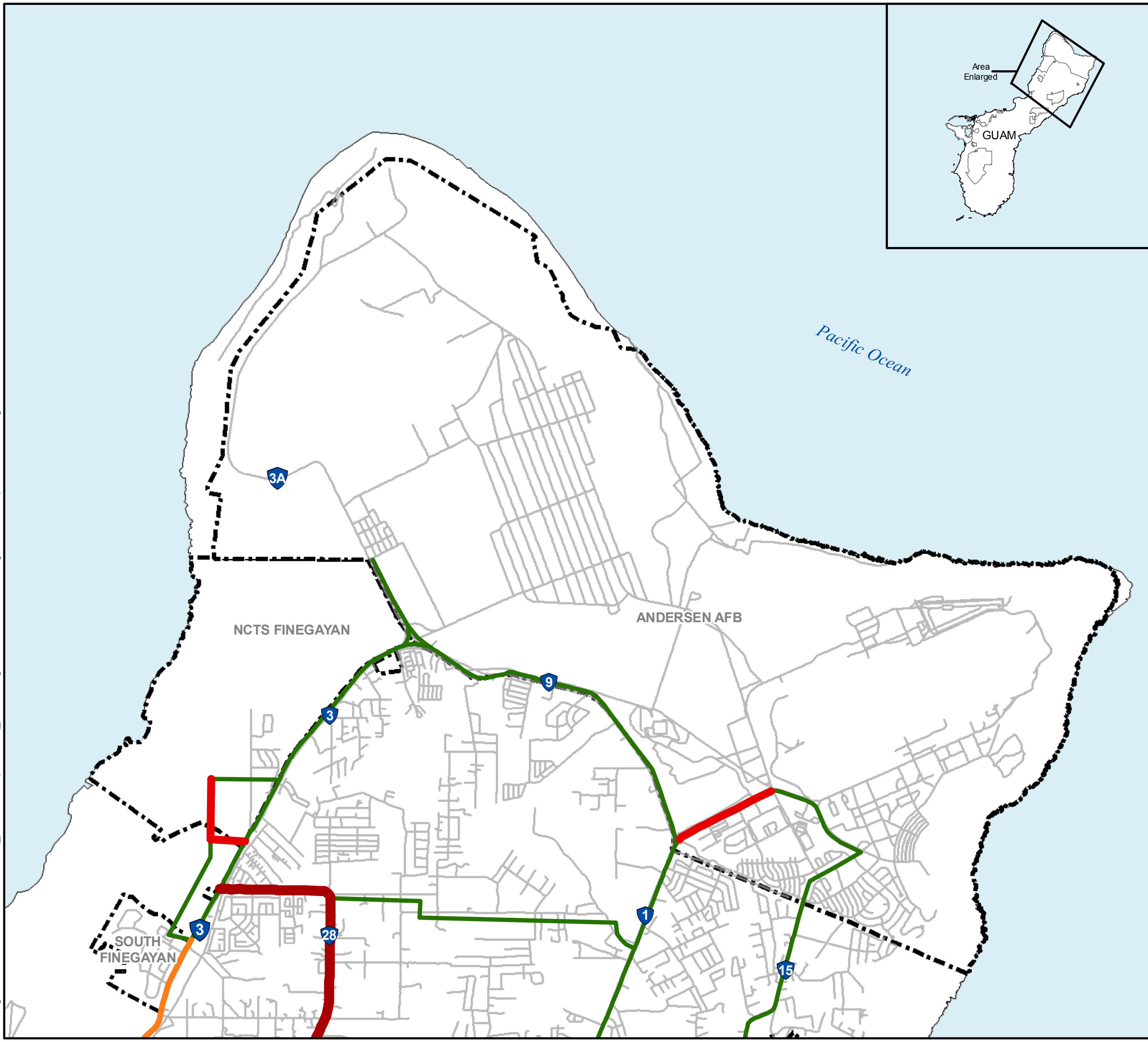


Figure 4.2-50
North Region–
2030 p.m. Peak
Congestion Levels –
Alternative 8

Legend

V/C Ratio
- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use
- Streets
- Military Installation

N
W E
S

Feet
0 1,450 2,900
0 400 800
Meters

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-50. North Region - 2030 p.m. Peak Congestion Levels- Alternative 8.mxd

The results of the future operational analysis are shown in Table 4.2-22 for both the 2014 a.m. and p.m. and 2030 a.m. and p.m. conditions.

For the North Region, there are three intersections for which the traffic is worse in 2014 than in 2030 in both the a.m. and p.m. peak hour. This can be attributed to an increase in construction equipment and personnel in addition to the first military deployment that would occur in 2010.

As shown in Table 4.2-22, there are three intersections and two access points with LOS F for at least one peak hour, which is considered unacceptable. None of the intersections are operating at LOS F in the a.m. and p.m. peak hours in both 2014 and 2030.

Table 4.2-22. Alternative 8 Future Level of Service and Delay Results – North Region

	2014				*2030*			
	a.m. Peak Hour		*p.m. Peak Hour*		*a.m. Peak Hour*		*p.m. Peak Hour*	
	LOS	*Delay Seconds*	*LOS*	*Delay Seconds*	*LOS*	*Delay Seconds*	*LOS*	*Delay Seconds*
Signalized*								
Route 1/9	C	25.8	D	38.2	C	23.3	D	53.0
Route 1/29	F	338.4	F	192.3	E	73.2	E	57.7
Route 3/28	E	57.3	F	131.1	C	33.2	D	47.5
Route 15/29**	C	22.9	C	24.1	C	32.9	C	30.0
Unsignalized***								
Route 3/3A/9	F	176.0	F	561.5	D	27.0	F	140.7
Access Points								
Route 3 - Main Cantonment/Commercial Gate	-	-	-	-	B	18.4	C	30.4
Route 3 - Main Cantonment/Main Gate	-	-	-	-	D	41.0	E	56.7
Route 3 - South Finegayan/Residential Gate	-	-	-	-	C	31.1	B	19.0
Route 9 – Andersen AFB/ Andersen AFB North Gate****	-	-	-	-	F	1031.0	F	NA

Notes: *Signalized intersection LOS based on average delay for the overall intersection.
**Intersection is proposed to be signalized in future build conditions.
***Unsignalized intersection LOS based on approach delay on STOP-controlled approach.
****Delay exceeded maximum calculated value.

Public Transportation Impacts. Impacts would be similar to those of Alternative 1.

Pedestrian and Bicycle Impacts. Impacts would be similar to those of Alternative 1.

<u>Central</u>

On Base Roadways

Andersen South

Construction. The impacts for Alternative 8 are the same as Alternative 1.

Operation. The impacts for Alternative 8 are the same as Alternative 1.

Barrigada

Construction. Only Air Force Barrigada is used for constructing off base housing and community support structures. The construction is similar to explained in Alternative 3, except there is no Connector road to the Navy Barrigada base (because Navy Barrigada is not being utilized).

The impacts for Alternative 8 are similar to those of Alternative 3.

Operation. Impacts for Alternative 8 would be similar to those of Alternative 3; however, there would be more impacts to the Air Force Barrigada area near Route 15, due to heavier traffic loading in that area.

Off Base Roadways

Future Traffic Impacts. A summary of future ADT volumes and the V/C ratio for 2014 and 2030 for Alternative 8 can be found in Table 4.2-23. Generally, there is a substantial increase in volumes on roadways from 2008 to 2014, and then a modest decrease in volumes on roadways from 2014 to 2017. This can be attributed to the increase in construction traffic and coinciding military expansion during peak construction time, which is in 2014, and then a reduction in traffic once off-island construction workers leave the island.

Table 4.2-23. Alternative 8 Future ADT and Volume to Capacity Ratio Summary – Central Region

Roadway	*2014*		*2030*	
	ADT Summary	*V/C Ratio*	*ADT Summary*	*V/C Ratio*
Route 1	Route 1 ranges from 40,000 to 100,000 vpd. Traffic decreases significantly south of the intersection with Route 4.	The V/C ratio is generally less than 1 in the p.m. condition. In the a.m. condition, there are segments near the intersections with 14A, 30, 28, 16, and Route 6 that have a V/C ratio of more than 1, which indicates the roadway is congested in Tamuning.	Route 1 ranges from 33,000 to 96,000 vpd. Traffic decreases significantly south of the intersection with Route 4.	The V/C ratio is generally less than 1 in both the a.m. and p.m. condition; however, there are segments south of Route 30, near Route 14, and north of 28 that have a V/C ratio of more than 1 in the p.m. peak. The roadway is congested in Tamuning.
Route 3	Route 3 ranges from 57,000 to 71,000 vpd. Traffic increases toward the intersection with Route 1.	The V/C ratio in both the a.m. and p.m. peak is 1.00-1.15. This indicates the roadway is considered congested.	Route 3 ranges from 48,000 to 59,000 vpd. Traffic increases toward the intersection with Route 1.	The V/C ratio is generally between 1.00-1.15, indicating the roadway is considered congested at this location.
Route 8/8A	Route 8 ranges from 52,000 to 67,000 vpd. There is a decrease in traffic west of the intersection with Sunset Boulevard. Route 8A has 5,800 vpd.	During peak hours, the V/C ratio is generally 0.00-0.90 Other than a small section near Tiyan Parkway, the roadway is not considered congested.	Route 8 ranges from 50,000 to 59,000 vpd. There is a decrease in traffic west of the intersection with Sunset Boulevard. Route 8A has 5,700 vpd.	During peak hours, the V/C ratio is generally 0.00-0.90 Other than a small section near Tiyan Parkway, the roadway is not considered congested.
Route 10	Route 10 ranges from 60,000 to 63,000 vpd between Routes 8 and 15.	The V/C ratio in the a.m. and p.m. conditions is greater than 1. The roadway is considered congested.	Route 10 ranges from 58,000 to 60,000 vpd between Routes 8 and 15.	The V/C ratio in the a.m. and p.m. conditions is greater than 1. The roadway is considered congested.

Table 4.2-23. Alternative 8 Future ADT and Volume to Capacity Ratio Summary – Central Region

Roadway	2014		2030	
	ADT Summary	V/C Ratio	ADT Summary	V/C Ratio
Route 15	Route 15 ranges from 6,600 to 26,000 vpd. There is an increase in traffic south of the intersection with Route 26.	North of Route 26, Route 15 has a V/C ratio of 0.00-0.90 in both a.m. and p.m. conditions. South of Route 26, the V/C ratio is generally greater than 1.00 in the a.m. and less than 1.00 in the p.m.. The roadway is congested between Routes 10 26 in the a.m. condition.	Route 15 ranges from 8,200 to 24,000 vpd. There is an increase in traffic south of the intersection with Route 26.	North of Route 26, Route 15 has a V/C ratio of 0.00-0.90 in both a.m. and p.m. conditions. South of Route 26, the V/C ratio is generally greater than 1.00 in the a.m. and less than 1.00 in the p.m.. The roadway is congested between Routes 10 26 in the a.m. and p.m. condition.
Route 16	Route 16 ranges from 50,000 to 96,000 vpd. There is a decrease in traffic south of the residential developments south of Route 25.	The V/C ratio is generally less than 1.00 in the a.m. and p.m. for the segment of the road south of Route 25. North of Route 25 (and around the intersection), the V/C level is greater than 1.00, indicating the roadway is congested at this location.	Route 16 ranges from 42,000 to 80,000 vpd. There is a decrease in traffic south of the residential developments south of Route 25.	The V/C ratio is less than 1.00 during peak hours, except for south of the intersection with Route 25. The roadway is considered congested at this location.
Route 25	Route 25 ranges from 24,000 to 28,000 vpd.	Route 25 has a V/C ratio greater than 1.00, indicating that the roadway is congested.	Route 25 ranges from 30,000 to 34,000 vpd.	The V/C ratio is generally greater than 1.00 during peak hours, indicating the roadway is congested.
Route 26	Route 26 ranges from 14,000 to 28,000 vpd. There is a decrease in traffic south of the large residential development just north of the intersection with Route 15.	Route 26 generally has a V/C ratio greater than 1.00 during both the a.m. and p.m. peak conditions. The roadway is considered congested.	Route 26 ranges from 17,000 to 36,000 vpd. There is a decrease in traffic south of the large residential development just north of the intersection with Route 15.	The V/C ratio is less than 1.00 north of Route 25 during peak hours. South of Route 25, the V/C ratio is greater than 1.00 in the both a.m. and p.m. peak conditions. The roadway is considered congested at this location.
Route 27	Route 27 ranges from 60,000 to 63,000 vpd between Routes 16 and 1.	The V/C ratio is less than 1.00 during the a.m. and p.m. peak conditions. This roadway is not considered congested.	Route 27 ranges from 49,000 to 52,000 vpd between Routes 16 and 1.	The V/C ratio is 0.00-0.90 during peak conditions, indicating the roadway is not considered congested.

Table 4.2-23. Alternative 8 Future ADT and Volume to Capacity Ratio Summary – Central Region

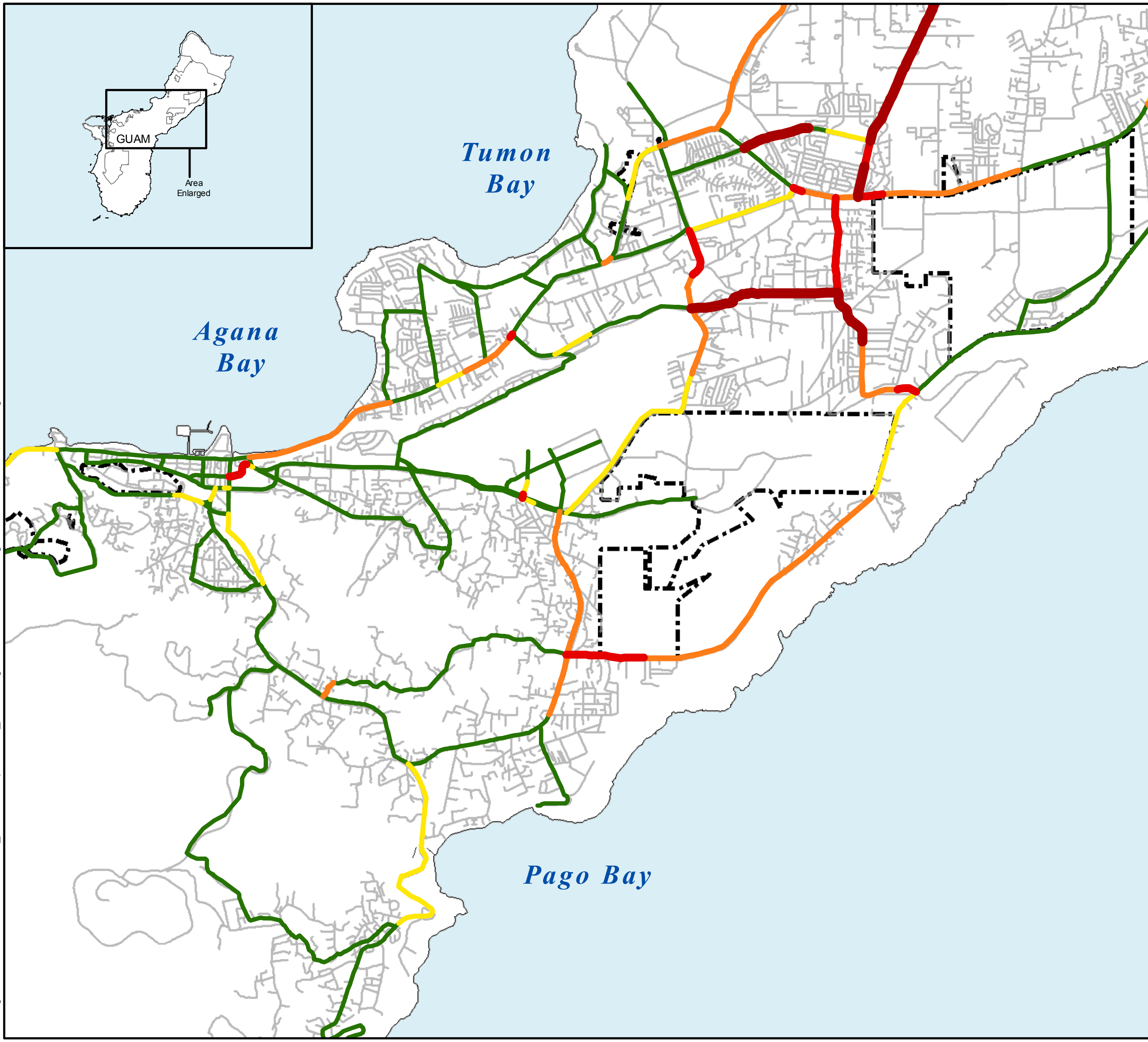
Roadway	*2014*		*2030*	
	ADT Summary	*V/C Ratio*	*ADT Summary*	*V/C Ratio*
Route 28	Route 28 ranges from 23,000 to 26,000 vpd.	The V/C ratio is greater than 1.50 in both the a.m. and p.m. peak hours, indicating the roadway is considered congested.	Route 28 ranges from 18,000 to 24,000 vpd.	The V/C ratio is greater than 1.50 in both the a.m. and p.m. peak, indicating the roadway is considered congested.
Chalan Lujuna	Chalan Lujuna has 23,000 vpd.	The V/C ratio is 1.00-1.15 during the a.m. and p.m. peak hours, indicating the roadway is considered congested.	Chalan Lujuna ranges from 6,000 to 7,000 vpd.	The V/C ratio is 0.00-0.90 during the a.m. and p.m. peak hours, indicating the roadway is not considered congested.

Figure 4.2-51 through Figure 4.2-54 show future levels of traffic congestion in the Central Region for the a.m. and p.m. peak hours, respectively. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested. There are a few areas of congestion in the Central Region, primarily on roads that serve the DoD lands to the north and the commercial districts in Tamuning and Hagatna. During both the morning and afternoon peaks in both 2014 and 2030, the road with the greatest congestion levels in the Central Region is Route 28 and a portion of Route 26. Segments of Routes 1, 10, 15, 16, 25, and 26 also exhibit failing congestion levels. All have an LOS F in both the a.m. and p.m. peak hours.

For the Central Region, there are 13 intersections for which the traffic is worse in 2014 than in 2030 for both the a.m. and p.m. peak hour. As shown in Table 4.2-24, there are 22 out of 28 intersections with LOS F for at least one peak hour, which is considered unacceptable. The following intersections would operate at LOS F in the a.m. and p.m. peak hours in both 2014 and 2030:

- Route 1/28
- Route 1/26
- Route 1/27
- Route 1/10A
- Route 1/14 (ITC)
- Route 1/30
- Route 4/7A
- Route 8/10
- Route 10/15
- Route 16/27
- Route 16/10A
- Route 7/7A

Figure 4.2-51
Central Region–
2014 a.m. Peak
Congestion Levels –
Alternative 8



Legend

V/C Ratio

- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use

- Streets
- Military Installation

N W E S

Feet
0 1,450 2,900
0 400 800
Meters

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-51. Central Region - 2014 a.m. Peak Congestion Levels- Alternative 8.mxd

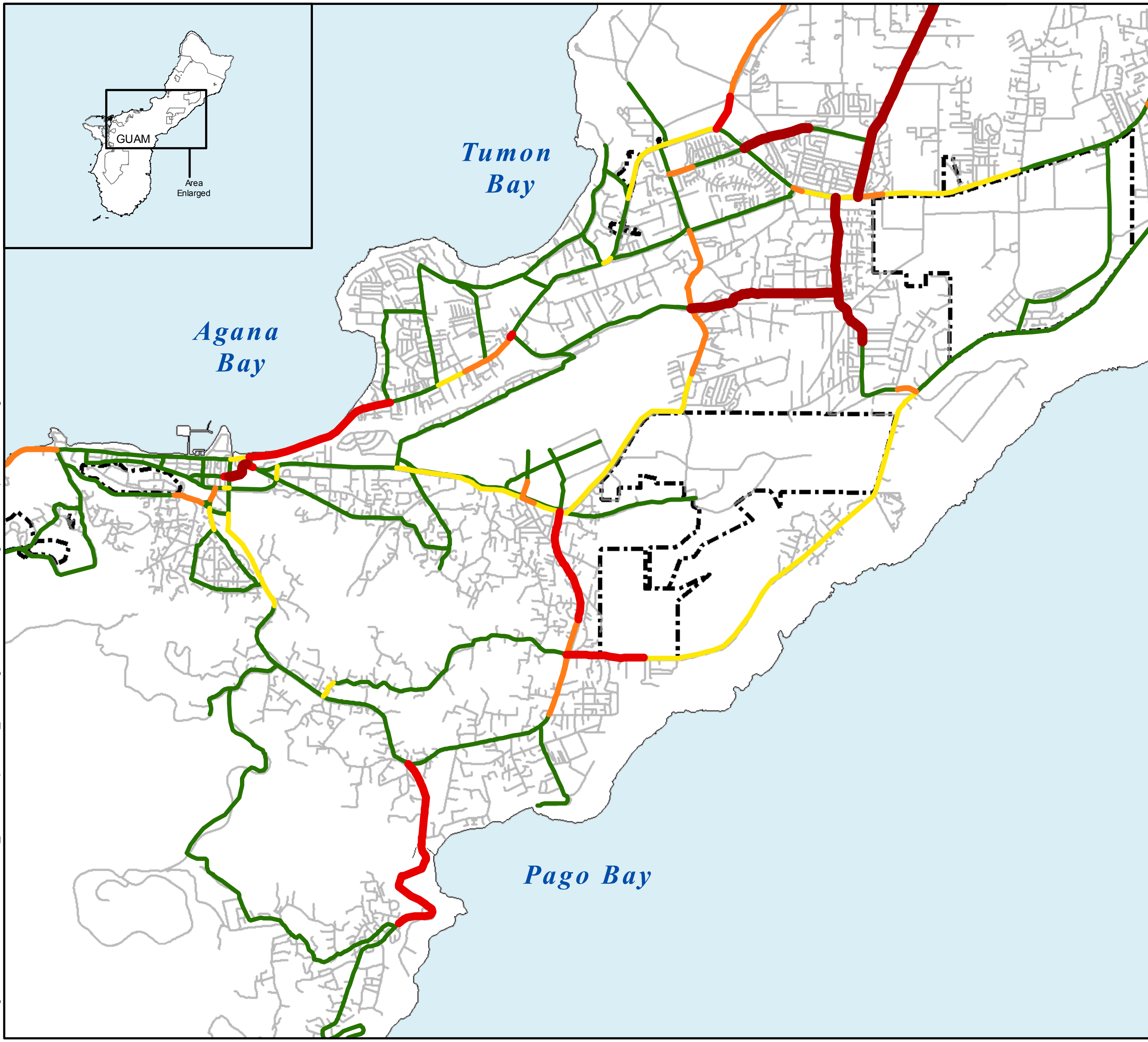


Figure 4.2-52
Central Region–
2014 p.m. Peak
Congestion Levels –
Alternative 8

Legend

V/C Ratio
- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use
- Streets
- Military Installation

N
W E
S

Feet
0 1,450 2,900
0 400 800
Meters

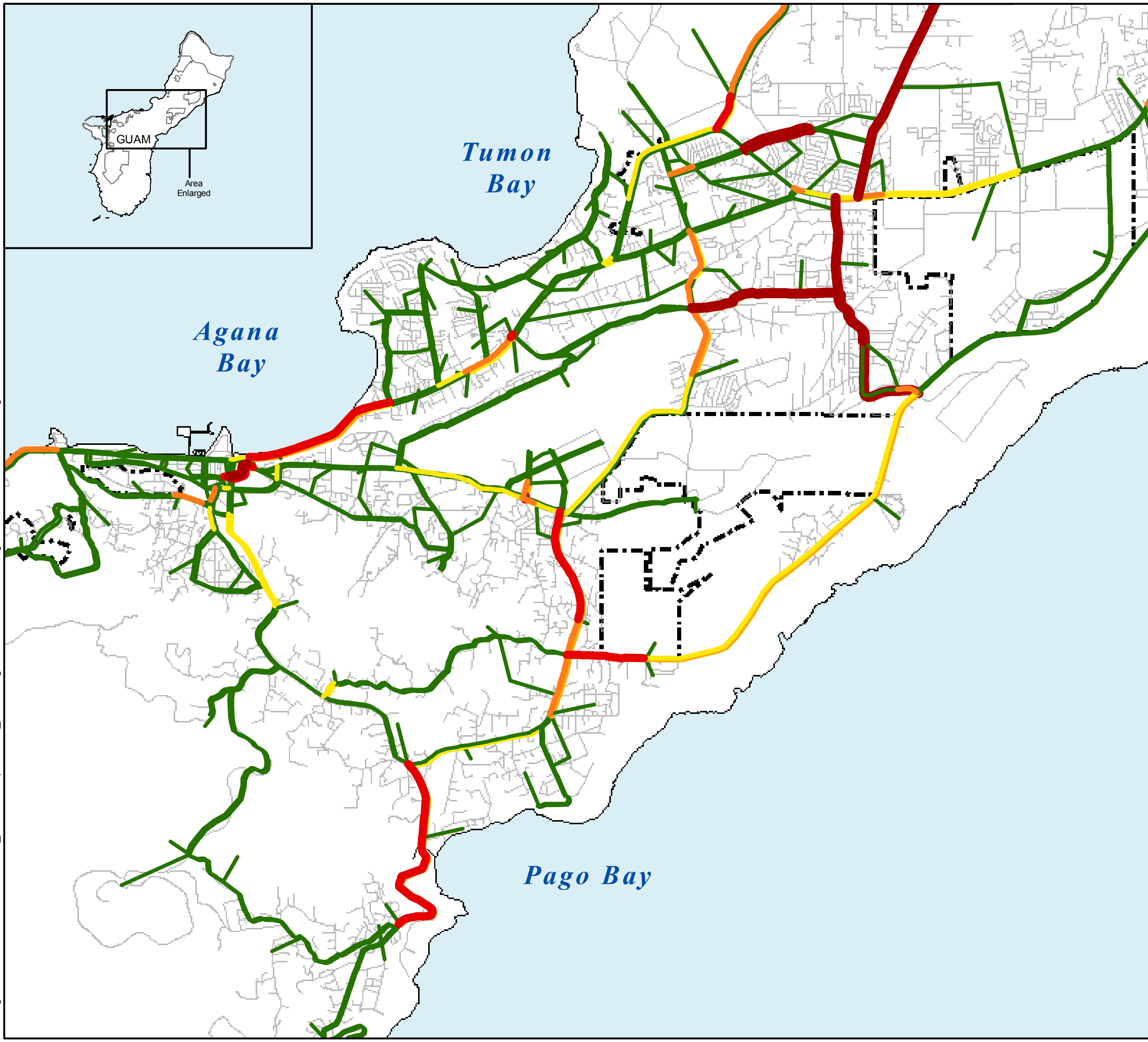


Figure 4.2-53

Central Region–2030 a.m. Peak Congestion Levels – Alternative 8

Legend

V/C Ratio

- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use

- Streets
- Military Installation

N W E S

Feet 0 1,450 2,900

0 400 800 *Meters*

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-53. Central Region - 2030 a.m. Peak Congestion Levels- Alternative 8.mxd

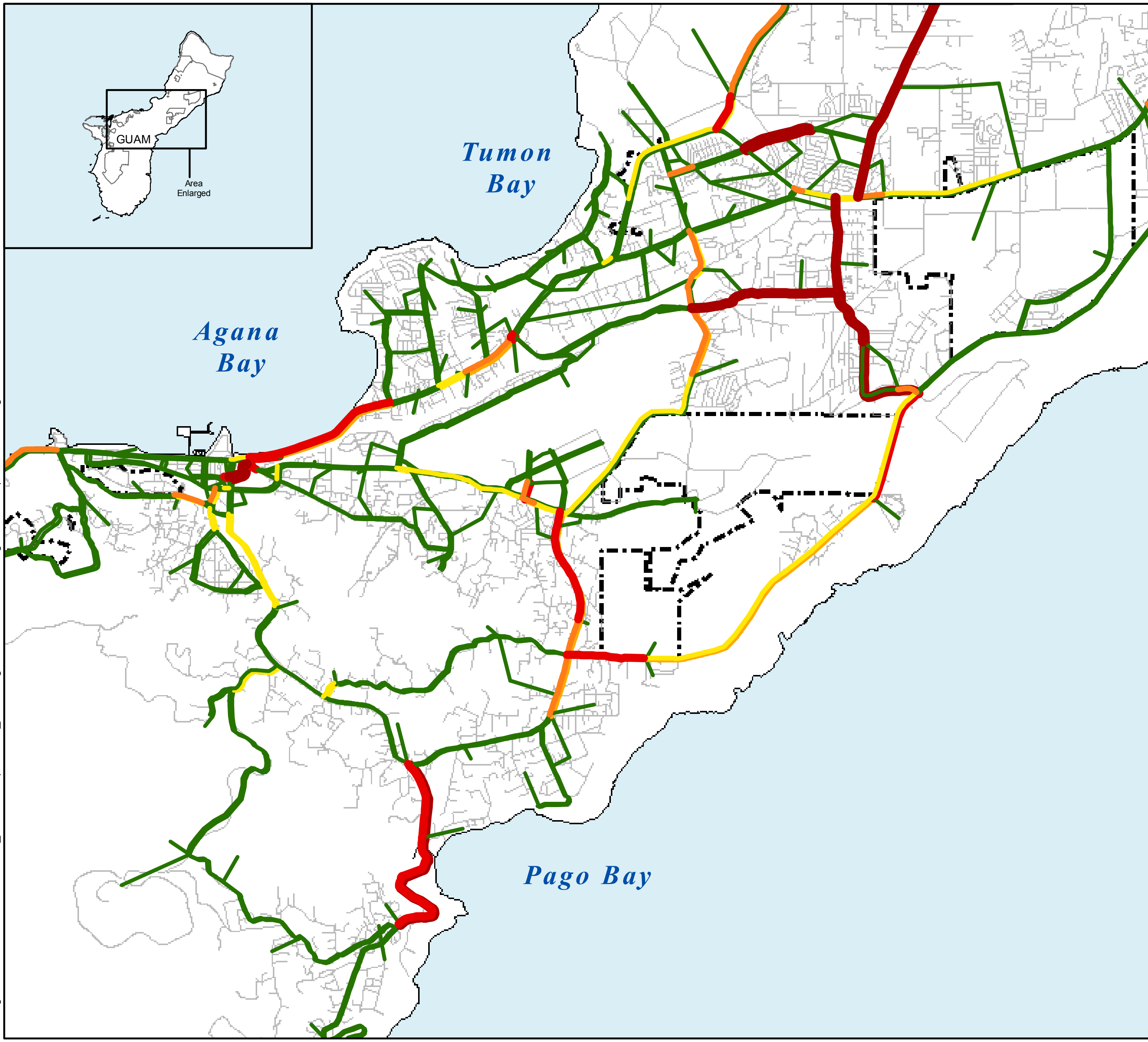


Figure 4.2-54
Central Region–
2030 p.m. Peak
Congestion Levels –
Alternative 8

Legend

V/C Ratio
- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use
- Streets
- Military Installation

N
W E
S

Feet
0 1,450 2,900
0 400 800
Meters

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-54. Central Region - 2030 p.m. Peak Congestion Levels- Alternative 8.mxd

Table 4.2-24. Alternative 8 Future Level of Service and Delay Results – Central Region

	2014				2030			
	a.m. Peak Hour		p.m. Peak Hour		a.m. Peak Hour		p.m. Peak Hour	
	LOS	Delay Seconds	LOS	Delay Seconds	LOS	Delay Seconds	LOS	Delay Seconds
Signalized*								
Route 1/28	F	275.4	F	252.3	F	215.5	F	115.3
Route 1/26	F	154.6	F	265.3	F	145.9	F	250.6
Route 1/27	F	210.5	F	627.3	F	178.8	F	329.4
Route 1/27A	F	98.4	F	178.0	D	53.9	D	51.2
Route 1/3	F	113.9	F	106.8	E	70.5	E	64.7
Route 1/16	F	180.3	F	144.6	E	57.0	F	103.9
Route 1/14 (North San Vitoris)	F	178.9	F	146.8	E	69.6	E	77.6
Route 1/14A	F	313.4	F	328.3	E	74.2	F	126.0
Route 1/10A	F	182.1	F	221.3	F	126.1	F	186.0
Route 1/14B	F	153.4	F	146.2	F	90.4	E	79.5
Route 1/14 (ITC)	F	158.9	F	318.3	F	113.6	F	267.2
Route 1/30	F	365.0	F	338.6	F	146.3	F	285.3
Route 1/8	F	200.1	F	199.7	E	77.8	F	150.4
Route 1/4	C	25.4	D	36.0	C	33.6	D	33.5
Route 1/6 (Adelup)	C	34.5	F	114.0	D	38.1	D	44.9
Route 4/7A	F	273.8	F	541.8	F	372.9	F	654.2
Route 4/10	F	160.5	F	82.9	F	198.7	E	71.0
Route 4/17	C	33.9	C	34.3	D	40.1	E	56.2
Route 8/33	D	38.7	E	72.1	D	45.5	E	77.8
Route 8/10	F	351.4	F	474.5	F	177.3	F	218.4
Route 10/15	F	260.9	F	235.5	F	197.9	F	178.1
Route 16/27A	C	28.9	E	75.0	C	31.4	D	35.5
Route 16/27	F	459.6	F	587.3	F	361.1	F	336.6
Route 16/10A	F	556.5	F	494.6	F	582.9	F	488.7
Route 26/25**	F	116.2	D	42.4	F	113.1	F	119.3
Route 26/15**	D	45.0	C	34.1	F	154.9	F	168.2
Route 28/27A**	C	47.4	F	89.4	C	31.3	E	59.6
Unsignalized* **								
Route 7/7A	F	174.7	F	290.0	F	174.7	F	300.8
Access Points								
Route 1 - South Andersen Main Gate/(Turner Street)**					C	32.4	E	78.8
Route 15 - South Andersen/Second Gate	-	-	-	-	C	22.1	C	22.6
Route 16 - Navy Barrigada/(Sabana Barrigada) Residential Gate	-	-	-	-	NA	NA	NA	NA
Route 8A - Navy Barrigada/(Residential Gate) (on base)	-	-	-	-	NA	NA	NA	NA
Route 15 - Barrigada Air Force/(Chada Street)**	-	-	-	-	D	48.4	D	43.2

Legend: NA= Not Applicable
Notes: *Signalized intersection LOS based on average delay for the overall intersection.
**Intersection is proposed to be signalized in future build conditions.
***Unsignalized intersection LOS based on approach delay on STOP-controlled approach.
****Delay exceeded maximum calculated value.

Public Transportation Impacts. Impacts would be similar to those of Alternative 1.

Pedestrian and Bicycle Impacts. Impacts would be similar to those of Alternative 1.

Apra Harbor

On Base Roadways

Naval Base Guam

Construction. The impacts for Alternative 8 are the same as Alternative 1.

Operation. The impacts for Alternative 8 are the same as Alternative 1.

Off Base Roadways

Future Traffic Impacts. A summary of future ADT volumes and the V/C ratio for 2014 and 2030 for Alternative 8 can be found in Table 4.2-25 Generally, there is a substantial increase in volumes on roadways from 2008 to 2014, and then a modest decrease in volumes on roadways from 2014 to 2017. This can be attributed to the increase in construction traffic and coinciding military expansion during peak construction time, which is in 2014, and then a reduction in traffic once off-island construction workers leave the island.

Table 4.2-25. Alternative 8 Future ADT and Volume to Capacity Ratio Summary – Apra Harbor Region

Roadway	*2014*		*2030*	
	ADT Summary	*V/C Ratio*	*ADT Summary*	*V/C Ratio*
Route 1	Route 1 ranges from 23,000 to 63,000 vpd. The traffic decreases into the entrance into the Naval base, which is at the Route 1/2A intersection.	The V/C ratio is generally less than 1.00. This roadway is not considered congested.	Route 1 ranges from 24,000 to 56,000 vpd. The traffic decreases into the entrance into the Naval base, which is at the Route 1/2A intersection.	The V/C ratio is less than 1.00. This roadway is not considered congested.
Route 2A	Route 2A has 35,000 vpd.	The V/C ratio is 0.00-0.90 during the a.m. and p.m. peak hours, indicating the roadway is not considered congested.	Route 2A has 35,000 vpd.	The V/C ratio is 0.00-0.90 during the a.m. and p.m. peak hours, indicating the roadway is not considered congested.
Route 11	Route 11 has 14,000 vpd.	The V/C ratio is 0.00-0.90 during peak hours, indicating the roadway is not considered congested.	Route 11 has 8,800 vpd.	The V/C ratio is 0.00-0.90 during peak hours, indicating the roadway is not considered congested.

Figure 4.2-55 through Figure 4.2-58 show future levels of traffic congestion in the Apra Harbor Region for the a.m. and p.m. peak hours for 2014 and 2030, respectively. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested.

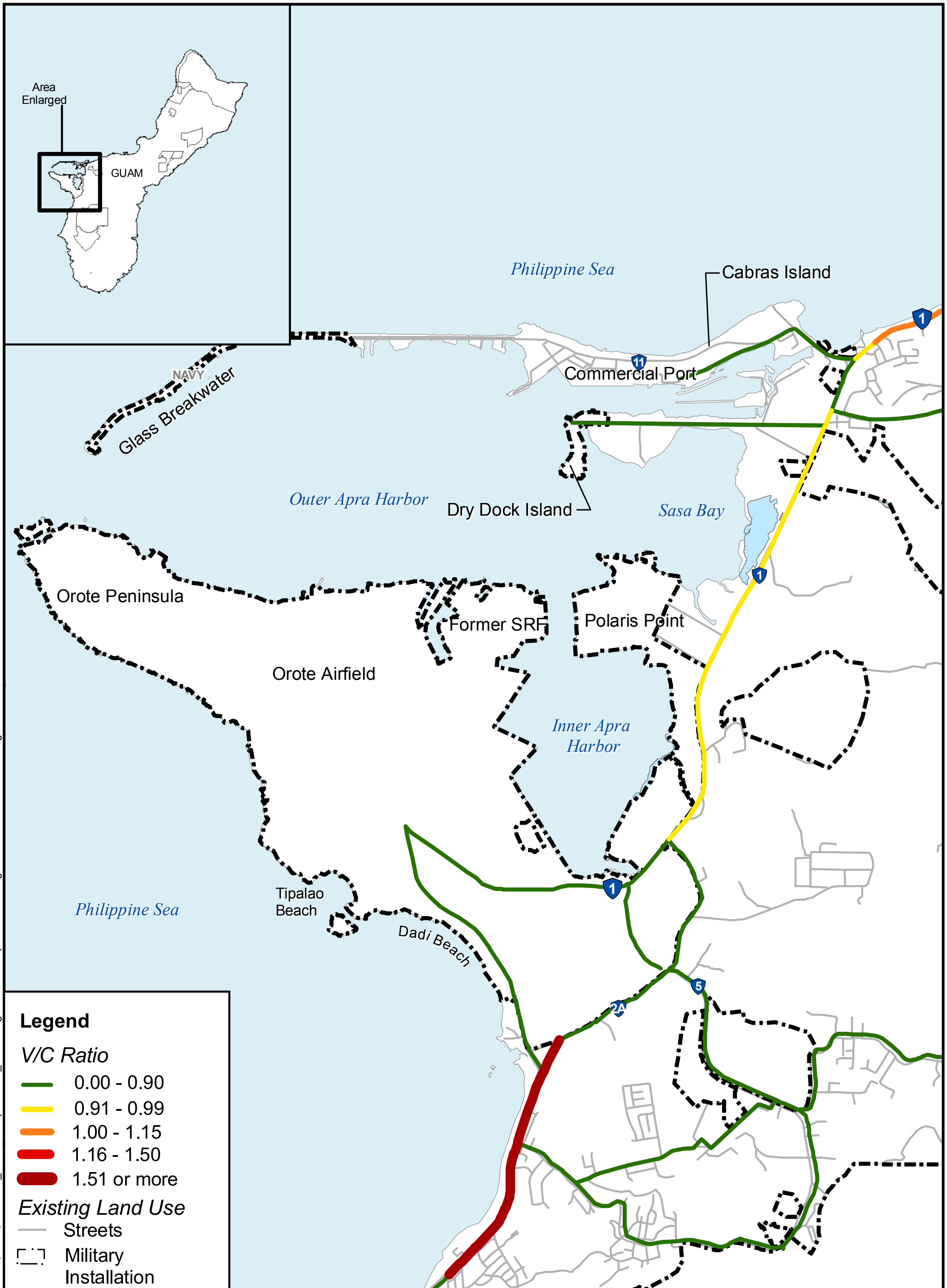


Figure 4.2-55
Apra Harbor Region – 2014 a.m. Peak Congestion Levels – Alternative 8

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4192_MXDs\Figure 4.2-55. Apra Harbor Region - 2014 a.m. Peak Congestion Levels- Alternative 8.mxd

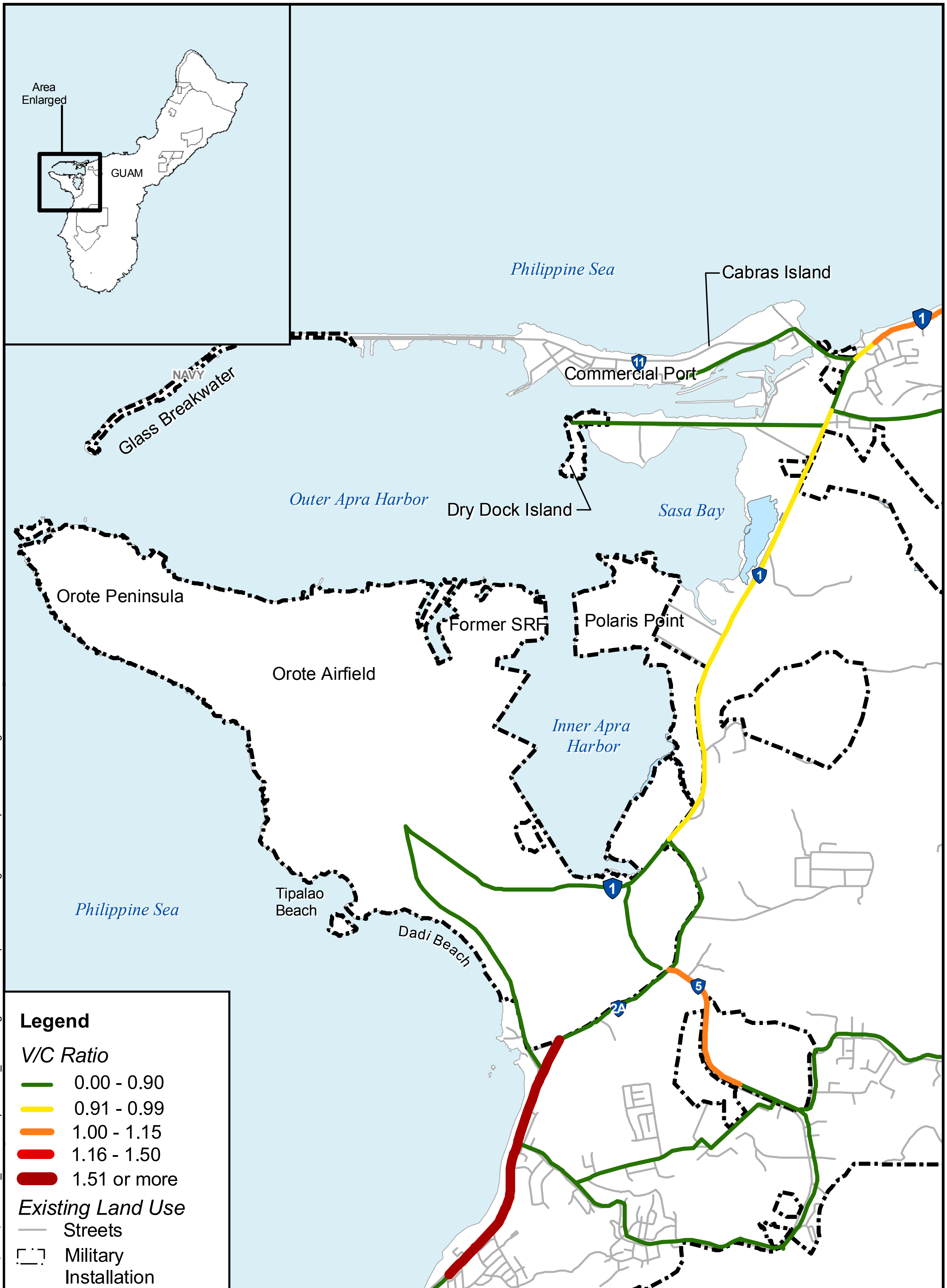


Figure 4.2-56
Apra Harbor Region – 2014 p.m. Peak Congestion Levels – Alternative 8

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4192_MXDs\Figure 4.2-56. Apra Harbor Region - 2014 p.m. Peak Congestion Levels- Alternative 8.mxd

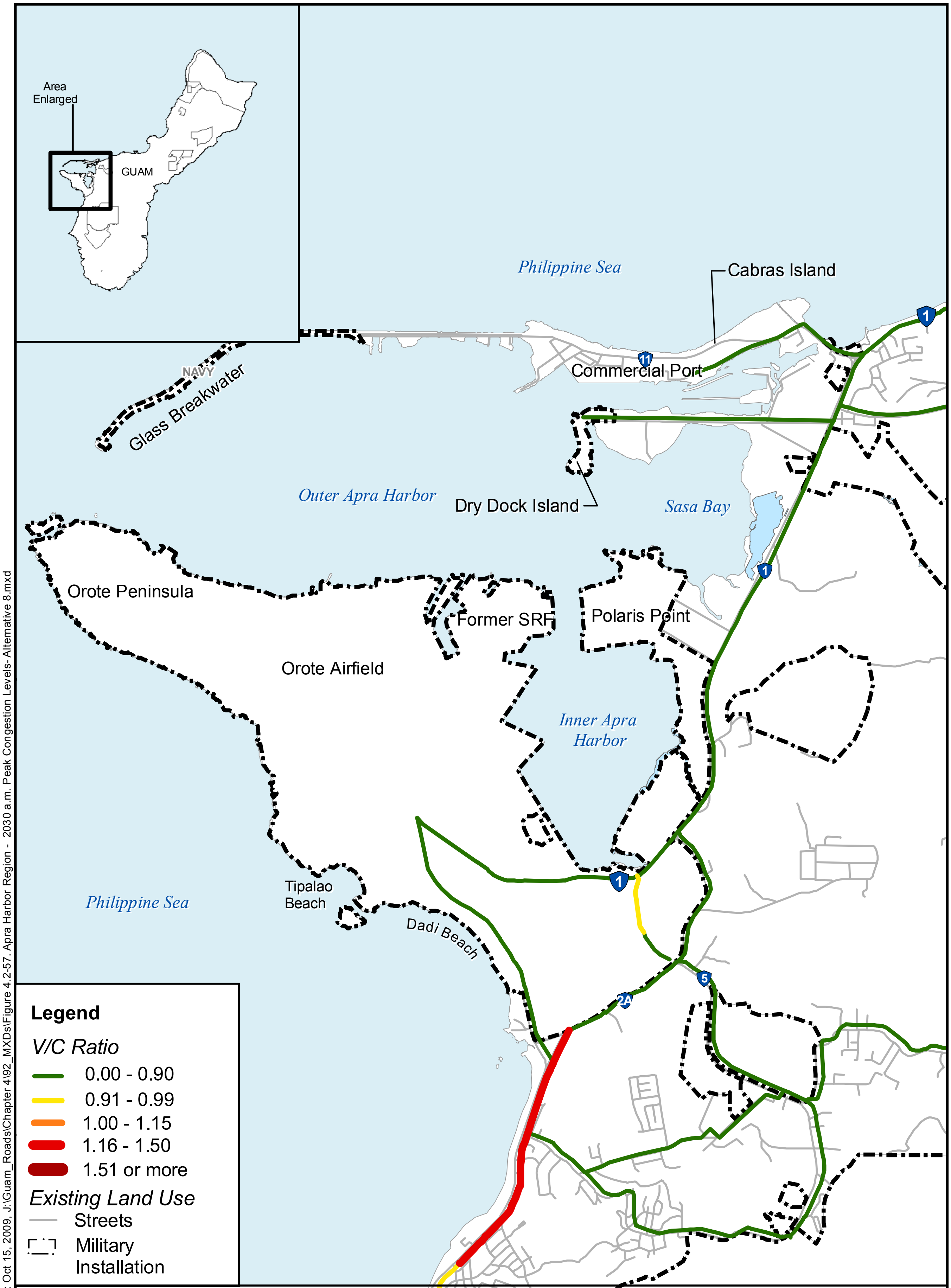


Figure 4.2-57
Apra Harbor Region – 2030 a.m. Peak Congestion Levels – Alternative 8

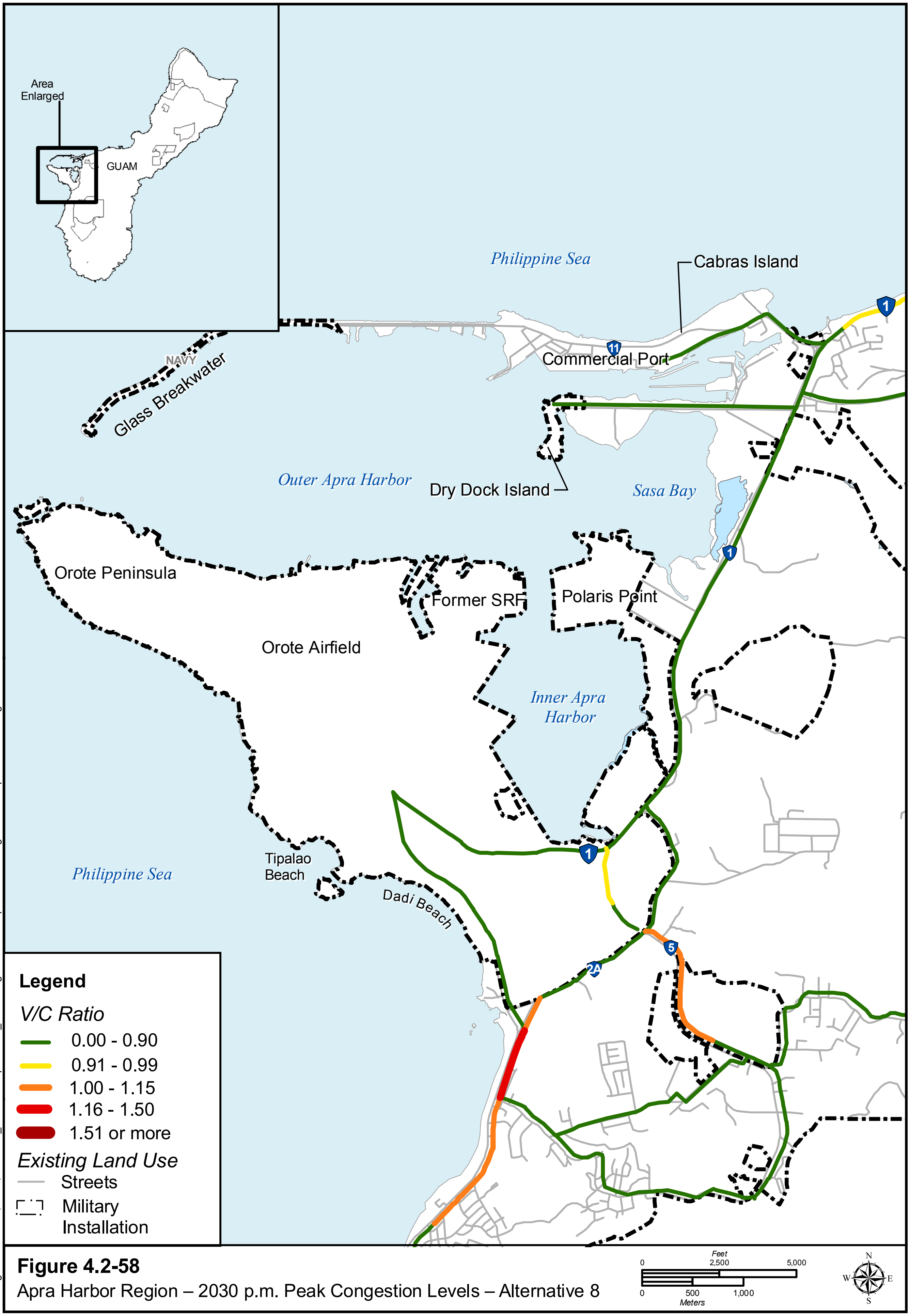


Figure 4.2-58
Apra Harbor Region – 2030 p.m. Peak Congestion Levels – Alternative 8

As shown in Table 4.2-26, Route 1/2A is operating at LOS F in the a.m. peak hour for 2014, which is considered unacceptable.

Table 4.2-26. Alternative 8 Future Level of Service and Delay Results – Apra Harbor Region

	2014				*2030*			
	a.m. Peak Hour		*p.m. Peak Hour*		*a.m. Peak Hour*		*p.m. Peak Hour*	
	LOS	*Delay Seconds*	*LOS*	*Delay Seconds*	*LOS*	*Delay Seconds*	*LOS*	*Delay Seconds*
Signalized*								
Route 1/11	C	25.3	E	67.7	B	14.3	D	43.3
Route 1/Polaris Point	A	4.5	A	5.5	A	6.8	A	7.5
Route 1/6 (west)	D	49.5	C	24.1	B	18.4	C	22.0
Route 1/2A	F	89.4	E	59.8	E	67.5	E	57.5
Route 5/2A	E	69.6	C	22.9	E	79.9	C	25.9

Note: *Signalized intersection LOS based on average delay for the overall intersection.

Public Transportation Impacts. Impacts would be similar to those of Alternative 1.

Pedestrian and Bicycle Impacts. Impacts would be similar to those of Alternative 1.

South

On Base Roadways

Naval Munitions Site

Construction. The impacts for Alternative 8 are the same as Alternative 1.

Operation. The impacts for Alternative 8 are the same as Alternative 1.

Off Base Roadways

Future Traffic Impacts. A summary of future ADT volumes and the V/C ratio for 2014 and 2030 for Alternative 3 can be found in Table 4.2-27. Generally, there is a substantial increase in volumes on roadways from 2008 to 2014, and then a modest decrease in volumes on roadways from 2014 to 2017. This can be attributed to the increase in construction traffic and coinciding military expansion during peak construction time, which is in 2014, and then a reduction in traffic once off-island construction workers leave the island.

Table 4.2-27. Alternative 8 Future ADT and Volume to Capacity Ratio Summary – South Region

Roadway	*2014*		*2030*	
	ADT Summary	*V/C Ratio*	*ADT Summary*	*V/C Ratio*
Route 5	Route 5 ranges from 10,000 to 17,000 vpd. Traffic decreases as Route 5 approaches the intersection with Route 17.	The V/C ratio is generally 0.00-0.90 in the a.m. peak and 1.00-1.15 in the p.m. peak. The roadway is congested during the p.m. peak hour.	Route 5 ranges from 11,000 to 18,000 vpd. Traffic decreases as Route 5 approaches the intersection with Route 17.	The V/C ratio is generally 0.00-0.90 in the a.m. peak and 1.00-1.15 in the p.m. peak. The roadway is congested during the p.m. peak hour.
Route 12	Route 12 ranges from 2,700 to 5,400 vpd. The traffic increases toward the intersection with Route 2.	The V/C ratio is 0.00-0.90 during both the a.m. and p.m. peak, indicating the roadway is not considered congested.	Route 12 ranges from 2,300 to 6,000 vpd. The traffic increases toward the intersection with Route 2.	The V/C ratio is 0.00-0.90 during both the a.m. and p.m. peak, indicating the roadway is not considered congested.

Figure 4.2-50 through Figure 4.2-61 show future levels of traffic congestion in the South Region for the a.m. and p.m. peak hours for 2014 and 2030, respectively. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested.

The roads in the South Region do not exhibit high levels of congestion. During both the afternoon peaks, Route 5 between the Naval base and the NMS has an LOS F.

As shown in Table 4.2-28, none of the intersections have LOS F in either the a.m. or p.m. peak hours in 2014 or 2030. Conditions remain fairly stable from 2014 to 2017.

Table 4.2-28. Alternative 8 Future Level of Service and Delay Results – South Region

	2014				*2030*			
	a.m. Peak Hour		*p.m. Peak Hour*		*a.m. Peak Hour*		*p.m. Peak Hour*	
	LOS	*Delay Seconds*	*LOS*	*Delay Seconds*	*LOS*	*Delay Seconds*	*LOS*	*Delay Seconds*
Signalized*								
Route 2/12	C	31.6	C	24.9	C	30.7	C	27.0
Unsignalized**								
Route 5/17	B	13.1	C	17.1	B	14.8	E	42.4
Route 4/4A	C	23.3	C	17.2	E	47.4	C	24.0
Route 17/4A	B	13.0	B	14.0	C	16.1	C	18.6
Access Points								
Route 5 - Naval Ordnance Annex/Harmon Road.**	-	-	-	-	A	9.5	A	10.6

*Notes: *Signalized intersection LOS based on average delay for the overall intersection.*
***Unsignalized intersection LOS based on approach delay on STOP-controlled approach.*

Public Transportation Impacts. Impacts would be similar to those of Alternative 1.

Pedestrian and Bicycle Impacts. Impacts would be similar to those of Alternative 1.

<u>Potential Mitigation Measures</u>

On Base Roadways

The proposed mitigation measures would be the same as for Alternative 1.

Off Base Roadways

The mitigation measures for Alternative 8 would be similar to those of Alternative 1.

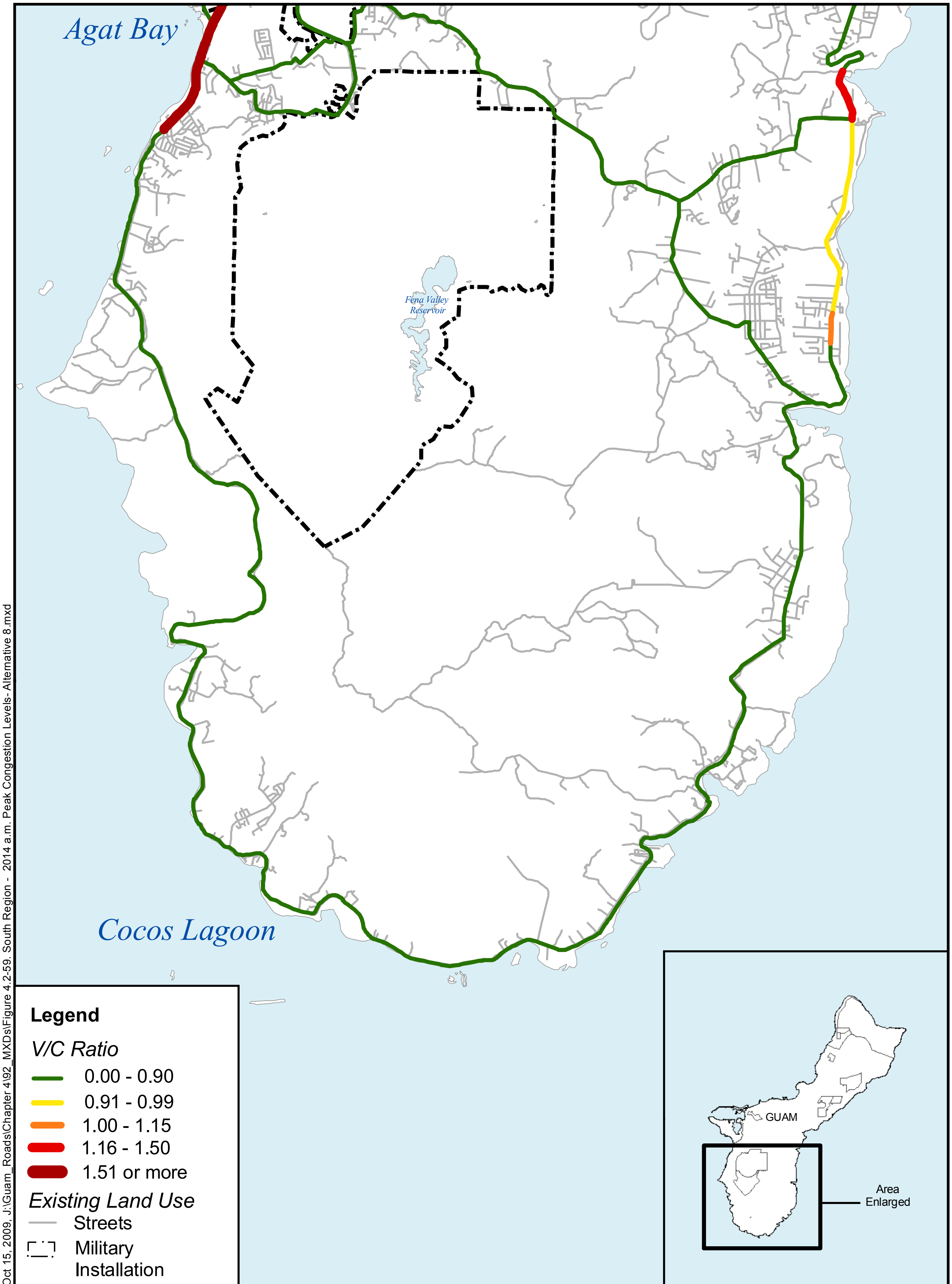


Figure 4.2-59
South Region – 2014 a.m. Peak Congestion Levels – Alternative 8

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-59. South Region - 2014 a.m. Peak Congestion Levels- Alternative 8.mxd

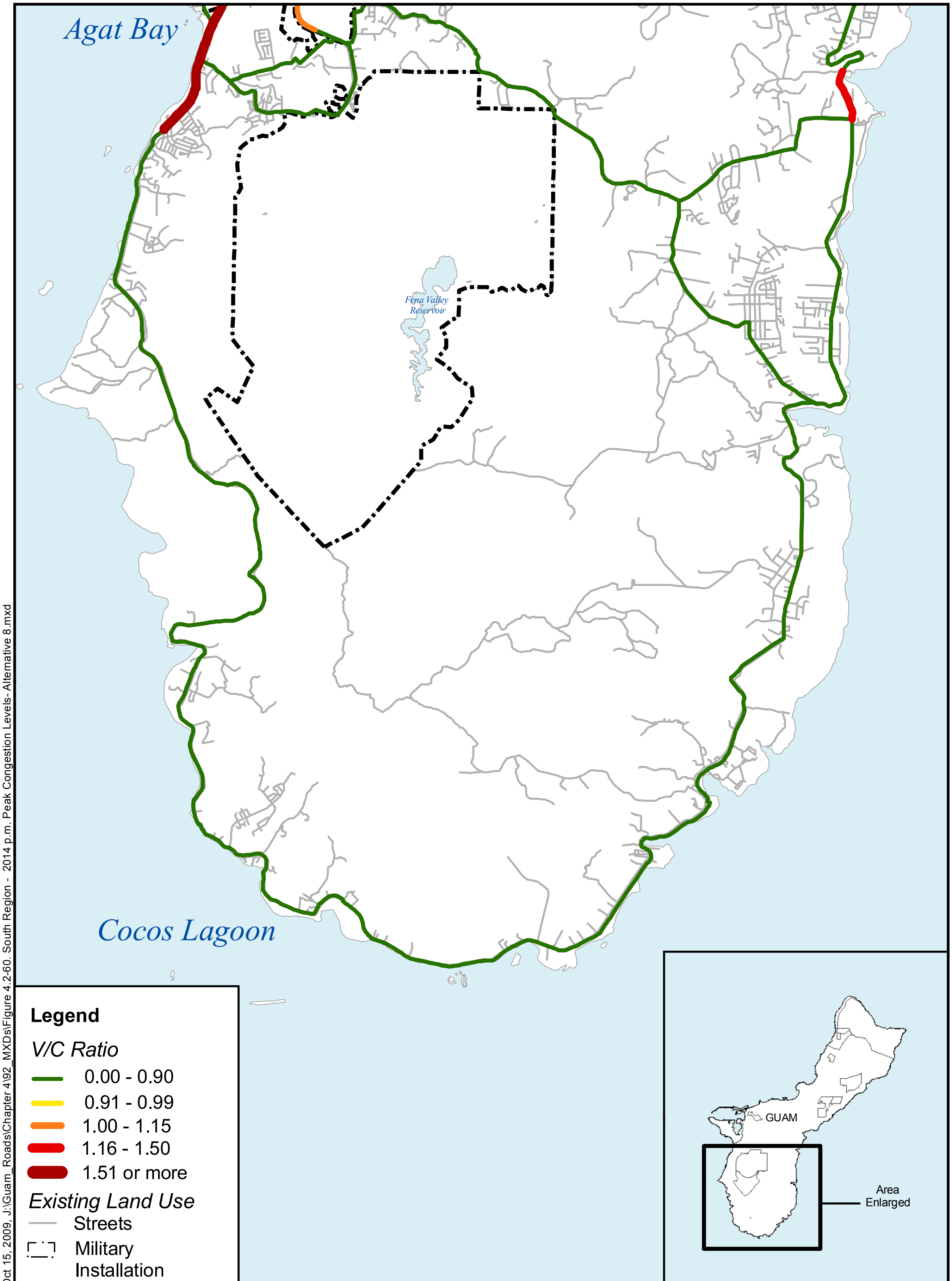


Figure 4.2-60
South Region – 2014 p.m. Peak Congestion Levels – Alternative 8

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-60. South Region - 2014 p.m. Peak Congestion Levels- Alternative 8.mxd

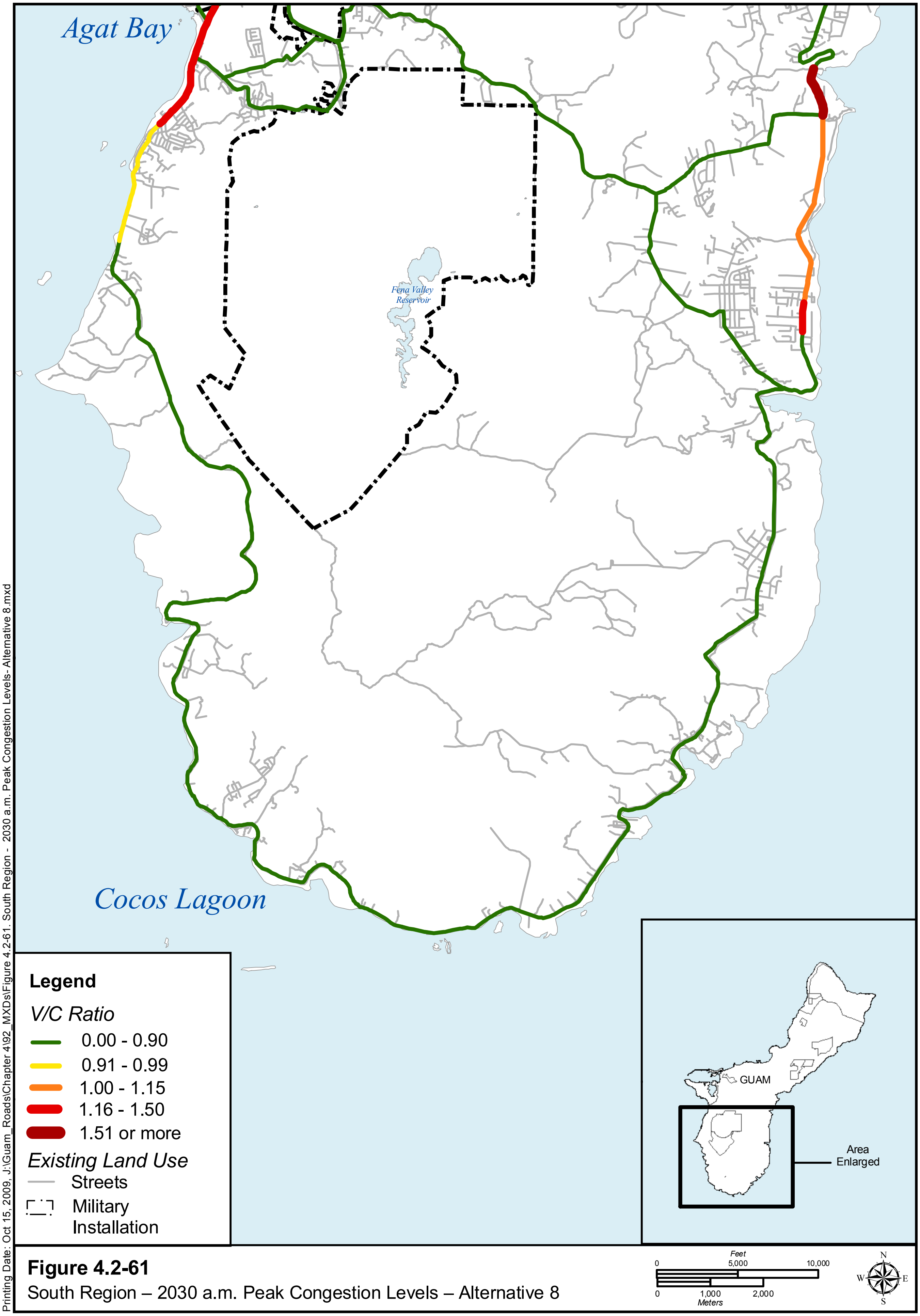
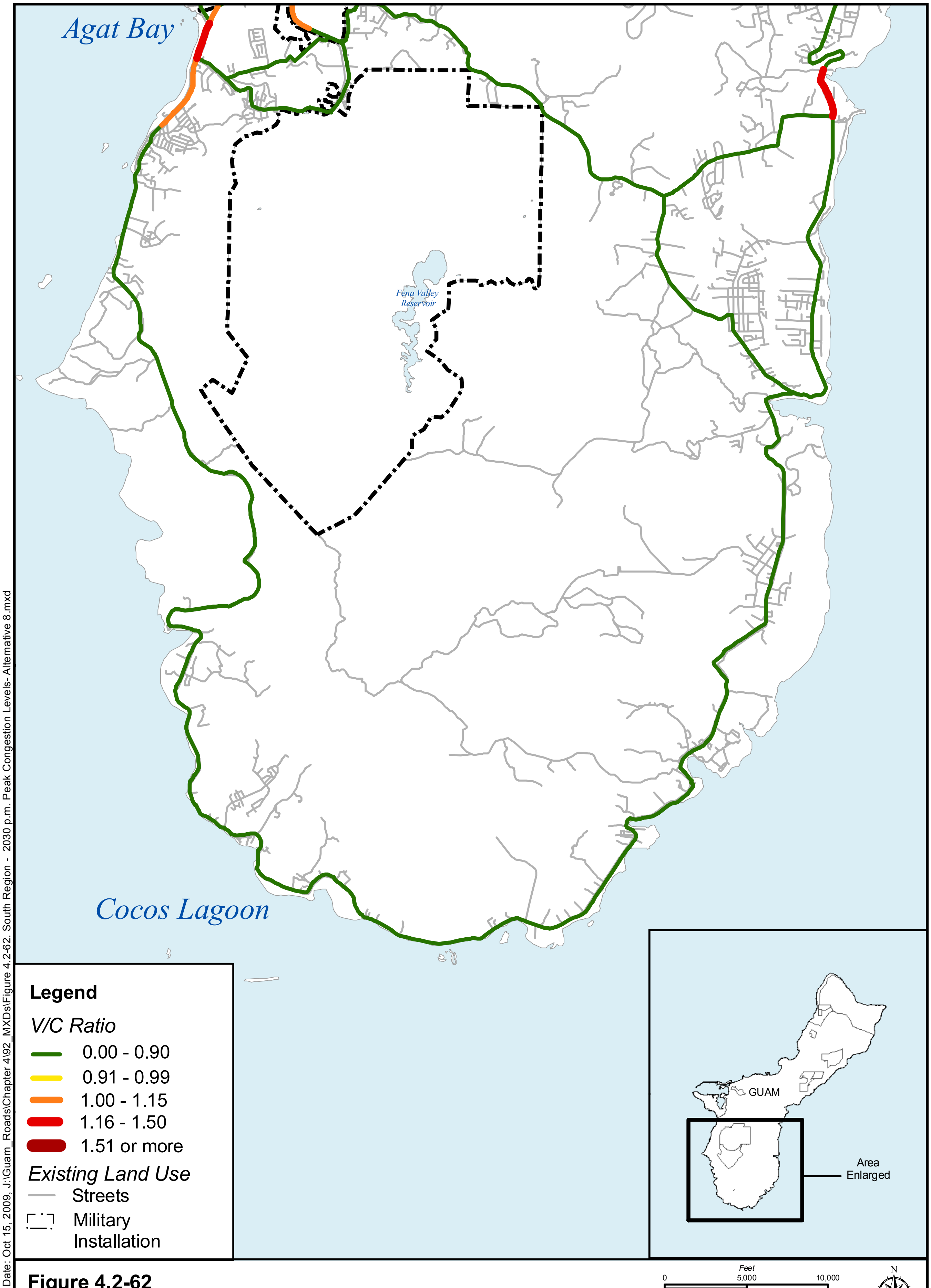


Figure 4.2-61
South Region – 2030 a.m. Peak Congestion Levels – Alternative 8



Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-62. South Region - 2030 p.m. Peak Congestion Levels- Alternative 8.mxd

Figure 4.2-62
South Region – 2030 p.m. Peak Congestion Levels – Alternative 8

4.2.2.5 No-Action Alternative (Off Base Roadways)

The no-action alternative includes all projects included in the fiscally constrained 2030 Guam Transportation Plan; however, it does not include the military buildup or roadway projects proposed specifically for the buildup as described in the build alternatives.

2014

Future Traffic Impacts

Most of the roads included in this study are considered congestion-free in 2014. A summary of future ADT volumes and the V/C ratio for 2014 for the no-action alternative can be found in Table 4.2-29. The exceptions are Route 25 and the southern portion of Route 28, which both have a V/C ratio greater than 1, indicating that the roadway is congested. The V/C ratios are considerably better compared to Alternatives 1/2, 3, and 8 in 2014, most noticeably on the following roadways, which all have congestion where there is no congestion in the no-action alternative in 2014:

Alternatives 1 and 2

- Route 1
- Route 3
- Route 8
- Route 10
- Route 15
- Route 26
- Route 28

Alternative 3

- Route 1
- Route 3
- Route 10
- Route 16
- Route 26

Alternative 8

- Route 1
- Route 3
- Route 5
- Route 8
- Route 10
- Route 25
- Route 26

Table 4.2-29. No Action Alternative Future ADT and Volume to Capacity Ratio Summary

Roadway	*2014*	
	ADT Summary	*V/C Ratio*
Route 1	Route 1 ranges from 19,000 to 81,000 vpd. Traffic decreases as Route 1 approaches Andersen AFB and gradually increases toward the intersection with Route 4, where it decreases again.	The V/C ratio is generally between 0.00-0.80 on Route 1. There are small sections of the roadway in Tamuning that have V/C ratios between 0.81-0.99; however, none of the roadway is considered congested.
Route 2A	Route 2A has 31,000 vpd.	The V/C ratio is between 0.00-0.80 on Route 2A. The roadway is not considered congested.
Route 3	Route 3 ranges from 23,000 to 46,000 vpd. Traffic decreases north of the intersection with Route 28.	The V/C ratio is between 0.00-0.80 on Route 3. The roadway is not considered congested.
Route 5	Route 5 ranges from 9,400 to 14,000 vpd. Traffic decreases as Route 5 approaches the intersection with Route 17.	The V/C ratio is generally between 0.81-0.99 on Route 5. The roadway is not considered congested.
Route 8/8A	Route 8 ranges from 41,000 to 48,000 vpd. There is a decrease in traffic west of the intersection with Sunset Boulevard. Route 8A has 3,500 vpd.	The V/C ratio is generally between 0.00-0.80 on Route 8/8A. However, in the p.m. peak hour, V/C ration for Route 8 east of Route 33 is between 0.81-0.99. The roadway is not considered congested.
Route 9	Route 9 ranges from 3,400 to 5,000 vpd.	The V/C ratio is between 0.00-0.80 on Route 9. The roadway is not considered congested.
Route 10	Route 10 ranges from 39,000 to 41,000 vpd between Route 8 and Route 15.	The V/C ratio is between 0.00-0.80 on Route 10. The roadway is not considered congested.
Route 11	Route 11 has 5,500 vpd.	The V/C ratio is between 0.00-0.80 on Route 11. The roadway is not considered congested.

Roadway	*2014*	
	ADT Summary	*V/C Ratio*
Route 12	Route 12 ranges from 1,300 to 4,900 vpd. Traffic increases toward the intersection with Route 2.	The V/C ratio is between 0.00-0.80 on Route 12. The roadway is not considered congested.
Route 15	Route 15 ranges from 5,200 to 18,000 vpd. Traffic increases gradually south to the intersection with Route 10.	The V/C ratio is between 0.00-0.80 on Route 15. The roadway is not considered congested.
Route 16	Route 16 ranges from 40,000 to 56,000 vpd. There is a decrease in traffic south of the residential developments south of Route 25.	The V/C ratio is between 0.00-0.80 on Route 16. The roadway is not considered congested.
Route 25	Route 25 ranges from 13,000 to 17,000 vpd.	The V/C ratio is 1.16-1.50 on Route 25 in both the a.m. and p.m. peak hour. The roadway is considered congested.
Route 26	Route 26 ranges from 6,800 to 16,000 vpd. There is a decrease in traffic south of the large residential development just north of the intersection with Route 15.	The V/C ratio is generally between 0.00-0.80 on Route 26. There is a small section of the roadway near the intersection with Route 25 where the V/C ratio is between 0.81-0.99; however, none of the roadway is considered congested.
Route 27	Route 27 ranges from 40,000 to 42,000 vpd between Route 16 and Route 1.	The V/C ratio is between 0.00-0.80 on Route 27. The roadway is not considered congested.
Route 28	Route 28 ranges from 9,600 to 19,000 vpd. Traffic generally increases closer to the intersection with Route 1.	The V/C ratio of the northern portion of Route 28 is 0.81-0.99 in the a.m. peak hour and 0.00-0.80 in the p.m. peak hour. The V/C ratio of the southern portion of Route 28 is generally 1.16-1.50, which indicates the road is congested in both the a.m. and p.m. peak hour.
Chalan Lujuna	Chalan Lujuna ranges from 4,400 to 4,900 vpd.	The V/C ratio is between 0.00-0.80 on Chalan Lujuna. The roadway is not considered congested.

Figure 4.2-63 through Figure 4.2-70 show future levels of traffic congestion in the North, Central, Apra Harbor, and South Regions for the a.m. and p.m. peak hours for 2014. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested.

The results of the future operational analysis are shown in Table 4.2-30 for both the 2014 a.m. and p.m. conditions.

As shown in Table 4.2-30, island-wide, there are 17 out of 42 intersections with LOS F for at least one peak hour, which is considered unacceptable. The following intersections are operating at LOS F in the a.m. and p.m. peak hours in 2014:

- Route 1/28
- Route 1/27
- Route 1/3
- Route 1/14A
- Route 1/10A
- Route 1/30
- Route 4/7A
- Route 16/27
- Route 16/10A
- Route 7/7A
- Route 15/29
- Route 28/27A

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-63. North Region - 2014 a.m. Peak Congestion Levels- Alternative No-Action Alternative.mxd

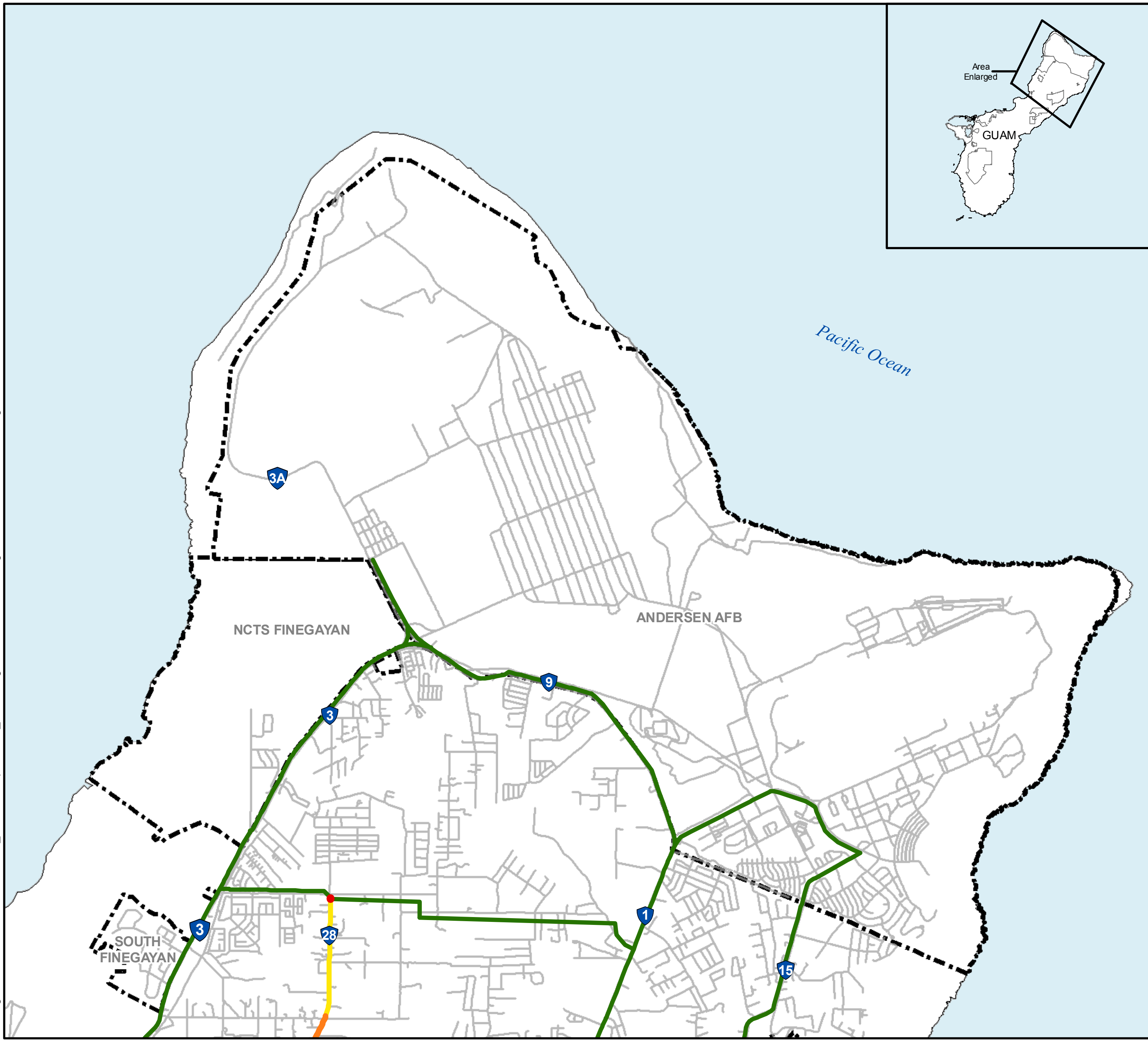


Figure 4.2-63
North Region–
2014 a.m. Peak
Congestion Levels –
No-Action Alternative

Legend

V/C Ratio

- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use

- Streets
- Military Installation

N
W E
S

Feet
0 1,450 2,900

0 400 800
Meters

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-64. North Region - 2014 p.m. Peak Congestion Levels- Alternative No-Action Alternative.mxd

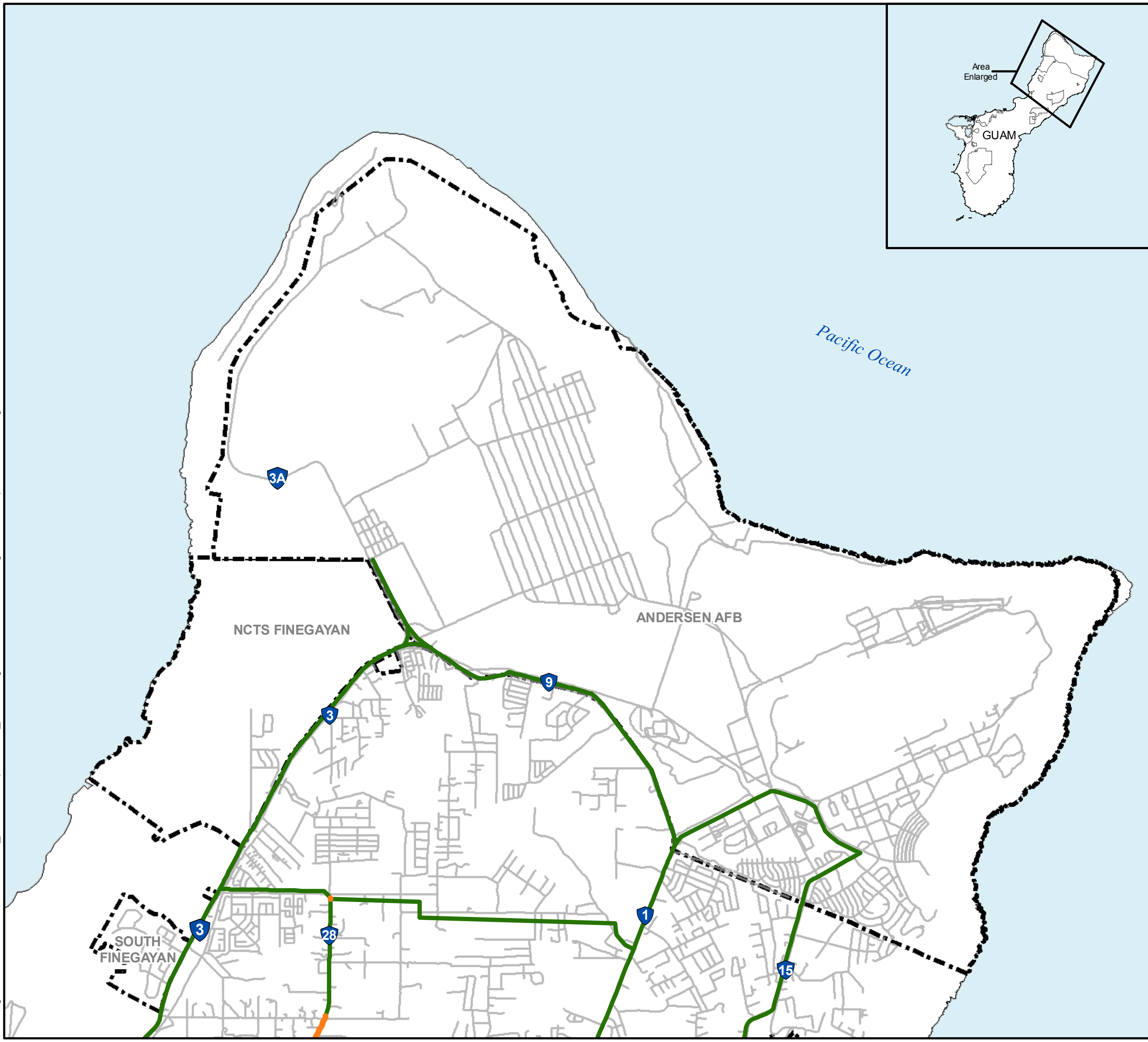


Figure 4.2-64
North Region–
2014 p.m. Peak
Congestion Levels –
No-Action Alternative

Legend

V/C Ratio
- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use
- Streets
- Military Installation

N
W E
S

Feet
0 1,450 2,900
0 400 800
Meters

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-65. Central Region - 2014 a.m. Peak Congestion Levels- No-Action Alternative.mxd

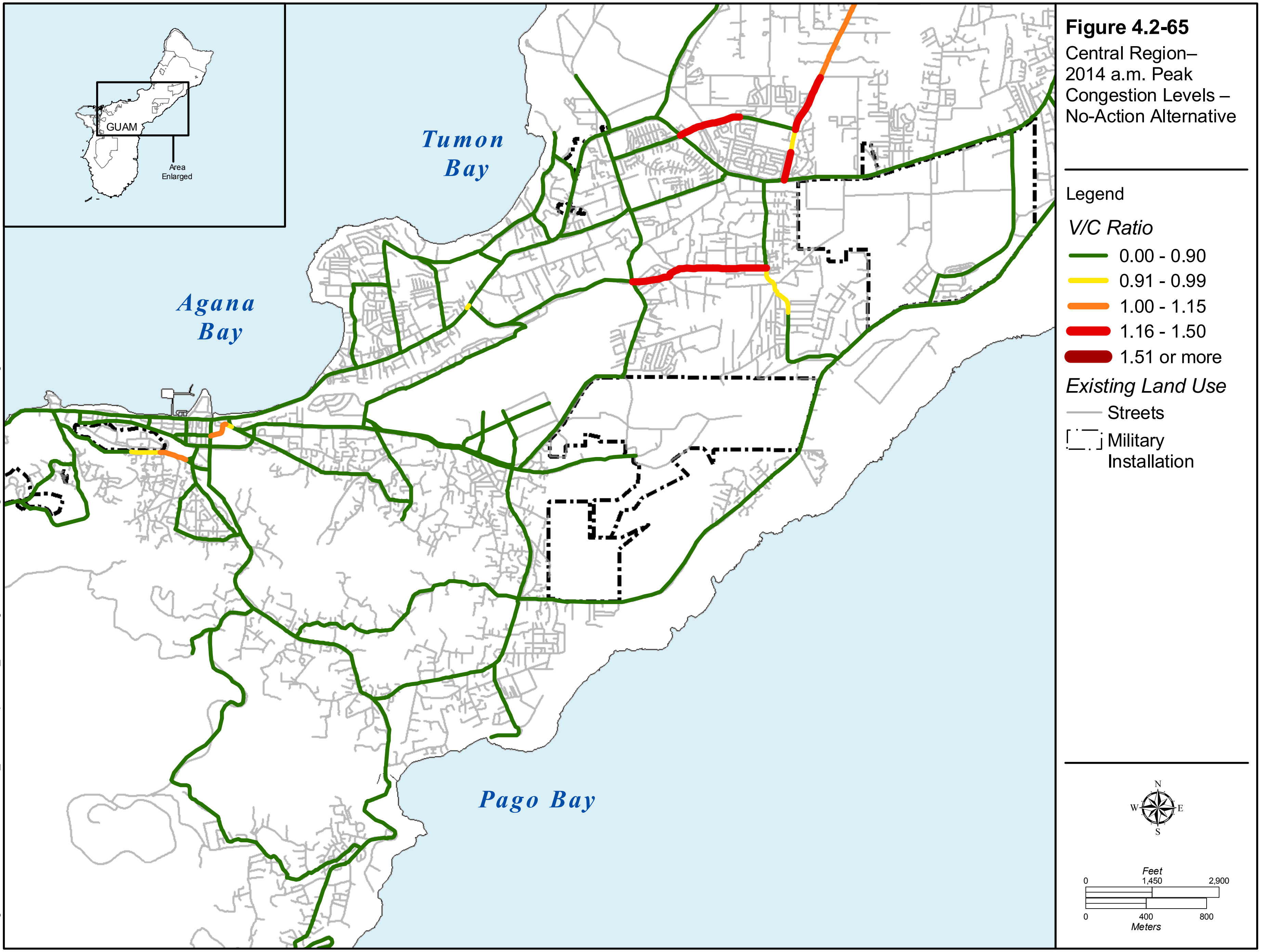


Figure 4.2-65
Central Region–2014 a.m. Peak Congestion Levels – No-Action Alternative

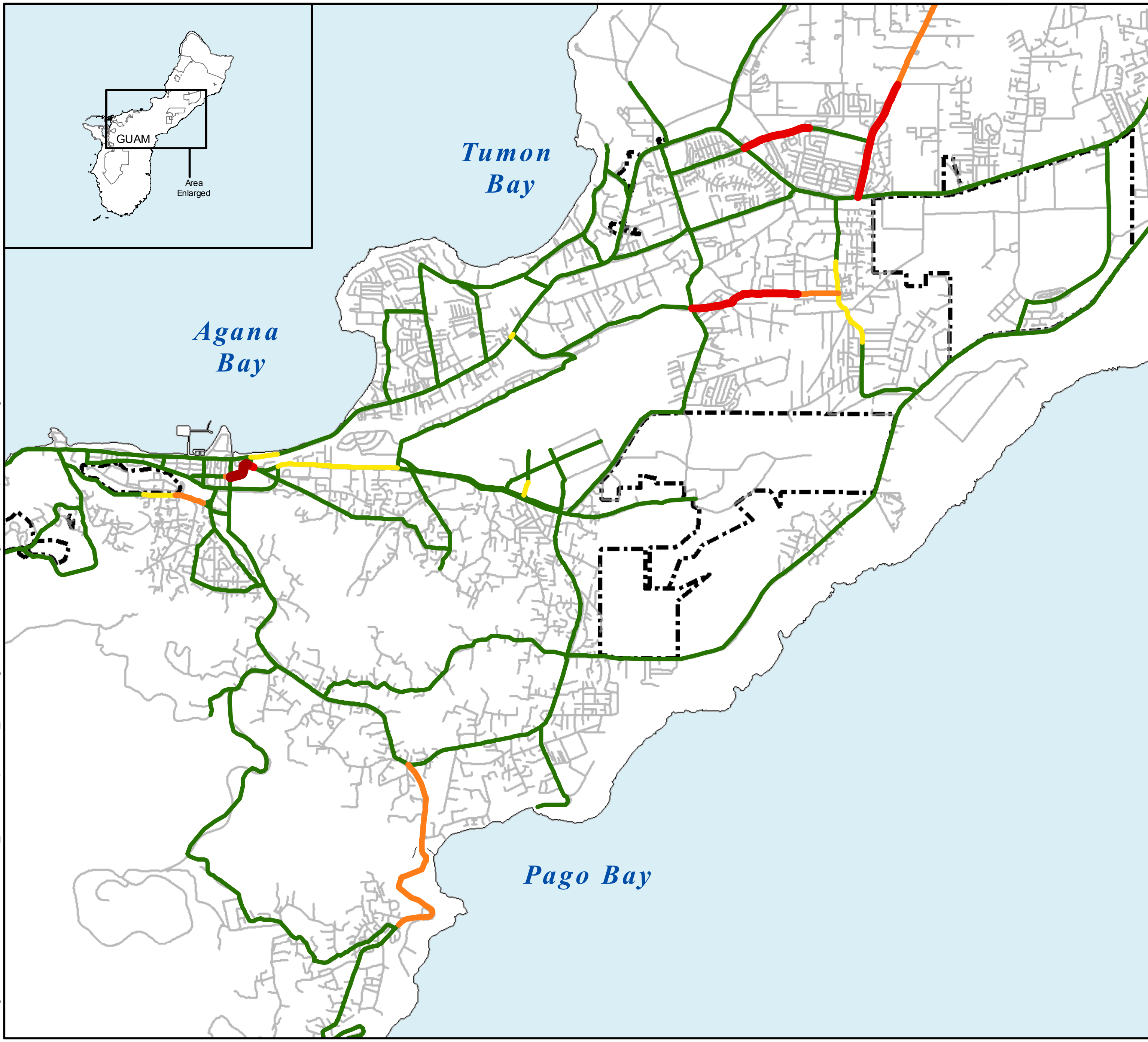


Figure 4.2-66
Central Region–2014 p.m. Peak Congestion Levels – No-Action Alternative

Legend

V/C Ratio
- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use
- Streets
- Military Installation

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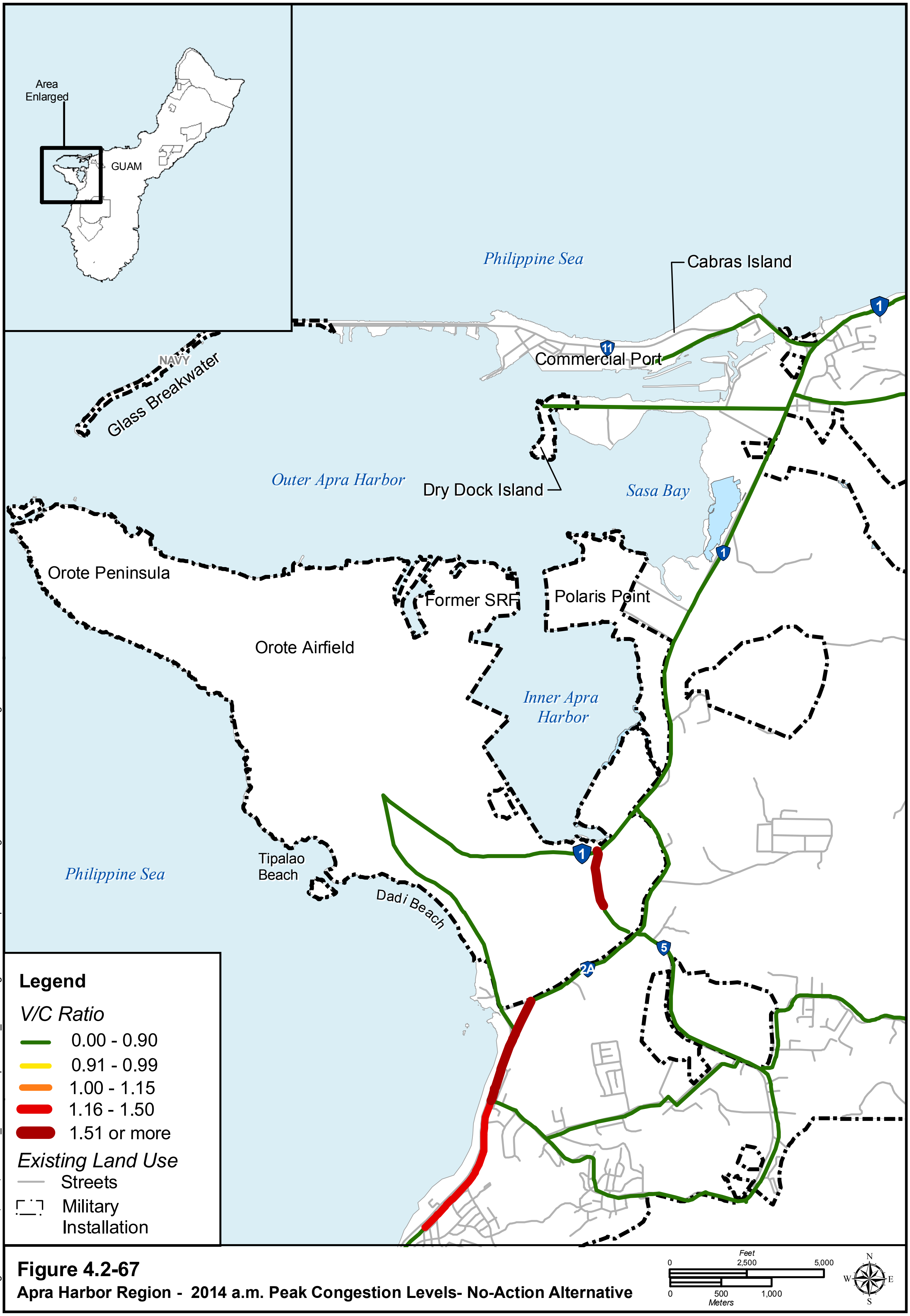


Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4192_MXDs\Figure 4.2-67. Apra Harbor Region - 2014 a.m. Peak Congestion Levels- No-Action Alternative.mxd

Figure 4.2-67
Apra Harbor Region - 2014 a.m. Peak Congestion Levels- No-Action Alternative

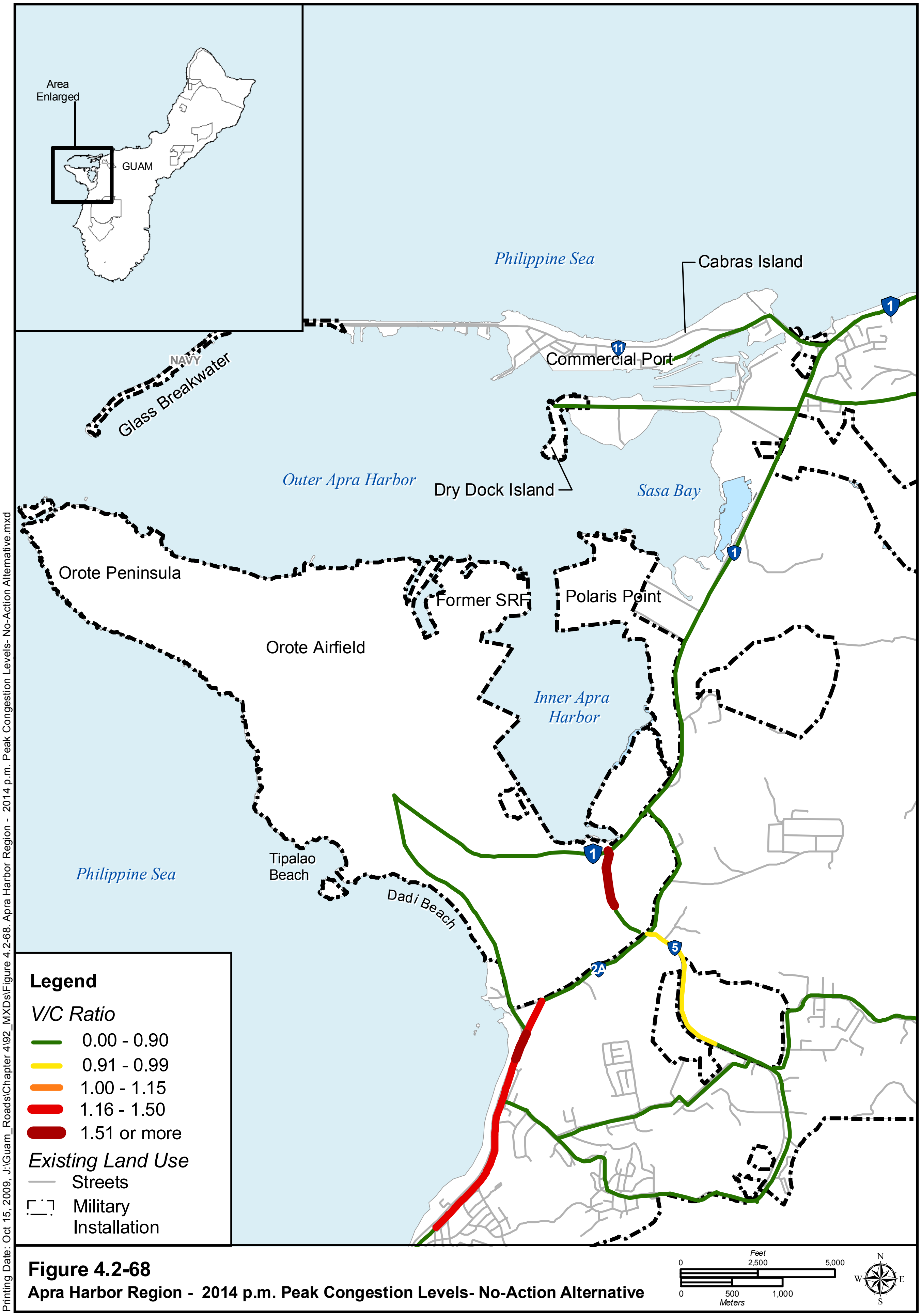


Figure 4.2-68
Apra Harbor Region - 2014 p.m. Peak Congestion Levels- No-Action Alternative

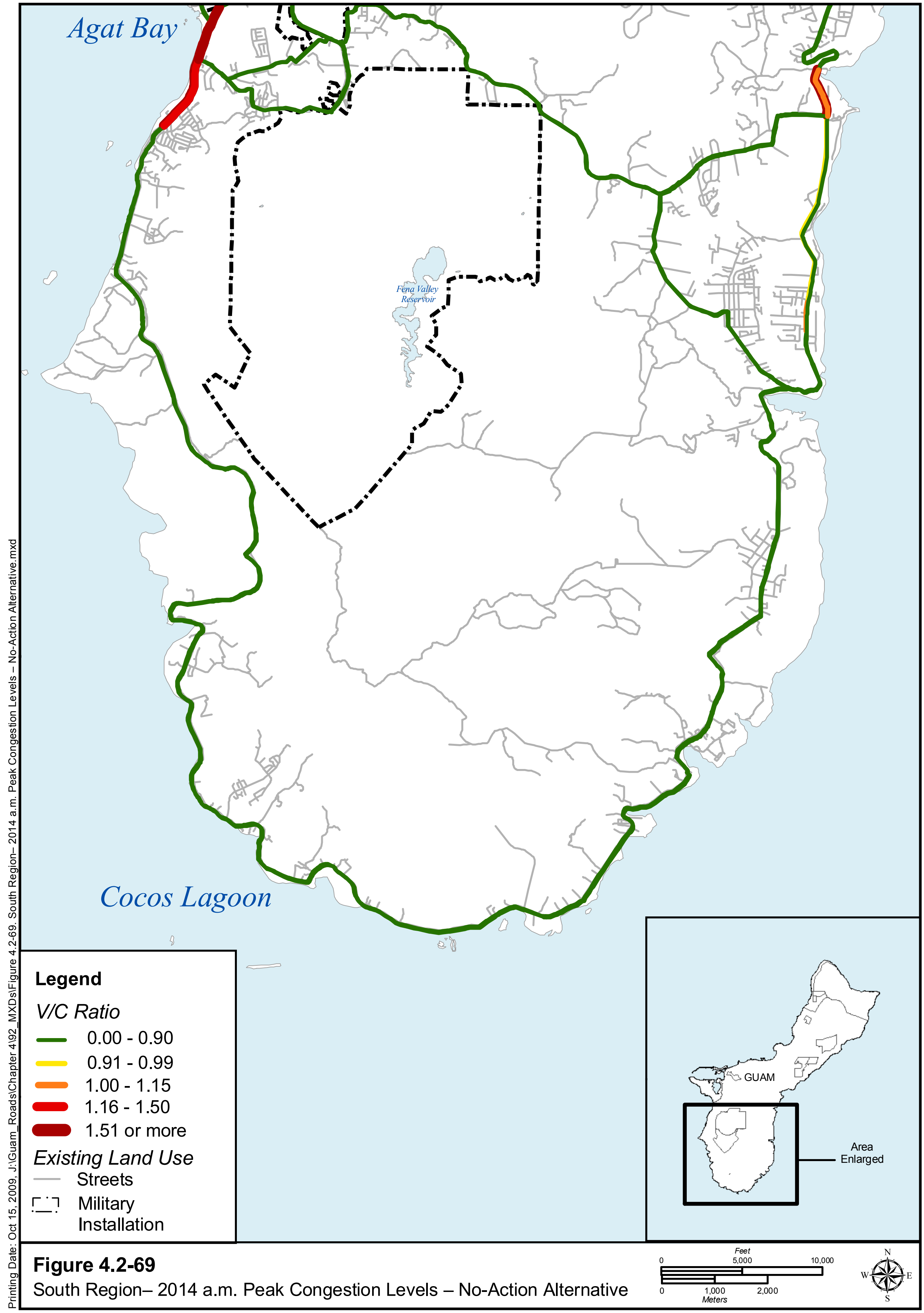


Figure 4.2-69
South Region– 2014 a.m. Peak Congestion Levels – No-Action Alternative

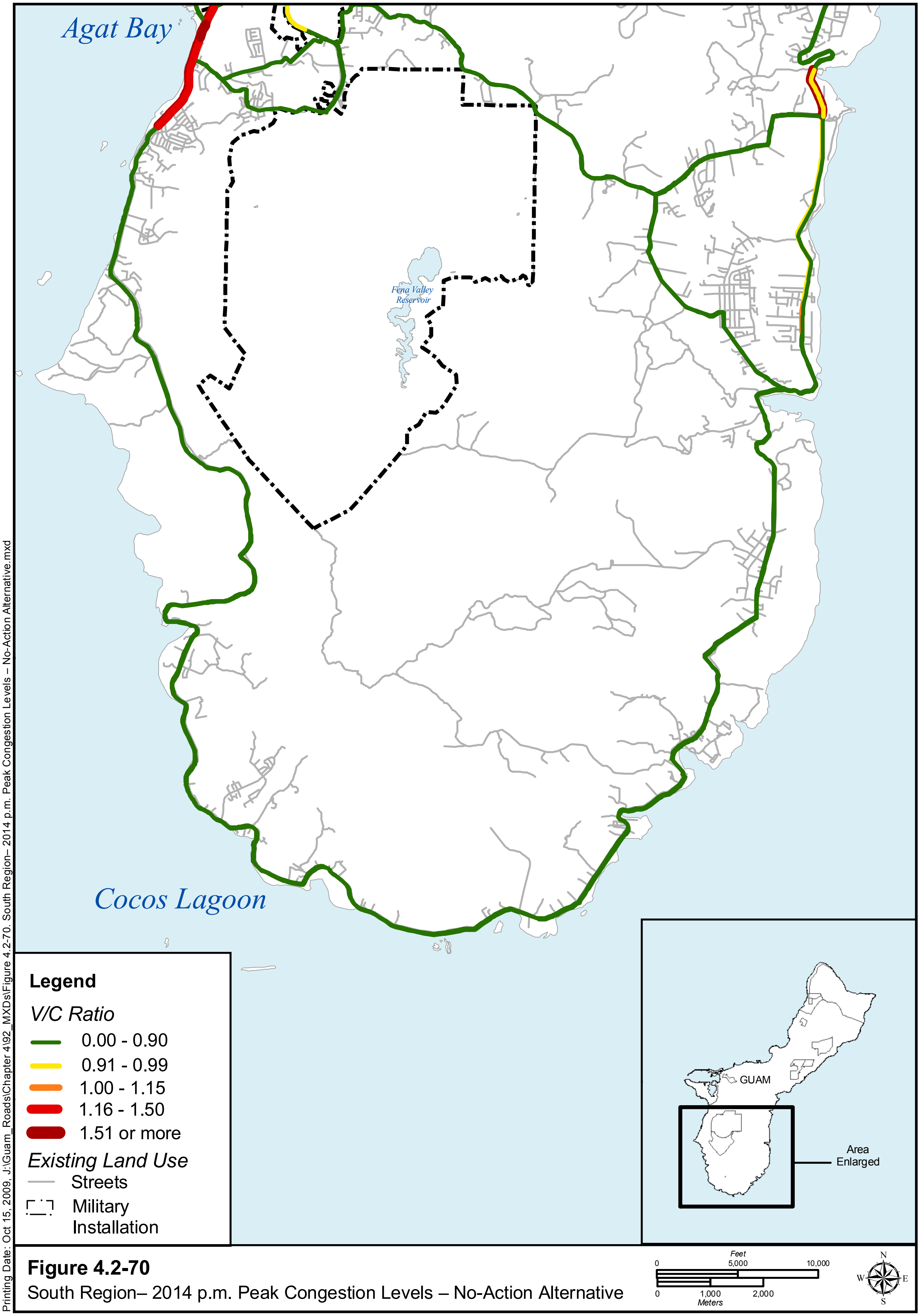


Figure 4.2-70
South Region– 2014 p.m. Peak Congestion Levels – No-Action Alternative

There is a noticeable difference between the no-action and Alternatives 1 and 3 in terms of LOS in 2014. Island-wide, there are 12 intersections with the no-action that have LOS F in both the a.m. and p.m. peak hours in 2014. For Alternatives 1 and 2, this number increases to 24 intersections in 2014; for Alternative 3, 23 intersections; and, for Alternative 8, 22 intersections. This is due to the proposed action, which increases the population and number of vehicles on the island, especially during peak construction time, which would occur in 2014. In addition, in 2014, the widening of Routes 25 and 26 have not been constructed; therefore, affecting the intersection analysis.

Table 4.2-30. No-Action Alternative Future Level of Service and Delay Results

	2014			
	a.m. Peak Hour		*p.m. Peak Hour*	
	LOS	*Delay Seconds*	*LOS*	*Delay Seconds*
Signalized*				
Route 1/9	C	21.8	B	19.5
Route 1/29	D	52.2	C	32.5
Route 1/28	F	207.3	F	120.7
Route 1/26	C	21.0	F	84.1
Route 1/27	F	1213.9	F	514.1
Route 1/27A	D	37.0	E	58.4
Route 1/3	F	113.5	F	191.7
Route 1/16	C	27.7	F	143.7
Route 1/14 (North San Vitoris)	F	102.8	D	53.7
Route 1/14A	F	205.8	F	155.4
Route 1/10A	F	89.6	F	207.8
Route 1/14B	E	77.6	D	44.3
Route 1/14 (ITC)	E	70.3	F	171.3
Route 1/30	F	371.7	F	263.5
Route 1/8	C	29.0	D	46.4
Route 1/4	C	27.1	C	30.1
Route 1/6 (westerly)	B	10.5	B	12.8
Route 1/11	B	16.6	B	19.9
Route 1/6 (Adelup)	C	20.9	D	39.7
Route 1/Polaris Point	A	4.3	A	6.5
Route 1/2A	F	92.1	E	70.5
Route 5/2A	D	44.5	C	20.9
Route 2/12	E	65.4	B	17.6
Route 3/28	C	20.8	B	10.9
Route 4/7A	F	106.0	F	181.3
Route 4/10	E	59.7	E	79.2
Route 4/17	C	25.8	C	24.1
Route 8/33	D	38.4	F	91.5
Route 8/10	E	58.9	F	105.5
Route 10/15	E	79.3	D	53.9
Route 16/27A	C	25.1	B	15.0
Route 16/27	F	207.6	F	303.1
Route 16/10A	F	540.8	F	674.4
Route 26/25**	C	23.9	C	27.8
Unsignalized***				
Route 5/17	C	23.7	C	15.9
Route 3/3A/9	B	11.9	A	9.7
Route 4/4A	C	16.7	C	15.2
Route 7/7A	F	225.7	F	127.7
Route 15/29	F	142.7	F	220.8
Route 17/4A	C	15.9	C	15.6

Table 4.2-30. No-Action Alternative Future Level of Service and Delay Results

	2014			
	a.m. Peak Hour		p.m. Peak Hour	
	LOS	Delay Seconds	LOS	Delay Seconds
Route 26/15	E	43.2	E	46.2
Route 28/27A	F	190.1	F	207.3
Access Points				
Route 3 – Main Cantonment/Commercial Gate	-	-	-	-
Route 3 – South Finegayan/Residential Gate	-	-	-	-
Route 1 – South Andersen Main Gate/(Turner Street)	-	-	-	-
Route 16 – Navy Barrigada (Sabana Barrigada) Residential Gate	-	-	-	-
Route 15 – Barrigada Air Force/(Chada Street)	-	-	-	-
Route 5 – Naval Ordnance Annex/Harmon Road	-	-	-	-

Notes: *Signalized intersection LOS based on average delay for the overall intersection.
**Intersection would be signalized in future no-action scenario.
***Unsignalized intersection LOS based on approach delay on STOP-controlled approach.

Public Transportation Impacts

The impacts to the public transportation system would result from construction delays associated with the roadway improvements included in the no-action alternative. This could affect the LOS for transit riders by increasing travel times, longer headways, and missed transfers.

Pedestrian and Bicycle Impacts

Impacts to the existing pedestrian and bicycle facilities would occur during construction of roadway improvements included in the no-action alternative. This includes a loss of intermittent sidewalk when widening Route 10A. Intersection improvements would impact safe pedestrian and bicycle crossing during the period of reconstruction.

2030

Future Traffic Impacts

Most of the roads included in this study are considered congestion-free in 2030. A summary of future ADT volumes and the V/C ratio for 2030 for the no-action alternative can be found in Table 4.2-31.

The exceptions are Route 28 and small portions of Routes 1 and 10 that have a V/C ratio greater than 1, which indicates that the roadway is congested. The V/C ratios are considerably better compared to Alternatives 1, 3, and 8 in 2030, most noticeably on the following roadways, which all have congestion where there is no congestion in the no-action alternative in 2030:

Alternative 1
- Route 1
- Route 3
- Route 10
- Route 26

Alternative 3
- Route 1
- Route 10
- Route 16
- Route 25
- Route 26

Alternative 8
- Route 1
- Route 3
- Route 10
- Route 15
- Route 25
- Route 26

Table 4.2-31. No-Action Alternative Future ADT and Volume to Capacity Ratio Summary

Roadway	*2030*	
	ADT Summary	*V/C Ratio*
Route 1	Route 1 ranges from 16,000 to 86,000 vpd. Traffic decreases as Route 1 approaches Andersen AFB and gradually increases toward the intersection with Route 4, where it decreases again.	The V/C ratio is generally between 0.00-0.80 on Route 1. There are small sections of the roadway in Tamuning and Andersen South that have V/C ratios between 0.81-0.99. In the p.m. peak hour, a portion of the roadway south of Route 30 has a ratio of 1.00-1.15, which is considered congested.
Route 2A	Route 2A has 33,000 vpd.	The V/C ratio is between 0.00-0.80 on Route 2A. The roadway is not considered congested.
Route 3	Route 3 ranges from 23,000 to 46,000 vpd. Traffic decreases north of the intersection with Route 28.	The V/C ratio is generally between 0.00-0.80 on Route 3 in the a.m. peak hour; however, in the p.m. peak hour, generally south of Route 28, the ratio is 0.81-0.99. The roadway is not considered congested.
Route 5	Route 5 ranges from 10,000 to 16,000 vpd. Traffic decreases as Route 5 approaches the intersection with Route 17.	The V/C ratio is between 0.81-0.99 on Route 5 in the a.m. peak hour; however, in the p.m. peak hour, the ratio is between 1.00-1.15 and is considered congested.
Route 8/8A	Route 8 ranges from 47,000 to 54,000 vpd. There is a decrease in traffic west of the intersection with Sunset Boulevard. Route 8A has 2,900 vpd.	The V/C ratio is generally between 0.00-0.80 on Route 8/8A in the a.m. peak hour; however, in the p.m. peak hour, V/C ratio for Route 8 east of Route 33 is between 1.00-1.15 and is considered congested.
Route 9	Route 9 ranges from 4,400 to 6,900 vpd.	The V/C ratio is between 0.00-0.80 on Route 9. The roadway is not considered congested.
Route 10	Route 10 ranges from 48,000 to 50,000 vpd between Route 8 and Route 15.	The V/C ratio is generally 0.81-0.99 on Route 10; however, there is a portion of Route 10 where the V/C ratio is 1.00-1.15 south of the intersection with Route 15 in the a.m. peak hour. Only that portion of the roadway is considered congested.
Route 11	Route 11 has 7,600 vpd.	The V/C ratio is between 0.00-0.80 on Route 11. The roadway is not considered congested.
Route 12	Route 12 ranges from 2,100 to 5,700 vpd. Traffic increases toward the intersection with Route 2.	The V/C ratio is between 0.00-0.80 on Route 12. The roadway is not considered congested.
Route 15	Route 15 ranges from 7,100 to 21,000 vpd. Traffic increases gradually south to the intersection with Route 10.	The V/C ratio is generally 0.00-0.80 on Route 15; however, there is a portion of Route 15 where the V/C ratio is 0.81-0.99 east of the intersection with Route 10. The roadway is not considered congested.
Route 16	Route 16 ranges from 30,000 to 64,000 vpd. There is a decrease in traffic south of the residential developments south of Route 25.	The V/C ratio is generally 0.00-0.80 on Route 16; however, there is a portion of Route 16 where the V/C ratio is 0.81-0.99 south of the intersection with Route 25. The roadway is not considered congested.
Route 25	Route 25 ranges from 22,000 to 26,000 vpd.	The V/C ratio is generally 0.81-0.99 on Route 25. The roadway is not considered congested.
Route 26	Route 26 ranges from 8,300 to 24,000 vpd. There is a decrease in traffic south of the large residential development just north of the intersection with Route 15.	The V/C ratio is generally between 0.00-0.80 on Route 26. There is a small section of the roadway near the intersection with Route 25 where the V/C ratio is between 0.81-0.99; however, none of the roadway is considered congested.
Route 27	Route 27 ranges from 43,000 to 46,000 vpd between Routes 16 and 1.	The V/C ratio is between 0.00-0.80 on Route 27. The roadway is not considered congested.
Route 28	Route 28 ranges from 11,000 to 22,000 vpd. Traffic generally increases closer to the intersection with Route 1.	The V/C ratio of the southern portion of Route 28 is generally greater than 1, which indicates the road is congested in both the a.m. and p.m. peak hours.
Chalan Lujuna	Chalan Lujuna ranges from 5,400 to 6,100 vpd.	The V/C ratio is between 0.00-0.80 on Chalan Lujuna. The roadway is not considered congested.

Figure 4.2-71 through Figure 4.2-78 show future levels of traffic congestion in the North, Central, Apra Harbor, and South Regions for the a.m. and p.m. peak hours for 2030. The color of the roadways corresponds to the LOS on the road. The green roads have an LOS of A, B, or C; the yellow roads have an LOS of D or E; and the orange and red roads have an LOS of F, with red being the most severely congested.

The results of the future operational analysis are shown in Table 4.2-32 for both the 2030 a.m. and p.m. conditions. As shown in Table 4.2-32, island-wide, there are 24 out of 42 intersections and three out of six access points with LOS F for at least one peak hour, which is considered unacceptable. The following intersections are operating at LOS F in the a.m. and p.m. peak hours in 2030:

- Route 1/28
- Route 1/27
- Route 1/3
- Route 1/14 (North San Vitoris)
- Route 1/14A
- Route 1/10A
- Route 1/14 (ITC)
- Route 1/30
- Route 1/8
- Route 4/7A
- Route 4/10
- Route 8/10
- Route 16/27
- Route 16/10A
- Route 15/29
- Route 26/15
- Route 28/27A
- Access Point at Route 16 – Navy Barrigada Residential Gate

There is also a difference between the no-action and Alternatives 1 and 3 in terms of LOS in 2030. Island wide, there are 17 intersections and one access point in the no-action alternative that have LOS F in both the a.m. and p.m. peak hours in 2030. For Alternative 1, this number decreases to 13 intersections and one access point in 2030; for Alternative 3, 16 intersections and one access point; and for Alternative 8, 14 intersections and one access point. This is due to the proposed action, which includes the roadway widening and intersection improvement projects; however, the results for the no-action alternative in 2030 are worse than 2014 due to natural population growth. That, in conjunction with the departure of the construction population around 2019, accounts for the similarity in the number of intersections operating at LOS F in Alternatives 1, 3, and 8, as compared with the no-action alternative. In addition, the inclusion of the roadway widening projects in 2030 accounts for a lessening in congestion impacts.

Public Transportation Impacts

The impacts to the public transportation system would result from construction delays associated with the roadway improvements included in the no-action alternative. This could affect the LOS for transit riders by increasing travel times, longer headways, and missed transfers.

Pedestrian and Bicycle Impacts

Impacts to the existing pedestrian and bicycle facilities would occur during construction of roadway improvements included in the no-action alternative. This includes a loss of intermittent sidewalk during the widening of Routes 8 and 26, as well as the removal of a shoulder along Route 1. Intersection improvements would impact safe pedestrian and bicycle crossing during the period of reconstruction.

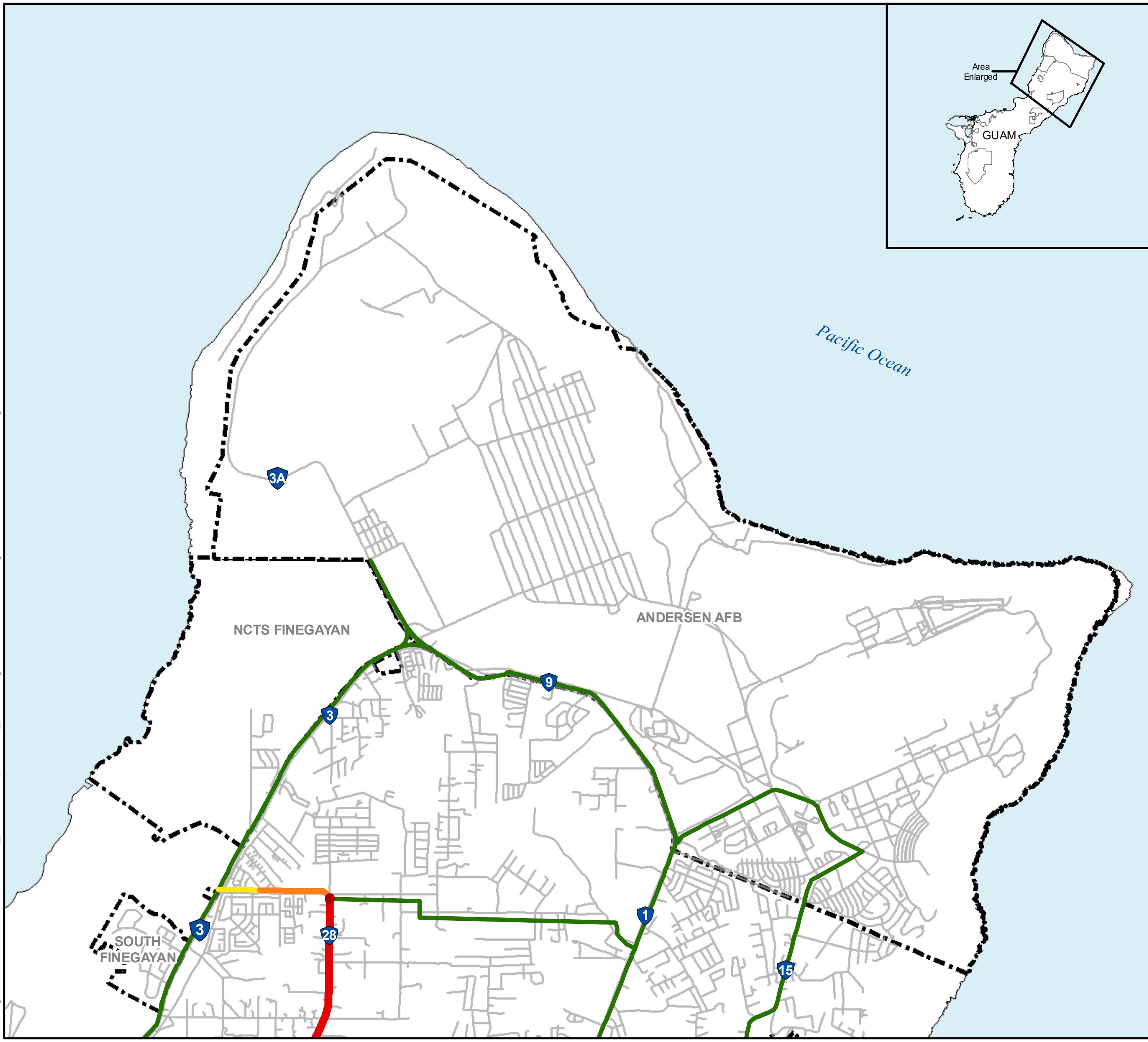


Figure 4.2-71
North Region–
2030 a.m. Peak
Congestion Levels –
No-Action Alternative

Legend

V/C Ratio

- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use

- Streets
- Military Installation

N E S W

Feet
0 1,450 2,900
0 400 800
Meters

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-71. North Region - 2030 a.m. Peak Congestion Levels- Alternative No-Action Alternative.mxd

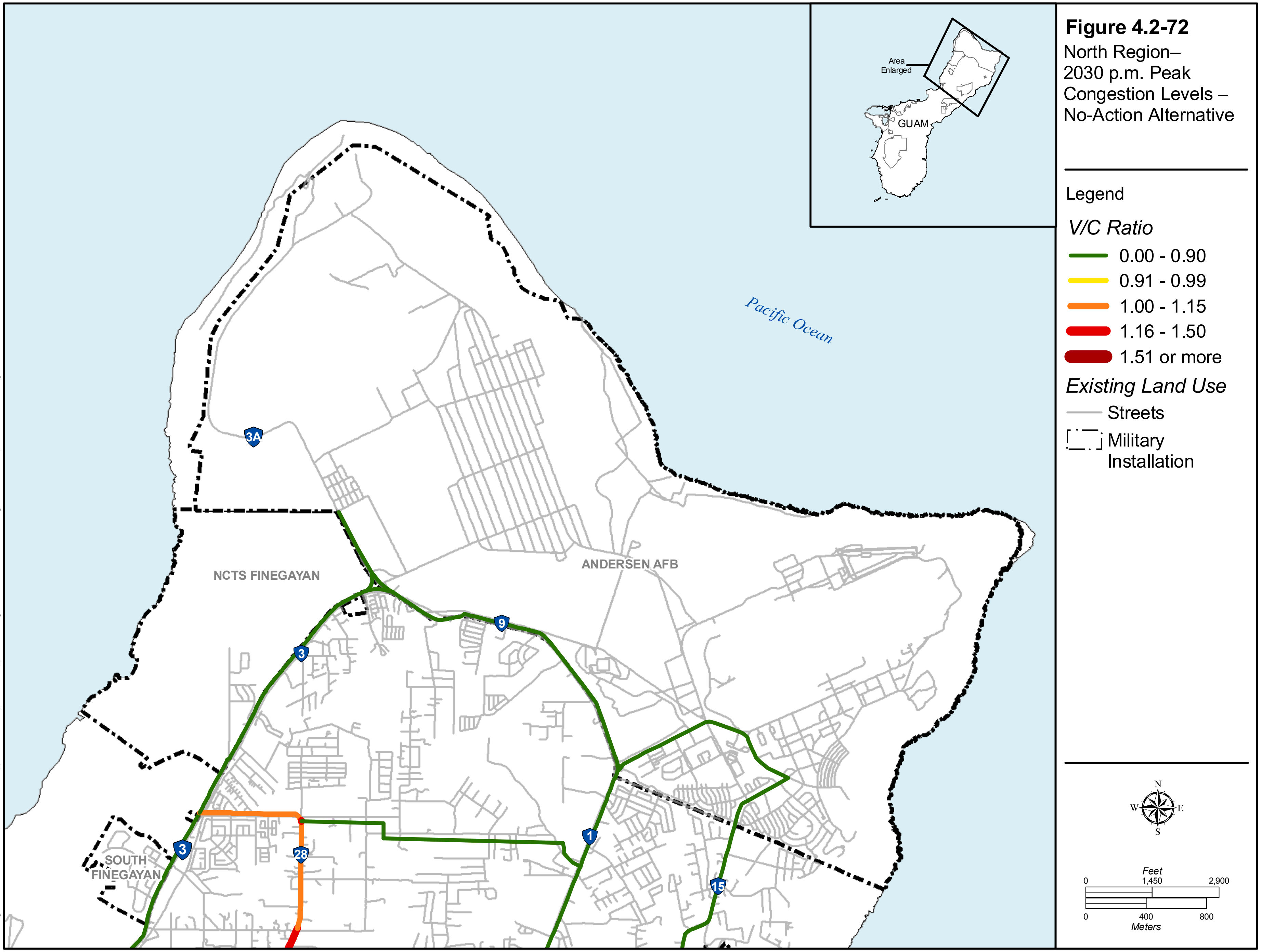


Figure 4.2-72
North Region–
2030 p.m. Peak
Congestion Levels –
No-Action Alternative

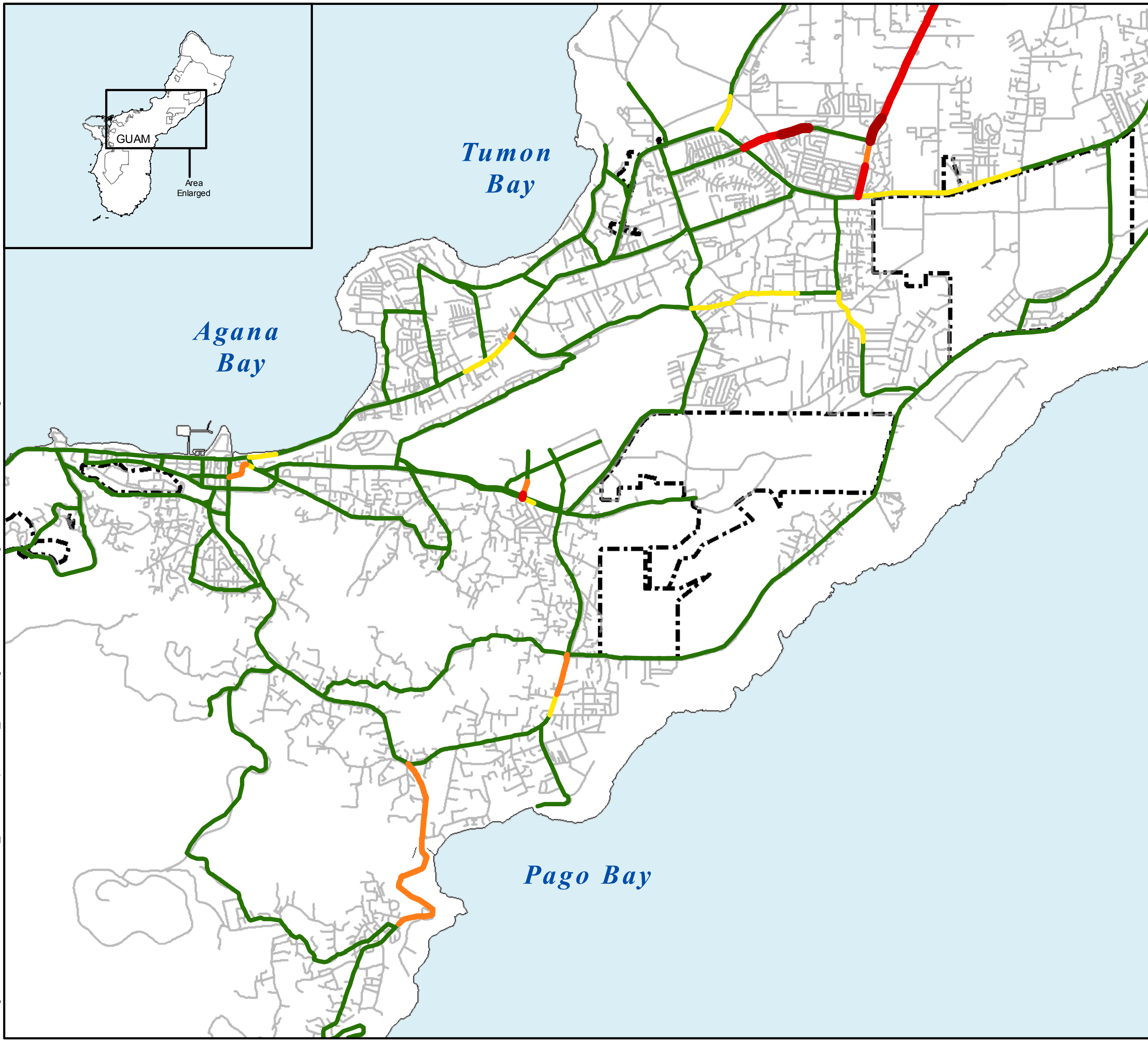


Figure 4.2-73
Central Region–
2030 a.m. Peak
Congestion Levels –
No-Action Alternative

Legend

V/C Ratio

- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use

- Streets
- Military Installation

N E S W

Feet
0 1,450 2,900

0 400 800
Meters

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-73. Central Region - 2030 a.m. Peak Congestion Levels- No-Action Alternative.mxd

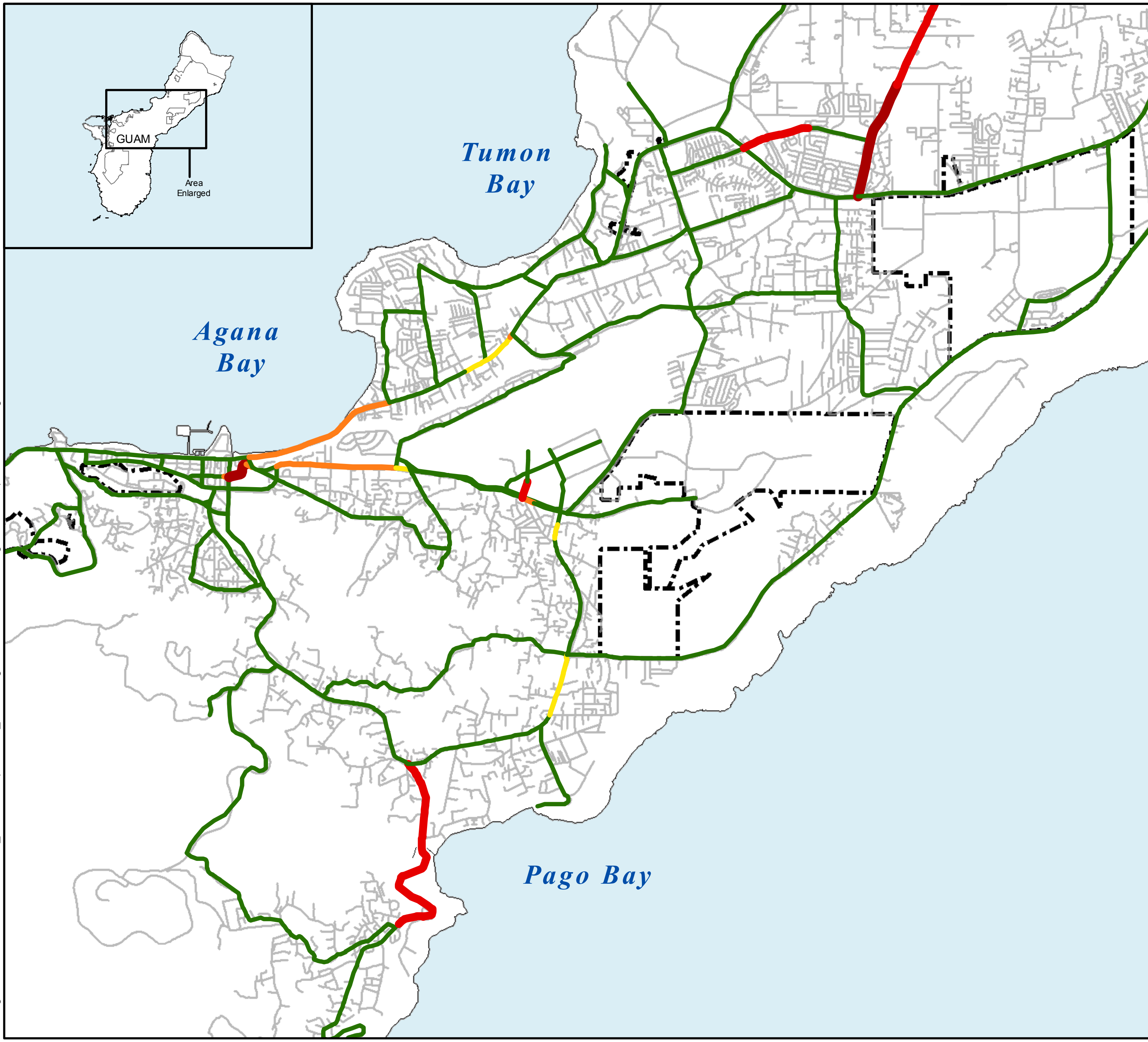


Figure 4.2-74
Central Region–2030 p.m. Peak Congestion Levels – No-Action Alternative

Legend

V/C Ratio
- 0.00 - 0.90
- 0.91 - 0.99
- 1.00 - 1.15
- 1.16 - 1.50
- 1.51 or more

Existing Land Use
- Streets
- Military Installation

N
W E
S

Feet
0 1,450 2,900
0 400 800
Meters

Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-74. Central Region - 2030 p.m. Peak Congestion Levels- No-Action Alternative.mxd

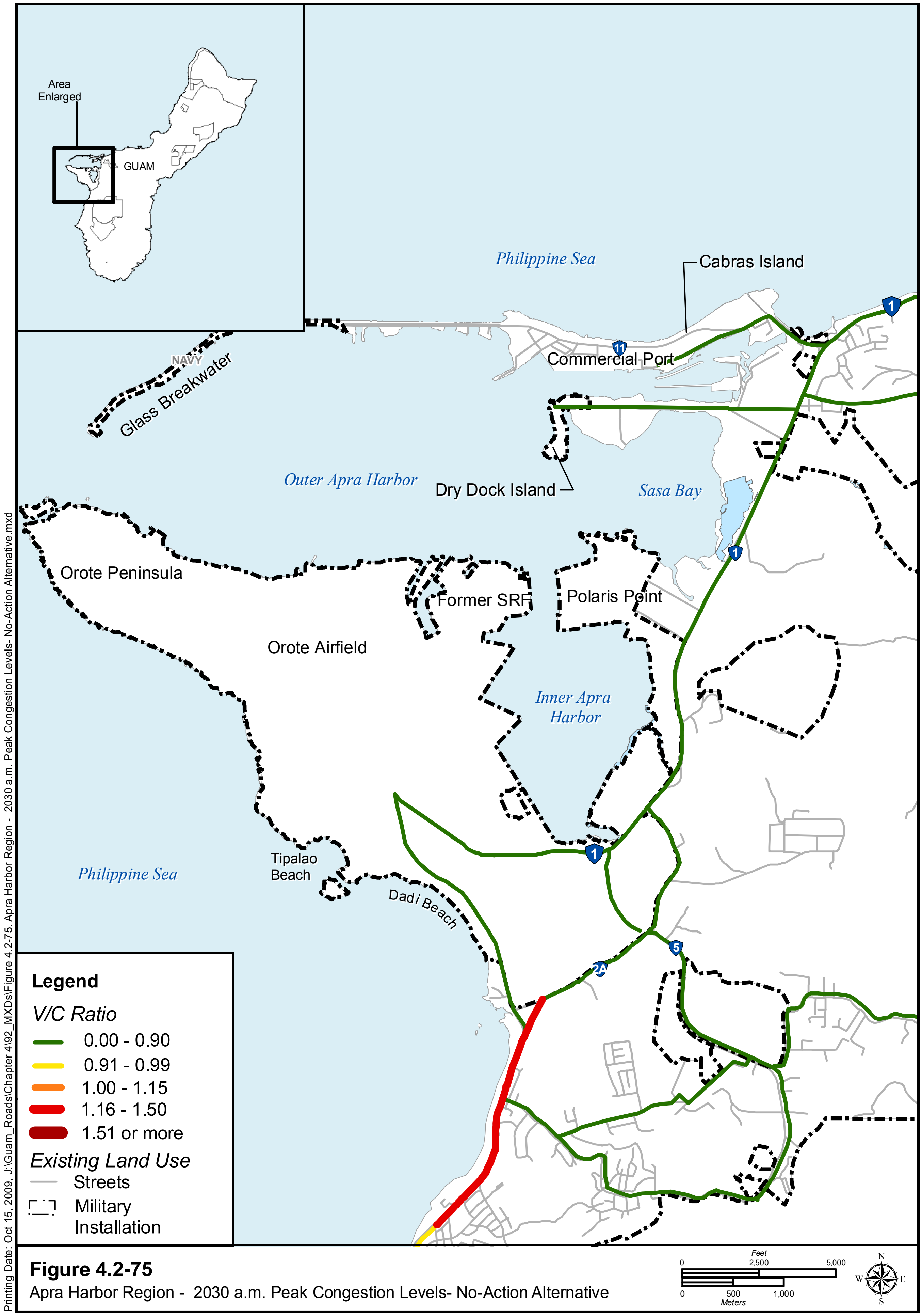


Figure 4.2-75
Apra Harbor Region - 2030 a.m. Peak Congestion Levels- No-Action Alternative

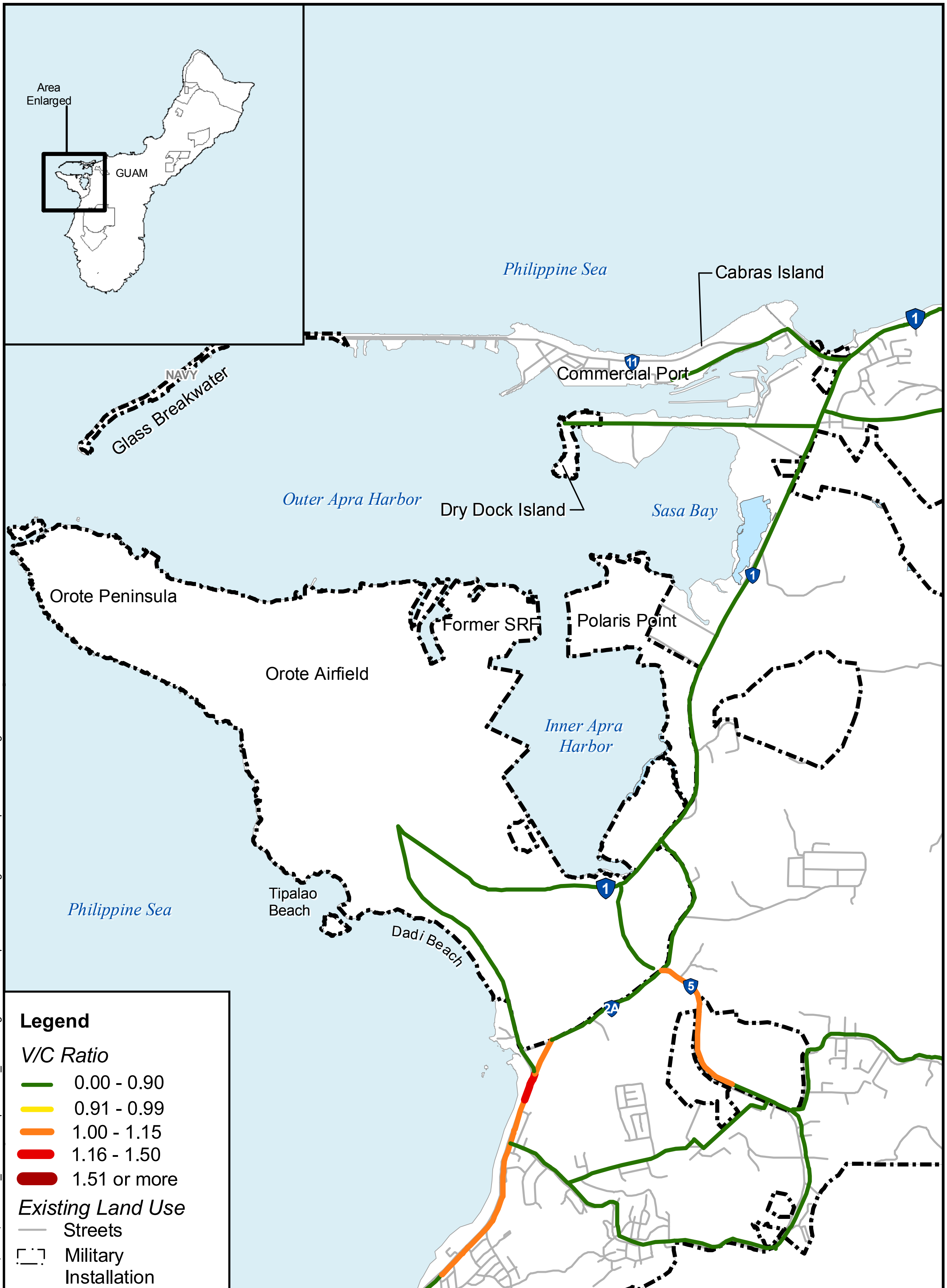
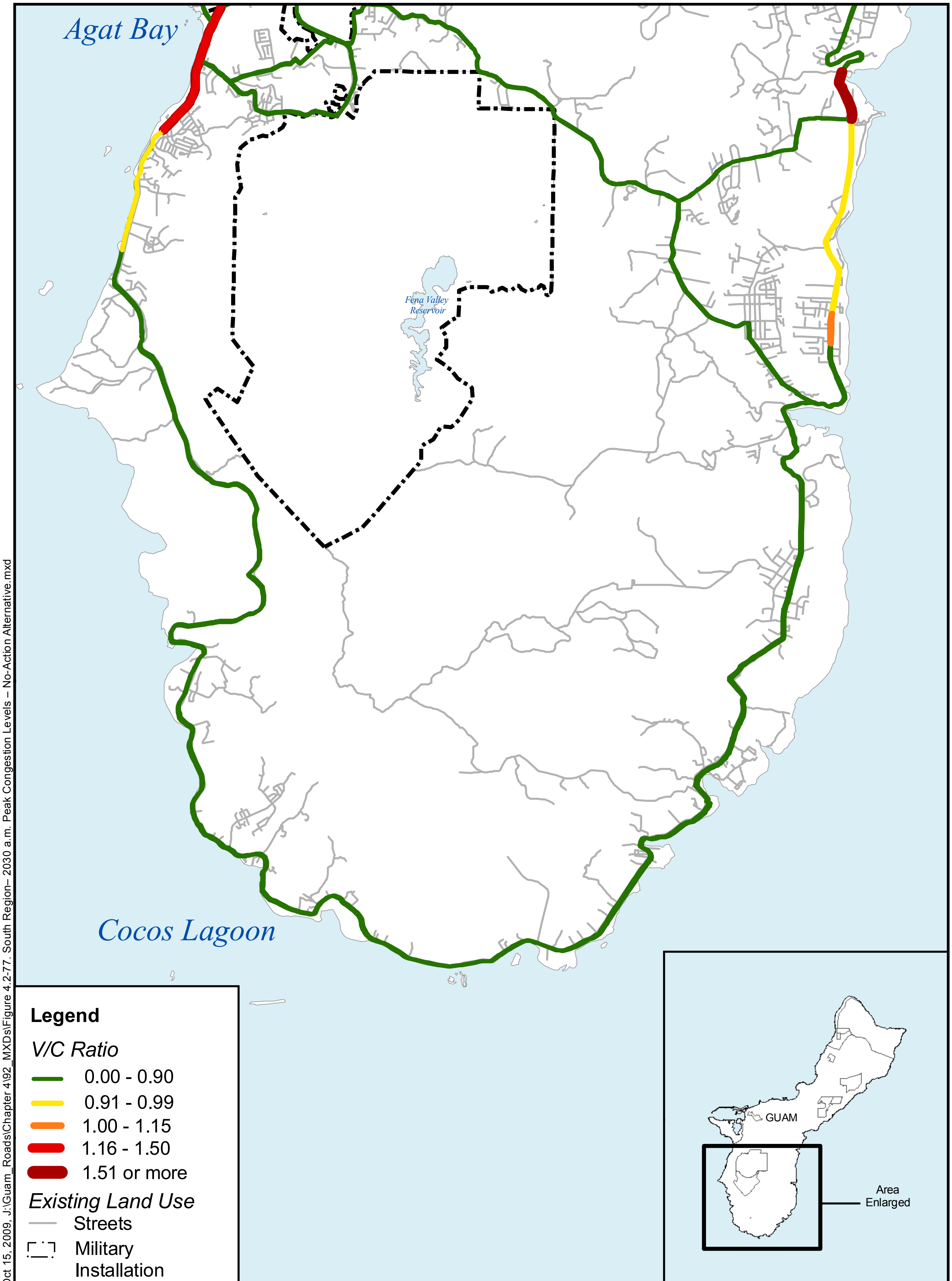


Figure 4.2-76
Apra Harbor Region - 2030 p.m. Peak Congestion Levels- No-Action Alternative



Printing Date: Oct 15, 2009, J:\Guam_Roads\Chapter 4\92_MXDs\Figure 4.2-77. South Region– 2030 a.m. Peak Congestion Levels – No-Action Alternative.mxd

Figure 4.2-77
South Region– 2030 a.m. Peak Congestion Levels – No-Action Alternative

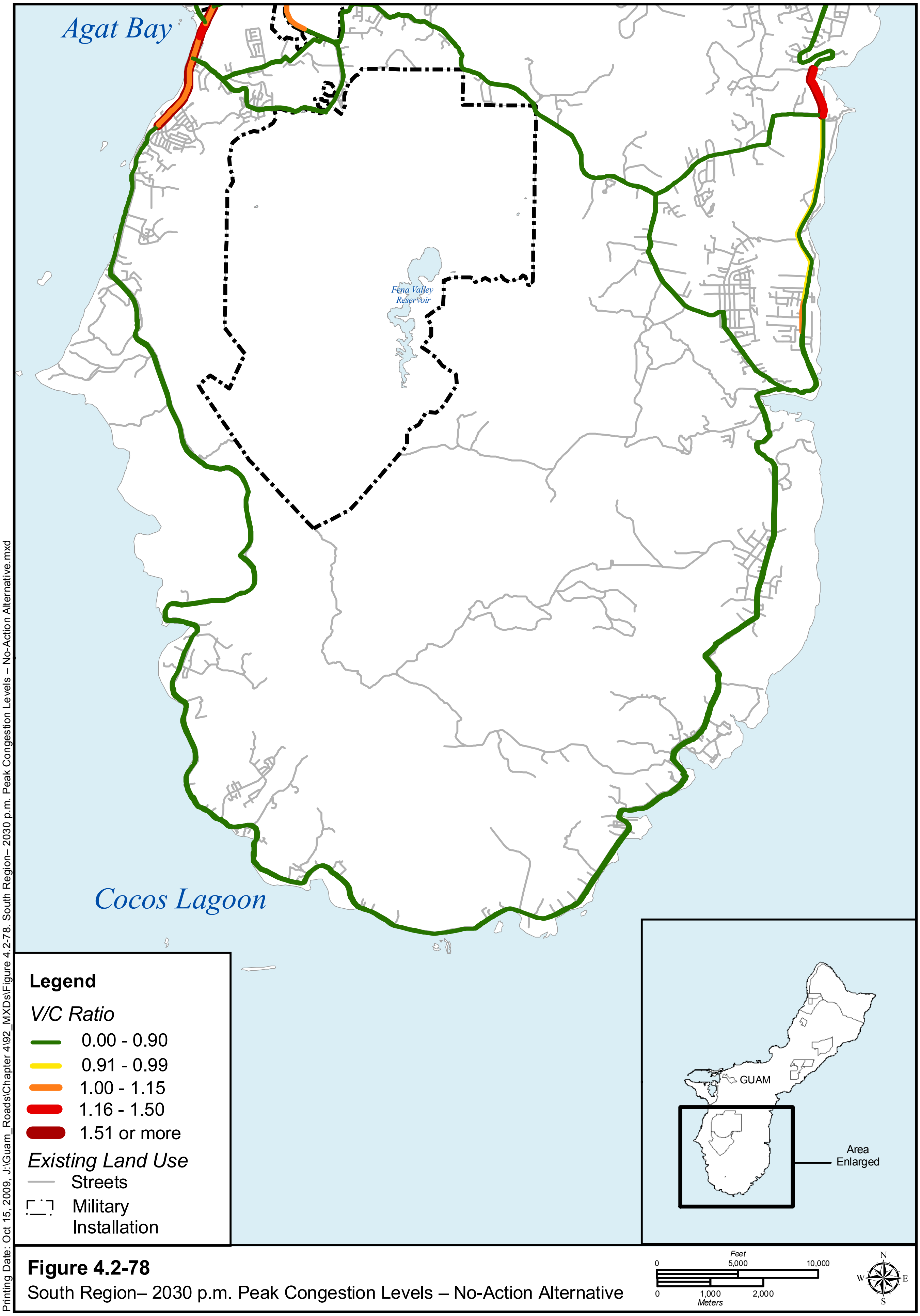


Figure 4.2-78
South Region– 2030 p.m. Peak Congestion Levels – No-Action Alternative

Table 4.2-32. No-Action Alternative Future Level of Service and Delay Results

	2030			
	a.m. Peak Hour		*p.m. Peak Hour*	
	LOS	*Delay Seconds*	*LOS*	*Delay Seconds*
Signalized*				
Route 1/9	B	15.8	B	14.6
Route 1/29	F	87.6	E	60.5
Route 1/28	F	226.2	F	157.7
Route 1/26	E	75.8	F	229.8
Route 1/27	F	157.2	F	533.7
Route 1/27A	E	67.2	F	189.5
Route 1/3	F	158.4	F	306.9
Route 1/16	D	52.2	F	305.5
Route 1/14 (North San Vitoris)	F	82.8	F	361.2
Route 1/14A	F	124.1	F	259.9
Route 1/10A	F	82.9	F	117.2
Route 1/14B	E	60.5	F	91.8
Route 1/14 (ITC)	F	93.3	F	212.5
Route 1/30	F	273.9	F	440.9
Route 1/8	F	107.6	F	94.1
Route 1/4	D	43.4	D	38.6
Route 1/6 (westerly)	A	7.8	B	15.6
Route 1/11	B	18.8	C	26.8
Route 1/6 (Adelup)	C	24.1	F	91.7
Route 1/Polaris Point	A	4.3	A	6.2
Route 1/2A	E	58.8	E	55.5
Route 5/2A	D	53.0	C	22.7
Route 2/12	F	83.1	C	25.4
Route 3/28	B	17.8	C	21.4
Route 4/7A	F	298.8	F	196.9
Route 4/10	F	95.5	F	115.9
Route 4/17	D	46.6	D	48.2
Route 8/33	C	31.2	F	147.3
Route 8/10	F	122.0	F	116.5
Route 10/15	D	49.7	F	101.1
Route 16/27A	C	24.3	C	26.4
Route 16/27	F	275.1	F	486.4
Route 16/10A	F	874.2	F	208.7
Route 26/25**	F	270.1	E	71.7
Unsignalized***				
Route 5/17	D	28.9	E	47.8
Route 3/3A/9	A	9.5	B	10.1
Route 4/4A	D	27.9	C	21.2
Route 7/7A	F	77.7	E	114.5
Route 15/29****	F	NA	F	NA
Route 17/4A	C	17.0	C	17.9
Route 26/15	F	134.8	F	2494.6
Route 28/27A	F	353.1	F	437.8
Access Points				
Route 3 - Main Cantonment/Commercial Gate	C	21.4	C	15.7
Route 3 – Main Cantonment/Residential Gate	D	32.1	C	20.7

Table 4.2-32. No-Action Alternative Future Level of Service and Delay Results

	2030			
	a.m. Peak Hour		*p.m. Peak Hour*	
	LOS	*Delay Seconds*	*LOS*	*Delay Seconds*
Route 3 - South Finegayan/Residential Gate	C	22.1	F	51.4
Route 1 – South Andersen Main Gate/(Turner Street)	B	13.5	F	458.6
Route 16 – Navy Barrigada (Sabana Barrigada) Residential Gate****	F	NA	F	NA
Route 15 – Barrigada Air Force/(Chada Street)	E	50.0	E	44.4
Route 5 – Naval Ordnance Annex/Harmon Road	A	9.7	A	9.8

Notes: *Signalized intersection LOS based on average delay for the overall intersection.
**Intersection would be signalized in future no-action scenario.
***Unsignalized intersection LOS based on approach delay on STOP-controlled approach.
****Delay exceeded maximum calculated value.

4.2.2.6 On Base Roadways Summary of Impacts

A summary of potential impacts is described in Table 4.2-33

Table 4.2-33 – Summary of Potential Impacts by Alternative for On Base Roads

Potentially Impacted Resource	*Alternative 1*	*Alternative 2**	*Alternative 3*	*Alternative 8*
North				
Andersen: Construction	SI	SI	SI	SI
Andersen: Operation	SI	SI	SI	SI
Finegayan: Construction	SI	SI	SI	SI
Finegayan: Operation	SI	SI	SI	SI
Central				
Andersen South: Construction	LSI	LSI	LSI	LSI
Andersen South: Operation	LSI	LSI	LSI	LSI
Barrigada: Construction	LSI	LSI	LSI	LSI
Barrigada: Operation	LSI	LSI	LSI	LSI
South				
Navy Base: Construction	SI	SI	SI	SI
Navy Base Operation	SI	SI	SI	SI
NMS: Construction	NI	NI	NI	NI
NMS: Operation	NI	NI	NI	NI

Legend: NI= No Impact, SI = Significant Impact, LSI = Less Than Significant Impact, *Preferred Alternative.

4.2.2.7 Off Base Roadways Summary of Impacts

Table 4.2-32 shows the LOS results for all of the intersections for the following:

- 2008 Existing Conditions
- 2014 No-Action
- 2014 Alternative 1
- 2014 Alternative 3
- 2014 Alternative 8
- 2030 No-Action
- 2030 Alternative 1
- 2030 Alternative 3
- 2030 Alternative 8

Table 4.2-34. Comparison of the No-Action, Alternatives 1 and 2, Alternative 3, and Alternative 8

Overall Intersection Level of Service Analysis Results - Existing Conditions and Alternatives Comparison

S.NO	INTERSECTION	Existing Conditions				2014 No Action				2014 Alternative 1/2				2014 Alternative 3				2014 Alternative 8			
		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
		LOS[1]	Delay[2]	LOS[1]	Delay[2]	LOS[1]	Delay[2]	LOS[1]	Delay[2]	LOS[1]	Delay[2]	LOS[1]	Delay[2]	LOS[1]	Delay[2]	LOS[1]	Delay[2]	LOS[1]	Delay[2]	LOS[1]	Delay[2]
1	ROUTE 1 AND ROUTE 9	C	25.8	D	46.1	B	11.6	B	11.9	C	27.6	D	39.8	C	25.9	D	38.2	C	25.8	D	38.2
2	ROUTE 1 AND ROUTE 29	F	87.4	C	24.0	D	62.2	C	32.5	F	256.2	F	138.7	F	347.0	F	278.8	F	338.4	F	192.3
3	ROUTE 1 AND ROUTE 28	C	30.0	D	40.6	F	207.3	F	120.7	F	359.8	F	301.0	F	256.0	F	275.0	F	275.4	F	252.3
4	ROUTE 1 AND ROUTE 26	C	33.8	E	58.5	C	21.0	F	84.1	F	109.0	F	278.1	F	126.1	F	279.1	F	164.6	F	358.3
5	ROUTE 1 AND ROUTE 27	E	74.6	D	51.8	F	1213.8	F	814.1	F	1830.9	F	928.9	F	1937.3	F	1013.1	F	210.5	F	627.3
6	ROUTE 1 AND ROUTE 27A	D	37.1	F	91.5	D	37.0	E	58.4	E	77.4	F	204.7	F	82.8	E	78.7	F	98.4	F	178
7	ROUTE 1 AND ROUTE 3	F	165.5	E	71.0	F	113.5	F	191.7	F	495.1	F	523.8	F	417.1	F	367.1	F	112.9	F	106.8
8	ROUTE 1 AND ROUTE 16	C	32.6	E	58.6	C	27.7	F	140.7	F	126.4	F	306.2	F	277.6	F	386.7	F	180.3	F	144.6
9	ROUTE 1 AND ROUTE 14 (North San Vitoris)	C	33.1	F	92.9	F	102.8	D	63.7	F	176.5	F	134.8	F	187.8	F	96.2	F	178.9	F	146.8
10	ROUTE 1 AND ROUTE 14A	D	52.1	E	69.6	F	226.8	F	158.4	F	313.6	F	326.8	F	307.3	F	338.1	F	312.4	F	329.3
11	ROUTE 1 AND ROUTE 10A	F	96.2	F	81.9	F	89.6	F	207.9	F	241.5	F	376.7	F	188.1	F	198.7	F	182.1	F	221.3
12	ROUTE 1 AND ROUTE 14B	D	43.3	C	30.6	E	77.6	D	44.3	F	188.4	F	159.1	F	149.4	F	144.0	F	153.4	F	146.2
13	ROUTE 1 AND ROUTE 14 (ITC)	D	51.4	F	116.2	E	70.3	F	171.3	F	234.7	F	428.6	F	127.6	F	294.6	F	158.9	F	318.3
14	ROUTE 1 AND ROUTE 30	E	67.8	D	51.5	F	371.7	F	262.5	F	408.1	F	568.6	F	348.3	F	466.2	F	365	F	336.6
15	ROUTE 1 AND ROUTE 8	B	19.3	C	34.1	C	29.0	D	46.4	F	216.2	F	143.5	F	162.2	F	164.3	F	290.1	F	199.7
16	ROUTE 1 AND ROUTE 4	C	23.2	C	20.4	C	27.1	C	30.1	C	24.3	D	44.6	C	24.8	D	40.1	C	26.4	D	36
17	ROUTE 1 AND ROUTE 6 (Adelup)	B	19.9	E	59.9	C	20.9	D	39.7	D	36.2	F	108.9	C	34.9	F	110.7	C	34.5	F	114
18	ROUTE 1 AND ROUTE 11	B	14.5	C	22.2	B	16.6	B	19.9	C	25.4	E	67.1	C	25.4	E	63.1	C	25.3	E	67.7
19	ROUTE 1 AND ROUTE 6 (Westerly)	B	10.0	C	20.1	B	10.5	B	12.8	D	53.2	C	23.6	D	50.7	B	17.1	D	49.5	C	24.1
20	ROUTE 1 AND POLARIS POINT	C	2.1	A	3.9	A	4.3	A	6.5	A	3.8	A	4.3	A	3.2	A	2.4	A	4.6	A	5.5
21	ROUTE 1 AND ROUTE 2A	B	15.9	C	29.1	F	92.1	E	70.6	F	94.1	F	82.1	F	89.7	E	68.3	F	89.4	E	59.8
22	ROUTE 5 AND ROUTE 2A	D	37.6	C	33.9	D	44.5	C	20.9	E	79.4	D	36.9	E	69.4	C	21.5	E	69.6	C	22.9
23	ROUTE 5 AND ROUTE 17	B	12.1*	B	11.0*	C	23.7*	C	15.9*	C	13.1*	C	29.2*	B	13.3*	C	18.3*	B	13.1*	C	17.1*
24	ROUTE 2 AND ROUTE 12	C	26.0	B	19.2	E	65.4	B	17.6	F	135.9	C	26.0	C	29.0	C	25.5	C	31.6	C	24.9
25	ROUTE 3 AND ROUTE 3A	B	10.1*	A	9.6*	B	11.9*	A	9.7*	C	19.7*	F	74.3	F	142.7*	F	565.0*	F	179.0*	F	561.5*
26	ROUTE 3 AND ROUTE 28	C	26.8	B	17.4	C	29.8	B	19.9	F	85.1	F	227.1	F	96.2	F	92.8	E	57.3	F	131.1
27	ROUTE 4 AND ROUTE 7A	C	23.2	E	57.8	F	106.0	F	181.3	F	270.5	F	989.8	F	274.6	F	1007.5	F	273.8	F	841.8
28	ROUTE 4 AND ROUTE 10	E	64.5	E	59.5	E	69.7	E	79.2	F	150.2	F	166.1	F	164.5	E	61.4	F	160.5	F	82.9
29	ROUTE 4 AND ROUTE 17	C	24.9	C	21.2	C	25.8	C	24.1	C	35.0	D	42.6	C	34.5	D	39.4	C	33.9	C	34.3
30	ROUTE 4 AND ROUTE 4A	C	16.2*	B	11.4*	C	16.7*	C	18.2*	C	22.9*	C	17.1*	C	21.7*	B	17.0*	C	23.3*	C	17.2*
31	ROUTE 7 AND ROUTE 7A	C	15.1*	C	19.9*	F	225.7*	F	127.7*	F	167.7*	F	295.7*	F	173.9*	F	290.0*	F	174.7*	F	290.0*
32	ROUTE 8 AND ROUTE 33	F	91.6	F	162.3	D	38.4	F	91.5	E	64.8	F	146.2	C	32.6	D	46.2	D	38.7	E	72.1
33	ROUTE 8 AND ROUTE 10	F	140.1	E	67.5	E	68.9	F	105.5	F	278.7	F	336.0	F	227.6	F	317.6	F	361.4	F	474.5
34	ROUTE 10 AND ROUTE 15	F	80.8	E	56.3	E	73.3	D	53.9	F	166.4	F	144.7	F	176.5	F	139.6	F	260.9	F	235.5
35	ROUTE 15 AND ROUTE 29	D	30.7*	C	18.3*	F	142.7*	F	220.8*	F	NA*	F	830.9*	C	27.0	C	22.8	C	22.9	C	24.1
36	ROUTE 16 AND ROUTE 27A	C	34.4	C	25.9	C	26.1	B	16.0	C	26.3	D	61.9	F	126.0	F	175.8	C	28.9	E	76
37	ROUTE 16 AND ROUTE 27	F	112.4	F	89.4	F	207.6	F	303.1	F	389.3	F	601.5	F	534.1	F	485.7	F	469.6	F	867.3
38	ROUTE 16 AND ROUTE 10A	F	125.4	F	89.3	F	840.8	F	674.4	F	250.1	F	566.1	F	232.4	F	149.5	F	656.5	F	494.6
39	ROUTE 17 AND ROUTE 4A	B	14.0*	B	11.4*	C	15.9*	C	15.6*	B	12.5*	B	14.0*	B	13.2*	B	14.0*	B	13.0*	B	14.0*
40	ROUTE 26 AND ROUTE 25	F	81.5*	F	400.4*	C	23.9	C	27.8	F	94.9	E	70.1	F	156.5	D	40.1	F	116.2	D	42.4
41	ROUTE 26 AND ROUTE 15	F	202.4*	E	39.5*	E	43.2*	E	46.2*	F	2554.1*	F	3440.9*	F	2444.5*	F	2416.0*	D	45	C	34.1
42	ROUTE 28 AND ROUTE 27A	F	152.9*	E	37.4*	F	190.1*	F	237.3*	C	31.8	F	402.8	D	38.6	E	60.6	C	47.4	F	89.4
	Access Points - NCTS Finegayan																				
1	ROUTE 3 AND NORTH (COMMERCIAL) GATE**	C	21.4	C	15.7																
2	ROUTE 3 AND SOUTH (MAIN) GATE**	D	32.1	C	20.7																
	Access Points - South Finegayan																				
3	ROUTE 3/CONTROL TREE DRIVE (RESIDENTIAL) GATE	C	22.1	F	51.4																
	Access Points - AAFB																				
5	ROUTE 9/AAFB NORTH GATE**	N/A	N/A	N/A	N/A																
	Access Points - South Anderson					NOT APPLICABLE, DESIGN AND EVALUATION OF ACCESS POINTS COMPLETED USING 2030 TIME HORIZON															
6	ROUTE 1/TURNER STREET (MAIN GATE)	B	11.5*	D	34.9*																
7	ROUTE 15/ROAD 1.36 m e/o ROUTE 26 (SECOND GATE)**	N/A	N/A	N/A	N/A																
	Navy Barrigada																				
8	ROUTE 16 AND SABANA BARRIGADA	F	75.5*	F	62.4*																
9	ROUTE 8A/BARRIGADA CONNECTOR**	N/A	N/A	N/A	N/A																
	Barrigada AF																				
10	ROUTE 15 AND CHADA STREET	E	37.4*	C	18.2*																
	Naval Ordinance Annex																				
11	ROUTE 5 AND HARMON ROAD	A	9.8*	B	10.2*																

S.NO	INTERSECTION	2030 No Action				2030 Alternative 1/2				2030 Alternative 3				2030 Alternative 8			
		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
		LOS[1]	Delay[2]	LOS[1]	Delay[2]	LOS[1]	Delay[2]	LOS[1]	Delay[2]	LOS[1]	Delay[2]	LOS[1]	Delay[2]	LOS[1]	Delay[2]	LOS[1]	Delay[2]
1	ROUTE 1 AND ROUTE 9	B	15.8	B	14.6	C	22.5	D	52.2	C	24.4	D	53.0	C	23.3	D	53.0
2	ROUTE 1 AND ROUTE 29	F	87.6	E	60.5	E	65.5	E	67.7	F	85.3	F	90.5	E	73.2	E	67.7
3	ROUTE 1 AND ROUTE 28	F	220.2	F	157.7	F	216.8	F	104.5	F	130.5	F	139.5	F	215.5	F	115.3
4	ROUTE 1 AND ROUTE 26	E	76.8	F	229.8	E	75.8	F	166.6	F	99.4	F	209.1	F	146.9	F	250.6
5	ROUTE 1 AND ROUTE 27	F	187.2	F	533.7	F	137.4	F	274.3	F	181.1	F	399.6	F	179.8	F	229.4
6	ROUTE 1 AND ROUTE 27A	E	67.2	F	189.5	D	44.4	E	76.7	F	120.2	F	157.1	D	53.9	D	51.2
7	ROUTE 1 AND ROUTE 3	F	158.4	F	306.9	D	48.5	D	50.6	F	341.3	F	474.4	E	70.5	E	64.7
8	ROUTE 1 AND ROUTE 16	D	52.2	F	365.5	E	65.3	F	87.5	F	232.2	F	340.0	E	57.0	F	100.9
9	ROUTE 1 AND ROUTE 14 (North San Vitoris)	F	82.8	F	361.2	E	68.0	F	92.0	E	66.6	E	71.6	E	69.6	E	77.6
10	ROUTE 1 AND ROUTE 14A	F	124.1	F	289.9	F	112.2	F	131.5	E	71.0	F	112.3	E	74.2	F	126.0
11	ROUTE 1 AND ROUTE 10A	F	82.9	F	117.2	F	118.1	F	102.0	F	129.6	F	193.6	F	126.1	F	186.0
12	ROUTE 1 AND ROUTE 14B	E	60.5	F	91.8	F	83.9	E	78.2	E	79.8	E	78.5	F	90.4	E	79.5
13	ROUTE 1 AND ROUTE 14 (ITC)	F	90.3	F	212.5	F	182.5	F	275.1	F	176.8	F	315.8	F	112.6	F	267.2
14	ROUTE 1 AND ROUTE 30	F	273.9	F	440.9	F	124.7	F	267.2	F	148.5	F	253.3	F	146.0	F	296.3
15	ROUTE 1 AND ROUTE 8	F	187.6	F	94.1	F	97.6	F	127.5	F	182.7	F	166.5	E	77.8	F	180.4
16	ROUTE 1 AND ROUTE 4	D	43.4	D	38.6	C	32.4	F	140.2	C	30.8	F	107.2	C	33.6	D	36.8
17	ROUTE 1 AND ROUTE 6 (Adelup)	C	24.1	F	91.7	D	40.6	E	61.8	C	29.7	F	959.7	D	38.1	D	44.9
18	ROUTE 1 AND ROUTE 11	B	18.8	C	26.8	C	29.7	D	40.5	B	18.4	D	40.1	B	14.3	D	40.3
19	ROUTE 1 AND ROUTE 6 (Westerly)	A	7.8	B	15.6	B	18.4	C	22.0	C	27.4	C	20.0	B	10.4	C	22.0
20	ROUTE 1 AND POLARIS POINT	A	4.3	A	6.2	A	8.2	A	7.4	A	6.8	A	7.4	A	6.8	A	7.6
21	ROUTE 1 AND ROUTE 2A	E	58.8	E	66.5	E	66.8	E	67.2	E	67.5	D	54.1	E	67.6	E	67.5
22	ROUTE 5 AND ROUTE 2A	D	53.0	C	22.7	F	96.3	C	26.2	E	55.1	C	22.8	E	79.9	C	25.9
23	ROUTE 5 AND ROUTE 17	D	28.9*	E	47.8*	F	56.8*	F	149.6*	E	42.5*	F	128.5*	B	14.8*	E	42.4*
24	ROUTE 2 AND ROUTE 12	F	80.1	C	25.4	C	27.8	C	27.1	C	30.6	C	24.9	C	30.7	C	27.0
25	ROUTE 3 AND ROUTE 3A	A	9.5*	B	10.1*	B	11.6*	F	79*	E	47.2*	F	100.7*	D	27.0*	F	140.7*
26	ROUTE 3 AND ROUTE 28	B	17.8	C	21.4	C	26.9	D	36.9	F	90.2	D	53.9	C	33.2	D	47.5
27	ROUTE 4 AND ROUTE 7A	F	298.8	F	196.9	F	607.3	F	534.1	F	596.7	F	339.2	F	372.9	F	654.2
28	ROUTE 4 AND ROUTE 10	F	95.5	F	115.9	F	159.5	E	65.1	F	199.7	E	65.9	F	198.7	E	71.0
29	ROUTE 4 AND ROUTE 17	D	46.6	D	48.2	D	39.6	E	57.7	D	39.6	E	55.9	D	40.1	E	56.2
30	ROUTE 4 AND ROUTE 4A	D	27.9*	C	21.2*	E	49.7*	F	424.2*	E	44.3*	C	21.9*	E	47.4*	C	24.0*
31	ROUTE 7 AND ROUTE 7A	F	77.7*	E	114.6*	D	29.2*	F	105.1*	D	28.3*	F	87.7*	F	174.7*	F	300.8*
32	ROUTE 8 AND ROUTE 33	C	31.2	F	147.3	D	64.6	F	91.7	D	62.9	C	29.1	D	46.5	E	77.8
33	ROUTE 8 AND ROUTE 10	F	122.0	F	116.5	F	96.9	F	172.7	F	137.9	F	171.8	F	177.3	F	218.4
34	ROUTE 10 AND ROUTE 15	D	49.7	F	101.1	F	156.9	F	152.3	F	187.9	F	147.2	F	197.9	F	179.1
35	ROUTE 15 AND ROUTE 29	F	Error	F	633.5*	C	27.7	C	25.4	F	161.4	C	26.2	C	32.9	C	30.0
36	ROUTE 16 AND ROUTE 27A	C	24.3	C	26.4	C	27.4	C	34.2	D	44.9	F	80.6	C	31.4	D	35.8
37	ROUTE 16 AND ROUTE 27	F	278.1	F	486.4	F	349.0	F	288.7	F	486.3	F	470.0	F	361.1	F	336.6
38	ROUTE 16 AND ROUTE 10A	F	874.2	F	286.7	F	123.1	F	123.5	F	210.3	F	692.7	F	582.9	F	488.7
39	ROUTE 17 AND ROUTE 4A	C	17.0*	C	17.9*	B	13.6*	C	18.7*	C	16.5*	C	18.5*	C	16.1*	C	18.6*
40	ROUTE 26 AND ROUTE 25	F	270.1	E	71.7	C	31.2	D	41.0	F	85.4	E	62.3	F	113.1	F	119.3
41	ROUTE 26 AND ROUTE 15	F	124.8*	F	2494.6*	C	27.9	C	32.1	C	30.2	C	25.4	F	184.9	F	168.2
42	ROUTE 28 AND ROUTE 27A	F	353.1*	F	437.8*	D	36.6	D	36.6	D	41.3	E	66.2	C	31.3	E	69.6
	Access Points - NCTS Finegayan																
1	ROUTE 3 AND NORTH (COMMERCIAL) GATE**	N/A	N/A	N/A	N/A	D	12.5	C	20.3	F	91.6	D	39.9	D	10.4	C	30.4
2	ROUTE 3 AND SOUTH (MAIN) GATE**	N/A	N/A	N/A	N/A	C	33.5	E	58.6	D	61.5	F	156.9	D	41.0	E	56.7
	Access Points - South Finegayan																
3	ROUTE 3/CONTROL TREE DRIVE (RESIDENTIAL) GATE	F	122.3*	F	74.2*	C	26.7	B	18.5	F	114.6	D	50.1	C	31.1	B	15.0
	Access Points - AAFB																
5	ROUTE 9/AAFB NORTH GATE**	E	39.5*	D	36.1*	F	Error*	F	Error*	F	1031.0*	F	9081.1*	F	1031.0*	F	Error*
	Access Points - South Anderson																
6	ROUTE 1/TURNER STREET (MAIN GATE)	B	13.5*	F	459.6*	C	32.4	E	79.1	C	32.4	E	79.5	C	32.4	E	79.8
7	ROUTE 15/ROAD 1.36 m e/o ROUTE 26 (SECOND GATE)**	N/A	N/A	N/A	N/A	C	22.1*	C	22.6*	C	22.1*	C	21.1*	C	22.1*	C	22.6*
	Navy Barrigada																
8	ROUTE 16 AND SABANA BARRIGADA	F	Error*	F	Error*	N/A	N/A	N/A	N/A	D	37.1	F	84.5	N/A	N/A	N/A	N/A
9	ROUTE 8A/BARRIGADA CONNECTOR**	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Barrigada AF																
10	ROUTE 15 AND CHADA STREET	E	50.0*	E	44.4*	N/A	N/A	N/A	N/A	E	64.4	C	25.9	D	48.4	D	43.3
	Naval Ordinance Annex																
11	ROUTE 5 AND HARMON ROAD	A	9.7*	A	9.8*	A	9.6*	A	10.5*	A	9.8*	A	10.6*	A	9.8*	A	10.6*

[1]Level of Service [2]Control Delay in Seconds Per Vehicle

NOTES: Signalized intersection LOS based on average delay for the overall intersection
*Unsignalized intersection LOS based on approach delay on STOP-controlled approach
**The intersections have not built in existing condition
Error = Delay exceeded maximum calculated value
Indicates LOS F

Source: Parsons Brinckerhoff

All of the LOS F listings are shown in red text. There is a considerable difference between the 2008 existing conditions and the future build conditions in both 2014 and 2030. Also important to note is the results for Alternative 3, which indicate worse intersection traffic conditions than Alternatives 1 and 2 and 8. Table 4.2-35 lists the number of intersections for each alternative indicating LOS F in at least one peak hour and the number indicating LOS F in both the a.m. and p.m. peak hours.

Table 4.2-35. Comparison of Alternatives 1 and 2, Alternative 3, and Alternative 8

	No-Action Alternative 2014	*Alternatives 1 and 2 2014*	*Alternative 3 2014*	*Alternative 8 2014*	*No-Action Alternative 2030*	*Alternative s 1 and 2 2030*	*Alternative 3 2030*	*Alternative 8 2030*
LOS F in at least one peak hour	17 intersections	30 intersections	27 intersections	26 intersections	24 intersections 3 access points	22 intersections 1 access point	24 intersections 5 access points	18 intersections 1 access point
LOS F in both peak hours	12 intersections	24 intersections	23 intersections	22 intersections	17 intersections 1 access point	13 intersections 1 access point	16 intersections 1 access point	14 intersections 1 access point

In both 2014 and 2030, Alternative 3 has slightly more intersections with LOS F, but the amount of delay at those intersections and other intersections is higher. For example, in 2030, the delay for the Route 16/10A intersection is 123.5 seconds in the p.m. for Alternative 1, 692.7 seconds in the p.m. for Alternative 3, and 488.7 seconds in the p.m. for Alternative 8. The comparisons in delay between alternatives can also be found in Table 4.2-34.

Table 4.2-36 summarizes the potential impacts of each action alternative and the no-action alternative. In general, the LOS are comparable or slightly better with the proposed roadway improvements than in the no-action alternative. Roadway capacity is generally better for all of the alternatives compared to the no-action alternative. The exceptions to this are Alternative 3 in the central Region, which has more significant impacts than the no-action alternative. In addition, the most noticeable difference is in the north, where all alternatives appear to be more congested than the no-action alternative. In terms of intersection capacity, the results are more consistent than roadway capacity.

Table 4.2-36. Summary of Potential Impacts by Alternative on Roadway and Intersection Capacity

Potentially Impacted Resource	*Alternative 1*	*Alternative 2**	*Alternative 3*	*Alternative 8*
Roadway Capacity				
North	SI	SI	SI	SI
Central	LSI	LSI	SI	LSI
Apra Harbor	LSI	LSI	LSI	LSI
South	LSI	LSI	LSI	LSI
Intersection Capacity				
North	LSI	LSI	LSI	LSI
Central	LSI	LSI	LSI	LSI
Apra Harbor	LSI	LSI	LSI	LSI
South	LSI	LSI	LSI	LSI

Legend: SI = Significant Impact, LSI = Less Than Significant Impact. *Preferred Alternative.

4.2.3 Other Foreseeable Projects

As part of the evaluation of cumulative impacts, a review of other reasonably foreseeable projects in the vicinity of the proposed GRN was conducted. A summary of past, present, and reasonably foreseeable future projects is provided in Volume 7, Chapter 3 of this EIS/OEIS. A summary of the general types of ongoing and foreseeable projects on Guam is provided in Table 4.2-37.

Table 4.2-37. Known Projects in the Vicinity of the Proposed Guam Road Network

No.	*Lead Agency or Proponent*	*Project Name and Description*	*Construction Year*
Government of Guam Projects			
1	Port Authority of Guam	Commercial port improvements	2009-2011
2	Department of Public Works	New landfill, Dandan	TBD
3	Guam International Airport Authority	Guam International Airport improvements	TBD
Navy Projects			
4	Navy	Replacement hospital	2009
5	Navy	Mariana Islands Range Complex training	2010
6	Navy	Training Concept Plan projects	TBD
7	Commander, Navy Region Marianas	Various projects, including improvements to wharves, ammunition storage areas, and other facilities	2005-2010
Air Force Projects			
8	Andersen AFB	Beddown of training and support initiatives at Northwest Field, Andersen AFB	2006-2011
		Intelligence surveillance and reconnaissance strike capability, Andersen AFB	2007-2016
Other Projects on Guam			
9	U.S. Environmental Protection Agency	Designation of ocean dredge material disposal site	2010
10	Private Developer	Residential construction in Tamuning, 700-unit condominium complex near Nikko Hotel to be complete by 2010	2007-2009
11	Base Corp	Residential construction in Yigo (private) Ironwood Estates (108-lot subdivision)	2007-2008
12	Core Tech	Residential construction in Machanao (private)	2007-2008
		Workforce housing (housing in Tiyan for up to 1,600 workers); possible temporary use of facility for JFK High School students	2008-2010
13	PIPE Networks	"Project Runway" Australia—Guam submarine cable (private)	2008-2009
14	Various Private Developers	400-room hotel in Tumon Bay, casino, residential (single-family housing, townhouses, and condominiums), commercial space	2007-2011 (and unknown)

Note: For additional information, refer to Chapter 3 of Volume 7 of this EIS/OEIS.
TBD = to be determined

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CHAPTER 5. GEOLOGICAL AND SOIL RESOURCES

5.1 INTRODUCTION

This chapter discusses the potential environmental consequences associated with implementation of the ROD associated alternatives within the region of influence (ROI) for this resource. For a description of the affected environment for all resources, refer to the respective chapter of Volume 2 (Marine Corps Relocation – Guam). The locations described in that volume include the ROI for the utilities and roadway projects. The chapters are presented in the same order as the resource areas discussed in this volume. Analysis on long-term alternatives was not done because those alternatives are not yet ripe for project specific analysis.

5.2 ENVIRONMENTAL CONSEQUENCES

5.2.1 Approach to Analysis

5.2.1.1 Methodology

Utilities

The methodology for identifying, evaluating, and mitigating impacts to geology and soil resources was established through geologic and soil studies and reports, along with federal laws and regulations, including state and local building codes and grading ordinances. The assessment of geological and soils impacts was conducted, in part, by reviewing available literature such as previously published National Environmental Policy Act (NEPA) documents for actions in the Mariana Islands Range Complex and surrounding area. A site-specific geotechnical investigation was not undertaken for this Environmental Impact Statement/Overseas Environmental Impact Statement EIS/OEIS. The impact analyses presented in this section discuss each alternative with geologic and soil impacts by geographic area as described in the previous affected environment section. Geology and soils also affect the placement or location of a land use; where such constraints occur, they are discussed. The geology and soils region of influence includes all the geologic resources on Guam that are subject to construction and operation activities.

LIDAR Contour Data was used to identify potential sinkholes on proposed sites. Development of road alignments were adjusted to avoid these potential sinkhole location and buffer areas of 100 feet (ft) (30 meters [m]) or more were implemented around the potential sinkhole sites. These buffer areas would be maintained in their current natural state and would not be used for any facility development. Analysis of topography, soil, and vegetation was completed during site characterization using LIDAR Contour Data, geotechnical reports, and site visits to ensure minimal impacts to geological and soil resources.

Project effects and constraints that can take place during construction and during operations or may limit activities may include:

Construction

- Cut and fill activities leading to soil erosion
- Removal of vegetation and landscaping leading to soil erosion
- Use of heavy equipment resulting in soil compaction
- Identification and avoidance of karst geological features, such as caves and sinkholes
- Increased risk of damage from liquefaction, landslides, and tsunamis

Operation

- Impervious surface increase resulting in increased runoff and soil erosion
- Vehicle movements resulting in increased soil erosion and compaction
- Troop movements resulting in increased soil erosion
- Munitions impacts resulting in soil and subsurface contamination
- Explosive detonations resulting in soil and subsurface contamination
- Fires resulting in reduced vegetation and increased soil erosion

The potential effects of these activities and their significance within the areas of occurrence under the alternative actions are described below. The analysis of potential impacts to geology and soils considers both direct and indirect impacts. Such disturbance may cause increased erosion and loss of productive soil.

- Potential direct impacts of construction include stormwater discharges that contain elevated sediment concentrations, that may increase pollutant loading into the surface water.
  - Indirect impacts are those that result from the completed project, such as the leaching of contaminants into soils. For non-training operation activities, indirect impacts include stormwater discharges that contain elevated sediment concentrations, as described under direct impacts of construction above.

Many effects are associated with the training operations activities. Increases in runoff due to the removal of ground cover may increase sedimentation. Siltation and formation of sediment plumes and heavy metals and hazardous materials may be leached from munitions and explosives of concern.

Indirect groundwater impacts associated with the construction and operational activities include direct contamination of groundwater resources through percolation for surface runoff. Stormwater runoff can contribute to groundwater contamination. Water impacts are addressed in Chapter 6.

Applicable Regulatory Standards

The U.S. Environmental Protection Agency Region 9 gives the Guam Environmental Protection Agency (GEPA) the authority to enforce portions of federal statutes via a Memorandum of Agreement. Under this agreement, the Safe Drinking Water Program, Water Resources Management Program, and the Water Pollution Control Program are administered by GEPA. GEPA Water Pollution Control Program is responsible for protecting Guam's resources from point and non-point source pollution, including administration of the National Pollutant Discharge Elimination System program. National Pollutant Discharge Elimination System permits are required for large and small construction activities. Requirements include a Notice of Intent, a Notice of Termination and a construction site Storm Water Pollution Prevention Plan. Permits are required for projects that disturb greater than one acre of soil, including lay-down, ingress and egress area. Phase I regulates construction activity disturbing 5 acres (ac) (2 hectares [ha]) or more of total land area and Phase II regulates "small" construction activity disturbing between 1 and 5 ac (0.4 and 2 ha) of total land area.

Government of Guam (GovGuam) has established a Soils and Water Conservation Program as defined in Chapter 26 of Title 17 of the Guam Code Annotated, as authorized by Public Law 28-179. The program is administered by the University of Guam. This regulation promotes the Territory of Guam's soil and water conservation policy in an effort to prevent erosion and water management problems; conserves and improves the use of the Territory's land and water resources; establishes Soil and Water Conservation Districts; and affirms the University of Guam's role as the Territory's lead soil conservation agency.

Conservation programs are also administered by the Public Utility Agency of Guam and GEPA (COMNAV Marianas 2008).

Seismic, Liquefaction and ground shaking would be reduced by following Unified Facility Criteria (UFC) 3-310-04 Seismic Design for Buildings (USACE 2007).

GovGuam regulations regarding solid waste landfills adhere to *Rules and Regulations for the Guam Environmental Protection Agency (GEPA) Solid Waste Disposal* (Guam Code Annotated Title 22, Div. 4, Chapter 23). These regulations are no less stringent than the U.S. Environmental Protection Agency (USEPA) standards. These requirements are common to all sites:

- Access Control
- Office and Maintenance Facilities
- Base Liner System
- Leachate Collection
- Stormwater Control
- Landfill Operation
- Landfill Closure/Post-Closure
- Landfill Gas Collection and Monitoring

In addition, soil at all municipal landfills must cover disposed solid waste with six inches (15 centimeters) of earthen material at the end of the work day (Guam DPW 2005).

<u>Off Base Roadways</u>

The affected environment for geological resources and soils for the proposed roadway improvement projects on Guam is described in the Geology and Soils chapter in Volume 2 of this Environmental Impact Statement/ Overseas Environmental Impact Statement.

Each of the action alternatives would result in construction and operation of a set of individual roadway improvement projects on the island of Guam, as defined in Chapter 2 of this volume. Implementation of each alternative would result in construction activities in each of the four geographic regions shown in that chapter.

Construction activities would consist of intersection improvements, bridge replacements, pavement strengthening, road relocation, road widening, and construction of a new road. Typical activities associated with each of these types of projects are described in Table 5.2-2. While many projects would involve construction work in developed and paved areas, some roadway projects could result in alteration of topography and disturbance to soils. A preliminary screening of project types and potential effects on geological resources is provided in Table 5.2-1.

Table 5.2-1. Typical Effects of Guam Road Network Roadway Project Construction Activities on Geological Resources

Item	*Project Type*	*Description*	*Potential Effect on Geological Resources and Soils*
1	Intersection Improvement (including military access points)	Installation of new traffic loop sensors, extending lanes through the intersection, striping and paving to include new approach or turn lanes, reconfiguring intersection shapes (i.e., from Y-intersection to T-intersections), combining lanes, creating shared lanes, restriping, signalization modifications or upgrades, and grade separations.	Generally, intersection improvement work would not result in contact with subsurface soils or any changes in topography. Geologic resources would be affected only when reconfiguration or grade separations include excavation, trenching, or grading into the subsoil.
2	Bridge Replacement	Bridge replacement would be conducted in phases. The new bridge structure would be lengthened to adequately accommodate the hydraulic flow of the river. The width of the new structure would accommodate more or wider lanes and a median, with sidewalks and barriers on each side.	Bridge replacement can include excavation, trenching, or grading into the subsoil. Geologic resources would be affected when foundation work requires excavation beneath the existing bridge structure, utility work requires new trenching, or when new structures require expansion of the footprint of the existing bridge.
3	Pavement Strengthening	Existing asphalt pavement sections would be strengthened by rehabilitating the existing pavement materials in place and placing an asphalt overlay or by reconstructing with new materials. The widened pavement section would be constructed of residual material from the existing pavement rehabilitation, new material, or a combination thereof, and an asphalt overlay. Pavement strengthening would also include matching existing access connections, pavement striping, signing, intelligent traffic systems, and safety lighting. The project would match existing horizontal and vertical alignment as required. Minor realignment of the road may be necessary to accommodate design elements.	Physical disturbance to soils from pavement strengthening would only occur when pavements are widened, new traffic systems or devices are installed, or minor road realignment occurs in previously undisturbed ground. Most activities associated with pavement strengthening would not require soil intrusion.

Item	*Project Type*	*Description*	*Potential Effect on Geological Resources and Soils*
4	Road Relocation (Route 15 only)	Route 15 would be realigned to accommodate the location of military firing ranges. New asphalt pavement would be constructed on the new alignment. The roadway cross section would consist of one lane in each direction, outside shoulders and inside shoulders, with an unpaved median that would accommodate future widening. Bicycles would be accommodated in the outside shoulders of the shared roadway. Alternatively, future widening would be accommodated to the outside, and the roadway cross section would consist of two lanes and outside shoulders with a paved median. Realignment would also include construction of new bridge(s) to grade separate Route 15 and the frontage road(s), obliterating existing Route 15 pavement, building removal, connecting to existing roadways or other access roads, utility relocation, pavement striping, signing, property fence, and guardrail installation.	Realignment into previously undisturbed soils may be required to accommodate design of the roadway. This activity would require building removal and relocation of existing utilities.
5	Road Widening	New lanes would be added to an existing roadway to accommodate predicted increased traffic volumes and to relieve congestion caused by increase in traffic volumes due to buildup activities. Widening would result in rebuilding the entire roadway, including removing the existing roadway segment. A new sub-base, base course, asphalt, and friction course layers would be constructed.	Road widening activities would affect previously undisturbed soil and topography of affected areas.
6	Construction of New Road	The Finegayan Connection would be constructed on a new alignment with new asphalt pavement on a compacted base or engineered fill.	New road construction would affect previously undisturbed soil and topography of affected areas.
7	Other	Temporary placement of equipment laydown areas may be required.	Equipment laydown areas associated with any of the above project types may require clearing and other disturbance of soils.

Potential impacts to geological resources and soils can occur during cut and fill operations, removal of vegetation, use of heavy equipment, and as a result of leaks and spills onto soils. Direct impacts that result in physical soil loss would occur during construction, while indirect impacts can result from the completed project (e.g., geologic hazards, increased erosion, or contaminants leach into soils). To evaluate the geological resource impacts of each project, physical activities associated with each project type were identified, as shown in Table 5.2-2.

Table 5.2-2. Activities Associated with Guam Road Network Roadway Project Types

Item	*Project Type*	*Minor Grading*	*Vegetation Removal*	*Excavation and/or Cut and Fill*	*Heavy Equipment Use*	*Leaks and Spills of Contaminants*
1	Intersection Improvement (including military access points)	•			•	•
2	Bridge Replacement		•	•	•	•
3	Pavement Strengthening	•			•	•
4	Road Relocation (Route 15 only)		•	•	•	•
5	Road Widening	•	•	•	•	•
6	Construction of New Road		•	•	•	•
7	Temporary placement of equipment laydown areas or storage areas for road demolition material	•	•		•	•

Based on the anticipated activities associated with each project type, it was determined that:

- Intersection improvements and pavement strengthening projects represented the project types with the lowest potential for impacts to geological resources and soils. These projects would involve the least amount of physical soil disturbance because most work would occur upon existing pavements or developed areas.
- The placement of temporary equipment laydown areas at any of the Guam Road Network (GRN) project work sites would represent a moderate potential for impacts to geologic resources and soils only when the use of previously undisturbed areas are selected. To avoid this impact, previously disturbed (e.g., paved) areas adjacent to the work site would be selected for use as temporary construction staging areas or storage for roadway demolition materials whenever possible. The use of heavy equipment would occur, and leaks or spills of contaminants could occur at equipment staging areas.
- Bridge replacement, road relocation, road widening, and construction of the new road would represent the greatest potential for impacts to geologic resources and soils because vegetation removal, excavation, and/or cut and fill operations would be required at various locations. These projects would result in changes in topographic features, exhibit the greatest degree of soil disturbance, and have the most potential for erosion.

For roadway projects that would not require road widening, all proposed improvements would occur within the existing impervious cover footprint. These projects would not directly or indirectly affect geological resources. Intersection improvement projects associated with military access points would require removal of vegetation and soil intrusion; therefore, they were not eliminated from evaluation.

Indirect impacts from the roadway projects could also occur. Indirect impacts would be associated with; geologic hazards, increased erosion, or contaminants leaching into soils. Projects with the most potential for increased vulnerability to geologic hazards would be those located in areas of high liquefaction potential and those in or near karst geological formations (nearest to known sinkholes or caves). In general, the potential vulnerability to effects from seismic activity is consistent throughout the island because of the presence of known and inferred earthquake faults that transect Guam. Increased erosion from the operation of new roadways and bridges would not be expected due to improved design features and proper maintenance. The potential for contaminants leaching into the soil would be prevented or managed through implementation of spill prevention and emergency spill response procedures.

5.2.1.2 Determination of Significance

For geology and soils, the significance of impacts is determined by subjective criteria and by regulatory standards. To be considered a significant impact, the following factors would be considered for each project area:

- Increased rate of erosion and soil loss from physical disturbance
- Reduced amounts of productive soils
- Loss of vegetation
- Alteration of surrounding landscape and affect on important geologic features (including soil or rock removal and filling of sinkholes)
- Diminished slope stability

Increased vulnerability to a geologic hazard (e.g., seismic activity, tsunami, liquefaction), and the probability that such an event could result in injury.

5.2.1.3 Issues Identified during Public Scoping Process

The following analysis focuses on possible effects to the geologic and soil resources that could be impacted by the proposed alternatives. As part of the analysis, concerns relating to geologic and soil resources mentioned by the public, including regulatory stakeholders, during scoping meetings were addressed. These include:

- Implementing erosion control measures for construction and post construction phases
- Ensuring that proper permitting and local government clearances are sought, where applicable

5.2.2 Power

5.2.2.1 Interim Alternative 1 (Preferred Alternative)

Interim Alternative 1 would recondition existing combustion turbines and upgrade transmission and distribution (T&D) systems. This work would be undertaken by the Guam Power Authority (GPA) on its existing permitted facilities. Reconditioning would be made to existing permitted facilities at the Marbo, Yigo, Dededo No. 1, and Macheche combustion turbines. These combustion turbines are not currently being used up to permit limits. T&D system upgrades would include above ground and underground transmission lines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Development under Interim Alternative 1 would disturb soil during construction associated with T&D upgrades, but would not require new construction or enlargement of the footprint of the power facilities. There is a risk of increased rate of erosion, compaction, and soil loss from physical disturbance caused by construction activity, but standard operating procedures (SOPs) and best management practices (BMPs) would be implemented to control and minimize impacts. The following measures are current SOPs for activities that could impact geology and soils in the project area:

- Locate ground-disturbing roadwork on previously disturbed sites whenever possible.
- Restrict vehicular activities to designated/previously identified areas.
- Prohibit off-road vehicle use except in designated off-road areas or on established trails.
- Monitor erosion and drainage at select locations.
- Comply with existing policies and management activities to conserve soils.
- Standard erosion control measures (i.e., temporary and permanent soil stabilization; location of temporary soil piles; placement of sediment barriers around storm sewer inlets; sediment controls

such as filter fabric fences, straw bales, or vegetative barriers; timely disposal of construction material wastes) would be implemented during any ground-disturbing activities (e.g., excavation and grading).

- Any topsoil removed from the site would be placed in the immediate area and reused for re-compaction purposes (if appropriate, in accordance with geotechnical recommendations).
- Any contaminated topsoil removed from the site would be properly disposed of in an approved landfill in accordance with applicable regulatory requirements.
- Earthwork would be planned and conducted in such a manner as to minimize the duration of exposure of unprotected soils.
- For soil disturbance activities that occur during the rainy season, installation of berms and plastic sheeting would be utilized.
- Locate temporary equipment laydown areas on previously disturbed or developed (i.e., paved) areas whenever possible to avoid the need for vegetation removal or grading.
- Proper storage and containment of contaminants would be required at all temporary equipment staging areas.
- Erosion control plans for roadway work shall be prepared and implemented in construction plans and practices to the maximum extent practicable, including but not limited to:
- the area of land to be graded shall be kept to a minimum, stabilized, or receive temporary covering if delays exceeding 2 months of exposure occur;
- critical areas shall be protected during construction with the use of temporary ditches, dikes, vegetation, and/or mulching;
- all disturbed areas, slopes, channels, ditches, and banks shall be stabilized as soon as possible after final grading has been completed;
- stormwater runoff from disturbed areas would be collected and diverted for removal of sediment before discharge to any surface or marine waters; and,
- all erosion and sedimentation control facilities would be maintained until stabilization of the site is complete.
- Ensure that all construction work areas are clearly identified or marked on contractor drawings. Restrict vehicular activities to designated/previously identified areas within the construction work zone only.
- Prohibit off-road vehicle use except in designated off-road areas or on established trails.
- Ensure that contaminants (i.e., oils, greases, lubrication fluids for heavy equipment) are properly stored at the work site to avoid spills and leaks.

Erosion potential of soils found at facilities proposed for reconditioning and in the areas underlying T&D upgrades under Interim Alternative 1 is shown in Table 5.2-3.

Table 5.2-3. Erosion Potential at Power Alternative Sites

Soil Type	*Location*	*Erosion Potential*
Guam Yigo Complex at 0-7% slope	Marbo, Yigo, and Dededo	slight
Guam Cobbly Clay Loam at 3-7% slope	Marbo, Yigo, Macheche, and Dededo, Andersen AFB, Potts Junction	slight
Guam Cobbly Clay Loam at 3-7% slope	Harmon/Yigo and Dededo/Andersen, Andersen AFB	slight
Guam Urban Land Complex at 0-3% slope	Orote Point, Potts Junction	slight
Urban Land-Ustorthents complex at 0% slope	Cabras/Piti	slight

Source: Young 1988.

Construction activities under Interim Alternative 1 would include clearing, grading and grubbing, trenching, and demolition of existing earthwork and grass. Temporary loss of vegetation would occur. Installation of underground T&D lines would permanently displace soil; however the volume of soil moved would result in less than significant impacts to soil resources. Therefore, Interim Alternative 1 would result in minimal impacts to unique geologic resources by changing the landscape of the affected area.

There are no known sinkholes in the vicinity of Interim Alternative 1 construction. Any sinkholes discovered would be avoided and a buffer zone of vegetation would be left around it to prevent further erosion or expansion. Therefore, Interim Alternative 1 would result in less than significant impacts to a unique geologic resource.

Construction areas are in a potentially active seismic zone. Hazards associated with earthquakes, fault rupture, slope instability and liquefaction would be minimized by adherence to UFC 3-310-04 Seismic Design for Buildings (USACE 2007). Therefore, Interim Alternative 1 would result in less than significant impacts associated with geologic hazards.

Soil types disturbed would not be agriculturally productive soils. Construction SOPs and BMPs would be followed to control and minimize soil erosion. The construction SOPs would include requirements for stormwater compliance, and with BMPs implementation would ensure that all aspects of the project construction would be performed in a manner to minimize impacts during construction activity. A description of the standard BMPs and resource protection measures required by regulatory mandates can be found in Volume 7. Implementations of measures such as revegetation as soon as possible after any ground disturbance or grading, and minimizing construction and grading during times of inclement weather would control and minimize erosion, thus there would be minimal impacts from soil erosion. A more detailed explanation of regulatory permitting requirements is also available in Volume 8.

Potential Mitigation Measures

There would be less than significant impacts to geological and soil resources as a result of implementing Alternative 1; therefore, no potential mitigation measures are proposed. Implementation of SOPs and BMPs including erosion and sedimentation controls and stormwater management would minimize impacts to geological and soil resources.

5.2.2.2 Interim Alternative 2

Interim Alternative 2 is a combination of reconditioning of existing permitted GPA facilities, an increase in operational hours for existing combustion turbines, and upgrades to existing T&D systems. Interim Alternative 2 would not require new construction or enlargement of the existing footprint of facilities. Reconditioning would be performed on the existing permitted GPA facilities at the Marbo, Yigo, and Dededo combustion turbines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Construction activities under Interim Alternative 2 would include clearing, grading and grubbing, trenching, and demolition of existing earthwork and grass. Temporary loss of vegetation would occur. Therefore, Interim Alternative 2 would result in minimal impacts to unique geologic resources by changing the landscape of the affected area. Soil types disturbed would not be agriculturally productive soils. Soil erosion is primarily a concern for discharge into surface or nearshore waters from the proposed construction. Construction SOPs and BMPs would be followed to control and minimize soil erosion. The construction SOPs would include requirements for stormwater compliance, with BMPs to ensure that all aspects of the project construction would be performed in a manner to minimize impacts during construction activity. A description of the standard BMPs and resource protection measures required by regulatory mandates can be found in Volume 7. Implementations of measures noted in the geology and soils column would prevent erosion, thus there would be minimal impacts from soil erosion. A more detailed explanation of regulatory permitting requirements is also available in Volume 8.

There are no known sinkholes in the vicinity of Interim Alternative 2 construction. Any sinkholes discovered would be avoided and a buffer zone of vegetation would be left around it to prevent further erosion or expansion. Therefore, Interim Alternative 2 would result in less than significant impacts to a unique geologic resource.

Construction areas are in a potentially active seismic zone. Hazards associated with earthquakes, fault rupture, slope instability and liquefaction would be minimized by adherence to UFC 3-310-04 Seismic Design for Buildings (USACE 2007). Therefore, Interim Alternative 2 would result in less than significant impacts associated with geologic hazards.

Development under Interim Alternative 2 would disturb soil during construction associated with T&D upgrades. Installation of underground T&D lines would permanently displace soil, however the volume of soil moved would result in less than significant impacts to soil resources.

<u>Potential Mitigation Measures</u>

Potential mitigation measures are the same as those for Interim Alternative 1.

5.2.2.3 Interim Alternative 3

Interim Alternative 3 is a combination of reconditioning existing GPA permitted facilities at Marbo, Yigo, and Dededo and upgrades to the Department of Defense power plant at Orote. Upgrades would be made to existing T&D. The proposed reconditioning to the existing power generation facilities at Marbo, Yigo, and Dededo would not require new construction or enlargement of the existing footprint of the facility. For the Orote power plant, upgrades would include a new fuel storage facility to facilitate longer run times between refueling. This would disturb approximately 1 acre (4,047 square m). This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

The proposed reconditioning to the facilities at Marbo, Yigo, and Dededo include overhauls of the existing systems that do not include new construction or enlargement of the existing footprint of the facility. For the Orote power plant, upgrades would include a new fuel storage facility to facilitate longer run times between refueling. This would disturb approximately 1 acre (4,047 square m).

Development under Interim Alternative 3 would disturb soil during construction associated with facilities upgrades. Installation of underground T&D lines would permanently displace soil, however the volume of soil moved would result in less than significant impacts to soil resources. There is a risk of increased rate of erosion, compaction, and soil loss from physical disturbance caused by construction activity, but SOPs would be implemented to prevent impacts. Soil types disturbed would not be agriculturally productive soils. Construction SOPs and BMPs would be followed to minimize soil erosion. The construction SOPs would include requirements for stormwater compliance, with BMPs to ensure that all aspects of the project construction would be performed in a manner to minimize impacts during construction activity. A description of the standard BMPs and resource protection measures required by regulatory mandates can be found in Volume 7. Implementations of measures noted in the geology and soils column would prevent erosion, thus there would be minimal impacts from soil erosion. A more detailed explanation of regulatory permitting requirements is also available in Volume 8.

In accordance with site-specific geotechnical reports produced for project planning and construction, specific SOPs and BMPs that would be utilized in this area include:

- Revegetation should occur as soon as possible after any ground disturbance or grading.
- Construction and grading should be minimized during times of inclement weather.

Construction activities under Interim Alternative 3 would include clearing, grading, and grubbing, and demolition of existing earthwork and grass. Temporary loss of vegetation would occur. Therefore, Interim Alternative 3 would result in minimal impacts to unique geologic resources by changing the landscape of the affected area.

There are no known sinkholes in the vicinity of Interim Alternative 3 construction. Any sinkhole discovered would be avoided and a buffer zone of vegetation would be left around it to prevent further erosion or expansion. Therefore, Interim Alternative 3 would result in less than significant impacts to a unique geologic resource.

Orote Point is located in a potentially active seismic zone. Hazards associated with earthquakes, fault rupture, and slope instability would be minimized by adherence to UFC 3-310-04 Seismic Design for Buildings (USACE 2007). The Interim Alternative 3 proposed developments are to be located on a relatively flat area that would not be subject to slope instability. Interim Alternative 3 would result in less than significant impacts associated with geologic hazards.

Seismic, liquefaction and ground shaking would be reduced by following UFC 3-310-04 Seismic Design for Buildings (USACE 2007).

Potential Mitigation Measures

Potential mitigation measures are the same as those for Interim Alternative 1.

5.2.2.4 Summary of Impacts

Table 5.2-4 summarizes the potential impacts of each interim power alternative. A text summary is provided below.

Table 5.2-4. Summary of Potential Power Impacts

Interim Alternative 1	*Interim Alternative 2*	*Interim Alternative 3*
Topography		
LSI • Interim Alternative 1 would result in minimal impacts to topography by changing the landscape at proposed development sites.	LSI • Interim Alternative 2 would result in minimal impacts to topography by changing the landscape at proposed development sites.	LSI • Interim Alternative 3 would result in minimal impacts to topography by changing the landscape at proposed development sites.
Geology		
LSI • Sinkholes would be avoided and a buffer zone of vegetation would be left around it to prevent further erosion or expansion. Minimal impacts to sinkholes would occur.	LSI • Sinkholes would be avoided and a buffer zone of vegetation would be left around it to prevent further erosion or expansion. Minimal impacts to sinkholes would occur.	LSI • Sinkholes would be avoided and a buffer zone of vegetation would be left around it to prevent further erosion or expansion. Minimal impacts to sinkholes would occur.
Soil		
LSI • Interim Alternative 1 operations would not result in significant soil erosion or loss of agriculturally productive soil. • Soil disturbances and loss of vegetation would cause increased rate of erosion and soil loss form physical disturbance at all proposed construction areas. Minimal impacts would occur with the use of BMPs. • Slope stability would not be altered, thus minimal impacts to soil resources would occur.	LSI • Interim Alternative 2 operations would not result in significant soil erosion or loss of agriculturally productive soil. • Soil disturbances and loss of vegetation would cause increased rate of erosion and soil loss form physical disturbance at all proposed construction areas. Minimal impacts would occur with the use of BMPs. • Slope stability would not be altered, thus minimal impacts to soil resources would occur.	LSI • Interim Alternative 3 operations would not result in significant soil erosion or loss of agriculturally productive soil. • Soil disturbances and loss of vegetation would cause increased rate of erosion and soil loss form physical disturbance at all proposed construction areas. Minimal impacts would occur with the use of BMPs. • Slope stability would not be altered, thus minimal impacts to soil resources would occur.
Geologic Hazards		
LSI • Adherence to UFC 3-310-04 Seismic Design for Buildings would reduce risk of damage to structures from seismic, liquefaction and ground shaking hazards.	LSI • Adherence to UFC 3-310-04 Seismic Design for Buildings would reduce risk of damage to structures from seismic, liquefaction and ground shaking hazards.	LSI • Adherence to UFC 3-310-04 Seismic Design for Buildings would reduce risk of damage to structures from seismic, liquefaction and ground shaking hazards.

Legend: LSI = Less Than Significant Impact. * Preferred Alternative

Relocation of Marines to Guam would require construction and reconditioning that would potentially disturb soil, increase erosion, and change the landscape of Guam in multiple areas. Reconditioning of existing generation facilities, upgrading and construction of a new fuel storage tank, and trenching for underground transmission line upgrades are required to support the increase in population.

Rates of erosion and soil loss from physical disturbance due to construction would temporarily increase during construction and renovation associated with all of the alternatives for power infrastructure improvements. With implementation of BMPs, less than significant impacts from soil erosion would occur. The soil types that would be lost are not agriculturally productive soils. The topographic and landscape features would not be substantially changed by proposed construction activities. Some areas contain karst geologic features that would be of concern during the construction and operation of the facilities. Careful planning would minimize changes to geological features such as Guam's caves and sinkholes.

5.2.3 Potable Water

5.2.3.1 Basic Alternative 1 (Preferred Alternative)

Basic Alternative 1 would consist of installation of up to 22 new potable water supply wells at Andersen Air Force Base (AFB), rehabilitation of existing wells, interconnection with the GWA water system, and associated T&D systems. A new 5 MG (19 ML) water storage tank would be constructed at ground level at Finegayan. Basic Alternative 1 would affect the following areas of Guam:

- North (water supply wells)
- Central (rehabilitation of Navy Regional Medical Center well)

A total of up to 22 new water wells (including one contingency well) at AFB would be drilled through the limestone plateau into the Northern Guam Lens Aquifer (NGLA). Total well depths would be from 512 to 577 feet (ft) (156 to 175 meters [m]). A new 5 MGD water storage tank would be placed on the ground on site at Finegayan and would be connected to the existing system.

Generally, soil erosion is a concern primarily for discharge into surface or nearshore waters, that are not located near the proposed wells. However, potential sediment contamination of groundwater may result from drilling new wells. Erosion potential for soils found at proposed upgrade sites is shown in Table 5.2-5. A new ground-level 5 MGD storage tank is proposed on Naval Computer and Telecommunications Station (NCTS) Finegayan. Development under Alternative 1 would disturb soil, but SOPs and BMPs would be implemented to control and minimize impacts. Therefore, Alternative 1 well-drilling would not result in significant soil erosion, compaction, or loss of agriculturally productive soil.

Table 5.2-5. Erosion Potential at Potable Water Sites

Soil Type	*Location*	*Erosion Potential*
Guam Cobbly Clay Loam at 3-7% slope	Andersen AFB	slight
Guam Cobbly Clay Loam at 7-15% slope	Andersen AFB	slight
Guam Urban Land Complex at 0-3% slope	Andersen AFB	slight
Guam Urban Land Complex at 0-3% slope	NCTS Finegayan	slight
Guam Cobbly Clay Loam at 7-15% slope	Andersen South	slight
Guam Cobbly Clay Loam at 7-15% slope	Andersen South	slight
Guam Urban Land Complex at 0-3% slope	Andersen South	slight
Guam Cobbly Clay Loam at 3-7% slope	Air Force Barrigada	slight
Chacha Clay at 0-5% slope	Air Force Barrigada	slight
Pulantat-Kagman Clays at 0-7% slope	Air Force Barrigada	slight
Inaranjan Clay at 0-4% slope	NMS	slight
Akina Silty Clay at 7-15% slope	NMS	severe
Akina-Urban Land Complex at 0-7% slope	NMS	slight

Source: Young 1988.

Construction of wells under Basic Alternative 1 would include minor clearing, grading, and grubbing, and demolition of existing earthwork and grass. Temporary loss of vegetation would occur. Therefore, Alternative 1 would result in minimal impacts to unique geologic resources by changing the landscape of the affected area.

Any sinkholes discovered would be avoided and a buffer zone of vegetation would be left around it to prevent further erosion or expansion. Therefore, Alternative 1 would result in less than significant impacts to a unique geologic resource.

Water distribution mains would be replaced and upgraded in central and northern Guam. Construction activities would include clearing, grading and grubbing, trenching, and demolition of existing earthwork and grass. Temporary loss of vegetation would occur. Therefore, Alternative 1 would result in minimal impacts to unique geologic resources by changing the landscape of the affected area.

Construction areas are in a potentially active seismic zone. Hazards associated with earthquakes, fault rupture, slope instability and liquefaction would be minimized by adherence to UFC 3-310-04 Seismic Design for Buildings (USACE 2007). Therefore, Alternative 1 would result in less than significant impacts associated with geologic hazards.

Soil types disturbed would not be agriculturally productive soils. Construction SOPs would be followed to minimize soil erosion. The construction SOPs would include requirements for stormwater compliance, with BMPs to ensure that all aspects of the project construction would be performed in a manner to minimize impacts during construction activity. A description of the standard BMPs and resource protection measures required by regulatory mandates can be found in Volume 7. Implementations of measures noted in the geology and soils column would control and minimize erosion, thus there would be minimal impacts from soil erosion. A more detailed explanation of regulatory permitting requirements may also be available in Volume 8.

To reduce significant impacts during construction under Alternative 1, the following measures are suggested for implementation in accordance with site-specific geotechnical reports produced for project planning and construction:

- Revegetation would occur as soon as possible after any ground disturbance or grading.
- Construction and grading would be minimized during times of inclement weather.

Seismic, liquefaction and ground shaking would be reduced by following UFC 3-310-04 Seismic Design for Buildings (USACE 2007).

<u>Potential Mitigation Measures</u>

There would be less than significant impacts to geological and soil resources as a result of implementing Potable Water Basic Alternative 1; therefore, no potential mitigation measures are proposed. Implementation of SOPs and BMPs including erosion and sedimentation controls and stormwater management would minimize impacts to geological and soil resources. Basic Alternative 2

Basic Alternative 2 includes water resource development options such as new water supply wells, rehabilitation of existing wells, interconnection with GWA, upgrades and construction of new transmission and distribution systems that would be staged over 5 years, from 2010 to 2015, much like Alternative 1. However, the number of wells would be up to 20 at Andersen AFB and up to 11 at Navy Barrigada.

Impacts to soil and geological resources at Andersen AFB are identical to those of Basic Alternative 1.

At Navy Barrigada, installation of up to 11 new wells, as well as replacement and upgrades to water distribution mains, would include minor clearing, grading, and grubbing, and demolition of existing earthwork and grass. Temporary loss of vegetation would occur. Any sinkholes discovered would be avoided and a buffer zone of vegetation would be left around it to prevent further erosion or expansion.

Construction areas are in a potentially active seismic zone. Hazards associated with earthquakes, fault rupture, slope instability and liquefaction would be minimized by adherence to UFC 3-310-04 Seismic Design for Buildings (USACE 2007). Therefore, Basic Alternative 2 would result in less than significant impacts associated with geologic hazards.

Soil types disturbed would not be agriculturally productive soils. Construction SOPs would be followed to minimize soil erosion as stated in Alternative 1 impacts.

Seismic, liquefaction and ground shaking would be reduced by following UFC 3-310-04 Seismic Design for Buildings (USACE 2007).

5.2.3.2 Basic Alternative 2

Basic Alternative 2 includes water resource development options such as new water supply wells, rehabilitation of existing wells, interconnection with GWA, upgrades and construction of new transmission and distribution systems that would be staged over 5 years, from 2010 to 2015, much like Alternative 1. However, the number of wells would be up to 20 at Andersen AFB and up to 11 at Navy Barrigada.

Impacts to soil and geological resources at Andersen AFB are identical to those of Basic Alternative 1.

At Navy Barrigada, installation of up to 11 new wells, as well as replacement and upgrades to water distribution mains, would include minor clearing, grading, and grubbing, and demolition of existing earthwork and grass. Temporary loss of vegetation would occur. Any sinkholes discovered would be avoided and a buffer zone of vegetation would be left around it to prevent further erosion or expansion.

Construction areas are in a potentially active seismic zone. Hazards associated with earthquakes, fault rupture, slope instability and liquefaction would be minimized by adherence to UFC 3-310-04 Seismic Design for Buildings (USACE 2007). Therefore, Basic Alternative 2 would result in less than significant impacts associated with geologic hazards.

Soil types disturbed would not be agriculturally productive soils. Construction SOPs would be followed to minimize soil erosion as stated in Alternative 1 impacts.

Seismic, liquefaction and ground shaking would be reduced by following UFC 3-310-04 Seismic Design for Buildings (USACE 2007).

Potential Mitigation Measures

Potential mitigation measures are the same as those for Basic Alternative 1.

5.2.3.3 Summary of Impacts

Table 5.2-6 summarizes the potential impacts of each action alternative. A text summary is provided below.

Table 5.2-6. Summary of Potential Potable Water Impacts

*Basic Alternative 1**	*Basic Alternative 2*
Topography	
LSI • Alternative 1 would result in minimal impacts to topography by changing the landscape at proposed sites.	LSI • Alternative 2 would result in minimal impacts to topography by changing the landscape at proposed sites.
Geology	
LSI • Sinkholes would be avoided and a buffer zone of vegetation would be left around it to prevent further erosion or expansion. Minimal impacts to sinkholes would occur.	LSI • Sinkholes would be avoided and a buffer zone of vegetation would be left around it to prevent further erosion or expansion. Minimal impacts to sinkholes would occur.
Soil	
LSI • Soil disturbances and loss of vegetation would cause increased rate of erosion and soil loss form physical disturbance at all proposed construction areas under Alternative 1. Minimal impacts would occur with the use of BMPs. • Soil types impacted would not be agriculturally productive soils, thus minimal impacts to soil resources would occur.	LSI • Soil disturbances and loss of vegetation would cause increased rate of erosion and soil loss form physical disturbance at all proposed construction areas under Alternative 2. Minimal impacts would occur with the use of BMPs. • Soil types impacted would not be agriculturally productive soils, thus minimal impacts to soil resources would occur.
Geological Hazards	
LSI • Adherence to UFC 3-310-04 Seismic Design for Buildings during construction would reduce risk of damage to structures from seismic hazards that could potentially impact operations. Minimal impacts would occur due to geologic hazards.	LSI • Adherence to UFC 3-310-04 Seismic Design for Buildings during construction would reduce risk of damage to structures from seismic hazards that could potentially impact operations. Minimal impacts would occur due to geologic hazards.

Legend: LSI = Less Than Significant Impact. * Preferred Alternative

Relocation of Marines to Guam would require construction and renovation that would potentially disturb soil, increase erosion, and change the landscape of Guam in multiple areas. Buildup of the potable water infrastructure is required to support the increase in population.

Temporarily increased rates of erosion, compaction, and soil loss due to physical disturbance from construction would occur during construction and renovation associated with all of the alternatives for the potable water infrastructure improvements. With implementation of BMPs, less than significant impacts from soil erosion would occur. The soil types that would be lost are not agriculturally productive soils. The topographic and landscape features would not be substantially changed by construction activities. Some areas contain karst geologic features that are of concern during construction and operation of the facilities. Careful planning would be used to minimize changes to geological features like Guam's caves and sinkholes.

5.2.4 Wastewater

5.2.4.1 Basic Alternative 1a (Preferred Alternative) and 1b

Basic Alternative 1 (1a supports Main Cantonment Alternatives 1 and 2; and 1b supports Main Cantonment Alternatives 3 and 8) combines upgrade to the existing primary treatment facilities and expansion to secondary treatment at the Northern District Wastewater Treatment Plant (NDWWTP).The difference between Alternatives 1a and 1b is a requirement for a new sewer line from Barrigada housing to NDWWTP for Alternative 1b.

The action areas are located in northern Guam, an area with karst geologic features that would require consideration when planning new construction. The proposed upgrade to the facilities does not include enlargement of the plant footprint. Expansion of the NDWWTP outfall would require a laydown area.

Generally, soil erosion is a concern primarily for discharge into surface or nearshore waters, none of which are found near Alternative 1 construction. Erosion potential for soils found at proposed upgrade sites is shown in Table 5.2-7. Soil types disturbed would not be agriculturally productive soils.

Table 5.2-7. Erosion Potential at Wastewater Alternative Sites

Soil Type	*Location*	*Erosion Potential*
Guam Cobbly Clay Loam at 3-7% slope	NDWWTP	Slight
Guam Yigo Complex at 0-7% slope	Proposed Sewer Line	Slight
Guam Cobbly Clay Loam at 3-7% slope	Proposed Sewer Line	Slight

Source: Young 1988.

Construction under Basic Alternatives 1a and 1b would include minor clearing, grading, and grubbing, and demolition of existing earthwork and grass. Temporary loss of vegetation would occur. Therefore, Alternative 1 would result in minimal impacts to topography by changing the landscape of the affected area.

Any sinkholes discovered would be avoided and a buffer zone of vegetation would be left around it to prevent further erosion or expansion. Therefore, Basic Alternative 1 would result in less than significant impacts to a unique geologic resource.

Construction areas are in a potentially active seismic zone. Hazards associated with earthquakes, fault rupture, slope instability and liquefaction would be minimized by adherence to UFC 3-310-04 Seismic Design for Buildings (USACE 2007). Therefore, Basic Alternative 1 would result in less than significant impacts associated with geologic hazards.

Standard construction BMPs would be included in the Regional Stormwater Pollution Prevention Plan as part of the Construction Stormwater Management Program for the Guam Military Buildup. As part of an integrated approach to stormwater management, construction managers and contractors would be required to follow this Regional SWPPP for development of their site specific SWPPP. To prevent soil erosion, erosion and sediment control measures would be included as part of the Regional SWPPP, and required for inclusion in the Contractor's Site Specific SWPPP under NPDES Construction Permit Compliance Program for the Guam Buildup. A description of the standard BMPs and resource protection measures required by regulatory mandates can be found in Volume 7. Implementations of measures noted in the geology and soils column would prevent erosion, thus there would be minimal impacts from soil erosion. A more detailed explanation of regulatory permitting requirements is also available in Volume 8.

To reduce significant impacts during construction under Basic Alternative 1, the following measures are suggested for implementation in accordance with site-specific geotechnical reports produced for project planning and construction:

- Revegetation would occur as soon as possible after any ground disturbance or grading.
- Construction and grading would be minimized during times of inclement weather.

Seismic, liquefaction and ground shaking would be reduced by following UFC 3-310-04 Seismic Design for Buildings (USACE 2007).

Potential Mitigation Measures

There would be less than significant impacts to geological and soil resources as a result of implementing Basic Alternative 1; therefore, no potential mitigation measures are proposed. Implementation of SOPs and BMPs including erosion and sedimentation controls and stormwater management would minimize impacts to geological and soil resources.

5.2.4.2 Basic Alternative 1b

Basic Alternative 1b supports Main Cantonment Alternatives 3 and 8 and consists of the same actions as Basic Alternative 1a with the addition of a new force main sewer from Barrigada to the existing sewer that feeds wastewater to the NDWWTP.

The action areas in addition to those in Basic Alternative 1a are located in central Guam, an area with karst geologic features that would require consideration when planning new construction. Erosion potential for soils found at proposed new force main sewer is shown in Table 5.2-7. Soil types disturbed would not be agriculturally productive soils.

Construction under Basic Alternative 1b would include minor clearing, grading, trenching, grubbing, and demolition of existing earthwork and grass. Temporary loss of vegetation would occur. Therefore, Basic Alternative 1b would result in minimal impacts to topography by changing the landscape of the affected area.

Any sinkholes discovered would be avoided and a buffer zone of vegetation would be left around it to prevent further erosion or expansion. Therefore, Basic Alternative 1b would result in less than significant impacts to a unique geologic resource.

Construction areas are in a potentially active seismic zone. Hazards associated with earthquakes, fault rupture, slope instability and liquefaction would be minimized by adherence to UFC 3-310-04 Seismic Design for Buildings (USACE 2007). Therefore, Basic Alternative 1b would result in less than significant impacts associated with geologic hazards. Standard construction BMPs would be included as discussed under Alternative 1.

Seismic, liquefaction and ground shaking would be reduced by following UFC 3-310-04 Seismic Design for Buildings (USACE 2007).

5.2.4.3 Potential Mitigation Measures

Potential mitigation measures are identical to those of Basic Alternative 1a.

Table 5.2-8. Summary of Wastewater Impacts

Interim Alternative 1a and 1b*
LSI • Interim Alternative 1 would result in minimal impacts to topography by changing the landscape at proposed development sites
LSI

• Sinkholes would be avoided and a buffer zone of vegetation would be left around it to prevent further erosion or expansion. Minimal impacts to sinkholes would occur.
LSI • Soil disturbances and loss of vegetation would cause increased rate of erosion and soil loss from physical disturbance at all proposed construction areas. Minimal impacts would occur with the use of BMPs. • Slope stability would not be altered, thus minimal impacts to soil resources would occur.
LSI • Adherence to UFC 3-310-04 Seismic Design for Buildings would reduce risk of damage to structures from seismic, liquefaction and ground shaking hazards.

Legend: LSI = Less Than Significant Impact. * Preferred Alternative

Relocation of Marines to Guam would require construction and renovation that would potentially disturb soil, increase erosion, and change the landscape of Guam in multiple areas. Buildup of wastewater treatment infrastructure is required to support the increase in population.

Rates of erosion and soil loss from physical disturbance due to construction would temporarily increase during construction and renovation associated with all of the alternatives for wastewater treatment infrastructure improvements. With implementation of BMPs, less than significant impacts from soil erosion would occur. The soil types that would be lost are not agriculturally productive soils. The topographic and landscape features would not be substantially changed by proposed construction activities. Some areas contain karst geologic features that would be of concern during the construction and operation of the facilities. Careful planning would minimize changes to geological features such as Guam's caves and sinkholes.

5.2.5 Solid Waste

5.2.5.1 Basic Alternative 1 (Preferred Alternative)

The Preferred Alternative for solid waste would be the continued use of Navy Landfill at Apra Harbor until Layon Landfill is opened, which is scheduled for July 2011. Though no construction or upgrades to utilities occur, geological and soil resources need to be analyzed for impact from increased amounts of solid waste at current facilities. An increase in the volume of solid waste would potentially impact the daily soil-covering routines at the existing plant. More soil would potentially be required to cover greater amounts of solid waste. Impact to soils and geological resources would be minimal, because soil is used at the landfill for the purpose of covering solid waste and more soil is available to use as pressure on the existing facility increases.

Potential Mitigation Measures

No mitigation measures are required.

5.2.5.2 Summary of Impacts

Table 5.2-9 summarizes the potential impact of the Preferred Alternative. A text summary is provided below.

Table 5.2-9. Summary of Potential Solid Waste Impacts

*Basic Alternative 1**
LSI • Alternative 1 would result in minimal impacts to topography by changing the landscape at proposed sites.
LSI • Sinkholes and other geological resources would not be affected by the increase in the

*Basic Alternative 1**
volume of solid waste taken to existing facility. Minimal impacts to sinkholes would occur.
LSI • Soil disturbances would not be greatly increased by the increase in the volume of solid waste taken to existing facility. Minimal impacts would occur with the use of BMPs.
LSI • Minimal impacts would occur due to geologic hazards.

Legend: LSI = Less Than Significant Impact.* Preferred Alternative

Solid waste basic alternative 1 would not involve new or expanded facilities. It would involve higher generation of solid waste. Therefore, the impacts of solid waste to geological and soil resources would be less than significant.

5.2.6 Off Base Roadways

5.2.6.1 Alternative 1

Alternative 1 would result in direct impacts to geologic resources as a result of construction. Impacts on geological resources could include soil disturbance and the suspension of soil, soil loss, and localized erosion. Ground disturbance for roadway improvements would be conducted in accordance with construction SOPs listed in Section 5.2.2.1 and below and BMPs listed in Volume 7

- Individual roadway projects would be designed and constructed in accordance with recommendations of the project- and site-specific geotechnical investigation and applicable geotechnical code requirements. Each project would be designed and constructed in accordance with recommendations from a registered professional geologist for the following aspects, as applicable, and included in the project-specific geotechnical investigation: liquefaction, erosion, site grading, excavation and utility trenches, foundations, mitigation of soil corrosivity on concrete, and seismic design criteria. Approval by a licensed Geotechnical Engineer would be required for placement and compaction of fill, backfilling of trenches, and testing of soils.
- Earthwork would be conducted using BMPs to minimize erosion during demolition and road or bridge construction including, but not limited to, watering for dust control during earthwork to minimize soil loss; and establishing grass or other landscaping in disturbed areas immediately after construction is completed.
- Material from demolition of existing road pavements shall be stored in previously disturbed areas whenever possible.
- For projects involving military access, control erosion through the Site Approval Process, whereby each proposed project is reviewed for its erosion potential. Obtain concurrence of the designated installation Natural Resource Specialist in the process.
- Manage erosion in accordance with the applicable Storm Water Pollution Prevention Plans at each roadway project location.

<u>North</u>

Thirteen GRN projects would occur in the North Region as a result of Alternative 1:

- One intersection improvement project (GRN #117) and two pavement strengthening projects (GRN #8 and 23) would not require road widening or road realignment in previously undisturbed ground. No impacts to geological resources and soils would occur.

- Four intersection improvement projects involving modifications to MAPs (GRN #38A, 39A, 41A, and 42) would be required. To construct new access gates, removal of vegetation and disturbance to Limestone Upland soils would be required.
- Five road widening projects (GRN #9, 10, 22, 22A, and 57) would require removal of vegetation and disturbance to Limestone Upland soils.
- Construction of the Finegayan Connection, a new road (GRN #124), would require removal of vegetation and disturbance to Limestone Upland soils.

Soil disturbances from the latter three project groups described above could result in an increased rate of erosion and soil loss. Soil erosion would be a concern for discharge into any nearby surface waters. With implementation of construction SOPs and BMPs, impacts from soil erosion would be prevented or minimized. Alternative 1 would result in less than significant impacts to unique geologic resources and would not result in significant soil erosion. Impacts to soils would be considered less than significant.

Central

Twenty-seven GRN projects would occur in the Central Region as a result of Alternative 1:

- Three intersection improvement projects (GRN #1, 2, and 113) and 16 pavement strengthening projects (GRN #6, 7, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 30, 31, 32, and 33) would not require road widening or road realignment in previously undisturbed ground. No impacts to geological resources and soils would occur.
- Two intersection improvement projects involving modifications to MAPs (GRN #44 and 46) would be required. Both projects would occur in previously developed areas, and minimal soil disturbance would be required.
- Two bridge replacement projects (GRN #3 and 35) would require clearing and excavation of soil, as well as construction activities adjacent to, and over water.
- Three road widening projects (GRN #16, 28, and 29) would require removal of vegetation and disturbance to Limestone Upland soils.
- The relocation of Route 15 (GRN #36) would require removal of vegetation and disturbance to Limestone Upland soils.

Soil disturbances from the latter three project groups described above could result in an increased rate of erosion and soil loss. Soil erosion would be a concern for discharge into any nearby surface waters. With implementation of appropriate SOPs and BMPs, impacts from soil erosion would be prevented or minimized. Impacts to soils would be considered less than significant.

Apra Harbor

Five GRN projects would occur in the Apra Harbor Region as a result of Alternative 1:

- One intersection improvement project (GRN #5) and three pavement strengthening projects (GRN #4, 24, and 26) would be required. While GRN #4, 24 and 26 would not require road widening or realignment, GRN #5 would require removal of vegetation for road widening and would result in limited soil disturbance.
- One intersection improvement project involving modification to a MAP (GRN #50) would be required. This access point would be constructed on previously cleared ground, and soil disturbance would be minimal.

Soil disturbances from projects GRN #5 and GRN #50 could result in an increased rate of erosion and soil loss. Soil erosion would be a concern for discharge into any nearby surface waters. With implementation of appropriate SOPs and BMPs, impacts from soil erosion would be prevented or minimized. Impacts to soils would be considered less than significant.

South

Four GRN projects would occur in the South Region as a result of Alternative 1:

- One intersection improvement project (GRN #110) and two pavement strengthening projects (GRN #25 and 27) would not require road widening. No impacts to geological resources and soils would occur.
- One intersection improvement project involving modification to a MAP (GRN #52) would be required. This access point would be constructed on previously cleared ground, and soil disturbance would be minimal.

Soil disturbances from the GRN #52 project could result in an increased rate of erosion and soil loss. Soil erosion would be a concern for discharge into any nearby surface waters. With implementation of appropriate SOPs and BMPs, impacts from soil erosion would be prevented or minimized. Impacts to soils would be considered less than significant.

Potential Mitigation Measures

No mitigation measures would be required. Alternative 2 (Preferred Alternative)

5.2.6.2 Alternative 2

North

Thirteen GRN projects would occur in the North Region as a result of Alternative 2:

- One intersection improvement project (GRN #117) and two pavement strengthening projects (GRN #8 and 23) would not require road widening or road realignment in previously undisturbed ground. No impacts to geological resources and soils would occur.
- Four intersection improvement projects involving modifications to MAPs (GRN #38, 39, 41, and 42) would be required. To construct new access gates, removal of vegetation and disturbance to Limestone Upland soils would be required.
- Five road widening projects (GRN #9, 10, 22, 22A and 57) would require removal of vegetation and disturbance to Limestone Upland soils.
- Construction of the Finegayan Connection, a new road (GRN #124), would require removal of vegetation and disturbance to Limestone Upland soils.

Soil disturbances from the MAP intersection improvements and road widening project groups described above could result in an increased rate of erosion and soil loss. Soil erosion would be a concern for discharge into any nearby surface waters. With implementation of construction SOPs as listed in Section 5.2.2.1 and Alternative 1 and BMPs listed in Volume 7, impacts from soil erosion would be prevented or minimized. Alternative 2 would result in less than significant impacts to unique geologic resources or result in significant soil erosion. Impacts to soils would be considered less than significant.

Central

Twenty-seven GRN projects would occur in the Central Region as a result of Alternative 2:

- Three intersection improvement projects (GRN #1, 2, and 113) and 16 pavement strengthening projects (GRN #6, 7, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 30, 31, 32, and 33) would not require road widening or road realignment in previously undisturbed ground. No impacts to geological resources and soils would occur.

- Two intersection improvement projects involving modifications to MAPs (GRN #44 and 46) would be required. These projects would occur in previously developed areas, and minimal soil disturbance would be required.
- Two bridge replacement projects (GRN #3 and 35) would require clearing and excavation of soil, as well as construction activities adjacent to, and over water.
- Three road widening projects (GRN #16, 28, and 29) would require removal of vegetation and disturbance to Limestone Upland soils.
- The relocation of Route 15 (GRN #36) would require removal of vegetation and disturbance to Limestone Upland soils.

Soil disturbances from the latter three project groups described above could result in an increased rate of erosion and soil loss. Soil erosion would be a concern for discharge into any nearby surface waters. With implementation of appropriate SOPs listed in Section 5.2.2.1 and Alternative 1 and BMPs listed in Volume 7, impacts from soil erosion would be prevented or minimized. Impacts to soils would be considered less than significant.

Apra Harbor

Impacts would be nearly identical to Alternative 1.

South

Impacts would be nearly identical to Alternative 1.

Potential Mitigation Measures

No mitigation measures would be required. Standard construction SOPs and BMPs would be to the same as Alternative 1.

5.2.6.3 Alternative 3

North

Twelve GRN projects would occur in the North Region as a result of Alternative 3. Roadway projects would be the same as those described for Alternative 1, with the exclusion of GRN #124 (Finegayan Connection) that would not be constructed and different locations of the Main Gate and commercial gate to NCTS Finegayan. Soil disturbances from Alternative 3 projects could result in an increased rate of erosion and soil loss. Soil erosion would be a concern for discharge into any nearby surface waters. With implementation of appropriate SOPs as listed in Section 5.2.2.1 and Alternative 1 and BMPs listed in Volume 7, impacts from soil erosion would be prevented or minimized.

Central

Twenty-nine GRN projects would occur in the Central Region as a result of Alternative 3:

- Three intersection improvement projects (GRN #1, 2, and 113) and 13 pavement strengthening projects (GRN #6, 7, 11, 12, 13, 14, 15, 17, 18, 21, 30, 32, and 33) would not require road widening or road realignment in previously undisturbed ground. No impacts to geological resources and soils would occur.

- Five intersection improvement projects involving modifications to MAPs (GRN #44, 46, 47, 48 and 49) would be required. These projects would occur in previously developed areas, and minimal soil disturbance would be required.
- Two bridge replacement projects (GRN #3 and 35) would require clearing and excavation of soil, as well as construction activities adjacent to, and over water.
- Five road widening projects (GRN #16, 28, 29, 63, and 74) would require removal of vegetation and disturbance to Limestone Upland soils.
- The relocation of Route 15 (GRN #36) would require removal of vegetation and disturbance to Limestone Upland soils.

Soil disturbances from the latter three project groups described above could result in an increased rate of erosion and soil loss. Soil erosion would be a concern for discharge into any nearby surface waters. With implementation of appropriate SOPs and BMPs, impacts from soil erosion would be prevented or minimized.

Apra Harbor

Impacts would be nearly identical to Alternative 1.

South

Impacts would be nearly identical to Alternative 1.

Potential Mitigation Measures

No mitigation measures would be required.

5.2.6.4 Alternative 8

North

Impacts would be nearly identical to Alternative 1.

Central

Impacts would be nearly identical to Alternative 1.

Apra Harbor

Impacts would be nearly identical to Alternative 1.

South

Impacts would be nearly identical to Alternative 1.

Potential Mitigation Measures

No mitigation measures would be required.

5.2.6.5 No-Action Alternative

Under the no-action alternative, Marine Corps units would remain in Japan and would not relocate to Guam, the visiting aircraft carrier would berth at Kilo Wharf, and an Army Air and Missile Defense Task Force would not be positioned on Guam; therefore, the no-action alternative would obviate the need to improve roads necessary for the military relocation. While none of the GRN projects identified herein would be constructed, road improvements associated with the organic growth of Guam's population would continue. The road segment and intersection improvement projects planned by the GovGuam are identified in Table 2.5-4. Road improvements supporting organic growth would most likely require vegetation removal, grading, excavation and/or cut and fill, use of heavy equipment, and possible leaching of contaminants into soils; therefore, direct and indirect effects associated with localized soil disturbance would also occur as a result of the no-action alternative. Future organic growth projects would be conducted in previously disturbed areas in accordance with established procedures and site-specific constraints, including BMPs to prevent effects such as erosion or loss of topsoil. With incorporation of SOPs and BMPs identified for Alternative 1, the roadway projects to be conducted for the no-action alternative would have minimal effects on geological resources and soils.

The geologic hazards associated with earthquakes, active volcanoes, and collapse of subterranean cavities in limestone formation have not resulted in any impact on existing roadways. Localized disruption of soils may result from GovGuam road widening projects that extend beyond the existing road footprints. With adherence to SOPs and BMPs for control of erosion, impacts to geologic resources would be less than significant.

2013/2014

The years 2013/2014 represent the roadway network without any future plans for improvements for the military buildup. While no construction associated with the planned military buildup would occur, GovGuam would have initiated construction of road segment and intersection improvement projects along segments of Routes 1, 7, 10A, and 27 (extension), and Tiyan Parkway, as identified in Table 2.5-4. With incorporation of SOPs and BMPs for roadway construction, the no-action alternative would have less than significant impacts on geological resources or soils.

2030

The year 2030 represents the roadway network without any future plans for improvements for the military buildup. While no construction associated with the planned military buildup would occur, GovGuam would have completed construction of road segment and intersection improvement projects along segments of Routes 1, 2, 4, 7A, 16, 25, and 26, as identified in Table 2.5-4. With incorporation of SOPs and BMPs for roadway construction, the no-action alternative would have less than significant impacts on geological resources or soils.

5.2.6.6 Summary of Impacts

Table 5.2-10 summarizes the potential impacts of each alternative.

Table 5.2-10. Sumary of Potential Roadway Project Impact

Potentially Impacted Resource	*Alternative 1*	*Alternative 2**	*Alternative 3*	*Alternative 8*
Increased rate of erosion and soil loss from physical disturbance	LSI	LSI	LSI	LSI
Soil contamination levels that are potentially harmful to human health or the environment	LSI	LSI	LSI	LSI
Increased vulnerability to geologic hazards	LSI	LSI	LSI	LSI

*Legend: LSI = Less Than Significant Impact. * Preferred Alternative*

Construction activities would consist of intersection improvements, bridge replacements, pavement strengthening, road relocation, road widening, and construction of a new road. While the typical activities associated with each of these types of roadway construction projects would involve work in developed and paved areas, some roadway projects could result in alteration of topography and disturbance to soils.

These disturbances could lead to an increased rate of erosion and soil loss. Loss of vegetation would contribute to soil loss and erosion. Improper storage of construction materials could result in spills or leaks that could result in contaminants leaching into the soil. Construction SOPs and BMPs would be implemented to avoid or minimize potential effects on geologic resources and soils. Roadways and bridges would be designed in accordance with specific geotechnical considerations to prevent impacts from geologic hazards. With implementation of SOPs and BMPs, these impacts would be less than significant.

CHAPTER 6. WATER RESOURCES

6.1 INTRODUCTION

Water resources as defined in this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) are sources of water available for use by humans, flora, or fauna, including surface and groundwater, nearshore waters, and wetlands. Surface water resources, including but not limited to lakes, streams and rivers, are important for economic, ecological, recreational, and human health reasons. Groundwater may be used for potable water, agricultural irrigation, and industrial applications. Groundwater is classified as any source of water beneath the ground surface, and is the primary source of potable water used to support human consumption. Consistent with the definition contained in 22 Guam Administrative Rule (GAR) 5105, nearshore waters are defined as all coastal waters lying within a defined reef area, all coastal waters of a depth of less than ten fathoms (60 feet [ft], 18.3 meters [m]), and all coastal waters greater than 10 fathoms up to 1,000 ft (305 m) offshore where there is no defined reef area. Nearshore waters can be directly affected by human activity, and are important for human recreation and subsistence. Wetlands are habitats that are subject to permanent or periodic inundation or prolonged soil saturation, and include marshes, swamps, and similar areas. Areas described and mapped as wetland communities may also contain small streams or shallow ponds, or pond or lake edges.

This chapter contains a discussion of the potential environmental consequences associated with implementation of the alternatives within the region of influence (ROI) for this resource. For a description of the affected environment for all resources (refer to the respective chapter of Volume 2 [Marine Corps Relocation – Guam]). The locations described in that volume include the region of influence for the utilities and roadway projects, and the chapters are presented in the same order as the resource areas contained in this volume.

6.2 ENVIRONMENTAL CONSEQUENCES

6.2.1 Approach to Analysis

6.2.1.1 Methodology

Utilities

This section contains a discussion of potential environmental consequences associated with implementation of the alternatives within the region of influence for water resources. The environmental consequences of each alternative and the no-action alternative are presented in this section. The available literature was used to assess the existing conditions and to establish a baseline for the assessment, as described in the affected environment section (Volume 2 Chapter 4 Section 4.1-1). The methodology for identifying, evaluating, and mitigating impacts to water resources have been established based on federal and Government of Guam (GovGuam) laws and regulations as described in Volume 2 Chapter 4 Section 4.1.1.

The environmental consequences evaluation for water resources includes a qualitative and quantitative analysis of surface water, groundwater, nearshore waters, and wetlands to the extent possible given available project data. Environmental impact assessments were made and compared to baseline conditions, items of public concern, and significance criteria to determine the magnitude of potential impacts to water resources.

The proposed action analysis is separated in two main activities: construction and operations. Each of these activities has potential effects with associated impacts. The analysis of potential impacts considers both direct and indirect impacts. Direct impacts are those that may occur during the construction phase of the project and cease when the project is complete or those that may occur as a result of project operations following the completion of construction. Indirect impacts are those that may occur as a result of the completed project or those that may occur during operations but not as a direct result of the construction or operational action.

Sustainability Requirements and Goals

Implementation of the proposed action would be consistent with Navy policy in compliance with laws and executive orders whereby Department of Defense (DoD) entities are required to reduce demand for indoor water by as much as 20% and outdoor water use by 50% in the coming years. Concurrent with these mandates is the Navy/Marine Corps policy to pursue and facilitate Leadership in Energy and Environmental Design Silver certification for their facilities. Leadership in Energy and Environmental Design is a voluntary point system tool that measures the degree of sustainability features incorporated into a development.

Water resource sustainability is addressed in two categories: minimize water demand and maximize the quantity and quality of groundwater recharge. Elements identified to achieve minimum water use are:

- Water Conservation - identify and specify appropriate minimum water demand fixtures and devices
- Irrigation - minimize use of irrigation systems and water
- Grey Water Use - evaluate options for use of grey water for irrigation
- Rainwater Harvesting - investigate harvesting, storage and distribution systems

The quantity and quality of groundwater recharge is addressed in the existing UFC Low Impact Development (LID) Manual that would be followed. This manual includes specific Integrated Management Practices to be considered and included in the drainage design of the proposed action sites. In addition, National Pollutant Discharge Elimination System (NPDES) permitting requirements, Leadership in Energy and Environmental Design goals, and recent laws (e.g., the Energy Independence and Security Act of 2007), mandate certain drainage quantity and quality performance standards. Thus, the proposed action includes incorporating post-construction drainage quality, quantity, and velocity dissipation measures to approximate (or improve upon) pre-construction conditions at the property line.

Surface Water/Stormwater

Surface water issues include:

- Water quality
- Flooding
- Flow path alterations

Surface water quality impacts are evaluated by examining the potential increase of contamination including chemicals, heavy metals, nutrients, and/or sediments in the surface water as a result of the proposed action. The analysis is performed by comparing existing water quality data with possible increases in water quality contaminants in the surface water. Potential impacts to surface water quantity and velocity are analyzed by examining changes in drainage volumes and patterns associated with the proposed action.

Construction activities that result in disturbance of more than one acre of land require a construction stormwater permit in order to mitigate pollutant impacts from contaminated runoff. Stormwater discharges from construction activity may contain elevated sediment concentrations, and spills and leaks of chemicals such as lubricants, fuels, or other construction materials that may increase pollutant loading in to the surface water. In addition, direct construction or alteration of stream channels or reservoirs may cause increased contamination by sedimentation or chemical constituents. Therefore, construction activities that result in disturbance of more than one acre of land are considered to have an impact to surface water.

Direct construction or alteration of stream channels or reservoirs may cause increased contamination by sedimentation or chemical constituents. If flow paths or patterns are altered, additional studies, such as instream flow analysis, would be conducted to ensure the human uses and/or biological services are preserved.

Operational effects include stormwater discharges that may increase the volume of sediment loading to the surface water as well as increase contaminants from vehicle maintenance, household discharge, privately-owned vehicles, and animal waste. Contamination of surface water from leaks or spills of hazardous, or otherwise regulated materials, is also a potential impact. Increased water usage may reduce the water availability in the reservoirs and/or reduce instream flows. Increased impervious areas may increase the runoff and increase the potential for flooding. Development in the floodplain may result in potential damage from flooding. Diversion of water courses for municipal water consumption may impact the ecological services that the resource provides.

Groundwater

Groundwater impact concerns include water quality and water quantity. Groundwater quality is assessed by examining the potential risk of a hazardous or regulated waste release, as well as approximating the amount of additional stormwater and associated non-point source pollution that enter the groundwater.

Construction activities that result in disturbance of more than one acre of land require a construction stormwater permit in order to mitigate pollutant impacts from contaminated infiltration. Stormwater discharges from construction activity may contain elevated sediment concentrations, and spills and leaks of chemicals such as lubricants, fuels, or other construction materials that may increase pollutant loading to groundwater resources.

The possible impacts connected with operational activities include increases of impervious areas, waste-generating activities, storage of potential contaminants, and landfill leaching. The direct impacts include an increase in polluted stormwater runoff and contamination from leaks or spills of hazardous or regulated materials. In addition, the increased water usage may increase the depletion of groundwater resources (see Volume 6, Chapter 3, Section 3.1.3, Potable Water). The potential impacts include decreases in groundwater recharge from increased impervious areas and saltwater intrusion from increased aquifer pumping.

Nearshore Waters

The nearshore water impact analysis focuses on water quality. Recreational nearshore issues are addressed in Volume 6 Chapter 11 Recreational Resources. The potential increases of contamination including chemicals, heavy metals, nutrients, and/or sediments in nearshore waters as a result of the proposed action are assessed by comparing existing water quality data with the projected changes in water quality.

Potential impacts associated with construction activities include construction spills and leaks that may discharge to nearshore waters, an increase in stormwater discharge that may increase non-point source pollution, and physical impacts to nearshore waters from dredging.

Operation effects include potential non-point source and point-source pollution. The point-source pollution consists of chemicals, heavy metals, nutrients, and/or sediments that may runoff from the increase in impervious, urban areas. The point source pollution would be related to direct discharges to the nearshore waters such as wastewater effluent.

Wetlands

The wetland impact areas of concern include:

- Pollutants
- Loss of area
- Loss of functionality

The potential for pollutants to impact a wetland was evaluated by examining the risk of hazardous materials leaking or spilling and their proximity to the wetlands. The loss of area was assessed by the total amount of delineated wetland area that would be directly removed either in loss of area or function as a result of the proposed action. The wetland functionality refers to the ability of the wetland to trap sediment and nutrients, receive and retain water, maintain wildlife habitat (both flora and fauna), and provide recreational uses. The impacts to wildlife habitat associated with wetlands are addressed in Chapter 12, Terrestrial Biological Resources.

For construction activities, the effects associated with activities in close proximity to any designated wetland or activities in the wetlands themselves are considered. Runoff from nearby construction sites may contain increased chemicals, heavy metals, nutrients, and/or sediment that could adversely affect those wetlands. Wetland impacts could result from changes in land uses and/or spills or leaks from construction operations and equipment. Loss of functionality can also occur if construction operations occur directly within the designated wetlands. Loss of wetland area would occur if the proposed action involves the direct removal of wetlands.

The effects associated with operations include an increase in potential spills and leaks from hazardous materials that may be stored in close proximity to designated wetlands. An indirect impact to existing wetlands may occur by altering (i.e., diverting or restricting) the surface water flowing into the wetlands. Indirect impacts to wetlands could also occur as a result of altered sedimentation of watercourses or drainage conveyances connected to wetland areas.

<u>Off Base Roadways</u>

This section contains a discussion of potential environmental consequences associated with implementation of the alternatives within the region of influence for water resources. The environmental consequences of each composite alternative and the no-action alternative are presented in this section. The available literature was used to assess the existing conditions and to establish a baseline for the assessment, as described in the Water Resources section of Volume 2. The methodology for identifying, evaluating, and mitigating impacts to water resources have been established based on federal and local laws and regulations, Federal Highway Administration (FHWA) guidelines, and Guam Environmental Protection Agency (GEPA) guidelines.

The environmental consequences evaluation for water resources includes a qualitative and quantitative analysis of floodplains, runoff and drainage, and water quality of surface and groundwater resources to the extent possible given available project data. The assessment was set up to ensure compliance with

FHWA requirements by identifying (1) public water sources with emphasis on sole source aquifers; (2) watershed characteristics, including overall runoff and drainage flow patterns and floodplains; (2) surface water resource characteristics, including streams, lakes, and bays; (3) coastal resources, that are delineated in Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) as identified in Volume 2; (4) National Wild and Scenic Rivers, that do not exist within the vicinity of the study area; (5) areas within the Coastal Zone Management Program; (6) areas subject to the Coastal Barriers Resources Act, that do not exist within the vicinity of the study area; (7) wetlands, that are primarily discussed under the Marine Biology section; and (8) factors that influence percolation and infiltration into the groundwater. Environmental impact assessments were made and compared to baseline conditions in the various hydrologic regimes of the island for the various types of roadway projects to determine the magnitude of potential impacts to water resources. The proposed action analysis is separated in two main activities: construction impacts (year 2014) and long-term impacts (year 2030). Each of these activities has potential effects with associated impacts.

6.2.1.2 Determination of Significance

The following factors are considered in evaluating impacts to water resources:

- Reducing availability or accessibility of water resources
- Creating noncompliance with all applicable laws and regulations
- Increasing risk associated with environmental hazards or human health
- Decreasing existing and/or future beneficial use
- Increasing risk of flooding
- Depletion, recharge, or contamination of a usable groundwater aquifer for municipal, private, or agricultural purposes
- Increases in soil settlement or ground swelling that damages structures, utilities, or other facilities caused by inundation and/or changes in groundwater levels
- Reducing the amount of wetlands available for human use or ecological services
- Long-Term increased inundation, sedimentation, and/or damage to water resources

If an activity is deemed as having an impact, the activity then can be evaluated to determine if the impact is significant or insignificant. For significant impacts, a determination is made as to whether the impacts can be mitigated to less than significant impacts.

6.2.1.3 Issues Identified During Public Scoping Process

As part of the analysis, concerns related to water resources that were mentioned by the public, including regulatory stakeholders, during the public scoping meetings were addressed. These include:

- Describing water quality with respect to public health requirements, drinking water regulations, and applicable water quality standards
- Estimating quality and quantity of stormwater runoff to be generated by increased impervious surface, methods of contaminant removal, methods of runoff redirection to recharge the aquifer, and groundwater under the direct influence of surface water
- Accidental or intentional contamination of groundwater
- Capacity of water resources to meet agricultural needs
- Stormwater management controls to prevent pollution during construction and subsequent operations
- Construction that could potentially cause runoff and could pollute the beaches and destroy marine life
- Effects of training and dredging on sedimentation stress for the coral reefs and other marine life

- Identifying ways to monitor and mitigate indirect impacts from sediments on coral reefs

6.2.2 Power

6.2.2.1 Interim Alternative 1 (Preferred Alternative)

Interim Alternative 1 would recondition existing combustion turbines and upgrade transmission and distribution (T&D) systems and would not require new construction or enlargement of the existing footprint of the facility. This work would be undertaken by the GPA on its existing permitted facilities. Reconditioning would be made to existing permitted facilities at the Marbo, Yigo, Dededo No. 1, and Macheche combustion turbines. These combustion turbines are not currently being used up to permit limits. T&D system upgrades would be on existing above ground and underground transmission lines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Reconditioning Guam Power Authority (GPA) Facilities

The proposed reconditioning of existing combustion turbines and upgrading T&D systems refurbishment would not impact surface water, groundwater, nearshore water, or wetlands because no new construction would occur under Interim Alternative 1. The DoD reconditioning of the GPA facilities would not involve additional storage of fuels or materials that would be exposed to rain events. GPA would continue to follow their Spill Prevention Control and Countermeasure Plan to prevent or control spills that might occur during operations to minimize potential impacts to water resources. Stormwater would continue to be managed by GPA through an existing USEPA stormwater multi-sector general permit. This multi-sector general permit requires the development of a Stormwater Pollution Prevention Plan (SWPPP) that incorporates best management practices (BMPs) to control pollutants. Therefore, this portion of the alternative would have no impacts on water resources.

Upgrades to Transmission and Distribution (T&D) Lines

Proposed upgrades to existing T&D lines associated with this alternative would include installation of new underground power lines. This would involve land disturbing activities greater than an acre in size that would trigger the requirement for a construction stormwater permit. Therefore, this portion of the alternative would result in impacts on water resources. These impacts would be minimized through the use of BMPs as required through the construction stormwater permit. Therefore, there would be less than significant impacts to water resources.

Summary of Interim Alternative 1 Impacts

Interim Alternative 1 would affect water resources. These impacts would be minimized through the use of BMPs as required through a construction stormwater permit and SWPPP with associated BMPs; therefore, these impacts are less than significant.

Potential Mitigation Measures

No mitigation measures related to water resources are needed for Interim Alternative 1.

6.2.2.2 Interim Alternative 2

Interim Alternative 2 is a combination of reconditioning of existing permitted GPA facilities, an increase in operational hours for existing combustion turbines, and upgrades to existing T&D systems. Interim Alternative 2 would not require new construction or enlargement of the existing footprint of the facility. Reconditioning would be performed on the existing permitted GPA facilities at the Marbo, Yigo, and Dededo combustion turbines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main

Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Reconditioning GPA Facilities and T&D Upgrades

The activities that would potentially impact water resources under this alternative are the same as Interim Alternative 1. Therefore, see Interim Alternative 1 for the impact analysis to water resources.

Summary of Interim Alternative 2 Impacts

The activities that would potentially impact water resources under this alternative are the same as Interim Alternative 1. Therefore, see Interim Alternative 1 for the impact analysis to water resources.

Potential Mitigation Measures

No mitigation measures related to water resources are needed for Interim Alternative 2.

6.2.2.3 Interim Alternative 3

Interim Alternative 3 is a combination of reconditioning existing GPA permitted facilities at Marbo, Yigo, and Dededo and upgrades to the DoD power plant at Orote. Upgrades would be made to existing T&D systems. The proposed reconditioning to the existing power generation facilities at Marbo, Yigo, and Dededo would not require new construction or enlargement of the existing footprint of the facility. For the Orote power plant, upgrades would include a new fuel storage facility to facilitate longer run times between refueling. This would disturb approximately 1 ac (4,047 square meters). This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Reconditioning GPA Facilities

The activities that would potentially impact water resources under this portion of the alternative are the same as Interim Alternative 1. Therefore, see Interim Alternative 1 for the impact analysis to water resources for this portion of the alternative.

Upgrade DoD Orote Substation

Construction

Under Interim Alternative 3, the proposed construction of the new Orote substation would result in the potential for a temporary increase in stormwater runoff, erosion, and sedimentation. This would involve land disturbing activities greater than an acre in size that would trigger the requirement for a construction stormwater permit. Therefore, this portion of the alternative would result in impacts on water resources. These impacts would be minimized through the use of BMPs as required through the construction stormwater permit. No wetlands are located in the construction area. Impacts to water resources associated with this portion of the alternative would be less than significant.

Therefore, construction activities associated with Interim Alternative 3 would result in less than significant impacts to water resources.

Operation

The operational phase of Interim Alternative 3 would result in a minor increase in the area of impervious surface, which would result in an associated relatively minor increase in stormwater discharge intensities and volume. This increase would be accommodated by stormwater infrastructure, and stormwater flow paths would continue to mimic area topography. The increase in impervious surface would not significantly decrease aquifer recharge rates, as no diversion or restriction of surface water flow would occur.

The Orote power facility is currently covered under the USEPA Stormwater multi-sector general permit. This multi-sector general permit requires the development of a SWPPP that incorporates BMPs to control pollutants. Additionally, facility-specific LID measures would be identified and developed as part of project design. Together, these actions would minimize potential water quality impacts from facility operation, to include the transportation, storage, and use of fuel on surface and groundwater resources. While alterations to the watershed have the potential result in indirect impacts that could alter nearshore water quality, these potential effects would be minimized by complying with all applicable orders, laws and regulations. No wetland areas would be affected by operations, as no delineated wetland areas are located near the proposed power substation. Therefore, operations associated with Interim Alternative 3 would result in less than significant impacts to water resources.

Summary of Interim Alternative 3 Impacts

Under Interim Alternative 3, there would be no reduction in the amount of wetlands on Guam, and there would be no reduction in the availability or accessibility of water resources. Increases in stormwater would be managed by stormwater infrastructure and stormwater flow paths would continue to mimic area topography, and no construction would occur in a flood zone. There would be no increase in flooding risk. With the development and implementation of site-specific BMPs (Volume 2 Chapter 4 Table 4.2.1) through the USEPA multi-sector stormwater permit, and the implementation the LID measures and facility-specific plans and procedures there would no increased risk from environmental hazards or to human health. All actions would be implemented in accordance with all applicable federal, GovGuam, and military orders, laws, and regulations (Volume 8 Table 3.1-1). Therefore, Interim Alternative 3 would result in less than significant impacts to water resources.

Potential Mitigation Measures

No mitigation measures related to water resources have been identified for Interim Alternative 3.

6.2.2.4 Summary of Impacts

Table 6.2-1 summarizes the potential impacts of each interim alternative. A text summary is provided below.

Table 6.2-1. Summary of Potential Power Impacts

*Interim Alternative 1**	*Interim Alternative 2*	*Interim Alternative 3*
Construction Impacts		
WR: NI	WR: NI	SW: LSI • temporary increase in stormwater runoff, erosion, and sedimentation GW: LSI • increased potential for local groundwater contamination NW: LSI • minor increase in runoff volume and pollutant loading potential WL: NI
Operation Impacts		
WR: NI	WR: NI	SW: LSI • temporary increase in stormwater runoff, erosion, and sedimentation GW: LSI • increased potential for local groundwater contamination NW: LSI • minor increase in runoff volume and pollutant loading potential WL: NI

Legend: LSI = Less Than Significant Impact, NI = No Impact, SW= Surface Water/Stormwater, GW=Groundwater, NW = Nearshore Waters, WL = Wetland. * Preferred Alternative
Note: Potential impacts under Long-term Alternatives 2 and 3 would be analyzed under future NEPA documentation; potential impacts listed herein are general and not final.

Implementation of the power interim alternatives would have no or less than significant impacts to water resources as there would be limited construction or change in operations under these alternatives. Stormwater would continue to be managed in accordance with laws, regulations, and plans which would reduce potential impacts to groundwater and nearshore waters. Land disturbing activities greater than an acre in size that would trigger the requirement for a construction stormwater permit. These impacts would be minimized through the use of BMPs as required through the construction stormwater permit. General construction BMPs (Volume 2 Chapter 4 Table 4.2.1) would be implemented to reduce the potential for erosion, runoff, sedimentation, and associated surface water quality impacts, which would also reduce potential impacts to groundwater and nearshore water resources. No impacts to wetlands would occur.

6.2.3 Potable Water

Chapter 3 Section 3.2.3 (Volume 6) describes the potential impacts from the potable water alternatives that could impact groundwater resources. These impacts relate to withdrawal of groundwater from the Northern Guam Lens Aquifer that would be required to meet the DoD water need on-base, and impacts related to further capacity needs that will result from off-base construction workforce housing and induce population. Please refer to this section for a detailed assessment of these impacts and associated mitigations and best management practices. This chapter and section focuses on other potential impacts to water resources, including groundwater, that could result from the construction and operation of potable water systems in support of the proposed action.

As discussed in greater detail in Section 3.2.3, the Navy recently initiated a study to determine optimal well and well field configurations needed to upgrade and integrate the DoD water systems to meet the future Marine Corps and other DoD water demands and to meet future regulatory requirements. The study would develop groundwater source well design criteria for projects that represent the best value water system improvements that would enable the DoD water systems on Guam to meet future DoD potable water requirements. The study results would be incorporated into the final EIS/OEIS.

6.2.3.1 Basic Alternative 1 (Preferred Alternative)

Basic Alternative 1 would consist of installation of up to 22 new potable water supply wells at Andersen Air Force Base (AFB), rehabilitation of existing wells, interconnection with the GWA water system, and associated T&D systems. A new 5 MG (19 ML) water storage tank would be constructed at ground level at Finegayan.

<u>New Water Supply Facilities</u>

Construction

Under Basic Alternative 1, proposed well construction activities would result in the potential for a temporary increase in stormwater runoff, erosion, and sedimentation. Construction would involve land disturbing activities greater than an acre in size that would trigger the requirement for a construction stormwater permit. Therefore, this portion of the alternative would result in impacts on water resources. These impacts would be minimized through the use of BMPs as required through the construction stormwater permit. General construction BMPs (Volume 2 Chapter 4 Table 4.2.1) would be implemented to reduce the potential for erosion, runoff, sedimentation, and associated surface water quality impacts, which would also reduce potential impacts to groundwater and nearshore water resources. Proposed construction activities would not occur within the 100-year flood zone.

Based on a preliminary review of GIS data, the proposed water main construction footprint associated with Alternative 1 appears to occur through and/or adjacent to several delineated and NWI-indicated wetlands (Figure 6.2-1). Specifically, based on GIS analysis, the proposed water main line construction corridor (for the purposes of this analysis, we assumed a 24 ft [7.3 m]-wide corridor) would overlap approximately 1.27 acres (0.51 ha) of NWI-indicated wetlands. Upon discovering this potential area of direct impact, a TEC biologist surveyed the entire proposed water main course to ground truth the GIS data. Upon inspection, it was determined that the proposed water main line construction footprint would occur in previously disturbed areas within the existing utility easement, outside of the identified potential wetland areas. No direct impacts to delineated or NWI-indicated wetlands would occur.

The Navy would strive to avoid directly impacting, to the greatest extent possible, the delineated and NWI-indicated wetland areas adjacent to the water main footprint in the design and construction phases of the water main; however, for the purposes of this analysis at this time, it is assumed indirect, temporary impacts would occur. During construction, indirect impacts to nearby wetland areas would be minimized by incorporating site-specific appropriate BMPs (Volume 2 Chapter 4 Table 4.2.1) that would reduce the potential for indirect construction impacts to these wetland areas. Therefore, construction activities associated with Alternative 1 would result in less than significant impacts to water resources.

Operation

The proposed new water wells that would draw from the Andersen and the Agafa-Gumas sub-basins are underdeveloped (as compared to the southern sub-basins). The proposed resulting withdrawals associated with the new and existing wells under Alternative 1 (including Guam Waterworks Authority and Andersen AFB planned expansions) would not exceed sustainable levels. The remaining three wells would be installed in the Finegayan sub-basin. As with the other sub-basins, the additional demand on this resource would not exceed the estimated sustainable yield. However, the planned withdrawal rate for the Agafa-Gumas and the Finegayan sub-basins is only slightly below or equal to the estimated sustainable yield so close monitoring of these water sources would occur to ensure these rates are sustainable.

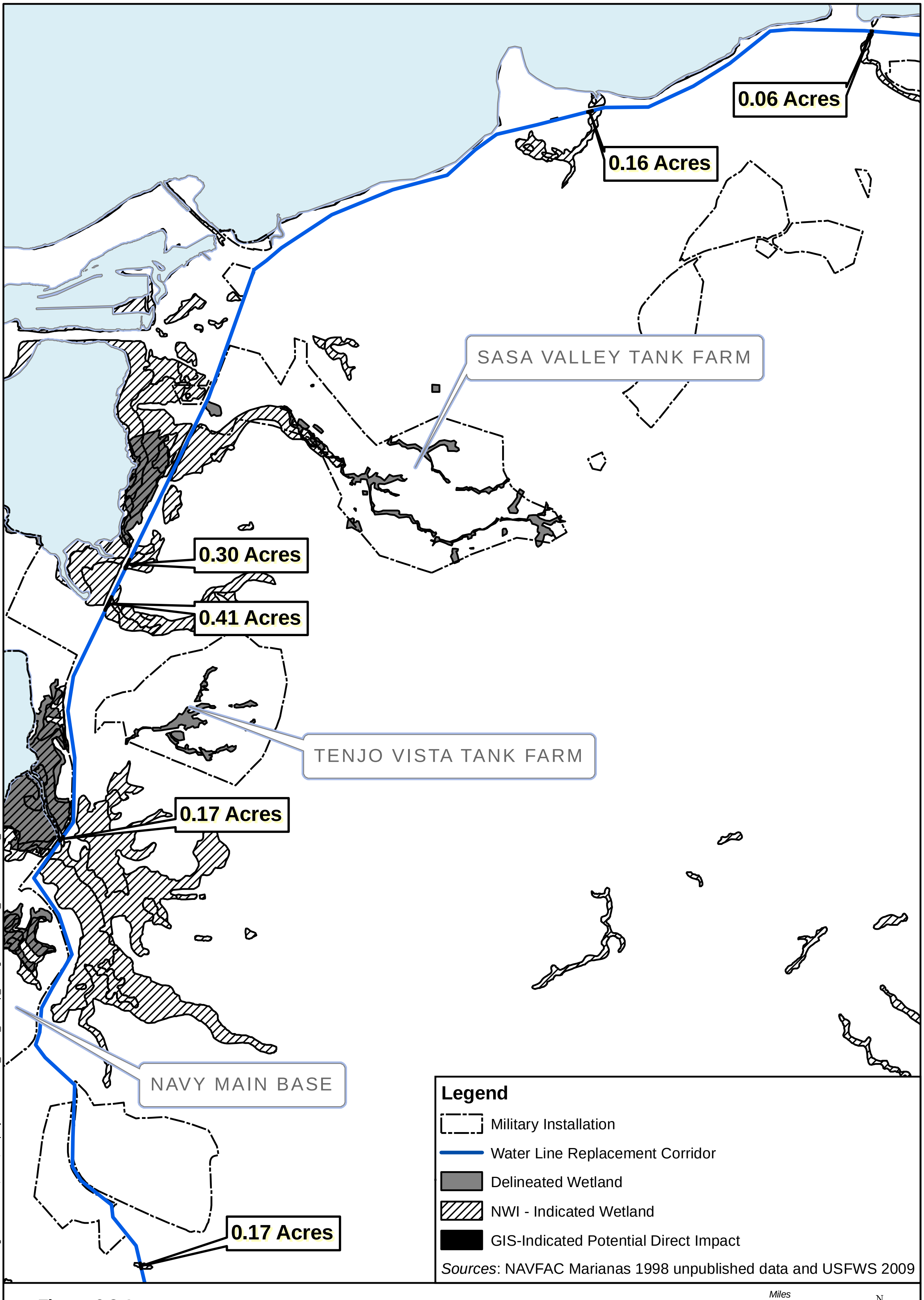

Figure 6.2-1
GIS-Indicated Potential Direct Impacts to NWI-Indicated Wetlands under Basic Alternative 1

There are numerous caves near the shoreline on Guam that provide flow paths for groundwater to the ocean. These caves commonly form along the water table surface and are thus sensitive to changes in groundwater table elevation (Taborosi et al. 2003). The cave and pool systems that have the greatest probability of being impacted by increased groundwater withdrawals are those along the northern shoreline. Each cave and pool system is unique and the actual impact is dependent on the hydrology for each system; in the absence of site-specific cave hydrogeology studies, this analysis relies on general aquifer-wide analysis. Increased groundwater withdrawals could potentially impact water levels in these caves by potentially decreasing the amount of fresh groundwater entering the cave system. The cave and pool systems may be considered jurisdictional waters of the U.S.; thus, any potential impacts to the system would be discussed and potentially permitted by the USACE.

The impact of increased groundwater withdrawals on the pools and caves would likely be dampened by the dynamics of the overall freshwater lens system. Increasing pumping would decrease the thickness of the freshwater lens, but majority of the thinning occurs as a shallowing of the bottom freshwater lens rather than a drop in the elevation of the water table. The Ghyben-Herzberg principle (described in Volume 2, Section 4.1.1.3) states that for every foot the top of the groundwater table drops the mid-point of the freshwater/saltwater transition zone becomes 40 feet (ft) shallower. Also, the average sea level itself imposes a constant boundary condition (as average for tidal fluctuations) that water table would remain slightly above the ocean level. Thus, due to the boundary imposed by ocean and the dynamics of the freshwater lens, the change in water table elevation near the coast where the pools and caves would likely experience very little change due to increase groundwater withdrawals. The majority of the recharge would still flow to the ocean.

Implementation of Basic Alternative 1 would be in compliance with all federal, GovGuam, and military orders, laws, and regulations, and would include the implementation of BMPs and facility-specific LID measures to be identified and developed as part of project design. These actions would minimize potential water quality impacts from facility operation, to include the transportation, storage, and use of fuel on surface and groundwater resources. While alterations to the watershed have the potential to result in indirect impacts that could alter nearshore water quality, these potential effects would be minimized by complying with all applicable orders, laws and regulations. No wetland areas would be affected by operations, as the segments of the water line would be buried in the areas where the line would cross wetland areas and there would be no change to existing hydrology; water flow to wetland areas would not change. Therefore, operations associated with Alternative 1 would result in less than significant impacts to water resources.

<u>New Water Storage Facilities</u>

Construction

Under Basic Alternative 1, the construction of the new facilities would involve land disturbing activities greater than an acre in size that would trigger the requirement for a construction stormwater permit. Therefore, this portion of the alternative would result in impacts on water resources. These impacts would be minimized through the use of BMPs as required through the construction stormwater permit. General construction BMPs (Volume 2 Chapter 4 Table 4.2.1) would be implemented to reduce the potential for erosion, runoff, sedimentation, and associated surface water quality impacts, which would also reduce potential impacts to groundwater and nearshore water resources. Proposed construction activities would not occur within the 100-year flood zone. No wetlands are located in the construction area. Therefore, construction activities associated with Basic Alternative 1 would result in less than significant impacts to water resources.

Operation

The operational phase of Basic Alternative 1 would result in a minor increase in the area of impervious surface that would result in an associated relatively minor increase in stormwater discharge intensities and volume. This increase would be accommodated by stormwater infrastructure, and stormwater flow paths would continue to follow area topography. The increase in impervious surface would not significantly decrease aquifer recharge rates, as no diversion or restriction of surface water flow would occur.

Implementation of Basic Alternative 1 would be in compliance with all federal, GovGuam, and military orders, laws, and regulations, and would include the implementation of BMPs and facility-specific LID measures to be identified and developed as part of project design. These actions would minimize potential water quality impacts from facility operation, to include the transportation, storage, and use of fuel on surface and groundwater resources. While alterations to the watershed have the potential result in indirect impacts that could alter nearshore water quality, these potential effects would be minimized by complying with all applicable orders, laws and regulations. No wetland areas would be affected by operations, as no delineated wetland areas are located near the proposed water treatment and storage sites. Therefore, operations associated with Alternative 1 would result in less than significant impacts to water resources.

Summary of Basic Alternative 1 Impacts

Under Basic Alternative 1, there would be no reduction in the amount of wetlands on Guam, and there would be no reduction in the availability or accessibility of water resources. However, increased groundwater withdrawals could potentially impact water levels in caves located along the northern shoreline of Guam by potentially decreasing the amount of fresh groundwater entering the cave system. The cave and pool systems may be considered jurisdictional waters of the U.S.; thus, any potential impacts to the system would be discussed and potentially permitted by the USACE. Implementation of sustainability practices would reduce the amount of groundwater needed, that would help minimize impacts to groundwater availability. Increases in stormwater would be managed by stormwater infrastructure and stormwater flow paths would continue to mimic area topography, and no construction would occur in a flood zone; therefore, there would be no increase in flooding risk. Through the development and implementation of site-specific BMPs (Volume 2 Chapter 4 Table 4.2.1) and LID measures, and facility-specific plans and procedures, there would no increased risk from environmental hazards or to human health. All actions would be implemented in accordance with all applicable federal, GovGuam, and military orders, laws, and regulations (Volume 8 Table 3.1-1). A detailed description of resource protection measures potentially required by regulatory mandates is in Volume 7, Section 3.1. A more detailed explanation of potential regulatory permitting requirements is also available in Volume 8 (Table 3.1-1). Therefore, with the implementation of these measures, Alternative 1 would result in less than significant impacts to water resources.

Potential Mitigation Measures

No mitigation measures related to water resources have been identified for Basic Alternative 1.

6.2.3.2 Basic Alternative 2

Basic Alternative 2 would consist of installation of up to 20 new potable water supply wells at AFB, up to 11 new potable water supply wells at Barrigada, rehabilitation of existing wells, interconnection with the GWA water system, associated transmission and distribution systems upgrades. Additionally, new 3.6 MG (13.6 ML) and 1 MG (3.8 ML) water storage tanks would be constructed at ground level at Finegayan and Barrigada, respectively.

Under Basic Alternative 2, impacts to water resources would be similar to those described under Alternative 1, as dispersing the groundwater wells would not change the overall pumping rates nor exceed sustainable yields for the subbasins, and no wetlands are located in the identified groundwater well areas. Please refer to Section 6.2.3.1 for a discussion of potential impacts.

<u>Summary of Basic Alternative 2 Impacts</u>

Under Basic Alternative 2, there would be no reduction in the amount of wetlands on Guam, and there would be no reduction in the availability or accessibility of water resources. Implementation of sustainability practices would reduce the amount of groundwater needed, that would help minimize impacts to groundwater availability, as would the development of brackish water. The monitoring of groundwater chemistry and brine discharge would ensure no harm to existing or beneficial use. Increases in stormwater would be managed by stormwater infrastructure and stormwater flow paths would continue to mimic area topography, and no construction would occur in a flood zone; therefore, there would be no increase in flooding risk. Through the development and implementation of site-specific BMPs (Volume 2, Chapter 4 Table 4.2.1) and LID measures, and facility-specific plans and procedures, there would no increased risk from environmental hazards or to human health. All actions would be implemented in accordance with all applicable federal, GovGuam, and military orders, laws, and regulations (Volume 8, Table 3.1-1). Therefore, with the implementation of these measures, Alternative 2 would result in less than significant impacts to water resources.

<u>Potential Mitigation Measures</u>

Basic Alternative 2 would include the same potential mitigation measures described under Basic Alternative 1. Please refer to Section 6.2.3.1.

6.2.3.3 Summary of Impacts

Table 6.2-2 summarizes the potential impacts of each basic alternative. A text summary is provided below.

Table 6.2-2. Summary of Potential Potable Water Impacts

*Basic Alternative 1**	*Basic Alternative 2*
Construction Impacts	
SW: LSI • temporary increase in stormwater runoff, erosion, and sedimentation GW: LSI • increased potential for local groundwater contamination; localized increase in sea water intrusion; NW: LSI • minor increase in runoff volume and pollutant loading potential WL: LSI • Indirect, temporary impacts to wetland areas	SW: LSI • temporary increase in stormwater runoff, erosion, and sedimentation GW: LSI • increased potential for local groundwater contamination; localized increase in sea water intrusion NW: LSI • minor increase in runoff volume and pollutant loading potential WL: LSI • Indirect, temporary impacts to wetland areas
Operation Impacts	
SW: LSI • minor increase in stormwater discharge intensities and volume; potential decrease in cave and pool water levels GW: LSI • increased potential for local groundwater contamination NW: LSI • minor increase in runoff volume and pollutant loading potential WL: NI	SW: LSI • minor increase in stormwater discharge intensities and volume; potential decrease in cave and pool water levels GW: LSI • increased potential for local groundwater contamination NW: LSI • minor increase in runoff volume and pollutant loading potential WL: NI

Legend: SI-M = Significant Impact Mitigable to Less Than Significant, LSI = Less Than Significant Impact, SW= Surface Water/Stormwater, GW=Groundwater, NW = Nearshore Waters, WL = Wetland.
* Preferred Alternative.

Construction and operational activities would have the potential to cause erosion and sedimentation that could degrade surface water quality. In addition, the action alternatives would increase the potential for leaks and spills from contaminants. These potential impacts would be reduced through the combination of site-specific BMPs (Volume 2 Chapter 4 Table 4.2.1), LID measures, and monitoring programs. Increases in stormwater would be managed by stormwater infrastructure and stormwater flow paths would continue to mimic area topography. While groundwater withdrawal rates would increase, implementation of sustainability practices would reduce the amount of groundwater needed, that would help minimize impacts to groundwater availability. The resulting total annual groundwater withdrawals would be less than the sustainable yield and monitoring of groundwater chemistry and brine discharge would ensure no harm to existing or beneficial use. With the implementation of potential mitigation measures (i.e., mitigation measures to be determined during the USACE permitting process for potential impacts to the cave/pool system), potential impacts to jurisdictional waters of the U.S. would be less than significant. The alternatives would be implemented in compliance with all federal, local, and military orders, laws, and regulations (Volume 8 Table 3.1-1), including Commander Navy Region Marianas Instruction 3500.4, as well as the implementation of BMPs, LID, and monitoring.

6.2.4 Wastewater

6.2.4.1 Basic Alternative 1a (Preferred Alternative) and 1b

Basic Alternative 1 (Alternative 1a supports Main Cantonment Alternatives 1 and 2; and Alternative 1b supports Main Cantonment Alternatives 3 and 8) combines upgrade to the existing primary treatment facilities and expansion to secondary treatment at the Northern District Wastewater Treatment Plant (NDWWTP). The difference between Alternatives 1a and 1b is a requirement for a new sewer line from Barrigada housing to NDWWTP for Alternative 1b.

<u>Basic Alternative 1a</u>

Construction

The proposed upgrade of the NDWWTP, expansion to secondary treatment, and installation of a sewer line would result in the potential for a temporary increase in stormwater runoff, erosion, and sedimentation. Construction would involve land disturbing activities that would trigger coverage under the NPDES stormwater construction general permit and preparation of a SWPPP. Therefore, this alternative would result in impacts on water resources. However, these impacts would be minimized during construction as a comprehensive stormwater management program will be implemented for the military buildup. The construction stormwater program would include preparation and implementation of a Regional SWPPP for the military buildup and a site-specific SWPPP for each construction project. Standard construction BMPs (Volume 2 Chapter 4 Table 4.2.1), as well as site-specific BMPs, would be identified and implemented to reduce the potential for erosion, runoff, sedimentation, and associated surface water quality impacts, which would also reduce potential impacts to groundwater, nearshore water resources, and the marine environment. Therefore, construction activities associated with Alternative 1a would result in less than significant impacts to water resources.

Operation

The Navy is conducting a study to evaluate potential impacts on water quality and the marine environment from the GPA NDWWTP wastewater discharge at its new ocean outfall (*The Draft Guam Northern District Outfall Assessment, October 2009*). The study is assessing the potential impacts to the receiving marine environment resulting from the primary and secondary treatment and disposal of wastewater, including additional wastewater loadings associated with the military buildup on Guam. The study was still in draft form at the time of this DEIS publication, but will be finalized before publication of the FEIS. Initial results indicate the upgrade of the NDWWTP to secondary treatment would allow the plant to meet all water quality standards.

<u>Summary of Basic Alternative 1a Impacts</u>

Under Basic Alternative 1a, there would be no reduction in the amount of wetlands on Guam, and there would be no reduction in the availability or accessibility of water resources. There would be no permanent increase in stormwater; stormwater flow paths would continue to follow area topography, and no construction would occur in a flood zone. There would be no increase in flooding risk.

Upon completion of the proposed upgrade to the NDWWTP's primary system and expansion to secondary treatment, the effluent discharge would meet discharge requirements in receiving waters and improve the water quality. Through the development and implementation of a Regional SWPPP, site-specific BMPs and the implementation the LID measures, and facility-specific plans and procedures, there would no increased risk from environmental hazards or to human health. All actions would be implemented in accordance with all applicable federal, GovGuam, and military orders, laws, and regulations (Volume 8 Table 3.1-1). Therefore, Alternative 1a would result in a beneficial impact to water resources upon completion of improvements.

Potential Mitigation Measures

No mitigation measures related to water resources are needed for Basic Alternative 1a.

Basic Alternative 1b

Under Basic Alternative 1b, the proposed upgrade of the NDWWTP, expansion to secondary treatment, and installation of a sewer line would be the same as described under Alternative 1b and would therefore have the same impacts for construction of these facilities. In addition to a sewer line proposed in Basic Alternative 1a, Basic Alternative 1b would include a new sewer line and pump stations to convey wastewater generated from Barrigada housing to the NDWWTP.

Construction

Under Basic Alternative 1b, new sewer lines and pump stations would be installed from Navy Barrigada to the existing NDWWTP collection system. The pipelines would follow along previously disturbed areas within the existing right of way, so there would be no direct impacts on wetlands or surface water features along the route. In addition, this area is part of an additional investigation to verify presence/absence of wetlands using remotely sensed data verified by ground truthing. Results of the investigation will be incorporated into the FEIS.

Construction would involve land disturbing activities that would trigger coverage under the NPDES stormwater construction general permit and preparation of a SWPPP. Therefore, this e alternative would result in impacts on water resources. However, these impacts would be minimized during construction as a comprehensive stormwater management program will be implemented for the military buildup. The construction stormwater program would include preparation and implementation of a Regional SWPPP for the military buildup and a site-specific SWPPP for each construction project. Standard construction BMPs (Volume 2 Chapter 4 Table 4.2.1), as well as site-specific BMPs, would be identified and implemented to reduce the potential for erosion, runoff, sedimentation, and associated surface water quality impacts, which would also reduce potential impacts to groundwater, nearshore water resources, and the marine environment. Therefore, construction activities associated with Basic Alternative 1b would result in less than significant impacts to water resources.

Operation

Operation of the collection system would not impact water resources as the line would be buried. Therefore, operations associated with Basic Alternative 1b would result in less than significant impacts to water resources.

Summary of Basic Alternative 1b Impacts

Under Basic Alternative 1b, there would be no reduction in the amount of wetlands on Guam, and there would be no reduction in the availability or accessibility of water resources. There would be no permanent increase in stormwater; stormwater flow paths would continue to follow area topography, and no construction would occur in a flood zone. There would be no increase in flooding risk.

Upon completion of proposed upgrade to the NDWWTP's primary system and expansion to secondary treatment, the effluent discharge would meet discharge requirements in receiving waters and improve the water quality. Through the development and implementation of a Regional SWPPP, site-specific BMPs and the implementation the LID measures, and facility-specific plans and procedures, there would be no increased risk from environmental hazards or to human health. All actions would be implemented in accordance with all applicable federal, GovGuam, and military orders, laws, and regulations (Volume 8, Table 3.1-1). Therefore, Basic Alternative 1b would result in a beneficial impact to water resources upon completion of improvements.

Potential Mitigation Measures

No mitigation measures related to water resources are needed for Basic Alternative 1b.

6.2.4.2 Summary of Impacts

Table 6.2-3 summarizes the potential impacts of each interim alternative. A text summary is provided below.

Table 6.2-3. Summary of Potential Wastewater Impacts

*Basic Alternative 1a**	*Basic Alternative 1b*
Construction Impacts	
SW: LSI • temporary increase in stormwater runoff, erosion, and sedimentation GW: LSI • increased potential for local groundwater contamination NW: LSI • localized increase in turbidity WL: NI	SW: LSI • temporary increase in stormwater runoff, erosion, and sedimentation GW: LSI • increased potential for local groundwater contamination NW: LSI • localized increase in turbidity WL: NI
Operation Impacts	
SW: NI GW: NI NW: BI • minor increase in effluent discharge but improved water quality WL: NI	SW: NI GW: NI NW: BI • minor increase in effluent discharge but improved water quality. WL: NI

Legend: LSI = Less Than Significant Impact, NI = No Impact, BI = Beneficial Impact, SW = Surface Water/Stormwater, GW = Groundwater, NW = Nearshore Waters, WL = Wetland. * Preferred Alternative

Implementation of Basic Alternative 1a or 1b would have no significant impacts to water resources as there would be limited construction or change in operations under these alternatives. Stormwater would continue to be managed in accordance with laws, regulations, and plans that would reduce potential impacts to groundwater and nearshore waters. No impacts to wetlands would occur. Upon completion of the improvements to the NDWWTP's primary treatment system and expansion to secondary treatment, discharge effluent would meet water quality standards (NPDES permit limits) and therefore would result in beneficial impacts on nearshore water quality.

6.2.5 Solid Waste

6.2.5.1 Basic Alternative 1 (Preferred Alternative)

The Preferred Alternative for solid waste would be the continued use of Navy Landfill at Apra Harbor until Layon Landfill is opened, which is scheduled for July 2011.

The proposed Layon Landfill and its impacts to water resources were evaluated in the *Final Supplemental Environmental Impact Statement for the Siting of a Municipal Solid Waste Facility, Guam* (Guam DPW 2005). The Layon Landfill has been designed to accommodate solid waste from all current and future DoD sources, as well as civilian and commercial sources. GEPA approved the *Final Integrated*

Hydrogeologic Assessment for the Layon Municipal Sanitary Landfill Site (AMEC Geomatrix Consultants 2008) that established that the proposed landfill would not be located over an important source of groundwater because of potential low yield and marginal groundwater quality. The following analysis focuses on the potential impacts to water resources as a result of the continued use of the Navy Sanitary Landfill at Apra Harbor.

There would be no construction associated with the Preferred Alternative and therefore no impacts to surface water, groundwater, nearshore waters, or wetlands would occur due to construction.

Because the existing Navy Sanitary Landfill is unlined, there is a potential for leachate to adversely affect the underlying groundwater. Studies are currently under way to assess whether or not the underlying groundwater has been affected by leachate. Based on the conclusions of these studies, further action may be required. Continued use of the Navy Sanitary Landfill under the Preferred Alternative would further contribute to the potential contamination of the underlying groundwater. However, the landfill is located over aquifers not used for supplying drinking water, thus any leachate that might percolate into the aquifer would not affect regional groundwater drinking quality or quantities. Surface waters, nearshore waters, and wetlands would not be affected by continued use of the Navy Sanitary Landfill. Therefore, less than significant impacts to water resources would occur under the Preferred Alternative.

<u>Potential Mitigation Measures</u>

No mitigation measures related to water resources are needed for the Preferred Alternative.

6.2.5.2 Summary of Impacts

Table 6.2-4 summarizes the potential impact of the Preferred Alternative. A text summary is provided below.

Table 6.2-4. Summary of Potential Solid Waste Impacts

Preferred Alternative
Construction Impacts
• No construction would occur.
Operation Impacts
SW: NI GW: LSI • Contamination from leachate at existing Navy Sanitary Landfill is being determined. NW: NI WL: NI

Legend: LSI = Less Than Significant Impact, NI = No Impact, SW = Surface Water/Stormwater, GW = Groundwater, NW = Nearshore Waters, WL = Wetland

Implementation of the Preferred Alternative has the potential to contribute to continued contamination of the underlying groundwater. However, the landfill is located over aquifers not used for supplying drinking water, thus any leachate that might percolate into the aquifer would not affect regional groundwater drinking quality or quantities. Surface waters, nearshore waters, and wetlands would not be affected by continued use of the Navy Sanitary Landfill. Therefore, less than significant impacts to water resources would occur under the Preferred Alternative.

6.2.6 Off Base Roadways

The major components of the proposed Guam Road Network (GRN) projects include intersection improvement, bridge replacement, pavement strengthening, road widening, roadway relocation, and construction of a new road, all of which impact water resources to various degrees. Intersection improvement projects include relocation of existing military access points (MAPs) and various levels of roadway intersection improvements throughout the island. These types of projects generally involve some pavement widening and subsequent increase in impervious surfaces. Pavement strengthening projects and roadway rehabilitation projects would involve rehabilitation of existing pavement materials and placement of an asphalt overlay or reconstruction of the pavement with new materials. Although such projects generally do not increase impervious surfaces, they may require retrofit of the existing drainage systems to convey stormwater to roadway BMPs. Roadway widening projects include clearing and grubbing, site grading, and widening of pavement and subsequent increase in impervious surfaces along the roadway. With respect to water resources, all of these proposed improvements would generally have (1) little to no impact on floodplains, unless the improvements encroach on an existing floodplain; (2) minor impact on runoff and drainage, possibly requiring relocation or adjustments of drainage catch basins and increasing roadway runoff due to the addition of impervious surfaces; (3) little to no impact to coastal resources because the projects do not involve work in the coastal bays or estuaries and most are located away from the coastline; (4) no impact to National Wild and Scenic Rivers because no rivers in the vicinity of the projects have been designated as such; and (5) potential impact to water quality due to the addition of impervious surfaces that would likely contain sediment, nutrients, hydrocarbons, metals, bacteria, and other particulates that accumulate on roadway surfaces (such pollutants originate from highway use and maintenance and from ambient atmospheric deposition), and due to impacts to erosion and siltation in the drainage area during construction when heavy storms or high wind events occur. These potential impacts are analyzed for each alternative. Also discussed are the impacts attributable to bridge and roadway relocation projects.

Wetlands and waters of the U.S. are discussed in a regulatory context in this chapter. Potential impacts to wetlands and waters of the U.S. are discussed in an ecological context (i.e., potential impacts to special status species, vegetation and marine communities) within the biological resource chapters (Chapter 12 for terrestrial and freshwater aquatic communities and species and Chapter 13 for marine environments).

6.2.6.1 Alternative 1

Year 2014 (Peak Construction and Peak Population)

North

Surface Water/Stormwater. Construction for the North Region projects for this alternative include pavement strengthening along Routes 1, 3, and 9; pavement widening along Routes 3, 9, and 28; construction of a new road; and intersection improvements including MAPs along Routes 3, 9 and 15. With construction of this type, the potential for accidental spills of sediment, fuel, and other toxic materials may occur at any time during the construction period. Water quality impacts from spills could be short or long-term depending on the type of material, size of the spill, and seasonal timing.

To address these potential impacts, roadway-specific BMPs would be included in the planning, design, and construction for all proposed projects. To start construction, regulations set forth by GEPA require a grading permit and a stockpiling permit to be obtained from the Guam DPW. The permits require development of an Erosion and Sediment Control Plan required for clearing, grading, grubbing, embankment or filling, excavation, or other earth-moving operations. This plan would also describe construction site BMPs to be used during construction to minimize the impacts of construction and construction-related activities on the watershed. These include, but are not limited to, temporary soil stabilization, temporary sediment control, scheduling, waste management, materials handling, and other non-stormwater BMPs. During construction, work within or adjacent to floodplains would be equipped with appropriate stormwater control BMPs to prevent spills from occurring within the waterways, debris from entering the waterway, and erosion from occurring within the streambed. Water would be diverted away from any construction activities using appropriate water diversion BMPs.

Through the development and implementation of site-specific BMPs (Volume 2 Chapter 4 Table 4.2.1) there would no increased risk from environmental hazards or to human health. Furthermore, all actions associated with Alternative 1 would be implemented in accordance with all applicable federal, local, and military orders, laws, and regulations (Volume 8 Table 3.1-1), including COMNAV Marianas Instruction 3500.4. Therefore, construction activities associated with Alternative 1, Year 2014 in the North Region would result in less than significant impacts to surface water.

Groundwater. As described in the Volume 2, Chapter 4, the infiltration characteristics are high in the North Region; therefore, any surface water quality impact could also impact groundwater quality if poor quality surface water percolates directly to the groundwater. Thus, the same surface water quality protection measures discussed above would also serve to protect groundwater resources. In addition, in the event groundwater dewatering is proposed or anticipated during construction, and an alternative method of disposal (e.g., discharge to sanitary sewer, retention on site) is not feasible, then the Contractor would coordinate with the Guam DPW prior to discharging waste. Therefore, construction activities associated with Alternative 1, Year 2014 in the North Region would result in less than significant impacts to groundwater.

Nearshore Waters. Potential impacts from roadway construction activities would be lessened through the implementation of the surface water BMPs and adherence to all applicable orders, laws, and regulations relating to water quality. No direct impacts to coastal resources would occur. Therefore, construction activities associated with Alternative 1, Year 2014 in the North Region would result in less than significant impacts to nearshore waters.

Central

Proposed construction projects located in the Central Region have been evaluated for two areas that have two very different hydrologic regimes. One is the northern section of the Central Region (characterized as a broad sloping limestone plateau) and the other is the southern section of the Central Region (characterized as a mountainous region composed of eroded volcanic formations and steep narrow streambeds that outlet directly into the bays). Proposed construction in the northern section includes pavement strengthening along Routes 1, 8, 8A, 10, 15, 16, 25, 26, and 27, and Chalan Lujuna; pavement widening along Routes 8, 8A, 16, 26, and 28, and Alageta-Lily; intersection improvements (including MAPs) along Routes 1, 8A, 15, and 16; and roadway relocation along Route 15. Proposed construction in the southern section of the Central Region includes pavement strengthening along Route 1 and replacement of five bridges along Route 1. Construction of the type proposed in the north section of the Central Region is the same as those described for the North Region.

Surface Water/Stormwater. In addition to the potential impacts and associated water quality protection measures discussed for Alternative 1, North (Section 6.2.6.1), construction of the type proposed in the south section of the Central Region has the potential to: 1) damage existing riverbeds and embankments for work occurring within waterways if appropriate construction BMPs, such as soil stabilization, sediment control, and surface water diversion away from the construction site, are not in place prior to commencement of construction activities; and 2) cause an increase in suspended sediment, hydrocarbons, oil and grease, and heavy metals in the surface water bodies if appropriate stormwater and non-stormwater BMPs are not in place prior to work occurring within or adjacent to the rivers where the bridge replacements are to occur.

Proposed dewatering activities associated with structure placement could also introduce contaminants into the surface waters if inappropriate sampling and disposal methods for potentially contaminated groundwater are not conducted during construction. The bridge replacement projects could impact erosion and sedimentation within the streams if the improvements result in increased flow velocities or incorporate inadequate erosion control practices for short-term (construction) operations and for long-term operations within and/or adjacent to the stream channels. Hydraulic modeling would therefore be required to assess the potential impacts and provide adequate data for the design of flood and erosion control facilities. The bridge replacements are proposed to span crossings along Route 1 over the Agana River, Atantano River, Laguas River, Sasa River, and Fonte Rivers. These rivers are considered perennial (flowing water for all or most of the year) and have a direct nexus with waters considered navigable under the CWA. Therefore, the channels of these rivers bounded by observed ordinary high water marks along each channel's stream bank should be considered jurisdictional under the CWA (waters of the U.S.). As shown in Table 6.2-5, construction activities associated with the five bridge replacements would temporarily remove a total area of approximately 1 acre. Temporary direct impacts associated with construction activities include the potential for increased erosion associated with grading into the subsoil within and outside the stream channel, vegetation removal, and potential impacts to aquatic communities in the immediate area of the bridge replacement. Indirect impacts may occur further downstream outside of the immediate construction area and be prolonged in time. These indirect effects may include degradation of stream channel aquatic habitats and marine habitats supporting coral communities and fisheries. FHWA and GEPA have mandated standard operating procedures and BMPs specific to sediment control that accounts for storm water runoff and other Guam-specific criteria for pollution prevention during construction and operation of the proposed roads. With respect to hydraulic conveyance, the bridge replacement projects could impact erosion and sedimentation within the streams if the improvements result in increased flow velocities or incorporate inadequate erosion control practices for short-term (construction) operations and for long-term operations within and/or adjacent to the stream channels. Hydraulic modeling would therefore be required to assess the potential impacts and provide adequate data for the design of flood and erosion control facilities. Improved hydraulic conveyance under the new bridges would benefit downstream channel segments, wetland areas and open water habitats by decreasing scour along the stream bank near the bridge replacements and decreasing sediment inputs into downstream freshwater and marine habitats. In summary, the bridge replacement projects would cause an unavoidable loss of approximately 1 acre of waters of the U.S. However, the impacts would be minimized through: 1) use of construction and source control BMPs cooperatively developed by the FHWA and GEPA and 2) improved hydraulic conveyance under the proposed bridge replacements.

Table 6.2-5. Bridge Replacements and Estimated Impacts to Potential Waters of the U.S.

GRN Project #	*Bridge Name*	*Dimensions (ft)*		*Impact to Potential Waters of the U.S.*	
		Structure Width	*Stream Channel Width*	*Square Ft*	*Acres*
3	Agana Bridge	87.0	39.3	5,777.1	0.13
35	Atantano Bridge	80.6	42.7	5,286.6	0.12
	Fonte Bridge	100.0	76.5	11,920.0	0.27
	Laguas Bridge	80.8	41.2	5,801.0	0.13
	Sasa Bridge	82.3	40.3	6,062.0	0.14
Total Area				**34,846.6**	**0.80**

Notes: Stream channel widths were calculated by averaging the width of four cross-stream lines between observed ordinary high water marks (OHWM) for each bridge. Two upstream lines and two downstream lines were measured for each bridge.
The estimated area of direct impacts to potential waters of the U.S. was calculated by the following equation: (Stream channel width) x (Structure width) + (Assumed area of upstream channel modifications [30']) + (Assumed area of downstream channel modifications [30']).

Through the development and implementation of site-specific BMPs (Volume 2 Chapter 4 Table 4.2.1) there would no increased risk from environmental hazards or to human health. Furthermore, all actions associated with Alternative 1 would be implemented in accordance with all applicable federal, local, and military orders, laws, and regulations (Volume 8 Table 3.1-1), including COMNAV Marianas Instruction 3500.4. Therefore, construction activities associated with Alternative 1, Year 2014 in the Central Region would result in less than significant impacts to groundwater.

Groundwater. Potential construction impacts to groundwater resources resulting from implementation of Alternative 1, Year 2014 in the Central Region would be similar to the potential impacts discussed under Alternative 1, Year 2014 for the North Region (refer to Section 6.2.6.1). Therefore, construction activities associated with Alternative 1, Year 2014 in the Central Region would result in less than significant impacts to groundwater.

Nearshore Waters. Potential construction impacts to nearshore waters resulting from implementation of Alternative 1, Year 2014 in the Central Region would be similar to the potential impacts discussed under Alternative 1, Year 2014 for the North Region (refer to Section 6.2.6.1). Therefore, construction activities associated with Alternative 1, Year 2014 in the Central Region would result in less than significant impacts to nearshore waters.

Apra Harbor

Proposed construction projects within the Apra Harbor Region include pavement strengthening along Routes 1 and 2A, roadway rehabilitation along Route 11, and intersection improvements along Route 1. Route 11 is the main entry to Apra Harbor which is shown to be within the coastal flood zone in the FEMA FIRMs. The Route 1/11 interchange is located within the floodplain of the Masso River. Construction of this type has the potential to cause an increase in suspended sediment, hydrocarbons, oil and grease, and heavy metals in the surface water bodies for work occurring within or adjacent to the Masso River and the adjacent Piti Canal.

Potential construction impacts to water resources in Apra Harbor are similar to those described for Alternative 1, Year 2014, North Region (refer to Section 6.2.6.1). Therefore, construction activities associated with Alternative 1, Year 2014 in Apra Harbor would result in less than significant impacts to water resources.

South

Proposed construction projects within the South Region include improvements along Route 5 (pavement strengthening only), Route 2 (intersection improvement) and Route 12 (relocation of MAPs).

Potential construction impacts to water resources in the South Region are similar to those described for Alternative 1, North Region (refer to Section 6.2.6.1). Therefore, construction activities associated with Alternative 1, Year 2014 in the South Region would result in less than significant impacts to water resources.

Potential Mitigation Measures

No potential mitigation measures have been identified for Alternative 1.

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North

The North Region projects for this alternative include pavement strengthening and intersection improvements for MAPs. Resulting long-term impacts on water resources within this area are itemized below.

Surface Water/Stormwater. Under Alternative 1, potential impacts to runoff and drainage flows could occur due to increased impervious surfaces and could require modifications to existing drainage systems. These impacts would be minimized through management of stormwater and erosion in accordance with the applicable SWPPP and associated BMPs (Volume 7 Chapter 2 Table 6.2-6); therefore, these impacts are less than significant. In this area, the roadway drainage generally flows off the pavement via sheet flow minimizing the need for underground storm drain and catch basin networks. This may require adjustments of adjacent swales or construction of new surface flow systems to enable proper drainage flow offsite. No impacts to floodplains are anticipated because no flood hazard zones have been designated where the proposed improvements are to take place.

Diversion of drainage from one watershed to another would be avoided. Roadway-specific BMPs would be included in the planning, design, and construction for all proposed projects. A Storm Water Runoff Drainage System Plan is required for a Grading Permit by the Guam DPW when the area to be graded is more than 5,000 square ft (464 square m) or a proposed cut or fill is greater than 5.0 ft (1.5 m) in height. This stormwater plan would describe the impacts and proposed mitigation related to runoff and drainage.

Through the development and implementation of site-specific BMPs (Volume 2 Chapter 4 Table 4.2.1) there would no increased risk from environmental hazards or to human health. Furthermore, all actions associated with Alternative 1 would be implemented in accordance with all applicable federal, local, and military orders, laws, and regulations (Volume 8 Table 3.1-1), including COMNAV Marianas Instruction 3500.4. Therefore, Alternative 1, Year 2030 in the North Region would result in less than significant impacts to surface waters.

Groundwater. Under Alternative 1, potential impacts to groundwater quality could occur due to the addition of impervious surfaces that would likely contain sediment, nutrients, hydrocarbons, metals, bacteria, and other particulates that accumulate on roadway surfaces (such pollutants originate from routine roadway use and maintenance and from ambient atmospheric deposition). Because the infiltration characteristics are high, any surface water quality impact could also impact groundwater quality. Groundwater is the primary drinking water supply for the island; therefore, water quality protection would be important. Thus, the same surface water quality protection measures discussed above would also serve to protect groundwater resources. Therefore, Alternative 1, Year 2030 in the North Region would result in less than significant impacts to groundwater.

Nearshore Waters. While alterations to the watershed have the potential result in indirect impacts that could alter the nearshore water quality, these potential effects would be minimized by complying with all applicable orders, laws and regulations presented in Volume 7 Section 3.1. In addition, the aforementioned surface water resource protection measures would minimize potential indirect impacts to nearshore waters. No direct impacts to coastal resources would occur. Therefore, Alternative 1, Year 2030 in the North Region would result in less than significant impacts to nearshore waters.

Central

Descriptions of affected water resources for the Central Region have been split into the northern and southern part and are described in detail in Volume 2. Roadway projects located in the northern part of the Central Region include pavement strengthening; pavement widening; intersection improvements, including MAPs; and roadway relocation.

Surface Water/Stormwater. Proposed GRN projects in the southern part of the Central Region include pavement strengthening and bridge replacement at five stream crossings. The bridge replacement projects would be undertaken to correct structural deficiencies, increase load capacity, and provide compliance with seismic requirements of the bridges. Studies have shown that the Agana Bridge #1 would not be able to support the proposed loadings for the military buildup. Due to the age and condition of this structure, replacement is required. The new structure would be lengthened to adequately accommodate the flood flow of the river. The width of the new structure would accommodate wider lanes and a median, with sidewalks and barriers on each side.

Hydraulic modeling and flood control improvements associated with the Agana River Bridge Replacement Project would be coordinated through the USACE Flood Control Study for the Hagatna (Agana) River. Flood control was originally studied by USACE in 1977 and was found to be feasible. Since then, conditions have changed, requiring reinvestigation by USACE. A new feasibility study is currently underway. The bridge projects also include replacement of the Atantano Bridge, Laguas Bridge, Sasa Bridge, and Fonte Bridge. These bridges would be replaced due to structural deficiencies, but they would have hydraulic conveyance capacity similar to those under existing conditions. Bridge replacement efforts would also include improvements to the underlying channel as necessary to enable adequate hydraulic conveyance capacity while maintaining or improving potential erosive characteristics of the channel embankments. Improvements to the channels would involve such items as debris removal; placement of erosion control, such as riprap, gabions, vegetated surfaces (with or without erosion control blankets depending on shear forces in the channel),or concrete channel lining on the upstream and/or downstream sides of the bridges and above piers where necessary; and wing wall replacement where necessary.

Under Alternative 1, potential impacts to floodplains located in the northern part of the Central Region would be minimal because very few designated flood hazard areas are shown to exist on the FEMA FIRMs (FIRMs 2009). Only two floodplain areas are shown to be within any of the improvements in the North Central Area, and these are both located on Route 1. These include the Harmon Sink and the Tamuning Drainageway. Route 1 road improvements in these areas are limited to pavement strengthening, that should have no impact to the floodplains. Impacts to floodplains in the southern part of the Central Region are also limited to Route 1. Numerous culverts and bridges along Route 1 cross narrow streams that outlet into the bays and to Apra Harbor. Encroachments into the floodplains and floodways of some of these streams would occur for the bridge replacement projects. These include replacement of five bridges located along Route 1. All of these bridge improvement projects would involve work within or adjacent to 100-year floodplains. Work occurring within the Agana and Fonte Rivers would be within a FEMA-designated floodway. Bridge lengthening, pier replacement, pier widening, channel lining, and/or bridge replacement activities could impact the upstream floodplain by increasing depths of flow for the 100-year storm event. Location hydraulic studies for each bridge site would require hydraulic modeling to demonstrate the pre- and post-project hydraulic conditions of the floodplain to assess and mitigate the impacts. In general, these bridges would be replaced due to structural deficiencies, but they would have hydraulic conveyance capacity similar to those under existing conditions with the possible exception of the Agana Bridge # 1, that may be designed with additional capacity in accordance with recommendations set forth by USACE as specified in their ongoing Hagatna River Flood Control Study.

Potential impacts to runoff and drainage in the northern part of the Central Region could occur due to roadway widening, intersection improvements, and relocation of Route 15, all of which would increase impervious surfaces and could require modifications to existing drainage systems, including swales, storm drains, catch basins, and connecting stormwater treatment BMPs such as detention basins or biofiltration systems. In this area, the roadway drainage on the east side of the island generally flows off the pavement via sheet flow, minimizing the need for underground storm drain and catch basin networks. This may require adjustments of adjacent swales or construction of new surface flow systems to enable proper drainage flow offsite. Roadway drainage on the west side of the island generally flows to a curb and gutter system and to a catch basin/ storm drain conveyance system. Route 1 is curbed and flows southerly in a storm drain system to the Tamuning Drainageway or to the Harmon Sink. Work along Route 1 may require adjustments to catch basins and incorporation of BMPs at the Tamuning Drainageway outlet. In other areas, runoff flows directly to sinks that allow the untreated runoff to percolate to the groundwater system below, that could impact groundwater quality if the percolation rates are too high. In the south central area, impacts to runoff and drainage would occur along Route 1. The roadway is generally curbed, and runoff flows to storm drain networks that outlet directly to the adjacent waterways. All bridge improvement projects could impact runoff and drainage if the bridge improvements/replacements increase flow depths or velocities within the stream channels. This could result in flow conveyance capacity reductions of the connecting drainage systems or increased erosion potential within the channel. Hydraulic modeling would therefore be required to assess the potential impacts and provide adequate data for the design of flood and erosion control facilities. Improved hydraulic conveyance under the new bridges would benefit downstream channel segments, wetland areas and open water habitats by decreasing scour along the stream bank near the bridge replacements and decreasing sediment inputs into downstream freshwater and marine habitats.

Through the development and implementation of site-specific BMPs (Volume 2 Chapter 4 Table 4.2.1) there would no increased risk from environmental hazards or to human health. Furthermore, all actions associated with Alternative 1 would be implemented in accordance with all applicable federal, local, and military orders, laws, and regulations (Volume 8 Table 3.1-1), including COMNAV Marianas Instruction 3500.4. Therefore Alternative 1, Year 2030 in the Central Region would result in less than significant impacts to surface water.

Groundwater. In the northern part of the Central Region, potential impacts to groundwater quality could occur due to the addition of impervious surfaces that would likely contain sediment, nutrients, hydrocarbons, metals, bacteria, and other particulates that accumulate on roadway surfaces (such pollutants originate from routine roadway use and maintenance and from ambient atmospheric deposition). Increases in suspended sediment, hydrocarbons, oil and grease, and heavy metals during construction could also impact surface and groundwater quality. Because the infiltration characteristics are so high, any surface water quality impact could also impact groundwater quality. Groundwater is the primary drinking water supply for the island; therefore, water quality protection would be important. In the southern part of the Central Region, impacts to water quality would generally involve surface water resources (groundwater resources are very limited in this area) and would mainly involve the bridge projects along Route 1. Impacts could occur if the bridge improvements/replacements increase flow velocities within the stream channels that could result in increased erosion potential within the channel and subsequent increase in suspended sediment downstream. Therefore, Alternative 1, Year 2030 in the Central Region would result in less than significant impacts to groundwater.

Nearshore Waters. Potential construction impacts to nearshore waters resulting from implementation of Alternative 1, Year 2030 in the Central Region would be similar to the potential impacts discussed under Alternative 1, Year 2030 for the North Region (refer to Section 6.2.6.1, Year 2030). Therefore, Alternative 1, Year 2030 in the Central Region would result in less than significant impacts to nearshore waters.

Apra Harbor

The proposed GRN projects within the Apra Harbor Region include pavement strengthening, roadway rehabilitation along Route 11, and intersection improvements. Route 11 is the main entry to Apra Harbor, that is shown to be within the coastal flood zone in the FEMA FIRMs. The Route 1/11 interchange is located within the floodplain of the Masso River. Proposed improvements could have the following impacts to water resources:

Surface Water/Stormwater. Potential impacts to surface water resources resulting from implementation of Alternative 1, Year 2030 in Apra Harbor would be similar to the potential impacts discussed under Alternative 1, Year 2030 for the North Region (refer to Section 6.2.6.1, Year 2030). Therefore, Alternative 1, Year 2030 in Apra Harbor would result in less than significant impacts to surface water.

Groundwater. Potential impacts to surface water resources resulting from implementation of Alternative 1, Year 2030 in Apra Harbor would be similar to the potential impacts discussed under Alternative 1, Year 2030 for the North Region (refer to Section 6.2.6.1, Year 2030). Therefore, Alternative 1, Year 2030 in Apra Harbor would result in less than significant impacts to groundwater.

Nearshore Waters. Potential impacts to nearshore waters resulting from implementation of Alternative 1, Year 2030 in Apra Harbor would be similar to the potential impacts discussed under Alternative 1, Year 2030 for the North Region (refer to Section 6.2.6.1, Year 2030). Therefore, Alternative 1, Year 2030 in Apra Harbor would result in less than significant impacts to nearshore waters.

South

The proposed GRN projects within the South Region include improvements along Route 5 (pavement strengthening only) and Route 12 (relocation of MAPs). These routes are located within the upper reaches of the Atantano River and Namo River watersheds along the southwest portion of the island. The Atantano River flows westerly into the Inner Apra Harbor, while the Namo River flows westerly to Agat Bay. Proposed improvements could have the following impacts to water resources:

Surface Water/Stormwater. Potential impacts to surface water resources resulting from implementation of Alternative 1, Year 2030 in the South Region would be similar to the potential impacts discussed under Alternative 1, Year 2030 for the South Region (refer to Section 6.2.6.1, Year 2030). Therefore, Alternative 1, Year 2030 in the South Region would result in less than significant impacts to surface water.

Groundwater. Potential impacts to surface water resources resulting from implementation of Alternative 1, Year 2030 in the South Region would be similar to the potential impacts discussed under Alternative 1, Year 2030 for the North Region (refer to Section 6.2.6.1, Year 2030). Therefore, Alternative 1, Year 2030 in the South Region would result in less than significant impacts to groundwater.

Nearshore Waters. Potential impacts to nearshore waters resulting from implementation of Alternative 1, Year 2030 in the South Region would be similar to the potential impacts discussed under Alternative 1, Year 2030 for the North Region (refer to Section 6.2.6.1, Year 2030). Therefore, Alternative 1, Year 2030 in the South Region would result in less than significant impacts to nearshore waters.

Potential Mitigation Measures

Most floodplain impacts are associated with the bridge rehabilitation/ improvement projects located along Route 1. A Floodplain Evaluation is required under the National Flood Insurance Program (23 *Code of Federal Regulations* 650, Subpart A Section 650). Measures to mitigate floodplain impacts could include:

- Channel widening, channel lining, channel recontouring
- Pier placement/reconfiguration
- Utility line relocation where utilities cause obstructions to flow
- Debris removal, incorporation of debris noses upstream of piers and wingwalls
- Steepening of embankments using lining such as gabions

6.2.6.2 Alternative 2 (Preferred Alternative)

Peak construction and permanent impacts on water resources under Alternative 2 would be similar to those described under Alternative 1 because the same projects are proposed under this alternative with the exception of varying locations of the MAPs along Route 3.

Potential Mitigation Measures

Potential mitigation measures for Alternative 2 would be the same as those proposed for Alternative 1.

6.2.6.3 Alternative 3

Peak construction and permanent impacts on water resources under Alternative 3 would be similar to those described under Alternative 1 because the same projects are proposed under this alternative, with a few projects that would not be built as part of the GRN improvements program and varying locations of a few MAPs.

Potential Mitigation Measures

Potential mitigation measures for Alternative 3 would be the same as those proposed for Alternative 1.

6.2.6.4 Alternative 8

Peak construction and permanent impacts on water resources under Alternative 8 would be similar to those described under Alternative 1 because the same projects are proposed under this alternative, with a few projects that would not be built as part of the GRN improvements program and varying locations of a few MAPs.

Potential Mitigation Measures

Potential mitigation measures for Alternative 8 would be the same as those proposed for Alternative 1.

6.2.6.5 No-Action Alternative

Under the no-action alternative, Marine Corps units would remain in Japan and would not relocate to Guam, the visiting aircraft carrier would berth at Kilo Wharf, and an Army Ballistic Missile Defense Task Force (BMDTF) would not be positioned on Guam; therefore, the no-action alternative would obviate the need to improve roads necessary for the military buildup. Road improvements associated with the natural growth of Guam's population would continue and include several projects previously identified. These include projects to be constructed by the years 2014 and 2030. Projects to be in place by 2014 include pavement widening along Routes 10A and 27, and Tiyan Parkway, and intersection improvement projects along Routes 1 and 7. All of these projects are located within the Central Region. Projects to be in place by 2030 include pavement widening along Routes 2, 7A, 25, and 26 and intersection improvements located along Routes 1, 4, and 16. All of these projects are located within the Central Region, with the exception of the Route 2 widening, that is located in the South Region.

<u>2009</u>

Construction activities for the improvement projects to be constructed by 2014 would commence in 2009 and would be typical of public works maintenance projects. Because the no-action alternative would involve significantly fewer projects to be constructed during the year 2014, construction impacts on water resources under this alternative would be less than with the action alternatives. Typical impacts to water resources from the proposed roadway improvements to be constructed in Year 2014 are described below.

Surface Water/Stormwater

Under the no-action alternative, Year 2009, there would be an increase in impervious surfaces and potential changes to drainage systems that include swales, storm drains, catch basins, and connecting stormwater treatment BMPs, such as detention basins. Increases in onsite drainage velocities and/or flow due to increased impervious area would be mitigated through the use of detention facilities, energy-dissipating devices at outlets, channel lining, use of grass swales or hydroseeded embankments where potential erosion could occur, incorporation of headwalls or flared end outlets, and use of appropriate stormwater treatment BMPs that would remove pollutants from the drainage system. Roadway-specific BMPs would be included in the planning, design, and construction for all proposed projects. A Storm Water Runoff Drainage System Plan is required for a Grading Permit by the Guam DPW when the area to be graded is more than 5,000 square ft (464 square m) or a proposed cut or fill is greater than 5.0 ft (1.5 m) in height. This stormwater plan would describe the impacts and proposed mitigation related to runoff and drainage. No impacts to floodplains are anticipated because no flood hazard zones have been designated where the proposed improvements are to take place.

Prior to starting construction, regulations set forth by GEPA require a grading permit and a stockpiling permit to be obtained from the Guam DPW. The permits require development of an Erosion and Sediment Control Plan required for clearing, grading, grubbing, embankment or filling, excavation, or other earth-moving operations. This plan would describe construction site BMPs to be used during construction to minimize the impacts of construction and construction-related activities on the watershed. These include, but are not limited to, temporary soil stabilization, temporary sediment control, scheduling, waste management, materials handling, and other non-stormwater BMPs. In the event groundwater dewatering is proposed or anticipated during construction, and an alternative method of disposal (e.g., discharge to sanitary sewer, retention on site) is not feasible, then the Contractor would coordinate with the Guam DPW prior to discharging waste. Therefore, the no-action alternative, Year 2009, would result in less than significant impacts to surface water.

Groundwater

Under the no-action alternative, Year 2009, potential impacts to groundwater quality could occur due to the addition of impervious surfaces that would likely contain sediment, nutrients, hydrocarbons, metals, bacteria, and other particulates that accumulate on roadway surfaces (such pollutants originate from routine roadway use and maintenance and from ambient atmospheric deposition). Because the infiltration characteristics are high, any surface water quality impact could also impact groundwater quality. Groundwater is the primary drinking water supply for the island; therefore, water quality protection would be important. Thus, the same surface water quality protection measures discussed above would also serve to protect groundwater resources. Therefore, the no-action alternative, Year 2009, would result in less than significant impacts to groundwater.

Nearshore Waters

Under the no-action alternative, alterations to the watershed have the potential result in indirect impacts that could alter the nearshore water quality; however, these potential effects would be minimized by complying with all applicable orders, laws and regulations presented in Volume 7, Section 3.1. In addition, the aforementioned surface water resource protection measures would minimize potential indirect impacts to nearshore waters. No direct impacts to coastal resources would occur. Therefore, the no-action alternative, Year 2009, would result in less than significant impacts to nearshore waters.

2014

Potential impacts and required mitigation associated with the no-action alternative to water resources would be the same as those described for 2009 (refer to Section 6.2.6.4, Year 2009). Therefore, the no-action alternative, Year 2014, would result in less than significant impacts to water resources.

2030

Potential impacts and required mitigation associated with the no-action alternative to water resources would be the same as those described for 2009 (refer to Section 6.2.6.4, Year 2009). Therefore, the no-action alternative, Year 2030, would result in less than significant impacts to water resources.

6.2.6.6 Summary of Impacts

Table 6.2-7 summarizes the potential impacts of each interim alternative. An analysis of long-term alternatives was not prepared because the alternatives are not ready for project-specific analysis. A text summary is provided below.

Table 6.2-6. Summary of Potential Roadway Project Impacts

Potentially Impacted Resource	*Alternative 1*	*Alternative 2**	*Alternative 3*	*Alternative 8*
Floodplains	LSI	LSI	LSI	LSI
Runoff and Drainage	LSI	LSI	LSI	LSI
Coastal Resources	NI	NI	NI	NI
Surface Water Quality	LSI	LSI	LSI	LSI
Groundwater Quality	LSI	LSI	LSI	LSI

Legend: LSI = Less Than Significant Impact, NI = No Impact. * Preferred Alternative

Construction activities would consist of intersection improvements, bridge replacements, pavement strengthening, road relocation, road widening and construction of a new road. With respect to water resources, all these types of improvements would generally have: (1) potential impact on floodplains where the bridge replacement projects are proposed; (2) minor impact on runoff and drainage for all projects, possibly requiring relocation or adjustments of drainage catch basins and increasing roadway runoff due to the addition of impervious surfaces; (3) little to no direct impact to coastal resources because the projects do not involve work in the coastal bays or estuaries and most are located away from the coastline; (4) potential impact to surface water quality due to the addition of impervious surfaces that would likely contain sediment, nutrients, hydrocarbons, metals, bacteria, and other particulates that accumulate on roadway surfaces (such pollutants originate from highway use and maintenance and from ambient atmospheric deposition) and due to impacts to erosion and siltation in the drainage area during construction when heavy storms or high wind events occur; and (5) potential impact to groundwater quality in the north area of the island because infiltration characteristics are high in this area causing the potential for groundwater to be under the influence of surface water impacts.

Each of the action alternatives would include physical changes that would be considered potentially significant impacts on water resources. Roadways, bridges, drainage systems, stormwater pollution control systems, erosion control systems, and flood control systems would be designed in accordance with specific water resource considerations to prevent impacts to surface and groundwater resources, floodplains, coastal resources, and the overall runoff and drainage systems. Storm Water Management Plans, Erosion and Sediment Control Plans, and Location Hydraulic Studies for Flood Plains would be required prior to construction. All of these documents would be used to develop and implement proper measures to prevent water resource impacts.

Through the development and implementation of site-specific BMPs (Volume 2 Chapter 4 Table 4.2.1) there would no increased risk from environmental hazards or to human health. Furthermore, all actions associated with Alternative 1 would be implemented in accordance with all applicable federal, local, and military orders, laws, and regulations (Volume 8, Table 3.1-1,), including COMNAV Marianas Instruction 3500.4.

6.3 LEAST ENVIRONMENTALLY DAMAGING PRACTICABLE ALTERNATIVE

Since none of the alternatives involve potential impacts to wetlands as defined in Section 404(b)(1) of the Clean Water Act (CWA), no analysis relative to Section 404 is necessary to identify the *least environmentally damaging alternative* as defined in the CWA.

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CHAPTER 7.
AIR QUALITY

7.1 INTRODUCTION

This chapter describes the potential environmental consequences associated with implementation of the alternatives within the four regions of influence (ROI) – North, Central, Apra Harbor, and South – for air quality resources. For a description of the affected environment for air quality resources, refer to Chapter 5 of Volume 2 (Marine Corps Relocation – Guam). The locations described in that volume include the ROIs for the utilities and off base roadway project components of the proposed action.

7.2 ENVIRONMENTAL CONSEQUENCES

The comprehensive air quality consequences analysis performed in this volume includes the following analysis components that examine potential impacts of utilities and roadway projects on Guam on air quality:

Utilities

- A microscale (localized) criteria pollutant analysis of potential impacts from a proposed major stationary source (i.e., power plant) for interim alternatives
- A Clean Air Act (CAA) general conformity applicability analysis of direct and indirect sulfur dioxide (SO_2) emission increases that would result from the proposed action within the two SO_2 nonattainment areas on Guam that were identified in Volume 2, Section 5.1.
- A net incremental emissions analysis of criteria pollutants and greenhouse gases (GHGs) in terms of carbon dioxide (CO_2) emissions with the potential to emit from the following stationary sources:
    - Power plant
    - Solid waste landfill facility
- A net incremental emissions analysis of criteria pollutants and CO_2 with the potential to emit from the following mobile sources:
- Construction equipment, hauling truck, and worker's commuting vehicle emissions during the construction period.

Roadway Projects

- A microscale carbon monoxide (CO) analysis of potential impacts from local traffic at congested intersections
- A qualitative particulate matter (PM) and primary mobile source air toxic analysis
- A microscale mobile source air toxic analysis of potential impacts from local traffic at congested intersections using USEPA recommended research guidance (TBD)
- A net incremental emissions analysis of criteria pollutants and CO_2 emissions with the potential to emit from the following mobile sources:
- Traffic-related on-road motor vehicle operations
- Roadway construction equipment and hauling truck emissions during the construction period.

Regional Analysis

The regional or mesoscale analysis of a project determines the overall impact of a project on regional air quality levels. A transportation project is analyzed as part of a regional transportation network developed by the County or State. Projects included in this network are found in GovGuam's *Territorial Transportation Improvement Plan* developed by the Department of Public Works. The Territorial Transportation Improvement Plan is the basis for the regional analysis, utilizing vehicle miles traveled (VMT) and vehicle hours traveled (VHT) within the region to determine daily "pollutant burden" levels. The results of this analysis determine if an area is in conformity with regulations set forth in the United States (U.S.) Environmental Protection Agency's (USEPA) Final Transportation Conformity Rule.

Particulate Matter

On March 10, 2006, the USEPA issued a Final Rule regarding localized or "hot-spot" analysis of particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) and particulate matter less than 10 microns in diameter (PM_{10}) (40 *Code of Federal Regulations* [CFR] Part 93). This rule requires that $PM_{2.5}$ hotspot analysis be performed only for transportation projects with significant diesel traffic in areas not meeting $PM_{2.5}$ air quality standards. The project area is classified as an attainment area for PM_{10} and $PM_{2.5.}$ The project is also not anticipated to generate additional diesel traffic. As such, a hot-spot analysis is not required.

Attainment of National Ambient Air Quality Standards (NAAQS)

The USEPA, under the requirements of the 1970 Clean Air Act (CAA), as amended in 1977 and 1990 (Clean Air Act Amendments [CAAA]), has established NAAQS for six contaminants, referred to as criteria pollutants (40 Code of Federal Regulations [CFR] 50). The regulations establish the NAAQS criteria in order to protect public health and the environment by limiting the amount of pollutants allowed in the ambient air. These six criteria pollutants are:

- Carbon monoxide (CO)
- Nitrogen dioxide (NO_2)
- Ozone (O_3), with nitrogen oxides (NO_x) and volatile organic compounds (VOCs) as precursors
- Particulate matter (PM_{10}—less than 10 microns in particle diameter; $PM_{2.5}$—less than 2.5 microns in particle diameter)
- Lead (Pb)
- Sulfur dioxide (SO_2)

Areas where concentration levels are below the NAAQS for a criteria pollutant are designated as being in "attainment." Areas where a criteria pollutant level equals or exceeds the NAAQS are designated as being in "nonattainment." Based on the severity of the pollution problem, nonattainment areas are categorized as marginal, moderate, serious, severe, or extreme. Where insufficient data exist to determine an area's attainment status, it is designated as either unclassifiable or in attainment.

Components of the proposed action would occur in various locations on Guam. Many of the areas where the actions are proposed are currently designated as attainment areas for all criteria pollutants. There are two areas on Guam that are designated as attainment areas for CO, NO_x, O_3, PM, and Pb, but are designated as nonattainment areas for SO_2, as follows:

- Piti: Portion of Guam within a 2.2-mile (3.5- kilometers [km]) radius of the Piti Power Plant
- Tanguisson: Portion of Guam within a 2.2 mile (3.5-km) radius of the Tanguisson Power Plant

The primary contributors of SO_2 in the environment are from burning fossil fuels such as fuel oil like that used by power plants, and gasoline used by vehicles. One way that EPA limits SO_2 emissions in the ambient air is to require the use of low sulfur fuels in power plants. It also limits the production and use of gasoline with a low sulfur content (termed "Tier 2 Standards"). These requirements were promulgated as part of the Clean Air Act (CAA), and implemented the CFRs. These low sulfur fuels are readily available in the continental U.S.

Although Guam is in nonattainment for SO_2 in the two areas around the Piti and Tanguisson power plants, on December 28, 2006 EPA issued a partial waiver to Guam that conditionally exempts Guam from the requirements to use low sulfur fuels in its power plants and in gasoline that is used islandwide in vehicles. The exemption also applies to American Samoa and the CNMI. In its decision to grant the partial waiver, EPA cited both economic and environmental reasons for granting the waiver:

> "We are exempting American Samoa, Guam, and CNMI from the Tier 2 gasoline sulfur standard due to the high economic burden of compliance, isolated nature of the territories, both in terms of gasoline importation and pollution transport, and minimal air quality effects."

> "Generally, the Far East market, primarily Singapore, supplies gasoline to the U.S. Pacific Island Territories. The Tier 2 sulfur standard effectively requires special gasoline shipments, which would increase the cost and could jeopardize the security of the gasoline supply to the Pacific Island Territories. The air quality in American Samoa, Guam, and C.N.M.I. is generally pristine, due to the wet climate, strong prevailing winds, and considerable distance from any pollution sources. We recognize that exempting the U.S. Pacific Island Territories from the gasoline sulfur standard will result in smaller emission reductions. However, Tier 2 vehicles using higher sulfur gasoline still emit 30% less hydrocarbons and 60% less nitrogen oxide (NO_X) than Tier 1 vehicles and negative effects on the catalytic converter due to the higher sulfur levels are, in many cases, reversible. Additionally, these reduced benefits are acceptable due to the pristine air quality, the fact that gasoline quality will not change, and the cost and difficulty of consistently acquiring Tier 2 compliant gasoline."

> "Guam is in attainment with the primary NAAQS, with the exception of sulfur dioxide in two areas. This action is not expected to have any significant impact on the ambient air quality status of Guam, including the status of the two areas designated as nonattainment for sulfur dioxide. Both areas are designated nonattainment for sulfur dioxide as a result of monitored and modeled exceedences in the 1970's prior to implementing changes to power generation facilities. In the 1990's both plants were rebuilt, upgrading their emission controls. Guam has submitted a redesignation request to EPA. That pending redesignation request shows that they are now in attainment. An emissions inventory shows that the power plants are the major source of SO_2 on Guam. Both plants are on the western side of the island. The Trade Winds blow persistently from east-to-west, further lessening the impact of the SO2 emissions on the people of Guam from the power plants."

> "Mobile sources, like cars, are a minor contributor to the SO_2 emission budget. Exempting Guam from the Tier 2 gasoline sulfur and vehicle emission standards would not cause an increase in emissions. Guam has received enforcement discretion for the Tier 2 gasoline sulfur standards from the onset of the program and therefore the gasoline sent to Guam has not been required to meet the Tier 2 sulfur levels. Emissions from older vehicles will remain unchanged. Tier 2 vehicles using high sulfur gasoline will be cleaner than Tier 1 vehicles. Tier 2 vehicles using gasoline with 330 ppm sulfur emit 30% less hydrocarbons and 60% less NOX than Tier 1 vehicles. While this rule will lead to a smaller reduction in emissions than would occur if the Tier 2 sulfur regulations are required, Guam's current air quality does not require further reductions. Because of Guam's remoteness, there are no cross border issues."

As cited in the EPA waiver decision, both Piti and Tanguisson areas are designated nonattainment for sulfur dioxide as a result of monitored and modeled exceedences in the 1970's prior to implementing changes to power generation facilities. Guam and EPA believes the area around Piti is now in attainment. The Tanguisson power plant is relatively far from sensitive land use areas. Since Guam is exempt from using low sulfur content fuel, it is anticipated that the allowance of using high sulfur content fuel by power generation facilities is the primary cause of the current nonattainment designation of the two areas.

MSAT Analysis

Mobile source air toxics (MSAT) are hazardous air pollutants, seven of which have been identified by the USEPA as mobile source pollutants of concern due to their high relative risk. These seven pollutants are: napthalene, acrolein, benzene, 1-3 butadiene, formaldehyde, polycyclic organic matter (POM) and diesel particulate matter plus diesel exhaust organic gases (DPM+DEOG). As part of the NEPA process, air toxics require review and evaluation as they could affect the quality of the human environment.

On February 3, 2006, the Federal Highway Administration (FHWA) issued Interim Guidance (FWHA 2006b) regarding mobile source air toxics (MSAT) analysis for National Environmental Policy Act (NEPA) documentation. Given the emerging state of the science and of project-level analysis techniques regarding MSATs, there are currently no established criteria for determining when MSAT emissions should be considered a significant issue. FHWA has suggested a tiered approached in determining potential project-induced MSAT impacts. The three tiers are:

- Tier 1 – No analysis for projects with no potential for meaningful MSAT effects. These projects include:
    - Projects qualifying as a categorical exclusion under 23 CFR 771.117(c)
    - Projects exempt under the CAA Conformity Rule under 40 CFR 93.126
    - Other projects with no meaningful impacts on traffic volumes or vehicle mix
- Tier 2 – Qualitative analysis for projects with low potential MSAT effects
- Tier 3 – Quantitative analysis to differentiate alternatives for projects with higher potential MSAT effects. These projects include:
    - Projects that would create or significantly alter a major intermodal freight facility that has the potential to concentrate high levels of diesel PM in a single location
    - Projects that would create new or add significant capacity to urban highways, such as interstates, urban arterials, or urban collector-distribution routes with traffic volumes where the average annual daily traffic is projected to be in the range of 140,000 to 150,000 vehicles or greater by the design year
    - Projects located in proximity to populated areas or in rural areas, in proximity to concentrations of sensitive populations (i.e., schools, nursing homes, hospitals).

FHWA developed this approach because currently available technical tools do not reliably predict project-specific health impacts of the emission changes associated with projects.

However,USEPA has requested an MSAT analysis based on the methodology described in the research report “Analyzing, Documenting, and Communicating the Impacts of Mobile Source Air Toxic Emissions in the NEPA Process” prepared for the American Association of State Highway and Transportation Officials (ASHTO) (ICF International 2007). Given the unusual scale of the proposed relocation as compared to other Navy actions, and to accommodate USEPA’s request as part of the NEPA disclosure process, additional MSAT analysis will be presented in the Final EIS/OEIS using the methodology based on the ASHTO report. The additional MSAT analysis will assess traffic volumes, particularly at intersections, and vehicle-hours for idling heavy duty diesel trucks during peak construction.

The methodology for MSAT analysis in the 2007 ASHTO report consists of a decision tree keyed to a set of policy-related questions to identify the appropriate level of analysis based on project information, potential community impact, and the public's level of concern. The policy-related questions are keyed to technical questions which identify the appropriate level of analysis based on health risk considerations. The following summarizes the levels of analysis in this alternate MSAT analysis.

- Level 1 – no review required (Projects that fall under a categorical exclusion)
- Level 2 – qualitative analysis recommended (Design activity less than 40,000 AADT for an intersection, or less than 100,000 AADT for an arterial, or less than 750 idling vehicle-hours per day for heavy duty diesel vehicles, or is a new or expanded intermodal facility)
- Level 3 – Level 2 plus quantitative emissions analysis (Design activity above those as listed in Level 2; MSAT exposure not identified as a concern during scoping process; no increase in sensitive population in proximity to MSAT emissions)
- Level 4 – Level 3 plus dispersion modeling to estimate concentration and risk from proposed action (Design activity above those as listed in Level 2; MSAT exposure identified as a concern during scoping process; increase in sensitive population in proximity to MSAT emissions; insufficient information on nearby population and human activity levels)
- Level 5 – Level 4 plus population activity pattern analysis to estimate exposure risk (Design activity above those as listed in Level 2; MSAT exposure identified as a concern during scoping process; increase in sensitive population in proximity to MSAT emissions; available information on nearby population and human activity levels)

It should be noted that the difference between the FHWA Interim Guidance and the method based on the ASHTO report is the criteria for when a quantitative analysis is required. The method based on the ASHTO report has a lower threshold in terms of traffic volumes and includes consideration of emissions from idling heavy duty diesel trucks. Projected traffic volumes are below the threshold for a quantitative analysis per the FHWA Interim Guidance, therefore the MSAT analysis provided in this DEIS is limited to a comparison of traffic volumes to the FHWA Interim Guidance threshold as well as a discussion on the limitations of methodologies for estimating emissions, concentrations, exposure levels and health effects.

Microscale CO Air Quality Analysis

Microscale air quality modeling was performed using the most recent version of the USEPA mobile source emission factor model (MOBILE6.2) (USEPA 2003b) and the CAL3QHC (Version 2.0) air quality dispersion model (USEPA 1995) to estimate future no-action (without the proposed project) and future build (with the proposed project) CO levels at selected locations in the project area.

Dispersion Model

Mobile source models are the basic analytical tools used to estimate CO concentrations expected under given traffic, roadway geometry, and meteorological conditions. The mathematical expressions and formulations that comprise the various models attempt to describe an extremely complex physical phenomenon as closely as possible. The dispersion modeling program used in this project for estimating pollutant concentrations near roadway intersections is the CAL3QHC (Version 2.0) dispersion model developed by USEPA and first released in 1992.

CAL3QHC is a Gaussian model recommended in the USEPA's *Guidelines for Modeling Carbon*

Monoxide from Roadway Intersections (USEPA 1992). Gaussian models assume that the dispersion of pollutants downwind of a pollution source follow a normal distribution from the center of the pollution source.

Different emission rates occur when vehicles are stopped (i.e., idling), accelerating, decelerating, and moving at different average speeds. CAL3QHC simplifies these different emission rates into two components:

- Emissions when vehicles are stopped (i.e., idling) during the red phase of a signalized intersection
- Emissions when vehicles are in motion during the green phase of a signalized intersection

The CAL3QHC (Version 2.0) air quality dispersion model has undergone extensive testing by USEPA and has been found to provide reliable estimates of inert (i.e., nonreactive) pollutant concentrations resulting from motor vehicle emissions. A complete description of the model is provided in the *User's Guide to CAL3QHC (Version 2.0): A Modeling Methodology for Predicting Pollutant Concentrations near Roadway Intersections (Revised)* (USEPA 1995).

Vehicular Emissions

Vehicular emissions were estimated using the USEPA MOBILE6.2 vehicular emission factor model. (USEPA 2003b). MOBILE6.2 is a mobile source emission estimate program that provides current and future estimates of emissions from highway motor vehicles. The latest in the MOBILE series, which dates back to 1978, MOBILE6.2 was designed by USEPA to address a wide variety of air pollution modeling needs and incorporates updated information on basic emission rates, more realistic driving patterns, separation of start and running emissions, improved correction factors, and changing fleet composition. It also includes impacts of new regulations promulgated since the previous version, MOBILE5b released in 1996.

Site Selection and Receptor Locations

A screening evaluation was performed to identify which intersections in the project area are most congested and most affected by the build alternatives. Sites fail the screening evaluation if: 1) the level of service (LOS) decreases below D in one of the build alternatives compared to the no-action alternative, or 2) if the delay and/or volume increase from the no-action to build alternatives along with an LOS below D. The LOS describes the quality of traffic operating conditions, ranging from A to F, and it is measured as the duration of delay that a driver experiences at a given intersection. LOS A represents free-flow movement of traffic and minimal delays to motorists. LOS F generally indicates severely congested conditions with excessive delays to motorists. Intermediate grades of B, C, D, and E reflect incremental increases in congestion.

Determination of Significance

Potential project impacts were evaluated against the appropriate thresholds and regulations set forth by the federal and local government, including USEPA and Guam Environmental Protection Agency (GEPA).

7.2.1 Approach to Analysis

7.2.1.1 Methodology

Utility Stationary Sources

The following new or existing stationary sources are associated with the utility development:

- Major power generation facilities under three interim and three long-term alternatives. Power facilities would use Number (No.) 6 oil fuel, No.2 oil fuel, or liquefied natural gas (LNG)
- Wastewater treatment plant under two interim and four long-term alternatives
- One preferred solid waste landfill alternative

Given the limited design specifics provided for the programmatic long-term alternatives, the air quality impact analysis cannot be performed at this time and, if required, may be addressed in separate NEPA documents in the future. Therefore, only the potential impact from applicable interim alternatives are quantitatively analyzed in this document. For long-term alternatives, a qualitative impact discussion is provided.

The major facility-associated potential annual emissions under each interim alternative are predicted based on the interim design capacities discussed in this EIS/OEIS and on manufacturer-provided emission factors or using USEPA-approved emission factor models. USEPA emission factor models that were used include:

- USEPA AP-42 Compilation of Air Pollutant Emission Factors for Stationary Point and Area Sources (USEPA 1995 and after) – AP-42 provides emission factors for combustion source emissions
- Landfill Gas Emissions model (LandGEM) (USEPA 2005a) – LandGEM is a screening tool to assist in estimating emission rates for total landfill gas, methane, CO_2, and non-methane VOCs from municipal solid waste landfills

A detailed discussion on emissions estimates is provided in Volume 9, Appendix I, Sections 3.1 Major Stationary Sources and 3.2 Minor Stationary Sources.

Annual emissions thresholds for air pollutants for a major source and a major source modification are summarized in Table 7.2-1. For sources with annual emission levels exceeding the threshold of a major stationary source or major modification of the existing major stationary source, microscale ambient concentration levels from these sources are predicted and compared with the applicable significance thresholds. The analysis is conducted in accordance with the NEPA requirements, and the air-permitting requirements established in various USEPA programs and GEPA's Air Pollution Control Standards and Regulations (APCSR) Section 1104.6 (c) (12) (ix) (GEPA 2004).

Table 7.2-1. Applicable Major Source and Major Modification Thresholds

Pollutant	*Major Source Threshold (TPY)*	*Major PSD Source Threshold (TPY)*	*Major Modification Threshold (TPY)*
Sulfur dioxide (SO2)	100	250/100[a]	40
Carbon monoxide (CO)	100	250/100[a]	100
Particulate matter (PM10)	100	250/100[a]	15
Nitrogen oxide (NOx)	100	250/100[a]	40
Volatile organic compounds (VOCs)	100	250/100[a]	40

Legend: PSD = Prevention of Significant Deterioration; TPY = tons per year.
Note: [a] 100 TPY applies to certain sources such as fossil fuel fired steam electric plants with more than 250 British thermal unit per hour heat input
Source: USEPA (40 CFR 52).

As discussed in Section 5.1 of Volume 2, Prevention of Significant Deterioration (PSD) regulations were established by the USEPA to ensure that air quality in clean (attainment) areas does not significantly deteriorate and that a margin for future industrial growth is maintained. This is to be accomplished by requiring major emission sources and major modifications to employ the best available control technology (BACT) to curb air pollutant emissions.

According to CAA regulations, a facility is considered to be a major source when annual emissions exceed 100 TPY of any criteria pollutants in an attainment area or a SO_2 nonattainment area. Under the PSD regulations, last modified under the 1990 CAA Amendments (42 U.S. Code §§7470-7479), a facility is considered to be a major stationary source when annual emissions exceed 250 or 100 tons per year (TPY) of attainment pollutants, depending on the specific source category. Examples of source categories with a 100 TPY major stationary source threshold include fossil-fuel-fired steam electric plants with more than 250 British thermal units (Btu) per hour heat input and many specific types of plants, mills, and smelters. For an existing major stationary source, the net emission increase of each attainment pollutant that exceeds a specified significant emission increase level is considered to be a major modification that is subject to the provisions of the PSD regulations and a PSD new source review (NSR).

Because Guam has two nonattainment areas for SO_2, a nonattainment NSR would be required by the project for SO_2 if the proposed stationary facility and the existing major stationary source modification within the SO_2 nonattainment area exceed the nonattainment NSR threshold. If applicable, the new sources would likely be required to use lowest achievable emission rate (LAER) technology, obtain emission offsets to satisfy the nonattainment NSR regulatory requirements, and reduce overall emissions facility-wide. Nonattainment area-specific regulations on emission offsets are provided in Guam APCSR Sections 1105.4 and 1105.5.

For each identified major stationary source or major modification of an existing major source under the proposed alternatives, the estimated emission rates were further used in ambient concentration dispersion modeling, as discussed below.

The dispersion modeling approach is designed to estimate near-field impacts, defined as within a 31-mile (mi) (50-kilometer [km]) transport radius (USEPA 2005b). The modeling approach was developed in accordance with the following USEPA guidance:

- Guideline on Air Quality Models (Revised), incorporated as Appendix W of 40 CFR Part 51, Federal Register (FR) Revision to the Guideline on Air Quality Models (USEPA 2005b)
- Draft New Source Review Workshop Manual (USEPA 1990)

The USEPA-recommended regulatory dispersion model for near-field applications, American Meteorological Society/USEPA Regulatory Model (AERMOD) (USEPA 2007), was used for interim alternative impact analysis. AERMOD is a steady-state plume dispersion model that simulates transport and dispersion from multiple point, area, or volume sources based on an up-to-date characterization of the atmospheric boundary layer. The model employs hourly sequential pre-processed meteorological data to estimate concentrations for selected averaging times ranging from 1 hour to 1 year.

Because the existing sources to be impacted under interim alternatives are located inland in areas remote from coastal effects, and under the influence of the relatively constant nature of the trade winds, the near-source steady-state regulatory model, AERMOD, is an appropriate tool for estimating air impacts from the affected existing major stationary sources.

The hourly emission rates and the daily and annual emission rates, as appropriate, from the existing sources to be utilized under interim alternatives were used as the inputs to AERMOD in order to determine both long-term (annual) and short-term (24-hour average or shorter) impact concentration levels with repect to the applicable impact thresholds. The PSD Significant Impact Levels (SILs) were used as the basis for evaluating potential impact significance from three power interim alternatives.

A detailed discussion of dispersion modeling methodology, meteorological data, receptor grid used, and dispersion modeling results is provided in Volume 9, Appendix I, Section 3.1 Major Stationary Sources.

Utility Construction Mobile Sources

Potential air quality impacts from mobile sources were evaluated in terms of net incremental annual emissions levels for each criteria pollutant and CO_2 associated with each source type and the annual activity level. The mobile sources considered in this volume include construction equipment and hauling truck emissions during the utility resources construction period.

Construction activities involving the operation of construction equipment, trucks, and workers' commuting vehicles may have short-term air quality impacts.

In order to predict construction emissions, estimates of construction crew and equipment requirements and productivity including the hours of equipment use were made, based on the data presented in 2003 *RSMeans Facilities Construction Cost Data* (RSMeans 2003) and 2006 *RSMeans Heavy Construction Cost Data* (RSMeans 2006). Given the lack of a specific construction schedule for each applicable project during the early planning stage, the overall length of utility construction for each project is assumed to be 4 years from 2011 through 2014. The subsequent emissions for construction were evenly distributed over the 4-year construction period to determine the average annual emissions levels.

Estimates of construction equipment operational emissions were based on: 1) the estimated hours of equipment use as described above and 2) the emission factors for each piece of equipment, as provided by the USEPA in the NONROAD emission factor model based on the national default model inputs (USEPA 2008b). The average equipment horsepower values and equipment power load factors are also provided in association with the NONROAD emission factors. Because the operational activity data presented in RSMeans' books are generated based on the overall duration of equipment presence on site, an equipment actual running time factor (i.e., actual usage factor) was further employed to determine actual equipment usage hours for the purposes of estimating equipment emissions. The usage factor for each equipment type was obtained from FHWA's Roadway Construction Noise Model User's Guide (FHWA 2006a). Emission factors related to construction-associated delivery trucks and workers' commuting vehicles were estimated using the USEPA Mobile6 emission factor model (USEPA 2003b). The detailed methodology used to calculate these emissions is presented in Volume 9, Appendix I, Section 3.4 Construction Activity Emissions.

Under the General Conformity Rule (GCR), emissions associated with all operational and construction activities from a proposed federal action, both direct and indirect, must be quantified and compared to annual *de minimis* (threshold) levels for pollutants that occur within the applicable nonattainment area. Direct emissions are emissions of a criteria pollutant or its precursors that are caused or initiated by a federal action and occur at the same time and place as the action. Indirect emissions are emissions occurring later in time and/or further removed in distance from the action itself. Indirect emissions must be included in the determination if both of the following apply:

- The federal agency proposing the action can practicably control the emissions and has continuing program responsibility to maintain control
- The emissions caused by the federal action are reasonably foreseeable

As previously mentioned, Guam has two SO_2 nonattainment areas around the Piti and Tanguisson power plants. The emissions from both stationary and mobile sources with potential to occur within the two SO_2 nonattainment areas were quantified using the same methodologies discussed previously for both stationary and mobile sources. If a proposed stationary and/or mobile source emission level is below the de minimis threshold, it is exempt from the GCR. Also, according to the GCR, if a proposed stationary source is a major stationary source or major PSD source that is required to be in compliance with the PSD and/or nonattainment NSR programs, it is exempt from the GCR. Therefore, if a proposed stationary source is a major source that triggers a PSD/Nonattainment NSR program, the operational emissions from this source are not considered in the general conformity applicability analysis.

Estimates of direct and indirect annual emissions within SO_2 nonattainment areas for utility resources are described in detail in Volume 9, Appendix I, Section 3.6 CAA General Conformity Applicability Analysis.

Roadway Mobile Sources

The primary on-road vehicle-related air pollutants are CO, PM, nitrogen oxide (NO_x), and VOCs (NO_x and VOCs are precursors to the formation of ozone). The project-level air quality impacts of traffic-related projects are generally evaluated on the following two scales for specific pollutants:

- Microscale (hot-spot) level for CO and PM (PM_{10} and $PM_{2.5}$). A microscale analysis of traffic-related impacts at intersections or free flow sites provides estimates of localized pollutant concentrations for direct comparison to the NAAQS and/or applicable impact thresholds.
- Mesoscale (regional) level for NO_x, VOC, CO, and PM (PM_{10} and $PM_{2.5}$). Emissions of these typical pollutants are calculated on a mesoscale basis to provide a comparison of regional emissions among alternatives.

On-road vehicular emissions impacts are predicted to estimate the CO concentration levels at the worst-case congested intersections under future conditions with and without the proposed action. If the model-predicted CO levels are below the NAAQS at the worst-case congested intersections, the traffic-related microscale air quality impacts are expected to be in compliance at other less-congested intersections where lower emissions would be generated.

The potential traffic-related PM ($PM_{2.5}$ and PM_{10}) impact hot-spot analyses were not warranted based on the guidelines and procedures outlined by the USEPA in *Transportation Conformity Guidance for Qualitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas* (USEPA 2006a).

The FHWA and USEPA have issued interim joint guidance for the assessment of MSAT in the NEPA process for highways (FHWA 2006b), which includes specific criteria for determining:

- Projects that are exempt from mobile source air toxic analysis requirements
- Projects that may require a qualitative analysis
- Projects that should undergo a quantitative assessment

The roadways with the greatest potential to be impacted by the proposed improvements would be mostly microscale local arterial roadways on Guam connected to each project site. The change in traffic volume and truck percentage was analyzed along the major travel routes. These quantitative forecasts and discussions are provided in this EIS/OEIS in accordance with FHWA guidance on air toxics analysis (FHWA 2006b).

The traffic forecasts and the future sensitive land use condition along the roadway network discussed in Chapter 4 would be used to determine the level of the analysis that would be applicable for the alternate analysis based on the ASHTO report as requested by the USEPA. If a microscale MSAT analysis is required based on the criteria as detailed in Section 7.2, a similar approach as utilized for the CO impact analysis would be implemented.

The mesoscale vehicular and roadway construction emissions of criteria pollutants as well as GHG in terms of CO_2 emissions were also considered through an estimate of vehicular emissions on the affected roadway system on Guam and construction equipment emissions during roadway construction.

7.2.1.2 Determination of Significance

The selected impact thresholds (significance criteria) for making a determination of the significance of impact using the analysis approach outlined in the previous section are summarized in Table 7.2-2 along with measuring metrics for individual utilities and roadway project mobile sources.

Microscale Concentration Impact

For major stationary emission source impacts, the PSD SILs shown in Table 7-2.3 were used to evaluate the incremental impact significance potentially resulting from the proposed operations of each modified existing PSD source individually under each interim alternative. If a predicted impact concentration showed no exceedances of the corresponding PSD SIL, the source is not considered to have a significant impact for that specific attainment pollutant and no further analysis is necessary for the corresponding pollutant. Conversely, if the PSD SILs are predicted to be exceeded, the EIS chooses that a further mitigation modeling analysis of the affected existing major sources would be required to eliminate the potential PSD SIL exceedance.

For traffic-related microscale impacts, the predicted CO concentrations at the worst-case congested intersections were compared with the CO NAAQS to determine the potential significance of traffic-related microscale air quality impacts. Additionally, the alternate MSAT analysis to be conducted and included in the Final EIS/OEIS will use the MSAT thresholds established in the ASHTO 2007 research report to evaluate potential health risk, as per the USEPA recommendation.

GCR *de minimis* Threshold

Under the GCR, total emissions resulting from the proposed federal actions must be compared to applicable *de minimis* levels on an annual basis. As defined by the GCR, if the emissions of a criteria pollutant (or its precursors) do not exceed the *de minimis* level, the federal action has minimal air quality impact and the action is determined to be in conformity for the pollutant under study. Therefore, no further analysis is necessary. Conversely, if the total direct and indirect emissions of a pollutant are above the *de minimis* level, a formal general conformity determination is required for that pollutant. According to the GCR, the *de minimis* level applicable to the two nonattainment areas on Guam is 100 TPY for SO_2. Therefore, if the total direct and indirect emissions of SO_2 are below 100 TPY, no formal conformity determination is required and no significant air quality impact would result from the implementation of the proposed action.

Table 7.2-2. Impact Analysis Thresholds

Emission Sources	*Measuring Metric*	*Significance Criteria*
Utility Operation and Construction Emissions		
Power plant	Criteria pollutant concentration from the proposed existing power plant modification	PSD Significant Impact Levels
	Criteria pollutant emissions	PSD and NSR source threshold
Solid waste landfill	VOC emission	250 TPY[a] (PSD major stationary

Emission Sources	*Measuring Metric*	*Significance Criteria*
Construction of power, water, wastewater and landfill facilities	Criteria pollutant emissions	source threshold)
Construction mobile source and non-major stationary source operation within nonattainment areas	SO_2 annual emissions in Piti and Tanguisson nonattainment areas	100 TPY[a] (de minimis level)
Roadway Project Mobile Sources		
On-road vehicles	CO concentration	NAAQS
On-road vehicles	PM and air toxics emissions discussion	N/A
Mesoscale on-road vehicle emissions and roadway construction emissions	Criteria pollutant emissions	250 TPY[a] (PSD major stationary source threshold)
All sources with emission factor data	CO_2 emissions	N/A

Legend: N/A = Not applicable.
Note: [a] Emissions from corresponding source activities are combined with the emissions from other components of the Proposed Action and presented in Volume 7. These impact significance threshold are considered as *de minimis* levels and are used to make an impact determination from a disclosure comparison with the combined annual emission levels. However, if such levels are exceeded for a specific pollutant, a further formal analysis is considered, when appropriate, in order to make a formal determination of impact significance.

Table 7.2-3. PSD Significant Impact Levels

Pollutant	*Averaging Period*	*Significant Impact Level ($\mu g/m^3$)*
NO_2	Annual	1
SO_2	Annual 24-hour 3-hour	1 5 25
PM_{10}	Annual 24-hour	1 5
$PM_{2.5}$	Annual 24-hour	1 5
CO	8-hour 1-hour	500 2,000

Legend: $\mu g/m^3$ = microgram per cubic meter.
Source: 40 CFR 51.165.

It should be noted that according to the GCR, if a proposed stationary source is a major stationary source or major PSD source that is required to be in compliance with the regulations established in the PSD and/or nonattainment NSR programs, the emissions from this source are exempt from the general conformity requirement. Therefore, the proposed operational emissions from those PSD/NSR sources within the nonattainment area should not be included in the comparison with the SO_2 *de minimis* criterion.

Mobile Source and Non-Major Stationary Source Incremental Emissions

Under the CAA, motor vehicles, other self-propelled vehicles with internal combustion engines, and non-self-propelled non-road engines are exempt from air-permitting requirements. The GCR is not applicable to these mobile source emissions associated with the construction and operation of the proposed improvements in areas that are in attainment of the NAAQS for all criteria pollutants. Nonetheless, NEPA and its implementing regulations require analysis of the significance of air quality impacts from these sources, as well as non-major stationary sources. However, neither NEPA nor its implementing regulations have established emissions criteria for determining the significance of air quality impacts from such sources in CAA attainment areas.

In the GCR applicable to nonattainment areas, USEPA uses the "major stationary source" definition under the NSR program as the *de minimis* level to separate presumably exempt actions from those requiring a positive conformity determination. Because the proposed action and alternatives would occur mostly in areas that have always been in attainment, the EIS selected the "major stationary source" definition (≥ 250 TPY of any air pollutant is subject to regulations under the CAA) from the PSD program. The "major stationary source" definition applies to locations that are in the attainment area as the criteria for determining the potential significance of air quality impacts from these sources.

As noted above, neither the PSD permitting program nor the GCR are applicable to mobile sources and non-major stationary sources in attainment areas. Therefore, the analysis of construction and operational incremental emissions from these sources in attainment areas and the significance criteria selected (250 TPY) are solely for the purpose of informing the public and decision makers about the relative air quality impacts from the proposed action and the alternatives under NEPA. However, since the 250 TPY threshold is selected in the context of the *de minimis* threshold established in the GCR providing only an indication of potential significant impact, a further formal impact analysis should be conducted if such threshold is exceeded, where appropriate. For example, CO is a localized pollutant, if the 250 TPY threshold is exceeded for CO, a subsequent dispersion modeling for major emission contributing sources is conducted to further evaluate potential impact significance with respect to the NAAQS.

7.2.1.3 Issues Identified During Public Scoping Process

The impact analyses focus on addressing potential air quality impacts from the proposed utility and roadway improvement actions. As part of the analyses, public concerns, including those of regulatory stakeholders, raised during public scoping meetings that relate to air quality effects were addressed (if sufficient project data and available impact criteria were available). Concerns relating to potential air quality impacts are listed below:

- Increase in vehicle and vessel emissions, and need for disclosure of available information of health risks associated with vehicle emissions and MSAT
- Increase in emissions from existing power sources due to power demand or construction of new power sources
- Increase in construction-related emissions and impacts including emissions estimates of criteria pollutants and diesel PM from construction of alternatives
- Compliance with the GCR in siting project facilities
- Emissions mitigation plans during construction
- Discussion of a potential installation of an air quality monitoring network on Guam
- Discussion of project elements that would be major contributors to greenhouse gases (GHGs) and identification of practices or project elements to reduce GHGs
- Need to control and monitor the buildup activities to ensure good air quality on Guam

7.2.2 Power

7.2.2.1 Historical Monitoring Observations and Existing Background Conditions

The existing major stationary source contributions under current operational conditions around the ROIs where the proposed power improvement actions (interim alternatives 2 and 3) would occur were evaluated to establish the existing condition. The ROIs with the potential to be affected by the proposed power improvement actions include North, Central, and Apra Harbor.

The government of Guam has not collected ambient air quality data since 1991. Therefore, no existing ambient air quality data are available to represent current air quality conditions with respect to the criteria pollutants for which the NAAQS were established. Historical data are available from 1972 through 1991, when ambient air quality data were collected at a number of sites through a USEPA-sponsored monitoring program. The monitored pollutants were total suspended particles (TSP), SO_2, NO_2, and nitrogen monoxide (NO). In 1991, PM_{10} was monitored in addition to TSP.

Prior to 1991, TSP were monitored at 20 sites, SO2 at 14 sites, NO2 at five sites, and NO at one site. In 1991, PM10 was monitored at four sites.

In addition to the historical monitoring identified above, the GPA established a network of five stations to measure SO2 at locations that are not downwind or close to any major electrical generating units (EGUs) during normal trade wind conditions from the fall of 1999 through the summer of 2000. All of the observed SO2 concentrations were below the 24-hour NAAQS. According to 40 CFR Parts 80 and 86, Guam has submitted a redesignation request to EPA. That pending redesignation request shows that they are now in attainment; however, EPA has not taken action on this request, so the areas remain in a nonattainment status. EPA did, however, recognize the need for this redesignation in their decision to allow a waiver for the use of low sulfur fuels in power plants and vehicles in Guam (see Section 7.2, "National Ambient Air Quality Standards"). An emissions inventory shows that the power plants are the major source of SO2 on Guam. Both plants are on the western side of the island. The Trade Winds blow persistently from east-to-west, further lessening the impact of the SO2 emissions on the people of Guam from the power plants. Mobile sources, like cars, are a minor contributor to the SO2 emission budget.

The areas around affected existing sources (Figure 7.2-1) under the three interim alternatives are in attainment areas. Ambient air quality conditions are expected to be affected by existing stationary source operations and other minor source operations such as vehicular traffic. Since the comparisons of the modeling results with PSD SILs (see Table 7.2-3) were used as the basis for evaluating potential impact significance from the three interim alternatives, ambient background conditions were not considered in the study.

7.2.2.2 Interim Alternative 1 (Preferred Alternative)

Interim Alternative 1 would recondition existing combustion turbines and upgrade T&D systems and would not require new construction or enlargement of the existing footprint of the facility. This work would be undertaken by the GPA on its existing permitted facilities. Reconditioning would be made to existing permitted facilities at the Marbo, Yigo, Dededo, and Macheche combustion turbines. These combustion turbines are not currently being used up to permit limits. T&D system upgrades would be on existing above ground and underground transmission lines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

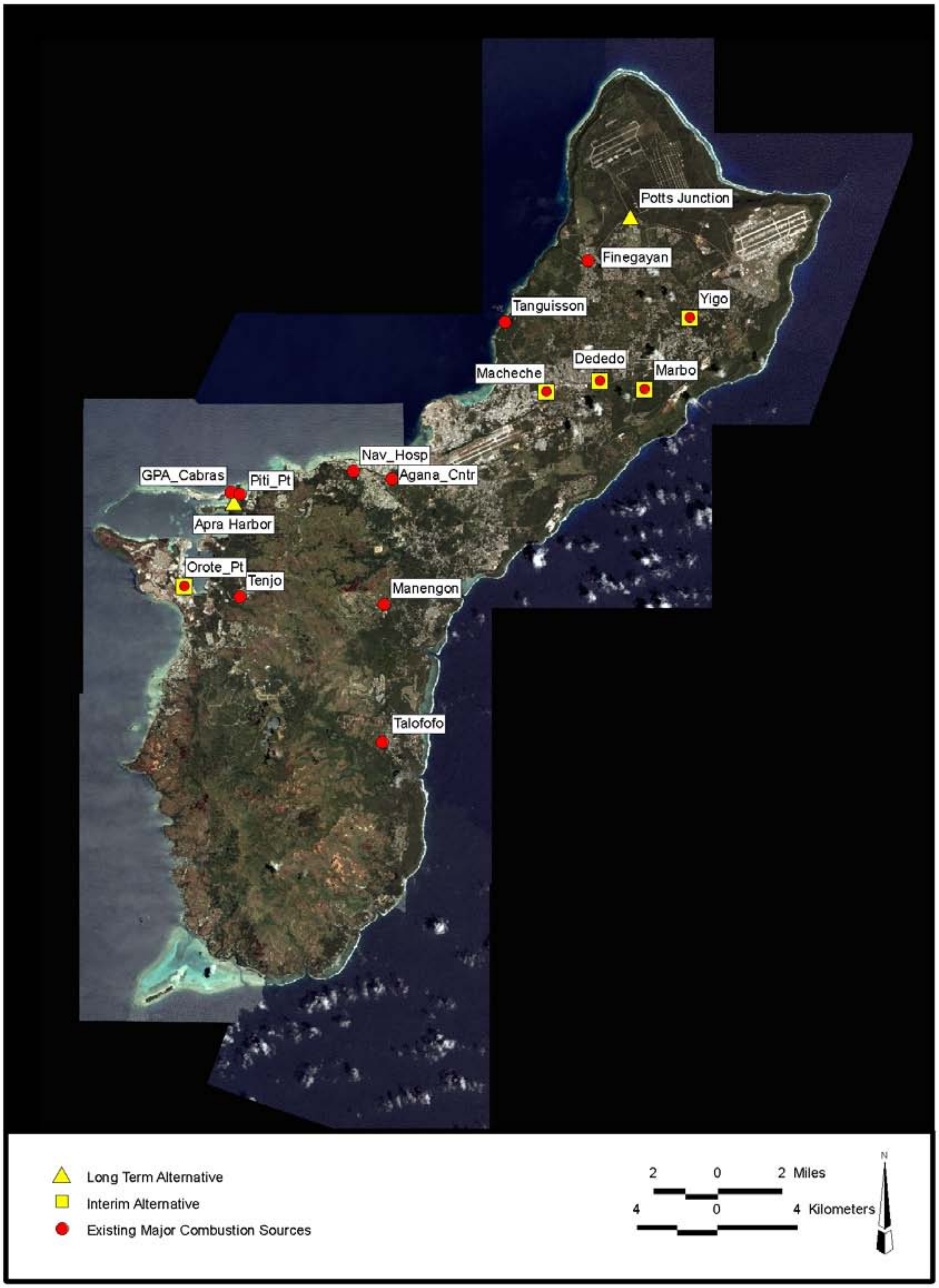

Figure 7.2-1. Locations of Candidate Major Existing EGU Sources on Guam

Construction

Table 7.2-4 presents the total annual construction emissions for Interim Alternative 1 that were calculated for the utilization and repair of the combustion turbines, and associated facility transmission line upgrade, using the methodology described in Section 7.2.1.1 and described in Volume 9, Appendix I, Section 3.4 Construction Activity Emissions.

Table 7.2-4. Total Annual Construction Emissions – Interim Alternative 1

Construction Activity	*Pollutant*						
	SO_2	*CO*	*PM_{10}*	*$PM_{2.5}$*	*NO_x*	*VOC*	*CO_2*
Total Annual Emissions (TPY)	0.1	3.8	0.0	0.0	0.4	0.1	52.0

Operation

Potential increases of air emissions, as compared to existing power operation actual conditions, are anticipated from the proposed action. For NEPA disclosure purposes, the annual emissions above the current actual condition were approximately estimated based on the percentage increase in power output required at each affected CT and summarized in Table 7.2-5. A detailed calculation is discussed in Volume 9, Appendix I, Section 3.1.4.4 Interim Alternative Criteria Pollutant Impact Analysis.

However, it is anticipated that the majority of increase in power required during the interim period would not exceed the permitted capacity at each affected CT, for which the compliance of any applicable CAA air quality standards had been already demonstrated during the air permitting process when GPA obtained the air permit for each affected source. Therefore, in addition to disclosing the net increase in emissions above the current actual emissions levels, the EIS/OEIS focuses on addressing the air quality impact at those CTs that require an increase in permitted capacity.

Because the overall permitted capacity and the operational scheme for these combustion turbines would not change, the resulting potential air quality impact would remain the same as the current permitted conditions established previously during each facility permitting process. Since the Interim Alternative 1 would not result in any increase of air emissions at these facilities under the permitted condition, utilization or reconditioning these permitted sources is in compliance with any applicable CAA air quality standards and would not result in a significant air quality impacts.

Table 7.2-5. Net Increase in Annual Emissions – Interim Alternative 1

Affected Source	*Pollutant*					
	SO_2	*CO*	*PM_{10}*	*NO_x*	*VOC*	*CO_2*
Dededo CT#1	907.1	87.4	82.4	345.4	16.6	120,780.1
Dededo CT#2	907.1	87.4	82.4	345.4	16.6	120,780.1
Yigo	245.0	49.0	74.9	101.8	15.9	53,561.1
Marbo	212.1	32.3	10.5	110.8	0.14	24,154.8
Macheche	134.3	25.0	22.0	67.6	0.45	23,888.2
Combined Sources	2,405.6	281.0	272.1	970.9	49.8	343,164.4
Net Increase in Potenital to Emit Above Permitted Capacity						
All Affected Sources	0	0	0	0	0	0

Potential Mitigation Measures

Potential mitigation measures, if applicable to construction activity-associated emissions, are discussed in Volume 7 where the combined air quality effects are addressed.

Since no significant operational air quality impact would occur under this alternative, mitigation measures would not be required.

7.2.2.3 Interim Alternative 2

Interim Alternative 2 is a combination of reconditioning of existing permitted GPA facilities, an increase in operational hours for existing combustion turbines, and upgrades to existing T&D systems. Interim Alternative 2 would not require new construction or enlargement of the existing footprint of the facility. Reconditioning would be performed on the existing permitted GPA facilities at the Marbo, Yigo, and Dededo combustion turbines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Construction

Total annual construction emissions for Interim Alternative 2 are shown in Table 7.2-6. Emissions would likely be similar to, but slightly lower than Interim Alternative 1 because the scale of construction, repair activities, and the transmission line upgrade is slightly smaller than Interim Alternative 1. Construction emissions are discussed in more detail in Volume 9, Appendix I, Section 3.4 Construction Activity Emissions.

Table 7.2-6. Total Annual Construction Emissions – Interim Alternative 2

	SO_2	CO	PM_{10}	$PM_{2.5}$	NO_x	VOC	CO_2
Total Annual Emissions (TPY)	0.4	2.1	0.0	0.0	0.1	0.0	16.2

Operation

This alternative is a phased combination of utilizing existing permitted facilities that would be undertaken by GPA to meet the power demands associated with the Marine Corps relocation to Guam. The existing GPA facilities that would be utilized are Dededo, Yigo, and Marbo plants. Among them, the operational permitted capacity would need to be increased at only the Yigo plant. The Yigo plant permitted annual hours of operation would increase from 4,280 hours per year to 7,760 hours per year. The expansion-associated increases in criteria pollutant emissions were predicted and are summarized in Table 7.2-7 using the methodology presented in Volume 9, Appendix I, Section 3.1.4.4 Interim Alternative Criteria Pollutant Impact Analysis. The level of emissions increases are above the major modification thresholds summarized in Table 7.2-1. In addition to the criteria pollutants, the greenhouse gas emission increase in terms of CO_2 was also estimated using the USEPA AP-42 emission factors associated with the size of combustion turbine Yigo uses (USEPA 1995 and after). The change of emissions levels at Yigo is significant and would require obtaining a permit modification for Yigo's Title V and PSD permits under Interim Alternative 2.

Table 7.2-7. Net Increase in Annual Emissions – Interim Alternative 2

Affected Source	Annual Emissions (TPY)					
	SO_2	CO	PM_{10}	NOx	VOC	CO_2
Dededo CT#1	859.4	82.8	78.0	327.2	15.8	114,423.3
Dededo CT#2	859.4	82.8	78.0	327.2	15.8	114,423.3
Yigo	470.4	94.1	143.8	195.5	30.5	102,823.1
Marbo	199.6	30.4	9.9	104.2	0.1	22,734.0
Combined Sources	2,388.7	290.0	309.7	954.1	62.2	354,403.7
Net Increase in Potenital to Emit Above Permitted Capacity						
Yigo	234.4	46.9	71.65	97.4	15.32	51,234.9
Other Affected Sources	0	0	0	0	0	0

Since the short-term emission rates for all three stationary sources (Yigo, Marbo, Dededo) would not change from the existing conditions, no short-term impacts under Interim Alternative 2 would occur. For both short-term and annual average conditions, the concentration levels under Interim Alternative 2 were predicted through the dispersion modeling around the Yigo power plant, and are described in Volume 9, Appendix I, Section 3.1.4.4 Interim Alternative Criteria Pollutant Impact Analysis.

Based on the predicted incremental concentration from Yigo alone, the annual levels were predicted to exceed the PSD SIL of 1 μg/m^3 for SO_2 (Table 7.2-8). In order to improve the existing conditions under Interim Alternative 2, mitigation measures would be considered to ensure that PSD SILs would not be exceeded. These measures could include 1) increasing the CT stack height, or 2) utilizing low sulfur content diesel fuel with 0.05% sulfur, as compared to the current 0.6% content, or 3) increasing stack exit velocity. However, the detailed mitigation measures would be determined during the design and permit application stage. The mitigation modeling analysis conducted assumes an increase of current stack height to 32 meters. Under such improved source conditions, the model-predicted incremental concentration levels are all below the PSD SILs (Table 7.2-9). Moreover, the worst-case short-term concentration levels would be below the existing condition levels. Therefore, under mitigated Interim Alternative 2 conditions, the short-term existing ambient air quality conditions would be generally improved around the Yigo Plant and no significant air quality impacts would occur.

Table 7.2-8. Predicted Criteria Pollutant Concentrations at Yigo – Interim Alternative 2

Pollutant	*Averaging Period*	*Baseline Yigo only μg/m^3*	*Proposed Yigo only μg/m^3*	*Proposed Yigo only Maximum Increment μg/m^3*	*PSD SIL μg/ m^3*
NO_2	Annual	0.777	1.407	0.630	1
SO_2	Annual 24-hour 3-hour	2.319 34.442 131.460	4.200 34.442 131.46	1.882 NA NA	1 5 25
PM_{10}	Annual 24-hour	0.370 4.687	0.672 4.687	0.301 NA	1 5
$PM_{2.5}$	Annual 24-hour	0.354 2.475	0.643 2.475	0.288 NA	1 5
CO	8-hour 1-hour	17.612 30.338	17.612 30.338	NA NA	500 2,000

Table 7.2-9. Predicted Criteria Pollutant Concentrations at Yigo – Mitigated Interim Alternative 2

Pollutant	*Averaging Period*	*Baseline Yigo only µg/m³*	*Proposed Mitigated Yigo only µg/m³*	*Proposed Mitigated Yigo only Maximum Increment µg/m³*	*PSD SIL µg/m³*
NO_2	Annual	0.777	0.932	0.306	1
SO_2	Annual	2.319	2.781	0.915	1
	24-hour	34.442	15.339	0.503	5
	3-hour	131.46	33.834	1.622	25
PM_{10}	Annual	0.370	0.445	0.147	1
	24-hour	4.687	2.189	0.0804	5
$PM_{2.5}$	Annual	0.354	0.418	0.138	1
	24-hour	2.475	1.315	0.0804	5
CO	8-hour	17.612	4.934	0.194	500
	1-hour	30.338	6.516	0.377	2,000

Potential Mitigation Measures

The predicted construction emissions for criteria pollutants within each ROI are all below the 250 tpy threshold. Therefore potential air quality impacts under Interim Alternative 2 are considered less than significant and emissions mitigation measures are not warranted.

The predicted operational concentrations around the affected Yigo CT, at which a permit modification would be required, exceed the PSD SILs. Therefore, operational air quality impacts under Interim Alternative 2 are considered potentially significant but mitigatable to less than significant with the measures evaluated. As discussed previously, an increase of Yigo CT stack height would not only eliminate the potential exceedances of PSD SILs but also result in an improvement of current existing air quality conditions around Yigo Plant.

7.2.2.4 Interim Alternative 3

Interim Alternative 3 is a combination of reconditioning existing GPA permitted facilities at Marbo, Yigo, and Dededo and upgrades to the Navy power plant at Orote. Upgrades would be made to existing T&D. The proposed reconditioning to the existing power generation facilities at Marbo, Yigo, and Dededo would not require new construction or enlargement of the existing footprint of the facility. For the Orote power plant, upgrades would include a new fuel storage facility to facilitate longer run times between refueling. This would disturb approximately 1 acre (4,047 square m). This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Construction

The calculated annual construction emissions under Interim Alternative 3 are summarized in Table 7.2-10 and described in Volume 9, Appendix I, Section 3.4 Construction Activity Emissions.

Table 7.2-10. Total Annual Construction Emissions – Interim Alternative 3

Construction Activity	*Pollutant*						
	SO_2	*CO*	*PM_{10}*	*$PM_{2.5}$*	*NO_x*	*VOC*	*CO_2*
Total Annual Emissions (TPY)	0.6	3.0	0.0	0.0	0.2	0.1	23.3

Operation

Interim Alternative 3 combines elements of Interim Alternatives 1 and 2 with phased utilization of existing GPA-permitted facilities at Marbo, Yigo, and Dededo, and the Navy's Orote Point plant. The differences in Interim Alternative 3 as compared to Interim Alternative 2 are the modification of the Orote Point plant in Apra Harbor/Central Guam West area. Interim Alternative 3 would increase hours of operation at Yigo from the permitted 4,280 hours per year to 7,760 hours per year. Orote hours of operation would increase from 1,350 hours per year (3 units combined) to 7,884 hours (3 units combined).

Table 7.2-11 presents the emission rates utilized for the annual modeling scenario based on the increase in the annual hours of operation at Yigo and Orote Point. The Dededo and Marbo annual emission rate would remain unchanged. The short-term modeling scenario is the same as the existing source modeling, as no change is proposed to short-term operation of the unit.

The increases in annual emissions levels estimated above the current permitted levels are considered significant, as shown in Table 7.2-11, and described in Volume 9, Appendix I, Section 3.1.4.4 Interim Alternative Criteria Pollutant Impact Analysis. The Yigo and Orote facilities would require permit modifications for both Title V and PSD permit under Interim Alternative 3.

Table 7.2-11. Net Increase in Annual Emissions – Interim Alternative 3

Affected Source	*Annual Emissions (TPY)*					
	SO2	*CO*	*PM10*	*NOx*	*VOC*	*CO2*
Dededo CT#1	763.9	73.6	69.4	290.8	14.0	101,709.6
Dededo CT#2	811.6	78.2	73.7	309.0	14.9	108,066.4
Yigo	444.3	88.9	135.8	184.6	28.8	97,110.7
Marbo	137.2	20.9	6.8	71.7	0.1	15629.6
Orote	107.2	28.5	32.2	448.5	34.8	27,857.3
Combined Sources	2,264.2	290.0	317.9	1,304.6	92.6	350,373.7
Net Increase in Potenital to Emit Above Permitted Capacity						
Orote Point	111.1	29.5	33.4	464.6	36.0	28,859.0
Yigo	234.4	46.9	71.65	97.4	15.32	51,234.9
Other Affected Sources	0	0	0	0	0	0

Since the short-term emission rates would not change from the existing conditions, no short-term impact under Interim Alternative 3 would occur. For the annual average condition, concentration levels under Interim Alternative 3 were predicted through the dispersion modeling around Orote and Yigo. The concentrations predicted around the Yigo power plant are the same as shown in Table 7.2-8. The modeling results around Orote are summarized in Table 7.2-12, and are discussed in detail in Volume 9, Appendix I, Section 3.1.4.4 Interim Alternative Criteria Pollutant Impact Analysis. The PSD SIL of 1 $\mu g/m^3$ annual average level would be exceeded for SO_2 and NO_2 at Orote. As presented in Table 7.2-8, the PSD SIL of 1 $\mu g/m^3$ annual average level would also be exceeded for SO_2 at Yigo.

Table 7.2-12. Predicted Criteria Pollutant Concentrations at Orote from Interim Alternative 3

Pollutant	*Averaging Period*	*Baseline Orote only µg/m³*	*Proposed Orote only µg/m³*	*Proposed Orote only Maximum Increment µg/m³*	*PSD SIL µg/m³*
NO_2	Annual	1.408	8.232	6.824	1
SO_2	Annual	0.449	2.632	2.183	1
	24-hour	36.184	36.184	NA	5
	3-hour	50.780	50.780	NA	25
PM_{10}	Annual	0.014	0.080	0.066	1
	24-hour	1.027	1.027	NA	5
$PM_{2.5}$	Annual	0.013	0.077	0.064	1
	24-hour	0.760	0.760	NA	5
CO	8-hour	12.068	NA	NA	500
	1-hour	24.603	NA	NA	2,000

Because the incremental concentration from Orote and Yigo were predicted to exceed the PSD SIL of 1 $\mu g/m^3$ for SO_2 and/or NO_2, mitigation measures would be considered through 1) increasing the modified CT stack heights for the Yigo and Orote power plants, 2) increasing stack exit velocities at Orote, and 3) adding NOx control for the three units at Orote. A more detailed discussion of the proposed type of add-on control to the NOx emissions at Orote is described in Volume 9, Appendix I, Section 3.1.4.4, Interim Alternative Criteria Pollutant Impact Analysis.

Although the detailed mitigation measures would be determined during the design and permit application stage, the mitigation modeling analysis conducted assumes a combination of 1) an increase of the Yigo current stack height to 32 meters and the Orote current stack heights to 45 meters, 2) increasing the stack exit velocities to 55.0 m/s for each stack at Orote power plants, and 3) adding NOx control for the three units at the Orote power plant.

Under such mitigated source conditions, the model-predicted incremental concentration levels for each facility are all below the PSD SILs (Tables 7.2-9, 7.2-13, and 7.2-14, also presented in Volume 9, Appendix I, Section 3.1.4.4, Interim Alternative Criteria Pollutant Impact Analysis). The modeling results of the combined sources of Orote and Yigo under the mitigation condition are summarized in Table 7.2-14.

Therefore, under Interim Alternative 3 mitigated conditions, no significant air quality impacts would occur.

Table 7.2-13. Predicted Criteria Pollutant Concentrations at Orote from Mitigated Interim Alternative 3

Pollutant	*Averaging Period*	*Baseline Orote only $\mu g/m^3$*	*Proposed Orote only $\mu g/m^3$*	*Proposed Orote only Maximum Increment $\mu g/m^3$*	*PSD SIL $\mu g/m^3$*
NO_2	Annual	1.408	0.868	0.008	1
SO_2	Annual	0.449	1.114	0.719	1
	24-hour	36.184	16.082	3.807	5
	3-hour	50.780	22.671	23.617	25
PM_{10}	Annual	0.014	0.034	0.022	1
	24-hour	1.027	0.445	0.115	5
$PM_{2.5}$	Annual	0.013	0.032	0.021	1
	24-hour	0.760	0.309	0.115	5
CO	8-hour	12.068	5.516	3.019	500
	1-hour	24.603	17.410	15.533	2,000

Table 7.2-14. Predicted Criteria Pollutant Concentrations from Mitigated Interim Alternative 3 Combined Sources

Pollutant	*Averaging Period*	*Baseline $\mu g/m^3$*	*Proposed $\mu g/m^3$*	*Proposed Maximum Increment $\mu g/m^3$*	*PSD SIL $\mu g/m^3$*
NO_2	Annual	1.419	0.932	0.307	1
SO_2	Annual	2.319	2.782	0.916	1
	24-hour	36.248	16.146	3.807	5
	3-hour	131.46	33.834	23.617	25
PM_{10}	Annual	0.370	0.445	0.147	1
	24-hour	4.687	2.189	0.115	5
$PM_{2.5}$	Annual	0.354	0.418	0.147	1
	24-hour	2.475	1.315	0.115	5
CO	8-hour	17.615	5.534	3.019	500
	1-hour	30.338	17.410	15.533	2,000

Potential Mitigation Measures

The predicted construction emissions for criteria pollutants within each ROI are all below the 250 tpy threshold. Therefore potential air quality impacts under Interim Alternative 3 are considered less than significant and emissions mitigation measures are not warranted.

The predicted operational concentrations around the affected Yigo CT and Orote Plant, at which permit modifications would be required, exceed the PSD SILs. Therefore operational air quality impacts under Interim Alternative 3 are considered potentially significant but mitigatable to less than significant with the measures evaluated. As discussed previously, a combination of increasing stack heights and/or exit velocities at Yigo and Orote power plants and adding-on NOx controls at Orote plant would eliminate potential exceedances of PSD SILs under Interim Alternative 3.

7.2.2.5 Hazadous Air Pollutants Under Interim Alternatives 2 and 3

HAP emissions from combustion turbines at Yigo and Orote Point were based on existing permit levels established in existing Title V permits for each facility. Under the proposed Interim Alternatives 2 and 3, the only variable that changed for each operating scenario was the annual hours of operation, while there would be no change under Interim Alternative 1. Based on the applicable hours of operation of the CTs for interim alternatives 2 and 3, the total resultant HAPs emissions above the permitted levels and the incremental differences for the CTs at Yigo and Orote were calculated and are provided in Table 7.2-15, and described in Volume 9, Appendix I, Section 3.1.5, Interim Alternatives 2 and 3 HAPs Emissions Analysis. Since the total HAP resultant levels at each modified source would be well below the major source threshold (25 TPY of total HAPs), the increase in total HAP level under each interim alternative is not considered significant.

Table 7.2-15. HAPs Emissions and Incremental Increase Above Permitted Level for Combustion Turbines

	Yigo	*Orote Point*
Total Current HAP Emissions (TPY)	0.64	0.06
Total Proposed HAP Emissions (TPY)	1.16	0.36
Incremental Difference (TPY)	0.52	0.30

7.2.2.6 Greenhouse Gas Emissions Under Interim Alternatives 2 and 3

GHG emissions in terms of CO_2 from combustion turbines at Yigo and Orote Point were calculated using USEPA AP42 emission factors (USEPA 1999, 2000), permit information, and manufacturer data. Specifically, a fuel input emission factor for distillate oil-fired turbines of 157 pound (lb)/MMBtu from USEPA (USEPA 2000) was used.

Heat input for each of the combustion turbines was calculated using manufacturer provided engine capacity output in MWs, and assumed an engine efficiency of 40% (as noted within the Yigo permit statement of basis) to generate input capacities for each turbine.

For Yigo and Orote Point, CO_2 emissions were calculated for both current operations and proposed future operations to determine the incremental change in CO_2 emissions. The only variable that would change for each operating scenario is the annual hours of operation. Based on the applicable hours of operation of the combustion turbines for both operating scenarios and the MW output of each engine, the total resultant CO_2 emissions and the incremental differences above the permitted levels for the combustion turbines at Yigo and Orote Point were calculated and are provided in Table 7.2-16 and described in Volume 9, Appendix I, Section 2.5, Greenhouse Gas Emissions.

Table 7.2-16. CO2 Emissions and Incremental Increase Above Permitted Level for Combustion Turbines

	Yigo	*Orote Point*
Total Current CO2 Emissions (TPY)	63,013.05	5,962.68
Total Proposed CO2Emissions (TPY)	114,247.96	34,822.07
Incremental Difference (TPY)	51,234.91	28,859.39

7.2.2.7 Summary of Impacts

Table 7.2-17 summarizes the potential air quality impacts associated with each of the interim alternatives. Construction activities for all alternatives would result in less than a significant impact to air quality resources because the existing power facility reconditioning associated emissions were well below the significance criterion of 250 TPY. Operational activities for Interim Alternative 1 would also result in less than significant impacts to air quality resources because required power output would be within the CAA Title V permitted capacity for each affected existing facility. Therefore the utiliazation and reconditioning alternatives. Since the affected existing facilities had demonstrated their compliance under the permitted condition with all CAA regulations and standards in obtaining Title V permits, Interim Alternative 1 would result in less than a significant impact. Under Interim Alternatives 2 and 3, potentially significant impacts could occur due to a requirement of increasing the permitted capacity at Yigo CT and/or Orote Plant resulting in permit modifications. However, the mitigation measures discussed previously would reduce potentially significant impacts to less than significant air quality impacts.

Table 7.2-5. Summary of Potential Air Quality Impacts – Power

	Interim Alternative 1	*Interim Alternatvie 2*	*Interim Alternative 3*
Power	LSI	SI-M	SI-M

Legend: SI-M = Significant impact mitigable to less than significant, LSI = Less than significant impact.

7.2.3 Potable Water

Water resource facilities to providing potable water for the proposed action would consist of various water pumps operated periodically for a number of processes. Water pumps are expected to be powered by electricity; therefore, no air emissions would be generated during water pumping operations. The potential air quality impacts addressed in this chapter only include estimates of air emissions associated with the construction of water resources.

7.2.3.1 Basic Alternative 1 (Preferred Alternative)

Basic Alternative 1 would consist of installation of up to 22 new potable water supply wells at Andersen Air Force Base (AFB), rehabilitation of existing wells, interconnection with the GWA water system, and associated T&D systems. A new 5 MG (19 ML) water storage tank would be constructed at ground level at Finegayan.

<u>Construction</u>

Estimates on construction activities were calculated to identify equipment, material, and manpower requirements for the construction associated with the proposed water resources components. Assumptions were made to develop a list of major construction items, necessary equipment, and productivity levels necessary for the completed construction of these facilities. The calculated emissions produced from potential construction and vehicle activities that would occur from 2011 to 2014 form the basis from which the total air pollutant emissions in TPY were calculated (Table 7.2-18).

These predicted emissions are combined with the emissions from other components of the proposed action in Volume 7 to determine the overall potential air emissions impact significance using the impact thresholds described in Section 7.2.1.2. The construction emissions shown in Table 7.2-18, and described in Volume 9, Appendix I, Section 3.4, Construction Activity Emissions, are all well below impact thresholds.

Table 7.2-18. Total Annual Construction Emissions –Alternative 1

Construction Activity	*Pollutant*						
	SO_2	*CO*	*PM_{10}*	*$PM_{2.5}$*	*NO_x*	*VOC*	*CO_2*
Total Annual Emissions (TPY)	0.3	2.2	0.2	0.2	2.7	0.3	422.9

<u>Operation</u>

As described at the beginning of this section, water pumps are expected to be powered by electricity, therefore no air emissions would be generated during water pumping operations.

Potential Mitigation Measures

Potential mitigation measures, if applicable, are discussed in Volume 7 where the combined air quality impacts are addressed.

7.2.3.2 Basic Alternative 2

Basic Alternative 2 would consist of installation of up to 20 new potable water supply wells at Andersen Air Force Base (AFB), up to 11 new potable water supply wells at Barrigada, rehabilitation of existing wells, interconnection with the GWA water system, associated transmission and distribution systems upgrades. Additionally, new 3.6 MG (13.6 ML) and 1 MG (3.8 ML) water storage tanks would be constructed at ground level at Finegayan and Barrigada, respectively.

Construction

The improvements planned for in Basic Alternative 2 would produce slightly lower total annual construction emissions than Alternative 1, as summarized below in Table 7.2-19 and presented in Volume 9, Appendix I, Section 3.4, Construction Activity Emissions.

Table 7.2-19. Total Annual Construction Emissions –Alternative 2

Construction Activity	*Pollutant*						
	SO_2	*CO*	*PM_{10}*	*$PM_{2.5}$*	*NO_x*	*VOC*	*CO_2*
Total Annual Emissions (TPY)	1.2	2.0	0.2	0.2	2.6	0.3	398.4

Operation

As described previously, water pumps are expected to be powered by electricity; therefore, no air emissions would be generated during water pumping operations.

Potential Mitigation Measures

The predicted construction emissions (2011 to 2014) and operational emissions (2015 and after) for criteria pollutants within each ROI are all below the 250 tpy threshold or 100 tpy SO_2 threshold applicable for SO_2 nonattainment areas. Therefore potential air quality impacts under Alternative 2 are considered less than significant and emissions mitigation measures are not warranted.

7.2.3.3 Summary of Impacts

Table 7.2-20 summarizes the potential air quality impacts associated with the two potable water alternatives. The construction activities associated with the water supply were well below the significance criterion of 250 TPY. Water pumps are expected to be powered by electricity so that no air emissions would be generated during water pumping operations. Therefore, both alternatives would result in less than significant impacts to air quality resources.

Table 7.2-20. Summary of Potential Air Quality Impacts – Potable Water

	Basic Alternative 1	*Basic Alternative 2*
Potable Water	LSI	LSI

Legend: LSI = Less Than Significant Impact.

7.2.4 Wastewater

Construction and operation of waste water treatment facilities would generate additional air emissions, including odor-related emissions. This section addresses potential air quality impacts, including odor impacts from the proposed interim and long-term alternatives using the methodologies described in Section 7.2.1. Given the relatively short duration of the construction period (i.e., mostly between 2011 and 2014), odor impacts under the interim alternatives were addressed qualitatively. A detailed analysis is provided in Volume 9, Appendix I, Section 3.2.1 Annual Operation Emissions for Wastewater Treatment.

7.2.4.1 Basic Alternative 1a (Preferred Alternative) and 1b

Basic Alternative 1 (Alternative 1a supports Main Cantonment Alternatives 1 and 2; and Alternative 1b supports Main Cantonment Alternatives 3 and 8) combines upgrade to the existing primary treatment facilities and expansion to secondary treatment at the Northern District Wastewater Treatment Plant (NDWWTP). The difference between Alternatives 1a and 1b is a requirement for a new sewer line from Barrigada housing to NDWWTP for Alternative 1b.

Construction

The plant construction activities would result in a short-term increase in criteria pollutant and CO_2 emissions. However, given the small scale of the activity, the emissions predicted are minimal and would have negligible air quality impacts associated with them, as shown in Table 7.2-21 and described in Volume 9, Appendix I, Section 3.4 Construction Activity Emissions. In Volume 7, these emissions are combined with the emissions from other components of the proposed action to determine the overall significance of potential air emissions impacts using the impact thresholds described in Section 7.2.1.2.

Table 7.2-21. Total Annual Construction Emissions - Alternative 1a and 1b

Construction Activity	*Pollutant*						
	SO_2	*CO*	*PM_{10}*	*$PM_{2.5}$*	*NO_x*	*VOC*	*CO_2*
Total Annual Emissions (TPY)	0.0	0.0	0.0	0.0	0.0	0.0	1.4

Operation

As additional wastewater flow would be treated at the NDWWTP, no changes to baseline operation impacts are predicted for Alternative 1a or 1b.

Potential Mitigation Measures

Potential mitigation measures, if applicable, are discussed in Volume 7, where the combined air quality impacts are addressed.

7.2.4.2 Long-Term Alternatives 1 through 4

Given the incomplete design data provided for these programmatic long-term alternatives, potential air quality impacts resulting from these alternatives are not analyzed in this study and, if required, would be addressed in a future NEPA document. However, given the size of a typical treatment plant and the limited combustion sources, potential criteria pollutants and HAP air quality impacts are expected to be minimal under both construction and operational conditions.

However, potential odor emissions from the long-term wastewater treatment facilities are expected to be significant particularly within the neighborhoods located around each facility, and given the relatively high temperature in Guam. Odor control measures are anticipated to be required for each long-term alternative.

7.2.4.3 Summary of Impacts

Table 7.2-22 summarizes the potential impacts associated with Basic Alternatives 1a and 1b for wastewater treatment. The construction and operation activities associated with wastewater facilities under this alternative would be well below the significance criterion of 250 TPY and therefore the alternative would result in less than significant impacts to air quality resources.

Table 7.2-22. Summary of Potential Air Quality Impacts – Wastewater

	Alternative 1a and 1b
Wastewater	LSI

Legend: LSI = Less Than Significant Impact

7.2.5 Solid Waste

Operation of the existing Navy Landfill at Apra Harbor to handle additional solid waste generated as a result of the proposed action would increase air emissions. This section addresses potential air quality impacts from Alternative 1 using the methodologies described in Section 7.2.1. A detailed analysis is provided in Volume 9, Appendix I, Section 3.2.2 Annual Operational Emissions for Solid Waste Disposal.

7.2.5.1 Basic Alternative 1 (Preferred Alternative)

The Preferred Alternative for solid waste would be the continued use of Navy Landfill at Apra Harbor until Layon Landfill is opened, which is scheduled for July 2011.

Construction

For Solid Waste Basic Alternative 1, there would be no new construction. Therefore, there are no construction impacts to air quality.

Operation

The USEPA LandGEM model (USEPA 2005a) was used to predict the increase in VOC and CO_2 emissions associated with the added solid waste disposal at the Navy Sanitary Landfill from the proposed action. The 2008 existing landfill throughput (input) based on 7.4 lbs (3.4 kg) per capita per day waste generation rate is considered as the baseline condition. The future additional waste throughput associated with Alternative 1 utilizing the Navy Sanitary Landfill was considered to begin in 2009 and the resulting net annual increases in air emissions, shown in Table 7.2-23, were predicted up to 2010.

Table 7.2-23. Total Annual Operation Emissions – Basic Alternative 1 / Apra Harbor

Year	*Pollutant (TPY)*		
	Uncontrolled VOC	*Controlled VOC*	*CO_2*
2010	1.0	N/A	62.9

Once the new Layon Landfill is opened, solid waste from the Navy Sanitary Landfill would be diverted to Layon per the Memorandum of Understanding between the DoD and GovGuam. The new landfill is assumed to open in 2011 and close in 2036.

The same methodology used for Basic Alternative 1 in Apra Harbor was used to predict the increase in VOC and CO_2 emissions associated with the added solid waste disposal at the proposed GovGuam landfill beyond 2011. Table 7.2-24 summarizes the predicted emissions for each year after the interim period. According to the Revised Final Report: Guam Solid Waste Utility Study for Proposed USMC Relocation (HDR/Hawaii Pacific Engineers 2008), a flare system to control VOC emissions would be installed in 2013. Therefore, the controlled VOC emission increase shown in Table 7.2-24 for 2014 reflects the presence of a flare controlling VOC emissions with a destruction rate of 98% or greater (USEPA 2003b).

Table 7.2-24. Total Annual Operation Emissions – Basic Alternative 1 / Layon

Year	*Pollutant (TPY)*		
	Uncontrolled VOC	*Controlled VOC*	*CO_2*
2011	2.7	N/A	170
2012	4.3	N/A	273
2013	6.2	N/A	399
2014	N/A	0.2	624
2015	N/A	0.3	946
2016	N/A	0.4	1,422
2017	N/A	0.6	1,908
2018	N/A	0.7	2,371
2019	N/A	0.9	2,812
2020	N/A	1.0	3,239
2021	N/A	1.1	3,645
2022	N/A	1.3	4,032
2023	N/A	1.4	4,400
2024	N/A	1.5	4,749
2025	N/A	1.6	5,082
2026	N/A	1.7	5,399
2027	N/A	1.8	5,700
2028	N/A	1.9	5,986
2029	N/A	2.0	6,258
2030	N/A	2.0	6,517
2031	N/A	2.1	6,764
2032	N/A	2.2	6,998
2033	N/A	2.3	7,221
2034	N/A	2.3	7,433
2035	N/A	2.4	7,635
2036	N/A	2.5	7,827

Legend: N/A = Not Applicable.

The predicted construction and operational emissions are combined with the emissions from other components of the Proposed Action in Volume 7 to determine the overall significance of potential air emissions impacts using the thresholds described in Section 7.2.1.2.

Potential Mitigation Measures

Mitigation measures, if applicable, for combined air quality effects are discussed in Volume 7.

7.2.5.2 Summary of Impacts

Table 7.2-25 summarizes the potential air quality impacts associated with the solid waste alternatives. The construction activities associated with solid waste facilities were well below the significance criterion of

250 TPY for all alternatives, as were operational emissions of criteria pollutants. Therefore, Alternative 1 would result in less than significant impacts to air quality resources with standard control measures.

It should be noted that CO_2 is not a criteria pollutant and therefore is not compared to criteria pollutant thresholds. The potential effects of CO_2 and other GHG emissions are by nature global and are based on cumulative impacts. Individual sources are not large enough to have an appreciable effect on climate change. Hence, the impact of proposed CO_2 and other greenhouse gas emissions is discussed in the context of cumulative impacts in Volume 7.

Table 7.2-25. Summary of Potential Air Quality Impacts – Solid Waste

	Alternative 1 / Apra Harbor	*Alternative 1 / Layon*
Solid waste	LSI	LSI

Legend: LSI = Less Than Significant Impact.

7.2.6 Off Base Roadways

Roadway projects are covered by four alternatives for the location of the cantonment area functions and family housing/community support functions, as summarized below. A detailed description of these alternatives is provided in Volume 2.

- Alternative 1. Represents one contiguous location for cantonment area functions and family housing/community support functions. It would include portions of Naval Computer and Telecommunications Station (NCTS) Finegayan and South Finegayan, as well as acquisition or long-term leasing of non-DoD lands at the former Federal Aviation Administration (FAA) parcel and the Harmon Annex parcel. A portion of the development would be constructed in the undeveloped overlay refuge.
- Alternative 2. Represents one contiguous land area for the cantonment and family housing /community support functions. It would include portions of NCTS Finegayan, portions of South Finegayan, and the acquisition or long-term leasing of portions of privately-held lands in the former FAA parcel. A portion of the development would be constructed in the undeveloped overlay refuge.
- Alternative 3. Plans for the main cantonment to include portions of NCTS Finegayan, and housing would be located on three geographically separated DoD parcels, including South Finegayan, Air Force Barrigada, and Navy Barrigada. No privately held lands would be acquired. Housing would be located non-contiguous to the main cantonment functions and a portion of the main cantonment would be constructed in the undeveloped overlay refuge.
- Alternative 8. would include portions of NCTS Finegayan, a portion of South Finegayan, the former FAA parcel, and a portion of the housing would be located on the geographically separated Air Force Barrigada parcel. A portion of privately held lands would be acquired by purchase or long-term lease. A portion of the main cantonment would be constructed in the undeveloped overlay refuge and a portion of the required housing would be non-contiguous to the Main Cantonment Area.

7.2.6.1 Alternative 1

<u>Mesoscale Emissions Burden</u>

Air quality impacts would also result from the provision of on-road vehicle operations and roadway constructions associated with the proposed action. As shown in Table 7.2-26 and Volume 9, Appendix I, Section 3.3.7.2 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 1, regional emissions are predicted to increase from 18% to 19% under Alternative 1 as, compared to the no-action alternative. This is primarily due to the estimated 18% increase in VMT under Alternative 1.

Table 7.2-26. Regional Annual Emission Burdens, Alternative 1

Scenario	*VMT*	*Speed*	*Emission Burden (tpy)*						
			CO	*NO_x*	*VOC*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*CO_2*
2030 No-Action Alternative	3,535,224	28.6	13,388	478	801	78	57	562	80,499
2030 Alternative 1	4,160,544	28.0	15,813	566	951	91	67	661	94,687
Net Change from No-Action			2,425	88	150	13	10	99	14,188
Percent Change from No-Action			18%	18%	19%	18%	18%	18%	18%

Legend: CO = carbon monoxide; VOC = volatile organic compounds; $PM_{2.5}$= particulate matter less than 2.5 microns in diameter;
PM_{10} = particulate matter less than 10 microns in diameter; tpy = tons per year; NOx = nitrogen oxides;
VMT = vehicle miles traveled.

North

Mobile Source Air Toxics

Technical shortcomings of emissions and dispersion models and uncertain science with respect to health effects prevent meaningful or reliable estimates of MSAT emissions and effects of this project; however, even though reliable methods do not exist to accurately estimate the health impacts of MSATs at the project level, it is possible to qualitatively assess the levels of future MSAT emissions under the project. Although a qualitative analysis cannot measure potential health impacts from MSATs, it can give a basis for identifying and comparing the potential differences in MSAT emissions, if any, from the alternatives. The qualitative assessment presented below is derived in part from *A Methodology for Evaluating Mobile Source Air Toxic Emissions among Transportation Project Alternatives* developed by FHWA (FHWA 2009) and is also presented in Volume 9, Appendix I, Section 3.3.7.1 Off Base On-road Vehicle Operational Emissions and Impact Methodology.

Based on the recommended tiering approach detailed in the FHWA methodology, the project falls within the Tier 3 category as a project with potential impacts on traffic volumes or vehicle mix. As shown in Table 7.2-26, the project is predicted to increase daily VMT by 18% and associated regional emissions by 18% to 19%. This is considered a significant increase in traffic for the project area.

FHWA requires quantitative emissions analysis for projects that involve new or additional capacity on roadways where the traffic volume would be 140,000 to 150,000 average annual daily traffic (AADT). The 2030 average daily traffic (ADT) estimates for the three most traveled roadways under Alternative 1 are shown in Table 7.2-27 and described in Volume 9, Appendix I, Section 3.3.7.2 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 1. Since the ADTs are less than 140,000 for the design year, a MSAT analysis is not required.

Table 7.2-27. Average Daily Traffic for Major Roadways, Alternative 1

Roadway	*Alternative 1 No Build*	*Alternative 1 Build*
Route 1	95,600	95,600
Route 8	58,500	58,600
Route 18	70,500	70,500

Roadway widening may also have the effect of moving some traffic closer to nearby homes, schools, businesses, and other locations where sensitive receptors may be present. Sensitive receptors include those facilities most likely to contain large concentrations of the more sensitive population. These include hospitals, schools, licensed day cares, and elder care facilities.

There may also be localized areas where ambient concentrations of MSATs could be higher under the action alternatives than under the no-action alternative. Dispersion studies have shown that the "roadway" air toxics start to drop off at approximately 328 ft (100 m). By 1,640 ft (500 m), most studies have found it very difficult to distinguish the roadway from background toxic concentrations in any given area; however, as discussed previously, the magnitude and duration of these potential increases compared to the no-action alternative cannot be accurately quantified because of the inherent deficiencies of current models. When new travel lanes are constructed, the localized level of MSAT emissions for the action alternatives could be higher relative to the no-action alternative, but this could be offset due to increases in localized speeds and reductions in congestion that are associated with lower MSAT emissions. In addition, MSATs would be lower in other locations when traffic shifts away from them; however, on a regional basis, USEPA's vehicle and fuel regulations, coupled with fleet turnover, would cause region-wide MSAT levels to be significantly lower than today in almost all cases.

This air quality section includes a basic analysis of the likely MSAT emission impacts of this project; however, available technical tools do not enable us to predict project-specific health impacts of the emission changes associated with the project alternatives. As a result of these limitations, the following discussion is included in accordance with the Council on Environmental Quality's (CEQ) regulations (40 CFR 1502.22(b)) regarding incomplete or unavailable information.

Information that is Unavailable or Incomplete

Evaluating the environmental and health impacts from MSATs on a proposed roadway project would involve several key elements, including emissions modeling, dispersion modeling to estimate ambient concentrations resulting from the estimated emissions, exposure modeling to estimate human exposure to the estimated concentrations, and then a final determination of health impacts based on the estimated exposure. Each of these steps is encumbered by technical shortcomings or uncertain science that prevents a more complete determination of the MSAT health impacts of the proposed action as follows:

- **Emissions**. The USEPA tools to estimate MSAT emissions from motor vehicles are not sensitive to key variables determining emissions of MSATs in the context of roadway projects.
- **Dispersion**. The tools to predict how MSATs disperse are also limited. USEPA's current regulatory models, CALINE3 and CAL3QHC, were developed and validated more than a decade ago for the purpose of predicting episodic concentrations of CO to determine compliance with the NAAQS. The performance of dispersion models is more accurate for predicting maximum concentrations that can occur at some time at some location within a geographic area. This limitation makes it difficult to

predict accurate exposure patterns at specific times at specific roadway project locations across an urban area to assess potential health risk.

- **Exposure Levels and Health Effects**. Finally, even if emission levels and concentrations of MSATs could be accurately predicted, shortcomings in current techniques for exposure assessment and risk analysis preclude reaching meaningful conclusions about project-specific health impacts. Exposure assessments are difficult because it is difficult to accurately calculate annual concentrations of MSATs near roadways and to determine the portion of a year that people are actually exposed to those concentrations at a specific location. These difficulties are magnified for 70-year (lifetime or chronic) cancer assessments, particularly because unsupportable assumptions would have to be made regarding changes in travel patterns and vehicle technology, which affects emissions rates, over a 70-year period.

Summary of Existing Credible Scientific Evidence Relevant to Evaluating the Impacts of MSATs

Research into the health impacts of MSATs is ongoing. For different emission types, a variety of studies show some statistical associations with adverse health outcomes through epidemiological studies that are frequently based on emissions levels found in occupational settings or using animal studies that demonstrate adverse health outcomes when animals are exposed to large doses.

Exposure to toxics has been a focus of many USEPA efforts. Most notably, the agency conducted the National Air Toxics Assessment in 1996 to evaluate modeled estimates of human exposure applicable to the county level. While not intended for use as a measure of or benchmark for local exposure, the modeled estimates in the National Air Toxics Assessment database best illustrate the levels of various toxics when aggregated to a national or state level.

USEPA is in the process of assessing the risks of various kinds of exposures to these pollutants. The USEPA Integrated Risk Information System (USEPA 2009b) is a database of human health effects that may result from exposure to various substances found in the environment.

There have been other studies that address MSAT health impacts in proximity to roadways. The Health Effects Institute, a non-profit organization funded by USEPA, FHWA, and industry, has undertaken a major series of studies to research near roadway MSAT hot spots, the health implications of the entire mix of mobile source pollutants, and other topics. The final summary of the series is not expected for several years.

Some recent studies have reported that proximity to roadways is related to adverse health outcomes – particularly respiratory problems (South Coast Air Quality Management District 2000, The Sierra Club 2004 and Yuhnke 2005). Much of this research is not specific to MSATs, but instead surveys the full spectrum of criteria and other pollutants. These studies do not provide information that would be useful to alleviate the uncertainties listed above to perform a more comprehensive evaluation of the health impacts specific to this project.

Relevance of Unavailable or Incomplete Information

Because of the uncertainties outlined above, a quantitative assessment of the effects of air toxic emission impacts on human health cannot be made at the project level. While available tools do allow for reasonably predicting relative emissions changes among alternatives for larger projects, the amount of MSAT emissions from each of the project alternatives and MSAT concentrations or exposures created by each of the project alternatives cannot be predicted with enough accuracy to be useful in estimating health impacts. (As noted above, the current emissions model is not capable of serving as a meaningful emissions analysis tool for smaller projects.) Therefore, it is not possible to make a determination of whether any of the alternatives would have a significant impact due to MSAT emissions.

Emissions would likely be lower than present levels in the design year as a result of USEPA's national control programs that are projected to reduce MSAT emissions by 57% to 87% between 2000 and 2020 (Figure 7.2-2). Local conditions on Guam may differ from these national projections in terms of fleet mix and turnover, VMT growth rates, and local control measures; however, the magnitude of the USEPA-projected reductions is so great that MSAT emissions are likely to be lower in the future in nearly all cases.

Therefore, although the proposed action may increase exposure to MSAT emissions in certain locations, the concentrations and duration of exposures are uncertain. Because of this uncertainty, the health effects from these emissions cannot be estimated.

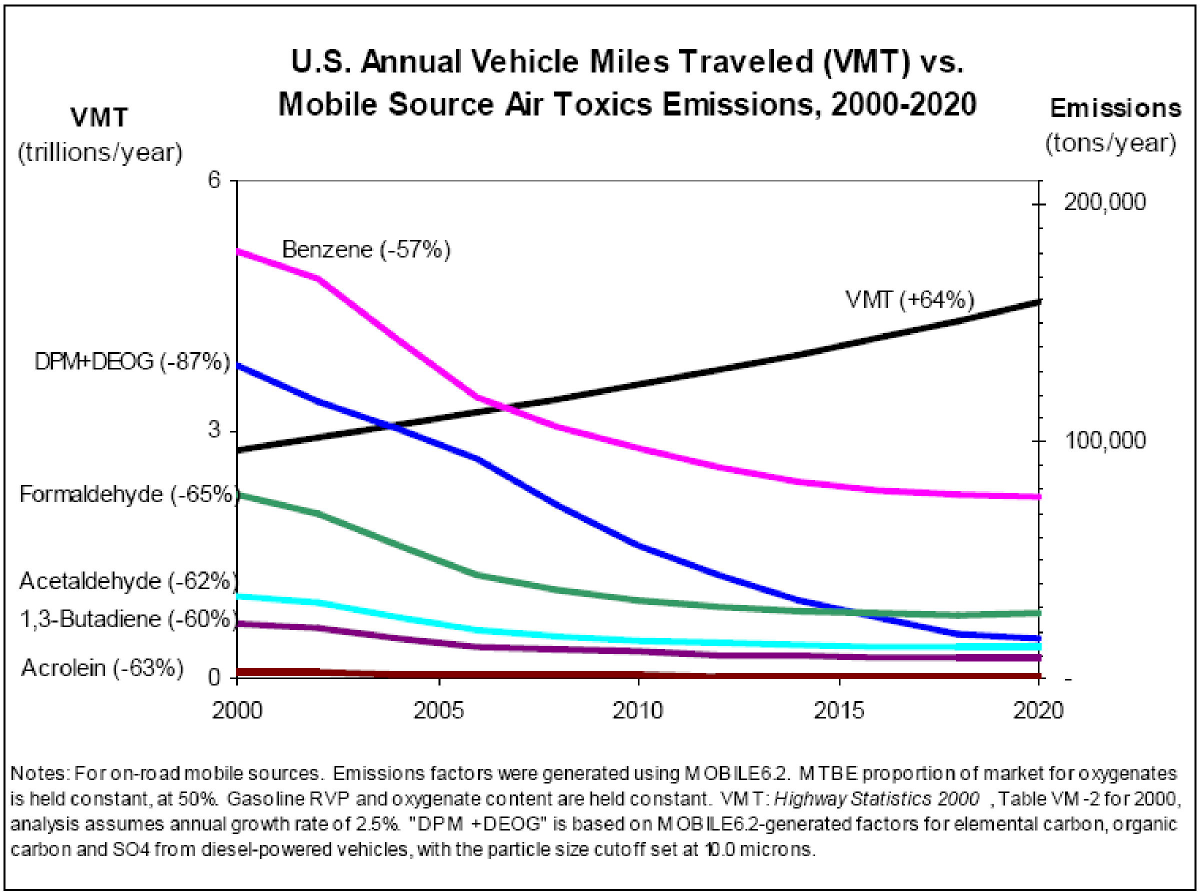

Figure 7.2-2 Projected MSAT Emissions and Traffic Volumes (2000-2020)

Microscale CO Impact Analysis

A screening analysis was performed to determine which intersections could potentially degrade air quality levels due to increased delay, volume, or worsening LOS due to the project examining each ROI. As detailed in Volume 9, Appendix I, Section 3.3.7.2 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 1, 10 North ROI locations were screened based on changes in intersection volumes, delay, and LOS between the no-action and build alternatives. Five of these locations failed the screening criteria. The Route 1/28 intersection has the highest overall volume of all the intersections that failed the screening. This site was chosen for detailed analysis. The Route 9/Andersen AFB North Gate intersection was also chosen for analysis due to the extremely high delay predicted in the build scenario and the predicted high volumes at this location. These intersections represent the worst-case combination of volumes, LOS, and delay of the intersections screened. As such, the predicted CO levels from these sites represent the worst-case microscale CO impacts expected from the project.

The results of the microscale analysis are shown in Table 7.2-28 and Table 7.2-29 and are described in Volume 9, Appendix I, Section 3.3.7.2 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 1. The values in these tables represent the background CO concentration combined with the modeled results from USEPA's CAL3QHC microscale dispersion model using worst-case meteorological parameters, along with a.m. and p.m. peak traffic data. Emission factors were calculated using USEPA's MOBILE6.2 emission factor program. A background value must be added into the results of the dispersion analysis to account for others sources of CO that are not accounted for in the CAL3QHC modeling. Usually a value from a representative local ambient air quality monitor is used. Guam, however, does not have any local monitoring stations, as discussed earlier in this chapter. Due to this, values from Hawaii were examined to determine their applicability to Guam. Using the 2006-2008 monitored data from the Punchbowl monitor, (rated as a middle scale monitor) located in Honolulu, Hawaii, the second highest maximum 1-hour reading was 1.7 parts ppm. This value was conservatively rounded to 2.0 ppm and represents the background CO concentration for this analysis. A persistence factor, that accounts for hourly variation of traffic and meteorological conditions, of 0.7, as recommended by USEPA was applied to the 1-hour CO concentrations to obtain 8-hour concentrations. As shown in Table 7.2-28 and Table 7.2-29, no violations of the applicable NAAQS are predicted.

Table 7.2-28. Predicted Worst-Case 1-Hour CO Concentrations (ppm) – North, Alternative 1

Analysis Site	*Existing*		*2014*		*2030*	
	a.m.	*p.m.*	*a.m.*	*p.m.*	*a.m.*	*p.m.*
Route 1/28	5.5	6.0	6.9	7.3	6.0	4.2
Route 9/Andersen AFB North Gate	2.3	2.3	2.6	3.1	2.9	2.8

Notes: 1-hour CO NAAQS = 35 ppm. Includes a background concentration of 2 ppm.

Table 7.2-29. Predicted Worst-Case 8-Hour CO Concentrations (ppm) – North Alternative 1

Analysis Site	*Existing*	*2014*	*2030*
Route 1/28	4.2	5.1	4.2
Route 9/Andersen AFB North Gate	1.6	2.2	2.0

Notes: 8-hour CO NAAQS = 9 ppm Includes a background concentration of 1.4 ppm

Construction Emissions Analysis

To determine the temporary air quality impacts arising from construction of the project, a detailed emission construction analysis was conducted. Using the estimated project schedule, along with typical equipment requirements for specific tasks, emission burden estimates of CO, NO_x, PM_{10}, and $PM_{2.5}$ were calculated. Equipment emissions were presumed to be Tier 3, with high sulfur fuel as confirmed by the construction management team. Based on the preliminary schedule, the highest emissions levels per year, per month, and the year that these emissions are predicted to occur in the North Region are shown in

Table 7.2-30 and also presented in Volume 9, Appendix I, Section 3.4 Construction Activity Emissions.

Table 7.2-30. Estimated Construction Emission Burden – North, Alternative 1

	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*VOC*	*SO_2*	*CO_2*
Maximum Yearly Value (Tons)	13.0	20.3	8.4	4.1	1.4	15.3	3,881
Highest Monthly Emission Burden (Tons)	4.7	7.3	1.8	1.3	0.51	5.4	1,462
Average Daily Emission Burden (Based on Highest Month) (Tons)	0.23	0.36	0.09	0.06	0.03	0.27	73.1
Year Highest Monthly Emission Burden Predicted to Occur	2011	2011	2011	2011	2011	2011	2011

Central

Mobile Source Air Toxics

MSAT impacts would be the same as those for the North ROI Alternative 1.

Microscale CO Analysis

A screening analysis was performed to determine which Central ROI intersections could potentially degrade air quality levels due to increased delay, volume, or worsening LOS due to the project. As detailed in Volume 9, Appendix I, Section 3.3.7.2 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 1, 34 locations were screened based on changes in intersection volumes, delay, and LOS between the no-action and build alternatives. Twenty-one (21) of these locations failed the screening criteria. The Route 1/8 intersection has the highest overall volume of all the intersections that failed the screening. This site was chosen for detailed analysis. The Route 4/7A intersection has the highest overall delay of any signalized intersection that failed the screening. This site was chosen for detailed analysis. The Route 16/27 intersection fails the screening criteria in other alternatives and was evaluated in this alternative for consistency. These intersections represent the worst-case combination of volumes, LOS, and delay of the intersections screened. As such, the predicted CO levels from these sites represent the worst-case microscale CO impacts expected from the project.

The results of the microscale analysis are shown in Table 7.2-31 and Table 7.2-32 and are presented in Volume 9, Appendix I, Section 3.3.7.2 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 1. The values in these tables, using the same analysis techniques and parameters as those applied in the North Region, represent the predicted worst-case CO concentrations. As shown in Table 7.2-31 and Table 7.2-32, no violations of the applicable NAAQS are predicted.

Table 7.2-31. Predicted Worst-Case 1-Hour CO Concentrations (ppm) – Central, Alternative 1

Analysis Site	*Existing*		*2014*		*2030*	
	a.m.	*p.m.*	*a.m.*	*p.m.*	*a.m.*	*p.m.*
Route 1/8	6.0	6.4	7.3	7.6	6.2	6.4
Route 4/7A	5.3	3.8	5.1	5.6	4.6	5.1
Route 16/27	8.4	9.4	8.1	9.0	7.0	7.9

Notes: 1-hour CO NAAQS = 35 ppm.Includes a background concentration of 2 ppm.

Table 7.2-32. Predicted Worst-Case 8-Hour CO Concentrations (ppm) – Central, Alternative 1

Analysis Site	*Existing*	*2014*	*2030*
Route 1/8	4.5	5.3	4.5
Route 4/7A	3.7	3.9	3.6
Route 16/27	6.6	6.3	5.5

Notes: 8-hour CO NAAQS = 9 ppm.Includes a background concentration of 1.4 ppm.

Construction Emissions Analysis

To determine the temporary air quality impacts arising from construction of the project, a detailed emission construction analysis was conducted using the same method as described for the North ROI. The highest predicted construction emissions per year, per month, and the year that these emissions are predicted to occur are shown in Table 7.2-33 and also presented in Volume 9, Appendix I, Section 3.4 Construction Activity Emissions.

Table 7.2-33. Estimated Construction Emission Burden – Central, Alternative 1

	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*VOC*	*SO_2*	*CO_2*
Maximum Yearly Value (Tons)	54.6	84.2	17.2	14.4	5.9	62.4	16,707
Highest Monthly Emission Burden (Tons)	8.5	13.1	2.2	2.2	0.9	9.7	2,590
Average Daily Emission Burden (Based on Highest Month) (Tons)	0.42	0.65	0.11	.11	0.05	0.48	129
Year Highest Monthly Emission Burden Predicted to Occur	2012	2012 & 2013	2012 & 2013	2012 & 2013	2012 & 2013	2012 & 2013	2012 & 2013

Apra Harbor

Mobile Source Air Toxics

MSAT impacts would be the same as those for the North ROI, Alternative 1.

Microscale CO Analysis

A screening analysis was performed to determine which intersections could potentially degrade air quality levels due to increased delay, volume, or worsening LOS due to the project. As detailed in Volume 9, Appendix I, Section 3.3.7.2 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 1, three locations were screened based on changes in intersection volumes, delay, and LOS between the no-action and build alternatives. One of these locations failed the screening criteria. The Route 1/2A intersection has the highest overall volume and highest delay of all the signalized intersections that failed the screening. This site was chosen for detailed analysis. This intersection represents the worst-case combination of volumes, LOS, and delay of the intersections screened. As such, the predicted CO levels from this site represent the worst-case microscale CO impacts expected from the project.

The results of the microscale analysis are shown in Table 7.2-34 and Table 7.2-35 and are presented in Volume 9, Appendix I, Section 3.3.7.2 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 1. The values in these tables, using the same analysis techniques and parameters as those applied in the North Region, represent the predicted worst-case CO concentrations. As shown in Table 7.2-34 and Table 7.2-35, no violations of the applicable NAAQS are predicted.

Table 7.2-34. Predicted Worst-Case 1-Hour CO Concentrations (ppm) – Apra Harbor, Alternative 1

Analysis Site	*Existing*		*2014 Alternative 1*		*2030 Alternative 1*	
	a.m.	*p.m.*	*a.m.*	*p.m.*	*a.m.*	*p.m.*
Route 1/2A	4.7	4.3	5.3	5.1	4.3	3.9

Notes: 1-hour CO NAAQS = 35 ppm.Includes a background concentration of 2 ppm.

Table 7.2-35. Predicted Worst-Case 8-Hour CO Concentrations (ppm) – Apra Harbor, Alternative 1

Analysis Site	*Existing*	*2014 Alternative 1*	*2030 Alternative 1*
Route 1/2A	3.3	3.7	3.0

Notes: 8-hour CO NAAQS = 9 ppm.Includes a background concentration of 1.4 ppm.

Construction Emissions Analysis

To determine the temporary air quality impacts arising from construction of the project, a detailed construction emissions analysis was conducted using the same method as described for the North Region. The highest predicted construction emissions per year, per month, and the year that these emissions are predicted to occur are shown in Table 7.2-36 and presented in Volume 9, Appendix I, Section 3.4 Construction Activity Emissions.

Table 7.2-36. Estimated Construction Emission Burden – Apra Harbor, Alternative 1

	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*VOC*	*SO_2*	*CO_2*
Maximum Yearly Value (Tons)	13.5	20.9	5.0	3.7	1.2	15.4	4,199
Highest Monthly Emission Burden (Tons)	1.6	2.5	0.59	0.44	0.34	1.82	494
Average Daily Emission Burden (Based on Highest Month) (Tons)	0.08	0.12	0.03	.02	0.02	0.0.9	24.7
Year Highest Monthly Emission Burden Predicted to Occur	2011	2011	2011	2011	2011	2011	2011

South

Mobile Source Air Toxics

MSAT impacts would be the same as those for the North Region.

Microscale CO Analysis

A screening analysis was performed to determine which intersections could potentially degrade air quality levels due to increased delay, volume, or worsening LOS due to the project. As detailed in Volume 9, Appendix I, Section 3.3.7.2 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 1, four locations were screened based on changes in intersection volumes, delay, and LOS between the no-action and build alternatives. Two of these locations failed the screening criteria. The Route 5/2A intersection has the highest overall volume and highest delay of all the signalized intersections that failed the screening. This site was chosen for detailed analysis. This intersection represents the worst-case combination of volumes, LOS, and delay of the intersections screened. As such, the predicted CO levels from this site represent the worst-case microscale CO impacts expected from the project.

The results of the microscale analysis are shown in Table 7.2-37 and Table 7.2-38 and are presented in Volume 9, Appendix I, Section 3.3.7.2 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 1. The values in these tables, using the same analysis techniques and parameters as those applied in the North Region, represent the predicted worst-case CO concentrations. As shown in Table 7.2-37 and Table 7.2-38 no violations of the applicable NAAQS are predicted.

Table 7.2-37. Predicted Worst-Case 1-Hour CO Concentrations (ppm) – South, Alternative 1

Analysis Site	*Existing*		*2014*		*2030*	
	a.m.	*p.m.*	*a.m.*	*p.m.*	*a.m.*	*p.m.*
Route 5/2A	4.2	3.9	4.5	4.0	4.0	3.7

Notes: 1-hour CO NAAQS = 35 ppm.Includes a background concentration of 2 ppm.

Table 7.2-38. Predicted Worst-Case 8-Hour CO Concentrations (ppm) – South, Alternative 1

Analysis Site	*Existing*	*2014*	*2030*
Route 5/2A	2.9	3.2	2.8

Notes: 8-hour CO NAAQS = 9 ppm. Includes a background concentration of 1.4 ppm.

Construction Emissions Analysis

To determine the temporary air quality impacts arising from construction of the project, a detailed construction emissions analysis was conducted using the same method as described for the North Region. As shown in Table 7.2-39 and Volume 9, Appendix I, Section 3.4 Construction Activity Emissions, construction emissions are negligible.

Table 7.2-39. Estimated Construction Emission Burden – South, Alternative 1

	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*VOC*	*SO_2*	*CO_2*
Maximum Yearly Value (Tons)	11.1	17.3	2.9	2.8	1.2	12.9	3310
Highest Monthly Emission Burden (Tons)	3.1	4.9	0.83	0.81	0.34	3.7	957
Average Daily Emission Burden (Based on Highest Month) (Tons)	0.16	0.25	0.04	0.04	0.02	0.18	47.8
Year Highest Monthly Emission Burden Predicted to Occur	2012	2013	2012 & 2013	2012 & 2013	2013	2013	2013

Potential Mitigation Measures

Because the alternative is not predicted to cause a significant impact on air quality levels, no mitigation is proposed.

7.2.6.2 Alternative 2 (Preferred Alternative)

Mesoscale Emissions Burden

As shown in Table 7.2-40 and Volume 9, Appendix I, Section 3.3.7.3 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 2, regional emissions are predicted to increase in the range of 18% to 19% under Alternative 2 and are the same as compared to Alternative 1. This is primarily due to the estimated 18% increase in VMT under Alternative 2.

Table 7.2-40. Regional Annual Emission Burdens, Alternative 2

Scenario	*VMT*	*Speed*	*Emission Burden (tpy)*						
			CO	*NO_x*	*VOC*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*CO_2*
2030 Alternative 2	4,160,544	28.0	15,813	566	951	91	67	661	94,687,2

Legend: CO = carbon monoxide; VOC = volatile organic compounds; $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; PM_{10} = particulate matter less than 10 microns in diameter; tpy = tons per year; NOx = nitrogen oxides; VMT = vehicle miles traveled.

North

Mobile Source Air Toxics

MSAT impacts would be the same as those discussed for the North Region under Alternative 1.

Microscale CO Analysis

A screening analysis was performed to determine which intersections could potentially degrade air quality levels due to increased delay, volume, or worsening LOS due to the project. As detailed in Volume 9, Appendix I, Section 3.3.7.3 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 2, 10 locations were screened based on changes in intersection volumes, delay, and LOS between the no-action and build alternatives. Five of these locations failed the screening criteria. The Route 1/28 intersection has the highest overall volume of all the intersections that failed the screening. This site was chosen for detailed analysis. The Route 9/Andersen AFB North Gate intersection was also chosen for analysis due to the extremely high delay predicted in the build scenario and the predicted high volumes at this location. These intersections represent the worst-case combination of volumes, LOS, and delay of the intersections screened. As such, the predicted CO levels from these sites represent the worst-case microscale CO impacts expected from the project.

The results of the microscale analysis are shown in Table 7.2-41 and Table 7.2-42 and are presented in Volume 9, Appendix I, Section 3.3.7.3 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 2. The values in these tables, using the same analysis techniques and parameters as those applied in the North Region under Alternative 1, represent the predicted worst-case CO concentrations. As shown in Table 7.2-41 and Table 7.2-42, no violations of the applicable NAAQS are predicted.

Table 7.2-41. Predicted Worst-Case 1-Hour CO Concentrations (ppm) – North, Alternative 2

Analysis Site	*Existing*		*2014*		*2030*	
	a.m.	*p.m.*	*a.m.*	*p.m.*	*a.m.*	*p.m.*
Route 1/28	5.5	6.0	6.9	7.3	6.0	4.2
Route 9/Andersen AFB North Gate	2.3	2.3	2.6	3.1	2.9	2.8

Notes: 1-hour CO NAAQS = 35 ppm. Includes a background concentration of 2 ppm.

Table 7.2-42. Predicted Worst-Case 8-Hour CO Concentrations (ppm) – North Region, Alternative 2

Analysis Site	*Existing*	*2014*	*2030*
Route 1/28	4.2	5.1	4.2
Route 9/Andersen AFB North Gate	1.6	2.2	2.0

Notes: 8-hour CO NAAQS = 9 ppm. Includes a background concentration of 1.4 ppm.

Construction Emissions Analysis

To determine the temporary air quality impacts arising from construction of the project, a detailed construction emissions analysis was conducted using the same method as described for the North Region (Alternative 1). The highest predicted construction emissions per year, per month, and the year that these emissions are predicted to occur are shown in Table 7.2-43 and Volume 9, Appendix I, Section 3.4 Construction Activity Emissions. These emissions were further combined with those from other project components and discussed in Volume 7 to determine the potential impact significance.

Table 7.2-43. Estimated Construction Emission Burden – North, Alternative 2

	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*VOC*	*SO_2*	*CO_2*
Maximum Yearly Value (Tons)	13.0	20.3	8.4	4.1	1.4	15.3	3,881
Highest Monthly Emission Burden (Tons)	4.7	7.3	1.8	1.3	0.51	5.4	1,462
Average Daily Emission Burden (Based on Highest Month) (Tons)	0.23	0.36	0.09	0.06	0.03	0.27	73.1
Year Highest Monthly Emission Burden Predicted to Occur	2011	2011	2011	2011	2011	2011	2011

Central

Mobile Source Air Toxics

MSAT impacts would be the same as those for the North Region under Alternative 1.

Microscale CO Analysis

A screening analysis was performed to determine which intersections could potentially degrade air quality levels due to increased delay, volume, or worsening LOS due to the project. As detailed in Volume 9, Appendix I, Section 3.3.7.3 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 2, 34 locations were screened based on changes in intersection volumes, delay, and LOS between the no-action and build alternatives. Twenty-one (21) of these locations failed the screening criteria. The Route 1/8 intersection has the highest overall volume of all the intersections that failed the screening. This site was chosen for detailed analysis. The Route 4/7A intersection has the highest overall delay of any signalized intersection that failed the screening. This site was chosen for detailed analysis. The Route 16/27 intersection fails the screening criteria in other alternatives and was evaluated in this alternative for consistency. These intersections represent the worst-case combination of volumes, LOS, and delay of the intersections screened. As such, the predicted CO levels from these sites represent the worst-case microscale CO impacts expected from the project.

The results of the microscale analysis are shown in Table 7.2-44 and Table 7.2-45 and are presented in Volume 9, Appendix I, Section 3.3.7.3 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 2. The values in these tables, using the same analysis techniques and parameters as those applied in the North Region (Alternative 1), represent the predicted worst-case CO concentrations. As shown in Table 7.2-44 and Table 7.2-45, no violations of the applicable NAAQS are predicted.

Table 7.2-44. Predicted Worst-Case 1-Hour CO Concentrations (ppm) – Central, Alternative 2

Analysis Site	*Existing*		*2014*		*2030*	
	a.m.	*p.m.*	*a.m.*	*p.m.*	*a.m.*	*p.m.*
Route 1/8	6.0	6.4	7.3	7.6	6.2	6.4
Route 4/7A	5.3	3.8	5.1	5.6	4.6	5.1
Route 16/27	8.4	9.4	8.1	9.0	7.0	7.9

Notes: 1-hour CO NAAQS = 35 ppm. Includes a background concentration of 2 ppm.

Table 7.2-45. Predicted Worst-Case 8-Hour CO Concentrations (ppm) – Central, Alternative 2

Analysis Site	*Existing*	*2014*	*2030*
Route 1/8	4.5	5.3	4.5
Route 4/7A	3.7	3.9	3.6
Route 16/27	6.6	6.3	5.5

Notes: 8-hour CO NAAQS = 9 ppm.Includes a background concentration of 1.4 ppm.

Construction Emissions Analysis

To determine the temporary air quality impacts arising from construction of the project, a detailed emission construction analysis was conducted using the same method as described for the North Region (Alternative 1). The highest emissions per year, per month, and the year that these emissions are predicted to occur are shown in Table 7.2-46 and Volume 9, Appendix I, Section 3.4 Construction Activity Emissions. These emissions were further combined with those from other project components and discussed in Volume 7 to determine the potential impact significance.

Table 7.2-46. Estimated Construction Emission Burden – Central, Alternative 2

	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*VOC*	*SO_2*	*CO_2*
Maximum Yearly Value (Tons)	54.6	84.2	17.2	14.4	5.9	62.4	16,707
Highest Monthly Emission Burden (Tons)	8.5	13.1	2.2	2.2	0.9	9.7	2,590
Average Daily Emission Burden (Based on Highest Month) (Tons)	0.42	0.65	0.11	.11	0.05	0.48	129
Year(s) Highest Monthly Emission Burden Predicted to Occur	2012	2012 & 2013	2012 & 2013	2012 & 2013	2012 & 2013	2012 & 2013	2012 & 2013

Apra Harbor

Mobile Source Air Toxics

MSAT impacts would be the same as those for the North Region under Alternative 1.

Microscale CO Analysis

A screening analysis was performed to determine which intersections could potentially degrade air quality levels due to increased delay, volume, or worsening LOS due to the project. As detailed in Volume 9, Appendix I, Section 3.3.7.3 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 2, three locations were screened based on changes in intersection volumes, delay, and LOS between the no-action and build alternatives. One of these locations failed the screening criteria. The Route 1/2A intersection has the highest overall volume and highest delay of all the signalized intersections that failed the screening. This site was chosen for detailed analysis. This intersection represents the worst-case combination of volumes, LOS, and delay of the intersections screened. As such, the predicted CO levels from this site represent the worst-case microscale CO impacts expected from the project.

The results of the microscale analysis are shown in Table 7.2-47 and Table 7.2-48 and are presented in Volume 9, Appendix I, Section 3.3.7.3 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 2. The values in these tables, using the same analysis techniques and parameters as those applied in the North Region (Alternative 1), represent the predicted worst-case CO concentrations. As shown in Table 7.2-47 and Table 7.2-48, no violations of the applicable NAAQS are predicted.

Table 7.2-47. Predicted Worst-Case 1-Hour CO Concentrations (ppm) – Apra Harbor, Alternative 2

Analysis Site	*Existing*		*2014*		*2030*	
	a.m.	*p.m.*	*a.m.*	*p.m.*	*a.m.*	*p.m.*
Route 1/2A	4.7	4.3	5.3	5.1	4.3	3.9

Notes: 1-hour CO NAAQS = 35 ppm.Includes a background concentration of 2 ppm.

Table 7.2-48. Predicted Worst-Case 8-Hour CO Concentrations (ppm) – Apra Harbor, Alternative 2

Analysis Site	*Existing*	*2014*	*2030*
Route 1/2A	3.3	3.7	3.0

Notes: 8-hour CO NAAQS = 9 ppm. Includes a background concentration of 1.4 ppm.

Construction Emissions Analysis

To determine the temporary air quality impacts arising from construction of the project, a detailed construction emissions analysis was conducted using the same method as described for the North Region (Alternative 1). The highest predicted construction emissions per year, per month, and the year that these emissions are predicted to occur are shown in Table 7.2-49 and Volume 9, Appendix I, Section 3.4 Construction Activity Emissions. These emissions were further combined with those from other project components and discussed in Volume 7 to determine the potential impact significance.

Table 7.2-49. Estimated Construction Emission Burden – Apra Region, Alternative 2

	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*VOC*	*SO_2*	*CO_2*
Maximum Yearly Value (Tons)	13.5	20.9	5.0	3.7	1.2	15.4	4,199
Highest Monthly Emission Burden (Tons)	1.6	2.5	0.59	0.44	0.34	1.82	494
Average Daily Emission Burden (Based on Highest Month) (Tons)	0.08	0.12	0.03	.02	0.02	0.0.9	24.7
Year Highest Monthly Emission Burden Predicted to Occur	2011	2011	2011	2011	2011	2011	2011

<u>South</u>

Mobile Source Air Toxics

MSAT impacts would be the same as those for the North Region, Alternative 1.

Microscale CO Analysis

A screening analysis was performed to determine which intersections could potentially degrade air quality levels due to increased delay, volume, or worsening LOS due to the project. As detailed in Volume 9, Appendix I, Section 3.3.7.3 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 2, four locations were screened based on changes in intersection volumes, delay, and LOS between the no-action and build alternatives. Two of these locations failed the screening criteria. The Route 5/2A intersection has the highest overall volume and highest delay of all the signalized intersections that failed the screening. This site was chosen for detailed analysis. This intersection represents the worst-case combination of volumes, LOS, and delay of the intersections screened. As such, the predicted CO levels from this site represent the worst-case microscale CO impacts expected from the project.

The results of the microscale analysis are shown in Table 7.2-50 and Table 7.2-51 and are presented in Volume 9, Appendix I, Section 3.3.7.3 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 2. The values in these tables, using the same analysis techniques and parameters as those applied for the North Region (Alternative 1), represent the predicted worst-case CO concentrations. As shown in Table 7.2-50 and Table 7.2-51, no violations of the applicable NAAQS are predicted.

Table 7.2-50. Predicted Worst-Case 1-Hour CO Concentrations (ppm) – South, Alternative 2

Analysis Site	*Existing*		*2014*		*2030*	
	a.m.	*p.m.*	*a.m.*	*p.m.*	*a.m.*	*p.m.*
Route 5/2A	4.2	3.9	4.5	4.0	4.0	3.7

Notes: 1-hour CO NAAQS = 35 ppm.Includes a background concentration of 2 ppm.

Table 7.2-51. Predicted Worst-Case 8-Hour CO Concentrations (ppm) – South, Alternative 2

Analysis Site	*Existing*	*2014*	*2030*
Route 5/2A	2.9	3.2	2.8

Notes: 8-hour CO NAAQS = 9 ppm.Includes a background concentration of 1.4 ppm.

Construction Emissions Analysis

To determine the temporary air quality impacts arising from construction of the project, a detailed construction emissions analysis was conducted using the same method as described for the North Region (Alternative 1). As shown in Table 7.2-52 and Volume 9, Appendix I, Section 3.4 Construction Activity Emissions, construction emissions are negligible.

Table 7.2-52. Estimated Construction Emission Burden – South, Alternative 2

	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*VOC*	*SO_2*	*CO_2*
Maximum Yearly Value (Tons)	11.1	17.3	2.9	2.8	1.2	12.9	3310
Highest Monthly Emission Burden (Tons)	3.1	4.9	0.83	0.81	0.34	3.7	957
Average Daily Emission Burden (Based on Highest Month) (Tons)	0.16	0.25	0.04	0.04	0.02	0.18	47.8
Year Highest Monthly Emission Burden Predicted to Occur	2012	2013	2012 & 2013	2012 & 2013	2013	2013	2013

Potential Mitigation Measures

Because the alternative is not predicted to cause a significant impact on air quality levels, no mitigation is proposed.

7.2.6.3 Alternative 3

Mesoscale Emissions Burden

As shown in Table 7.2-53 and presented in Volume 9, Appendix I, Section 3.3.7.4 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 3, regional emissions are predicted to increase in the range of 20% to 23% under Alternative 3, as compared to the no-action alternative. This is primarily due to the estimated 20% increase in VMT under Alternative 3.

Table 7.2-53. Regional Annual Emission Burdens, Alternative 3

Scenario	VMT	Speed	Emission Burden (tpy)						
			CO	NOx	VOC	PM_{10}	$PM_{2.5}$	SO_2	CO_2
2030 No-Action Alternative	3,535,224	28.6	13,388	478	801	78	57	562	80,499
2030 Alternative 2	4,249,190	27.4	16,211	580	982	93	68	675	96,705
Net Change from No-Action			2,823	102	181	15	11	113	16,206
Percent Change from No-Action			21%	21%	23%	20%	20%	20%	20%

Legend: CO = carbon monoxide; VOC = volatile organic compounds; $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; PM_{10} = particulate matter less than 10 microns in diameter; tpy = tons per year; NOx = nitrogen oxides; VMT = vehicle miles traveled.

North

Mobile Source Air Toxics

FHWA requires quantitative emissions analysis for projects that involve new or additional capacity on roadways where the traffic volume would be 140,000 to 150,000 average annual daily traffic (AADT). The 2030 average daily traffic (ADT) estimates for the three most traveled roadways under Alternative 3 are shown in Table 7.2-54 and Volume 9, Appendix I, Section 3.3.7.4 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 3. Since the ADTs are less than 140,000 for the design year, a MSAT analysis is not required.

Table 7.2-54. Average Daily Traffic for Major Roadways, Alternative 3

Roadway	Alternative 3 No Build	Alternative 3 Build
Route 1	95,100	93,100
Route 8	59,000	60,400
Route 18	83,600	89,200

Microscale CO Analysis

A screening analysis was performed to determine which intersections could potentially degrade air quality levels due to increased delay, volume, or worsening LOS due to the project. As detailed in Volume 9, Appendix I, Section 3.3.7.4 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 3, 10 locations were screened based on changes in intersection volumes, delay, and LOS between the no-action and build alternatives. Nine of these locations failed the screening criteria. The Route 1/28 intersection has the highest overall volume of all the intersections that failed the screening. This site was chosen for detailed analysis. The Route 9/Andersen AFB North Gate intersection was also chosen for analysis due to the extremely high delay predicted in the build scenario and the predicted high volumes at this location. These intersections represent the worst-case combination of volumes, LOS, and delay of the intersections screened. As such, the predicted CO levels from these sites represent the worst-case microscale CO impacts expected from the project.

The results of the microscale analysis are shown in Table 7.2-55 and Table 7.2-56 and are presented in Volume 9, Appendix I, Section 3.3.7.4 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 3. The values in these tables, using the same analysis techniques and parameters as those applied for the North Region (Alternative 1), represent the predicted worst-case CO concentrations. As shown in Table 7.2-55 and Table 7.2-56, no violations of the applicable NAAQS are predicted.

Table 7.2-55. Predicted Worst-Case 1-Hour CO Concentrations (ppm) – North, Alternative 3

Analysis Site	Existing		2014		2030	
	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
Route 1/28	5.5	6.0	7.1	7.5	5.6	5.9
Route 9/Andersen AFB North Gate	2.3	2.3	2.7	3.3	2.9	2.8

Notes: 1-hour CO NAAQS = 35 ppm. Includes a background concentration of 2 ppm.

Table 7.2-56. Predicted Worst-Case 8-Hour CO Concentrations (ppm) – North, Alternative 3

Analysis Site	Existing	2014	2030
Route 1/28	4.2	5.3	4.1
Route 9/Andersen AFB North Gate	1.6	2.3	2.0

Notes: 8-hour CO NAAQS = 9 ppm. Includes a background concentration of 1.4 ppm.

Construction Emissions Analysis

To determine the temporary air quality impacts arising from construction of the project, a detailed construction emissions analysis was conducted using the same method as described for the North Region under Alternative 1. The highest predicted construction emissions per year, per month, and the year that these emissions are predicted to occur are shown in Table 7.2-57 and Volume 9, Appendix I, Section 3.4 Construction Activity Emissions.

Table 7.2-57. Estimated Construction Emission Burden – North, Alternative 3

	CO	NO_x	PM_{10}	$PM_{2.5}$	VOC	SO_2	CO_2
Maximum Yearly Value (Tons)	13.0	20.3	8.4	4.1	1.4	15.3	3,881
Highest Monthly Emission Burden (Tons)	4.7	7.3	1.8	1.3	0.51	5.4	1,462
Average Daily Emission Burden (Based on Highest Month) (Tons)	0.23	0.36	0.09	0.06	0.03	0.27	73.1
Year Highest Monthly Emission Burden Predicted to Occur	2011	2011	2011	2011	2011	2011	2011

Central

Mobile Source Air Toxics

MSAT impacts would be the same as those for the North Region under Alternative 1.

Microscale CO Analysis

A screening analysis was performed to determine which intersections could potentially degrade air quality levels due to increased delay, volume, or worsening LOS due to the project. As detailed in Volume 9, Appendix I, Section 3.3.7.4 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 3, 34 locations were screened based on changes in intersection volumes, delay, and LOS between the no-action and build alternatives. Twenty-eight of these locations failed the screening criteria. The Route 16/27 intersection has the highest overall volume of all the intersections that failed the screening. This site was chosen for detailed analysis. The Route 4/7A intersection has the highest overall delay of any signalized intersection that failed the screening. This site was chosen for detailed analysis. These intersections represent the worst-case combination of volumes, LOS, and delay of the intersections screened. As such, the predicted CO levels from these sites represent the worst-case microscale CO impacts expected from the project.

The results of the microscale analysis are shown in Table 7.2-58 and Table 7.2-59 and are presented in Volume 9, Appendix I, Section 3.3.7.4 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 3. The values in these tables, using the same analysis techniques and parameters as those applied for the North Region (Alternative 1), represent the predicted worst-case CO concentrations. As shown in Table 7.2-58 and Table 7.2-59 no violations of the applicable NAAQS are predicted.

Table 7.2-58. Predicted Worst-Case 1-Hour CO Concentrations (ppm) – Central, Alternative 3

Analysis Site	*Existing*		*2014*		*2030*	
	a.m.	*p.m.*	*a.m.*	*p.m.*	*a.m.*	*p.m.*
Route 1/8	6.0	6.4	7.3	7.6	6.2	6.4
Route 4/7A	5.3	3.8	5.1	5.6	4.6	5.1
Route 16/27	8.4	9.4	8.1	9.0	7.0	7.9

Notes: 1-hour CO NAAQS = 35 ppm. Includes a background concentration of 2 ppm.

Table 7.2-59. Predicted Worst-Case 8-Hour CO Concentrations (ppm) – Central, Alternative 3

Analysis Site	*Existing*	*2014*	*2030*
Route 1/8	4.5	5.3	4.5
Route 4/7A	3.7	3.9	3.6
Route 16/27	6.6	6.3	5.5

Notes: 8-hour CO NAAQS = 9 ppm. Includes a background concentration of 1.4 ppm.

Construction Emissions Analysis

To determine the temporary air quality impacts arising from construction of the project, a detailed construction emissions analysis was conducted using the same method as described for the North Region (Alternative 1). The highest predicted construction emissions per year, per month, and the year that these emissions are predicted to occur are shown in Table 7.2-60 and Volume 9, Appendix I, Section 3.4 Construction Activity Emissions.

Table 7.2-60. Estimated Construction Emission Burden – Central, Alternative 3

	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*VOC*	*SO_2*	*CO_2*
Maximum Yearly Value (Tons)	54.6	84.2	17.2	14.4	5.9	62.4	16,707
Highest Monthly Emission Burden (Tons)	8.5	13.1	2.2	2.2	0.9	9.7	2,590
Average Daily Emission Burden (Based on Highest Month) (Tons)	0.42	0.65	0.11	.11	0.05	0.48	129
Year(s) Highest Monthly Emission Burden Predicted to Occur	2012	2012 & 2013	2012 & 2013	2012 & 2013	2012 & 2013	2012 & 2013	2012 & 2013

Apra Harbor

Mobile Source Air Toxics

MSAT impacts would be the same as those for the North Region under Alternative 1.

Microscale CO Analysis

A screening analysis was performed to determine which intersections could potentially degrade air quality levels due to increased delay, volume, or worsening LOS due to the project. As detailed in Volume 9, Appendix I, Section 3.3.7.4 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 3, three locations were screened based on changes in intersection volumes, delay, and LOS between the no-action and build alternatives. One of these locations failed the screening criteria. The Route 1/2A intersection has the highest overall volume and highest delay of all the signalized intersections that failed the screening. This site was chosen for detailed analysis. This intersection represents the worst-case combination of volumes, LOS, and delay of the intersections screened. As such, the predicted CO levels from this site represent the worst-case microscale CO impacts expected from the project.

The results of the microscale analysis are shown in Table 7.2-61 and Table 7.2-62 and are presented in Volume 9, Appendix I, Section 3.3.7.4 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 3. The values in these tables, using the same analysis techniques and parameters as those applied for the North Region (Alternative 1), represent the predicted worst-case CO concentrations. As shown in Table 7.2-61 and Table 7.2-62 no violations of the applicable NAAQS are predicted.

Table 7.2-61. Predicted Worst-Case 1-Hour CO Concentrations (ppm) – Apra Harbor, Alternative 3

Analysis Site	*Existing*		*2014*		*2030*	
	a.m.	*p.m.*	*a.m.*	*p.m.*	*a.m.*	*p.m.*
Route 1/2A	4.7	4.3	5.3	5.1	4.3	3.8

Notes: 1-hour CO NAAQS = 35 ppm. Includes a background concentration of 2 ppm.

Table 7.2-62. Predicted Worst-Case 8-Hour CO Concentrations (ppm) – Apra Harbor, Alternative 3

Analysis Site	*Existing*	*2014*	*2030*
Route 1/2A	3.3	3.7	3.0

Notes: 8-hour CO NAAQS = 9 ppm. Includes a background concentration of 1.4 ppm.

Construction Emissions Analysis

To determine the temporary air quality impacts arising from construction of the project, a detailed construction emissions analysis was conducted using the same method as described for the North Region (Alternative 1). The highest predicted construction emissions per year, per month, and the year that these emissions are predicted to occur are shown in Table 7.2-63 and Volume 9, Appendix I, Section 3.4 Construction Activity Emissions.

Table 7.2-63. Estimated Construction Emission Burden – Apra Harbor, Alternative 3

	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*VOC*	*SO_2*	*CO_2*
Maximum Yearly Value (Tons)	13.5	20.9	5.0	3.7	1.2	15.4	4,199
Highest Monthly Emission Burden (Tons)	1.6	2.5	0.59	0.44	0.34	1.82	494

	CO	NO_x	PM_{10}	$PM_{2.5}$	*VOC*	SO_2	CO_2
Average Daily Emission Burden (Based on Highest Month) (Tons)	0.08	0.12	0.03	.02	0.02	0.0.9	24.7
Year Highest Monthly Emission Burden Predicted to Occur	2011	2011	2011	2011	2011	2011	2011

South

Mobile Source Air Toxics

MSAT impacts would be the same as those for the North Region under Alternative 1.

Microscale CO Analysis

A screening analysis was performed to determine which intersections could potentially degrade air quality levels due to increased delay, volume, or worsening LOS due to the project. As detailed in Volume 9, Appendix I, Section 3.3.7.4 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 3, four locations were screened based on changes in intersection volumes, delay, and LOS between the no-action and build alternatives. Two of these locations failed the screening criteria. The Route 5/2A intersection has the highest overall volume of all the signalized intersections that failed the screening. This site was chosen for detailed analysis. This intersection represents the worst-case combination of volumes, LOS, and delay of the intersections screened. As such, the predicted CO levels from this site represent the worst-case microscale CO impacts expected from the project.

The results of the microscale analysis are shown in Table 7.2-64 and Table 7.2-65 and are presented in Volume 9, Appendix I, Section 3.3.7.4 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 3. The values in these tables, using the same analysis techniques and parameters as those applied for the North Region (Alternative 1), represent the predicted worst-case CO concentrations As shown in Table 7.2-64 and Table 7.2-65, no violations of the applicable NAAQS are predicted.

Table 7.2-64. Predicted Worst-Case 1-Hour CO Concentrations (ppm) – South, Alternative 3

Analysis Site	*Existing*		*2014*		*2030*	
	a.m.	*p.m.*	*a.m.*	*p.m.*	*a.m.*	*p.m.*
Route 5/2A	4.2	3.9	4.5	3.9	3.8	3.5

Notes: 1-hour CO NAAQS = 35 ppm. Includes a background concentration of 2 ppm.

Table 7.2-65. Predicted Worst-Case 8-Hour CO Concentrations (ppm) – South, Alternative 3

Analysis Site	*Existing*	*2014*	*2030*
Route 5/2A	2.9	3.2	2.7

Notes: 8-hour CO NAAQS = 9 ppm. Includes a background concentration of 1.4 ppm.

Construction Emissions Analysis

To determine the temporary air quality impacts arising from construction of the project, a detailed construction emissions analysis was conducted using the same method as described for the North Region (Alternative 1). As shown in Table 7.2-66 and Volume 9, Appendix I, Section 3.4 Construction Activity

Emissions, construction emissions are negligible.

Table 7.2-66. Estimated Construction Emission Burden – South, Alternative 3

	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*VOC*	*SO_2*	*CO_2*
Maximum Yearly Value (Tons)	11.1	17.3	2.9	2.8	1.2	12.9	3310
Highest Monthly Emission Burden (Tons)	3.1	4.9	0.83	0.81	0.34	3.7	957
Average Daily Emission Burden (Based on Highest Month) (Tons)	0.16	0.25	0.04	0.04	0.02	0.18	47.8
Year(s) Highest Monthly Emission Burden Predicted to Occur	2012	2013	2012 & 2013	2012 & 2013	2013	2013	2013

Potential Mitigation Measures

Because the alternative is not predicted to cause a significant impact on air quality levels, no mitigation is proposed.

7.2.6.4 Alternative 8

Mesoscale Emissions Burden

As shown in Table 7.2-67 and Volume 9, Appendix I, Section 3.3.7.5 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 8 regional emissions are predicted to increase in the range of 19% to 21% under Alternative 8, as compared to the no-action alternative. This is primarily due to the estimated 20% increase in VMT under Alternative 8.

Table 7.2-67. Regional Annual Emission Burdens, Alternative 8

Scenario	*VMT*	*Speed*	*Emission Burden (tpy)*						
			CO	*NO_x*	*VOC*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*CO_2*
2030 No-Action Alternative	3,535,224	28.6	13,388	478	801	78	57	562	80,499
2030 Alternative 8	4,247,334	28.0	16,143	578	971	93	68	675	96,662
Net Change from No-Action			2,755	100	170	15	11	113	16,163
Percent Change from No-Action			21%	21%	21%	19%	19%	20%	20%

Legend: CO = carbon monoxide; VOC = volatile organic compounds; $PM_{2.5}$ = particulate matter less than 2.5 microns in diameter; PM_{10} = particulate matter less than 10 microns in diameter; tpy = tons per year; NOx = nitrogen oxides;
VMT = vehicle miles traveled.

North

Mobile Source Air Toxics

FHWA requires quantitative emissions analysis for projects that involve new or additional capacity on roadways where the traffic volume would be 140,000 to 150,000 average annual daily traffic (AADT). The 2030 average daily traffic (ADT) estimates for the three most traveled roadways under Alternative 8 are shown in Table 7.2-68 and Volume 9, Appendix I, Section 3.3.7.5 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 8. Since the ADTs are less than 140,000 for the design year, a MSAT analysis is not required.

Table 7.2-68. Average Daily Traffic for Major Roadways, Alternative 8

Roadway	Alternative 8 No Build	Alternative 8 Build
Route 1	96,100	95,300
Route 8	58,800	59,700
Route 18	75,100	75,100

Microscale CO Analysis

A screening analysis was performed to determine which intersections could potentially degrade air quality levels due to increased delay, volume, or worsening LOS due to the project. As detailed in Volume 9, Appendix I, Section 3.3.7.5 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 8, 10 locations were screened based on changes in intersection volumes, delay, and LOS between the no-action and build alternatives. Five of these locations failed the screening criteria. The Route 1/28 intersection has the highest overall volume of all the intersections that failed the screening. This site was chosen for detailed analysis. The Route 9/Andersen AFB North Gate intersection was also chosen for analysis due to the extremely high delay predicted in the build scenario and the predicted high volumes at this location. These intersections represent the worst-case combination of volumes, LOS, and delay of the intersections screened. As such, the predicted CO levels from these sites represent the worst-case microscale CO impacts expected from the project.

The results of the microscale analysis are shown in Table 7.2-69 and Table 7.2-70 and are presented in Volume 9, Appendix I, Section 3.3.7.5 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 8. The values in these tables, using the same analysis techniques and parameters as those applied for the North Region (Alternative 1), represent the predicted worst-case CO concentrations. As shown in Table 7.2-69 and Table 7.2-70, no violations of the applicable NAAQS are predicted.

Table 7.2-69. Predicted Worst-Case 1-Hour CO Concentrations (ppm) – North, Alternative 8

Analysis Site	Existing		2014		203	
	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
Route 1/28	5.5	6.0	7.1	7.4	5.8	5.7
Route 9/Andersen AFB North Gate	2.3	2.3	2.6	3.1	2.9	2.8

Notes: 1-hour CO NAAQS = 35 ppm. Includes a background concentration of 2 ppm.

Table 7.2-70. Predicted Worst-Case 8-Hour CO Concentrations (ppm) – North, Alternative 8

Analysis Site	Existing	2014	2030
Route 1/28	4.2	5.2	4.1
Route 9/Andersen AFB North Gate	1.6	2.2	2.0

Notes: 8-hour CO NAAQS = 9 ppm. Includes a background concentration of 1.4 ppm.

Construction Emissions Analysis

To determine the temporary air quality impacts arising from construction of the project, a detailed construction emissions analysis was conducted. Using the estimated project schedule along with typical equipment requirements for specific tasks, emission burden estimates of CO, NO_x, PM_{10}, and $PM_{2.5}$ were calculated. Equipment emissions were presumed to be Tier 3, with high sulfur fuel as confirmed by the construction management team. Based on the preliminary schedule, the highest emissions per year, per month, and the year that these emissions are predicted to occur are shown in Table 7.2-71 and Volume 9,

Appendix I, Section 3.4 Construction Activity Emissions

Table 7.2-71. Estimated Construction Emission Burden – North, Alternative 8

	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*VOC*	*SO_2*	*CO_2*
Maximum Yearly Value (Tons)	13.0	20.3	8.4	4.1	1.4	15.3	3,881
Highest Monthly Emission Burden (Tons)	4.7	7.3	1.8	1.3	0.51	5.4	1,462
Average Daily Emission Burden (Based on Highest Month) (Tons)	0.23	0.36	0.09	0.06	0.03	0.27	73.1
Year Highest Monthly Emission Burden Predicted to Occur	2011	2011	2011	2011	2011	2011	2011

Central

Mobile Source Air Toxics

MSAT impacts would be the same as those for the North Region.

Microscale CO Analysis

A screening analysis was performed to determine which intersections could potentially degrade air quality levels due to increased delay, volume, or worsening LOS due to the project. As detailed in Volume 9, Appendix I, Section 3.3.7.5 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 8, 34 locations were screened based on changes in intersection volumes, delay, and LOS between the no-action and build alternatives. Twenty of these locations failed the screening criteria. The Route 16/27 intersection has the third highest overall volume and the worst delay of the three highest volume intersections. This site was chosen for detailed analysis. The Route 4/7A intersection has the highest overall delay of any signalized intersection that failed the screening. This site was chosen for detailed analysis. These intersections represent the worst-case combination of volumes, LOS, and delay of the intersections screened. As such, the predicted CO levels from these sites represent the worst-case microscale CO impacts expected from the project.

The results of the microscale analysis are shown in Table 7.2-72 and Table 7.2-73 and are presented in Volume 9, Appendix I, Section 3.3.7.5 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 8. The values in these tables, using the same analysis techniques and parameters as those applied for the North Region (Alternative 1), represent the predicted worst-case CO concentrations. As shown in in Table 7.2-72 and Table 7.2-73, no violations of the applicable NAAQS are predicted.

Table 7.2-72. Predicted Worst-Case 1-Hour CO Concentrations (ppm) – Central, Alternative 8

Analysis Site	*Existing*		*2014*		*2030*	
	a.m.	*p.m.*	*a.m.*	*p.m.*	*a.m.*	*p.m.*
Route 1/8	6.0	6.4	7.3	7.4	5.6	6.0
Route 4/7A	5.3	3.8	5.2	5.3	4.6	5.0
Route 16/27	8.4	9.4	8.3	9.4	7.1	8.0

Notes: 1-hour CO NAAQS = 35 ppm. Includes a background concentration of 2 ppm.

Table 7.2-73. Predicted Worst-Case 8-Hour CO Concentrations (ppm) – Central, Alternative 8

Analysis Site	*Existing*	*2014*	*2030*
Route 1/8	4.5	5.2	4.2
Route 4/7A	3.7	3.7	3.5
Route 16/27	6.6	6.6	5.6

Notes: 8-hour CO NAAQS = 9 ppm. Includes a background concentration of 1.4 ppm.

Construction Emissions Analysis

To determine the temporary air quality impacts arising from construction of the project, a detailed construction emissions analysis was conducted using the same method as described for the North Region (Alternative 1). The highest predicted construction emissions per year, per month, and the year that these emissions are predicted to occur are shown in Table 7.2-74 and Volume 9, Appendix I, Section 3.4 Construction Activity Emissions.

Table 7.2-74. Estimated Construction Emission Burden – Central, Alternative 8

	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*VOC*	*SO_2*	*CO_2*
Maximum Yearly Value (Tons)	54.6	84.2	17.2	14.4	5.9	62.4	16,707
Highest Monthly Emission Burden (Tons)	8.5	13.1	2.2	2.2	0.9	9.7	2,590
Average Daily Emission Burden (Based on Highest Month) (Tons)	0.42	0.65	0.11	.11	0.05	0.48	129
Year Highest Monthly Emission Burden Predicted to Occur	2012	2012 & 2013	2012 & 2013	2012 & 2013	2012 & 2013	2012 & 2013	2012 & 2013

Apra Harbor

Mobile Source Air Toxics

MSAT impacts would be the same as those for the North Region.

Microscale CO Analysis

A screening analysis was performed to determine which intersections could potentially degrade air quality levels due to increased delay, volume, or worsening LOS due to the project. As detailed in Volume 9, Appendix I, Section 3.3.7.5 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 8, three locations were screened based on changes in intersection volumes, delay, and LOS between the no-action and build alternatives. One of these locations failed the screening criteria. The Route 1/2A intersection has the highest overall volume and highest delay of all the signalized intersections that failed the screening. This site was chosen for detailed analysis. This intersection represents the worst-case combination of volumes, LOS, and delay of the intersections screened. As such, the predicted CO levels from this site represent the worst-case microscale CO impacts expected from the project.

The results of the microscale analysis are shown in Table 7.2-75 and Table 7.2-76 and are presented in Volume 9, Appendix I, Section 3.3.7.5 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 8. The values in these tables, using the same analysis techniques and parameters as those applied for the North Region (Alternative 1), represent the predicted worst-case CO concentrations. As shown in Table 7.2-75 and Table 7.2-76, no violations of the applicable NAAQS are predicted.

Table 7.2-75. Predicted Worst-Case 1-Hour CO Concentrations (ppm) – Apra Harbor, Alternative 8

Analysis Site	Existing		2014		2030	
	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
Route 1/2A	4.7	4.3	5.3	5.1	4.3	3.9

Notes: 1-hour CO NAAQS = 35 ppm. Includes a background concentration of 2 ppm.

Table 7.2-76. Predicted Worst-Case 8-Hour CO Concentrations (ppm) – Apra Harbor, Alternative 8

Analysis Site	Existing	2014	2030
Route 1/2A	3.3	3.7	3.0

Notes: 8-hour CO NAAQS = 9 ppm. Includes a background concentration of 1.4 ppm.

Construction Emissions Analysis

To determine the temporary air quality impacts arising from construction of the project, a detailed construction emissions analysis was conducted using the same method as described for the North Region (Alternative 1). The highest predicted construction emissions per year, per month, and the year that these emissions are predicted to occur are shown in Table 7.2-77 and Volume 9, Appendix I, Section 3.4 Construction Activity Emissions.

Table 7.2-77. Estimated Construction Emission Burden – Apra Harbor, Alternative 8

	CO	NO_x	PM_{10}	$PM_{2.5}$	VOC	SO_2	CO_2
Maximum Yearly Value (Tons)	13.5	20.9	5.0	3.7	1.2	15.4	4,199
Highest Monthly Emission Burden (Tons)	1.6	2.5	0.59	0.44	0.34	1.82	494
Average Daily Emission Burden (Based on Highest Month) (Tons)	0.08	0.12	0.03	.02	0.02	0.0.9	24.7
Year Highest Monthly Emission Burden Predicted to Occur	2011	2011	2011	2011	2011	2011	2011

South

Mobile Source Air Toxics

MSAT impacts would be the same as those for the North Region.

Microscale CO Analysis

A screening analysis was performed to determine which intersections could potentially degrade air quality levels due to increased delay, volume, or worsening LOS due to the project. As detailed in and Volume 9, Appendix I, Section 3.3.7.5 Off Base On-road Vehicle Operational Emissions and Impact for Alternative 8 four locations were screened based on changes in intersection volumes, delay, and LOS between the no-action and build alternatives. One of these locations failed the screening criteria. The Route 5/2A intersection has the highest overall volume of all the signalized intersections that failed the screening. This site was chosen for detailed analysis. This intersection represents the worst-case combination of volumes, LOS, and delay of the intersections screened. As such, the predicted CO levels from this site represent the worst-case microscale CO impacts expected from the project.

The results of the microscale analysis are shown in Table 7.2-78 and Table 7.2-79 and are presented in Volume 9, Appendix I, Section 3.3.7.5 Off Base On-road Vehicle Operational Emissions and Impact for

Alternative 8. The values in these tables, using the same analysis techniques and parameters as those applied for the North Region (Alternative 1), represent the predicted worst-case CO concentrations. As shown in Table 7.2-78 and Table 7.2-79 no violations of the applicable NAAQS are predicted.

Table 7.2-78. Predicted Worst-Case 1-Hour CO Concentrations (ppm) – South Region, Alternative 8

Analysis Site	*Existing*		*2014*		*2030*	
	a.m.	*p.m.*	*a.m.*	*p.m.*	*a.m.*	*p.m.*
Route 5/2A	4.2	3.9	4.5	4.0	3.9	3.7

Notes: 1-hour CO NAAQS = 35 ppm. Includes a background concentration of 2 ppm.

Table 7.2-79. Predicted Worst-Case 8-Hour CO Concentrations (ppm) – South Region, Alternative 8

Analysis Site	*Existing*	*2014*	*2030*
Route 5/2A	2.9	3.2	2.7

Notes: 8-hour CO NAAQS = 9 ppm. Includes a background concentration of 1.4 ppm.

Construction Emissions Analysis

To determine the temporary air quality impacts arising from construction of the project, a detailed emission construction analysis was conducted using the same method as described for the North Region (Alternative 1). As shown in Table 7.2-80 and Volume 9, Appendix I, Section 3.4 Construction Activity Emissions, construction emissions are negligible.

Table 7.2-80. Estimated Construction Emission Burden – South, Alternative 8

	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*VOC*	*SO_2*	*CO_2*
Maximum Yearly Value (Tons)	11.1	17.3	2.9	2.8	1.2	12.9	3310
Highest Monthly Emission Burden (Tons)	3.1	4.9	0.83	0.81	0.34	3.7	957
Average Daily Emission Burden (Based on Highest Month) (Tons)	0.16	0.25	0.04	0.04	0.02	0.18	47.8
Year Highest Monthly Emission Burden Predicted to Occur	2012	2013	2012 & 2013	2012 & 2013	2013	2013	2013

Potential Mitigation Measures

Because the alternative is not predicted to cause a significant impact on air quality levels, no mitigation is proposed.

7.2.6.5 Summary of Impacts

Table 7.2-81 summarizes the potential air quality impacts associated with each of the roadway project alternatives.

Construction activities for all alternatives would result in less than a significant impact to air quality resources because the roadway construction associated emissions were predicted to be below the significance criterion of 250 TPY.

The proposed project would increase regional operation VMT by approximately 18% to 20%, compared to the no-action alternative. This would increase regional pollutant levels (i.e., CO, HC, PM_{10}, $PM_{2.5}$,

NO_x) under the build alternatives by approximately 18% to 23%. However, the predicted operational emissions would be below the significance criteria of 250 TPY with an exception of CO under each alternative. However, since the 250 TPY threshold is selected in the context of the *de minimis* threshold established in the CAA general conformity rule providing only an indication of potential significant impact, a formal impact analysis was conducted with respect toe potenital CO impact. Based on a refined CO concentration modeling analysis for on road vehicle operational impact described in this volume, no exceedances of the CO NAAQS were predicted at the location of anticipated highest emissions. Therefore, each proposed alternative would not result in a significant CO impact even though the regional emissions would exceed 250 TPY. Consequently, the proposed alternatives would result in a less than significant impact on air quality.

MSAT levels are also predicted to increase under the build alternatives compared to the no-action alternative. However, given future reductions in overall MSAT levels due to USEPA-mandated regulations, projected MSAT levels, even with the predicted VMT increases under the build alternatives, are expected to be lower than they are today and would result in a less than significant MSAT impact.

Table 7.2-81. Summary of Potential Impacts to Air Quality -Roadway Projects

Potentially Impacted Resource	*Alternative 1*	*Alternative 2*	*Alternative 3*	*Alternative 8*
Regional Air Quality	LSI	LSI	LSI	LSI
Mobile Source Air Toxics	LSI	LSI	LSI	LSI
Local Carbon Monoxide Levels	LSI	LSI	LSI	LSI
Air Quality during Construction	LSI	LSI	LSI	LSI

Legend: LSI = Less than significant impact.

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CHAPTER 8. NOISE

8.1 INTRODUCTION

This chapter describes the potential traffic noise-related consequences associated with implementation of the alternatives. Refer to the respective chapters of Volume 2 (Marine Corps Relocation – Guam) for a description of the affected environment for all resources. The locations described in that volume include the region of influence (ROI) for the utilities and off base roadway projects component of the proposed action. Analysis on long-term alternatives was not done because those alternatives are not yet ripe for project specific analysis.

8.2 ENVIRONMENTAL CONSEQUENCES

8.2.1 Approach to Analysis

Potential sound-generating events associated with the proposed action were identified and the potential sound levels that could result from these activities were estimated on the basis of published military information on sound sources. These estimated sound levels were reviewed to determine if they would represent a significant increase in the current ambient sound level, would have an adverse impact on a substantial population of sensitive receptors, or would be inconsistent with any relevant and applicable standards. Detailed descriptions of activities and analysis of noise resulting from them are provided in their respective chapters.

8.2.1.1 Methodology

Utilities

Construction

Construction noise is generated by the use of heavy equipment on job sites and Table 8.2-1 provides a list of representative samples of construction equipment and associated noise levels. Impact devices typically generate more noise than non-impact devices. Acoustical Usage Factor refers to the percentage of time the equipment is running at full power on the job site. The Federal Highway Administration (FHWA) published a Roadway Construction Noise Model to predict noise levels adjusted from empirical data for construction operations to the actual distance of a receptor.

Table 8.2-1. Samples of Construction Noise Equipment

Equipment Description	*Impact Device[1]*	*Acoustical Usage Factor[2] (%)*	*Actual Measured Lmax @ 50 feet[3] (dBA, slow) (Samples Averaged)*	*Number of Actual Data Samples[4] (Count)*
All Other Equipment > 5 HP	No	50	N/A	0
Backhoe	No	40	78	372
Clam Shovel (dropping)	Yes	20	87	4
Compactor (ground)	No	20	83	57
Compressor (air)	No	40	78	18
Concrete Mixer Truck	No	40	79	40
Concrete Saw	No	20	90	55
Crane	No	16	81	405
Dozer	No	40	82	55

Equipment Description	*Impact Device*[1]	*Acoustical Usage Factor*[2] *(%)*	*Actual Measured Lmax @ 50 feet*[3] *(dBA, slow) (Samples Averaged)*	*Number of Actual Data Samples*[4] *(Count)*
Dump Truck	No	40	76	31
Excavator	No	40	81	170
Front End Loader	No	40	79	96
Generator	No	50	81	19
Grader	No	40	N/A	0
Impact Pile Driver	Yes	20	101	11
Jackhammer	Yes	20	89	133
Pavement Scarifier	No	20	90	2
Paver	No	50	77	9
Pneumatic Tools	No	50	85	90
Roller	No	20	80	16
Scraper	No	40	84	12
Tractor	No	40	N/A	0
Vibratory Pile Driver	No	20	101	44

Notes: [1] Indication whether or not the equipment is an impact device.
[2] The acoustical usage factor refers to the percentage of time the equipment is running at full power on the job site and is assumed at a typical construction site for modeling purposes.
[3] The measured "Actual" emission level at 50 feet for each piece of equipment based on hundreds of emission measurements performed on Central Artery/Tunnel, Boston MA work sites.
[4] The number of samples that were averaged together to compute the "Actual" emission level.
Source: U.S. Department of Transportation (DOT) 2006.

Maximum sound levels expressed as L_{max} is the greatest sound pressure level generated by the source. Another way of describing fluctuating sound is to describe the fluctuating sound heard over specific periods as if it had been a steady, unchanging sound. For this condition, the “equivalent sound level” (L_{eq},) can be computed. L_{eq} is the constant sound level that, in a given situation and period (e.g., 1 hour, denoted by $L_{eq}(1)$, or 24 hours, denoted as $L_{eq}(24)$), conveys the same sound energy as the actual time-varying sound. Sound pressure levels reported in this chapter are L_{max} and one hour L_{eq}.

The decibel (dB) level of a sound decreases (or attenuates) exponentially as the distance from the source increases. For a single point source, like a construction bulldozer, the sound level decreases by approximately 6 decibels for each doubling of distance from the source. Sound that originates from a linear, or 'line' source, such as a passing aircraft, attenuates by about 3 decibels for each doubling of distance where no other features such as vegetation, topography, or walls absorb or deflect the sound. Depending upon their nature, such features can range from minimal to substantial ability to reduce noise levels.

Operational Noise

Operational noise associated with utility and roadway projects would be noise levels for operating conditions of power generation facilities, water treatment facilities, wastewater facilities, and landfills. Operational roadway noise would be due to the traffic on the roadways. FHWA has prepared a traffic study and road traffic noise is included in Volume 2 Section 6.2. Power transmission lines carrying high voltage can make a buzzing noise, but generally at low levels and is not discussed further in this EIS/OEIS.

Off Base Roadways

Noise analysis for the proposed roadway improvement projects is performed following FHWA procedures outlined in 23 *Code of Federal Regulations* 772 and Guam Department of Public Works (DPW) Traffic Noise Abatement Policy. The following paragraphs provide a brief description of:

- noise characteristics
- applicable policies on noise within the Island of Guam
- noise modeling procedures performed as part of the noise analysis

As required by FHWA, the noise analysis presented in this section includes year 2030 no-action alternative, Alternatives 1, 2, 3, and 8 traffic noise level predictions, noise impact evaluation, and noise abatement for primary noise sources in the project study area resulting from local traffic.

Noise Characteristics

Sound is a disturbance created by a moving or vibrating source in a gaseous or liquid medium or the elastic stage of a solid, and it is capable of being detected by the hearing organs. Noise is defined as unwanted sound. It is emitted from many sources, including airplanes, factories, railroads, power generation plants, and highway vehicles. Highway noise or traffic noise is usually a composite of noise from engine, exhaust, and tire-roadway interaction. The magnitude of noise is usually described by its sound pressure. Because the range of sound pressure varies greatly, the logarithmic scale dB is used to relate sound pressure. Sound pressures described in decibels are often defined in terms of frequency-weighted scales (i.e., A, B, C, or D). The A-weighted decibel (dBA) scale is used in vehicle noise measurements because it reflects the frequency range to which the human ear is most sensitive (i.e., 500 to 6,000 Hertz). Sound measured using an A-weighted decibel scale is generally expressed as dBA. Throughout this chapter, all noise levels are expressed in dBAs. Several examples of sound pressure levels in dBA scale are listed in Figure 8.2-1. The degree of disturbance or annoyance of unwanted sound depends essentially on three factors:

- The amount and nature of the intruding noise
- The relationship between background noise and the intruding noise
- The type of activity occurring where the noise is heard

Because sound is described in a logarithmic scale, sound levels cannot be added by ordinary arithmetic means. In fact, a doubling of the sound energy produces only a 3-dBA increase in the decibel level. Studies have shown that this increase is barely perceptible to the human ear, whereas a change of 5 dBA is readily perceptible. As a general rule, an increase or decrease of 10 dBA in sound level is perceived by an observer to be a doubling or halving of the sound, respectively.

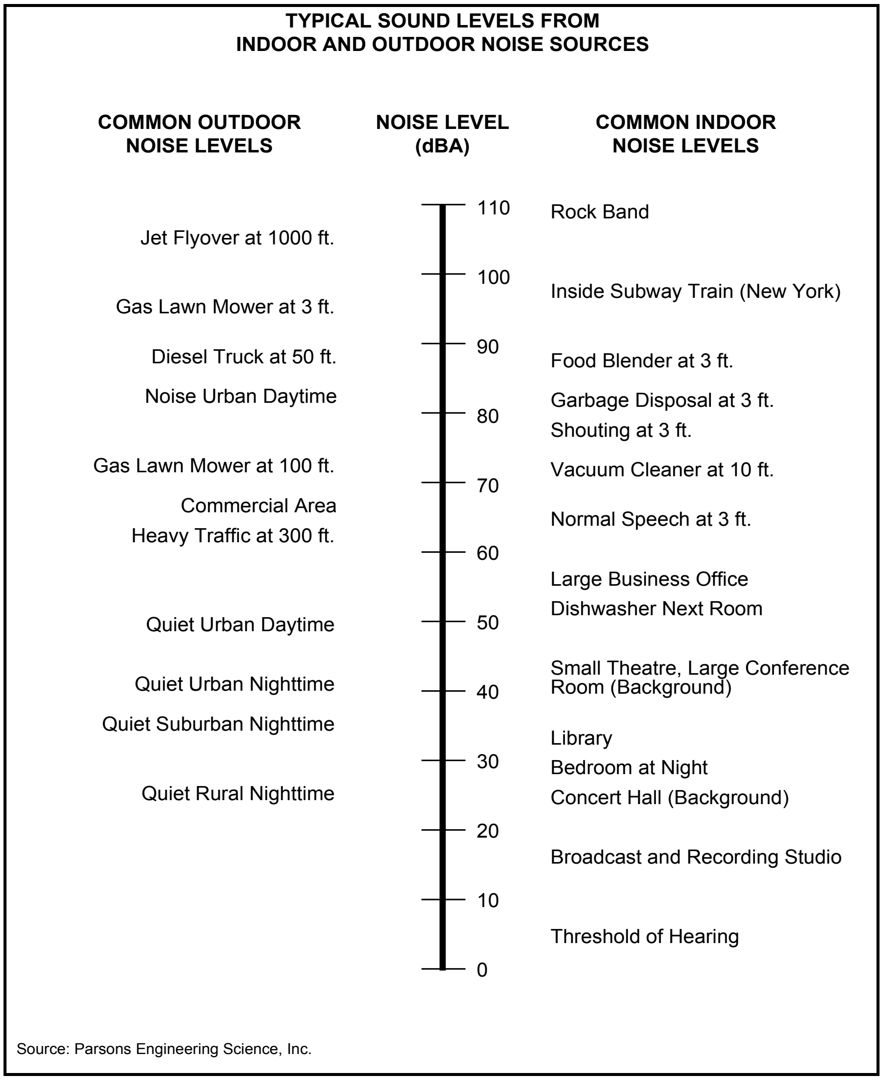

Figure 8.2-1. Typical A-Weighted Noise Levels

Decibels measure sound levels at just one moment, and since very few sounds are constant in nature, other ways of describing sound over more extended periods have been developed. One way of describing fluctuating sound is to describe the fluctuating sound heard over specific periods, as if it had been a steady, unchanging sound. For this condition, a descriptor called the "equivalent sound level," L_{eq}, can be computed. L_{eq} is the constant sound level that, in a given situation and period (e.g., 1-hour, denoted by $L_{eq(1)}$, or 24 hours, denoted as $L_{eq(24)}$), conveys the same sound energy as the actual time-varying sound. All sound pressure levels reported in this chapter would be $L_{eq(1)}$.

Noise Model

The FHWA Traffic Noise Model version 2.5 was used for the noise computations (FHWA 2004). Traffic Noise Model input data is based on a three-dimensional model created for the terrain of the study area being modeled. All roadway, barrier, and receiver points are defined by their x, y, and z coordinates. Roadways and barriers are coded into Traffic Noise Model as line segments defined by their end points. Receptors, defined as single points in an array perpendicular to the alignment for each Guam Road Network (GRN), were used to determine the distance from the alignment center line at which the future traffic-generated noise for different alternatives could impact a noise-sensitive receiver. Receivers were modeled at a height of 5 feet (ft) (2 meters [m]) above ground elevation. After noise impacts were determined, mitigation analysis was completed by adding an array of receptors parallel to alignment for noise impacted areas that were determined to be feasible for mitigation.

Morning and evening (a.m. and p.m.) peak-hour traffic volumes were used in the noise model; however, for most of the modeled cases, the p.m. peak traffic volumes were used because the future peak afternoon traffic volumes are typically larger than the future traffic volumes for the morning. Where future traffic peak-hour traffic volumes were Level of Service (LOS) D or worse, LOS C was used to represent the worst-case future noise condition because highest traffic noise levels occur when traffic is heavy, but remains free-flowing. Studies have demonstrated that high LOS C or low LOS D volumes and related speeds create the highest traffic noise levels. While normal stop-and-go situations at intersections could generate localized instantaneous elevated noise levels, noise impacts are determined from the average hourly noise levels. Stop-and-go conditions near intersections produce lower traffic noise levels than similar conditions in congested peak hour traffic (i.e., free flowing traffic results in higher noise levels than at intersections). Volumes and speeds used in the traffic analysis represent the highest traffic noise levels associated with each roadway.

8.2.1.2 Determination of Significance

Noise impacts result from perceptible changes in the overall noise environment that increase annoyance or affect human health. Annoyance is a subjective impression of noise and is subject to both physical and emotional variables. To increase annoyance, the cumulative noise energy must increase measurably. Human health effects such as hearing loss and noise-related awakenings can result from noise. For this EIS, noise is evaluated for both construction and operational activities. It is not anticipated that maintenance activities would noticeably contribute to the noise environment due to their intermittent nature and short duration. The threshold level of significant impacts for noise is:

- Facility Construction noise resulting in an hourly equivalent sound level of 75 dBA (based on U.S. Environmental Protection Agency (USEPA) data for construction noise) at a sensitive receptor (such noise exposure would be equivalent to noise Zone III) or consistent exposure to noise levels at 85 dBA, over an 8-hour period, the National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit.
- Road construction noise uses a significance threshold based on Federal Transit Authority guidelines of 80 dBA during daylight hours and 70 dBA during nighttime (10 p.m. to 7 a.m.). This differs from facility construction thresholds because facility construction is concentrated at the same location and typically last for longer durations. In contrast, road construction proceeds along the road alignment and sensitive receptors are affected for shorter durations.

For road traffic noise, federal and Guam regulations, standards, and policies relating to traffic noise are discussed in detail in the Guam Department of Public Works Traffic Noise Abatement Policy. The following is a brief discussion of Guam regulations, standards, and policies.

<u>Guam Department of Public Works Traffic Noise Abatement Policy</u>

The purpose of this Traffic Noise Abatement Policy is to protect the public from traffic noise associated with highways and maintain quality of life of the public by setting forth methods to: (a) identify potential noise-sensitive areas; (b) provide the basis for uniformity in analysis of traffic noise; and (c) determine feasibility and reasonableness of noise abatement measures. This policy adopted by the Guam DPW is in reference to the currently accepted practices and procedures used by FHWA to assess highway-related traffic noise levels.

The Traffic Noise Abatement Policy has seven sections: Introduction, Definitions, Noise Abatement Criteria, Noise Impact Determination, Feasibility and Reasonableness of Abatement, Noise Abatement Implementation and Public Involvement, and Extenuating Circumstances.

Under the Guam DPW policy, future traffic noise levels would be considered as posing an impact, if any noise sensitive receiver that has a loudest hourly noise level $L_{eq(h)}$ approaching (within 1 dB) or exceeding the noise abatement criteria (NAC) as summarized in Table 8.2-2 for the corresponding land use category, or exceeding existing noise levels by 12 dB.

Table 8.2-2. Activity Categories and Noise Abatement Criteria

Activity Category	*$L_{eq(h)}$ dBA*	*Description of Activity Category*
A	57 (Exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, places of worship, libraries, and hospitals.
C	72 (Exterior)	Developed lands, properties, or activities not included in Categories A or B above.
D	--	Undeveloped lands.
E	52 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

When potential impacts are identified, Guam DPW would consider noise abatement measures and make a determination regarding the feasibility and reasonableness of such measures. Guam DPW policies provide that only abatement measures that have been determined to be feasible and reasonable would be incorporated in projects. Feasibility depends primarily on engineering considerations, such as the local topography, safety, road maintenance requirements, or the ability to achieve at least a 5 dBA reduction in noise at an impacted receptor. Findings based upon common sense and good judgment should be cited in the determination of reasonableness. Factors such as the ability to achieve at least a 5 dBA reduction in noise for at least one first row receptor, the number of receptors that would benefit from the noise barrier, the cost of the noise barrier per benefited receptor (with a maximum allowance of $35,000 per benefited receptor), neighborhood opinions, and environmental effects are considered when determining reasonableness. Each benefited nonresidential receptor, such as schools, parks, and cemeteries, would be counted as one benefited residential receptor per 100 ft (30 m) of frontage outdoor land use along the roadway. A memo disseminated by FHWA in 1995 added cemeteries to NAC Category B (FHWA 1995). Guam DPW coordinates with local governments to support compatible land use development. Guam DPW would identify noise receptors within project corridors that are on or along developed land. Guam DPW would also identify noise receptors on undeveloped land for which development is planned, provided such development includes activity sites of the types described in the NAC and provided that local permits for the development have been acquired or applied for on or before commencement of the noise analysis. Guam DPW would furnish the results of highway traffic noise analyses to local government officials and would encourage local communities and developers to practice noise-compatible development. Local government coordination would be accomplished through the distribution of highway project environmental documents and noise study reports.

The significance criteria expressed in this section applies to human receptors, but noise could also affect biological resources, land use and cultural resources. Please refer to specific resource sections for details about the noise impacts to biological resources and other resources.

8.2.1.3 Issues Identified During Public Scoping

The Scoping Summary Meeting Report did not specifically mention public concerns, about increased noise pollution due to the proposed action for the utility and roadway construction.

8.2.2 Power

8.2.2.1 Interim Alternative 1 (Preferred Alternative)

Interim Alternative 1 would recondition existing combustion turbines and upgrade T&D systems and would not require new construction at or enlargement of the existing footprint of the facility. This work would be undertaken by the GPA on its existing permitted facilities. Reconditioning would be made to existing permitted facilities at the Marbo, Yigo, Dededo No. 1, and Macheche combustion turbines. These combustion turbines are not currently being used up to permit limits. T&D system upgrades would be on existing above ground and underground transmission lines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Construction

The only construction activities associated with this alternative would be in installation of transmission lines. Power transmission line installation typically does not involve a concentration of heavy equipment. Specifically, for overhead transmission line upgrades there is usually a grader for site preparation, concrete work for foundations, and a crane for tower installation. The footprint of transmission towers are usually small and the equipment would not remain in place for long periods of time. Therefore, there are less than significant noise impacts because the construction of transmission lines is expected to be minimal and very short-term.

Some of the transmission lines will be installed underground. Construction equipment associated with installing underground utilities primarily include backhoes and trenchers for digging the trench and backhoes, pavers and rollers for refilling and finishing the surface creating noise levels of about 80 dBA at 50 ft (15 m) from the source attenuating to 68 dBA L_{eq} at 250 ft (76 m). Installation of transmission lines involves excavating a portion of the trench, installing a segment of the line, and backfilling the trench. Usually this occurs in segments anywhere from 100 ft (31 m) to 1,000 ft (305 m) or more and the activities move relatively rapidly along the corridor, thus not impacting any single receptor for much more than a couple of days. Therefore impacts would be considered less than significant.

Operation

Combustion turbines generate noise similar to jet aircraft engines, but sound generation can be controlled by the facility since the turbine is located inside a building. Since Interim Alternative 1 would be for reconditioning only, the expected sound levels would remain about the same as the existing noise levels. Therefore, there would be no new noise impacts.

Potential Mitigation Measures

The only noise impacts identified for Interim Alternative 1 would be due to the installation of the transmission lines and be less than significant, therefore no mitigation is proposed.

8.2.2.2 Interim Alternative 2

Interim Alternative 2 is a combination of reconditioning of existing permitted GPA facilities, an increase in operational hours for existing combustion turbines, and upgrades to existing T&D systems. Interim Alternative 2 would not require new construction at or enlargement of the existing footprint of the facility. Reconditioning would be performed on the existing permitted GPA facilities at the Marbo, Yigo, and Dededo combustion turbines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Construction

Transmission line installation noise impacts resulting from Interim Alternative 2 would be the same as for Interim Alternative 1.

Operation

Similar to Interim Alternative 1, combustion turbine noise levels would remain about the same. The difference for this alternative would be an increased duration of the sound exposure.

Potential Mitigation Measures

The only noise impacts identified for Interim Alternative 2 would be due to the installation of the transmission lines and be less than significant; therefore, no mitigation is proposed.

8.2.2.3 Interim Alternative 3

Interim Alternative 3 is a combination of reconditioning to existing GPA permitted facilities at Marbo, Yigo, and Dededo and upgrades to the Department of Defense (DoD) power plant at Orote. Upgrades would be made to existing T&D systems. The proposed reconditioning to the existing power generation facilities at Marbo, Yigo, and Dededo would not require new construction at or enlargement of the existing footprint of the facility. For the Orote power plant, upgrades would include a new fuel storage facility to facilitate longer run times between refueling. This would disturb approximately 1 acre (ac) (4,047 square m). This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Construction

The proposed reconditioning to facilities at Marbo, Yigo, and Dededo include overhauls of the existing systems that do not include new construction at or enlargement of the existing footprint of the facility. For the Navy facility at Orote, a new fuel storage tank would be required and the generation equipment would be reconditioned for expanding its operational hours per year. The construction of this new fuel storage tank would be on the Naval base at Apra Harbor in a relatively isolated location. The noise expected from this new construction would be within normal construction scenarios and of limited impact to areas beyond 1,000 ft (305 m) distance. Transmission line installation noise impacts resulting from Interim Alternative 3 would be the same as for Interim Alternative 1.

Operation

These upgrades would have negligible difference in noise levels at each of the power generating facilities.

Potential Mitigation Measures

The only noise impacts identified for Interim Alternative 3 would be due to the installation of the transmission lines and the new fuel storage tank at Orote. These impacts would be less than significant, therefore no mitigation is proposed.

8.2.2.4 Summary of Impacts

Table 8.2-3 summarizes the potential impacts of each interim alternative. A text summary is provided below.

Table 8.2-3. Summary of Potential Noise Impacts - Power

Potentially Impact	*Interim Alternative 1**	*Interim Alternative 2*	*Interim Alternative 3*
Construction	LSI	LSI	LSI

Legend: LSI= Less than significant impact. *Preferred Alternative.

The interim alternatives would have minimal noise impacts because these projects predominately use existing facilities. No mitigation would be required for any alternative of this proposed action.

8.2.3 Potable Water

8.2.3.1 Basic Alternative 1 (Preferred Alternative)

Basic Alternative 1 would consist of installation of up to 22 new potable water supply wells at Andersen Air Force Base (AFB), rehabilitation of existing wells, interconnection with the GWA water system, and associated T&D systems. A new 5 MG (19 ML) water storage tank would be constructed at ground level at Finegayan.

Construction

At Andersen AFB, up to 22 new water wells (including one contingency well) would be drilled. A 1,000-foot (ft) (305- m) wellhead protection arc is generated at each well that constrains land use within the arc. Drill rig augers create noise levels of 84.4 dBA $L_{max.}$ At 1,000 ft (305 m), the noise would attenuate to a level of 58.3 L_{max} and 52.5 L_{eq}, both well under the acceptable standard limits of 75 dBA.

New ground level storage tanks are proposed on NCTS Finegayan and Air Force Barrigada. Erecting storage tanks would involve use of graders, cranes, man-lifts, welders, and other equipment generating noise levels up to about 80 dBA. At 250 ft (76 m), this would attenuate to 64 dBA L_{eq} and about 58 dBA at 500 ft (152 m).

Distribution pipelines would be installed underground. The alignment of the pipelines would be along the southern boundary of Anderson AFB and along Route 3. Water main replacement would occur at numerous locations throughout Guam. Construction equipment associated with installing pipelines primarily include backhoes and trenchers for digging the trench and backhoes, pavers and rollers for refilling and finishing the surface. This equipment would create noise levels of about 80 dBA at 50 ft (15 m) from the source attenuating to 68 dBA L_{eq} at 250 ft (76 m). Installation of pipelines involves excavating a portion of the trench, installing a segment of pipeline, and backfilling the trench. Usually this occurs in segments anywhere from 100 ft (31 m) to 1,000 ft (305 m) or more and the activities move relatively rapidly along the work corridor. Consequently, any single receptor would not be impacted for much more than a couple of days. Therefore, the potential noise impacts would be less than significant.

Operation

Wells would be located within the property, overhead tanks do not create operational noise, and once installed, pipeline would not make any noise. Although nowhere near as noisy, similar to power plant design, design engineers would take into consideration noise producing equipment and design appropriate sound dampening equipment, if necessary. Therefore, potential noise impacts would be less than significant.

Potential Mitigation Measures

No long-term adverse noise impacts were identified. No mitigation is proposed.

8.2.3.2 Basic Alternative 2

Basic Alternative 2 would consist of installation of up to 20 new potable water supply wells at Andersen AFB, up to 11 new potable water supply wells at Barrigada, rehabilitation of existing wells, interconnection with the GWA water system, associated transmission and distribution systems upgrades. Additionally, new 3.6 MG (13.6 ML) and 1 MG (3.8 ML) water storage tanks would be constructed at ground level at Finegayan and Barrigada, respectively.

Construction

Construction noise would be the same as Alternative 1.

Operation

Operational noise would be the same as Alternative 1.

Potential Mitigation Measures

No long-term adverse noise impacts were identified. No mitigation is proposed.

8.2.3.3 Summary of Impacts

Table 8.2-4 summarizes the potential impacts of each basic alternative. A text summary is provided below.

Table 8.2-4. Summary of Potential Noise Impacts-Potable Water

Potentially Impact	*Alternative 1**	*Alternative 2*
Construction	LSI	LSI
Operation	NI	NI

Legend: LSI= Less than significant impact, NI= No impact. *Preferred Alternative.

Noise impacts associated with the potable water installation projects would be limited to pipeline installation and replacement. Construction noise could approach 68 dBA as the construction progresses, but would be short-term, lasting only a few days or weeks in the particular section of pipeline being installed at the time. Therefore, based on the above noise analysis, both Potable Water Alternatives 1 and 2 are deemed to have less than significant impacts from additional noise during construction and no impact during operation to the inhabitants and environment of Guam.

8.2.4 Wastewater

8.2.4.1 Basic Alternative 1a (Preferred Alternative) and 1b

Basic Alternative 1 (Alternative 1a supports Main Cantonment Alternatives 1 and 2; and Alternative 1b supports Main Cantonment Alternatives 3 and 8) combines upgrade to the existing primary treatment facilities and expansion to secondary treatment at the Northern District Wastewater Treatment Plant (NDWWTP). The difference between Alternatives 1a and 1b is a requirement for a new sewer line from Barrigada housing to NDWWTP for Alternative 1b.

Construction

Sewer lines will be placed within areas where there are no sensitive noise receptors such as residential areas, schools, and hospitals. Similarly, the sewer lines will not be constructed in the T&E species sensitive areas. As such, construction noise impacts associated with the refurbishment of the existing NDWWTP would be temporary and short-term, resulting in less than significant noise impact.

Construction of the secondary treatment portion of the NDWWTP would be in an area where there are no sensitive noise receptors such as residential areas, schools, and hospitals. This area is not in any T&E species sensitive areas. As such, construction noise impacts associated with the new secondary treatment portion of the NDWWTP would be temporary and short-term, resulting in less than significant noise impact.

Operation

There will be no operational noise impacts associated with the refurbishment of the existing NDWWTP and the expanded secondary treatment portion to the existing NDWWTP.

Potential Mitigation Measures

No adverse noise impacts were identified, and no mitigation is proposed.

8.2.4.2 Summary of Impacts

Table 8.2-5 summarizes the potential impacts of each interim alternative. A text summary is provided below.

Table 8.2-5. Summary of Potential Noise Impacts-Wastewater Projects

Potentially Impact	*Interim Alternative 1a**	*Interim Alternative 1b*
Construction	LSI	LSI
Operation	NI	NI

Legend: LSI= Less Than Significant Impact, NI= No Impact. *Preferred Alternative.

The only noise impacts associated with the wastewater projects would be during installation of pipelines, refurbishment of the primary treatment capability at the existing NDWWTP, and construction of the new secondary treatment portion at the existing NDWWTP, which would be less than significant as these impacts would be short-term and not elevate noise in any particular area for more than several days.

8.2.5 Solid Waste

8.2.5.1 Basic Alternative 1 (Preferred Alternative)

The Preferred Alternative for solid waste would be the continued use of Navy Landfill at Apra Harbor until Layon Landfill is opened, which is scheduled for July 2011.

Construction

Since there is no new construction involved in this alternative, there would be no noise impacts from construction.

Operation

For operations, there would be a higher solid waste generation from the DoD buildup. Thus there could be additional hours of operations required and additional truck traffic for hauling solid waste. The operations are adequately isolated to prevent significant noise impacts to the surrounding environment. Increased noise from traffic is analyzed in the traffic section in this chapter.

8.2.5.2 Summary of Impacts

Table 8.2-6 summarizes the potential impacts of the basic alternative.

An analysis of long-term alternatives was not developed because the alternatives are not ready for project-specific analysis. A text summary is provided below.

Table 8.2-6. Summary of Potential Noise Impacts-Solid Waste Projects

Potentially Impact	*Alternative 1**
Construction	NI
Operation	LSI

Legend: LSI= Less Than Significant Impact, NI= No Impact.
*Preferred Alternative.

The only noise impacts associated with the solid waste alternative would be during operations, which would be less than significant as these impacts are a small increase to the current situation and adequately isolated from the surrounding environment.

8.2.6 Off Base Roadways

Noise impacts for each alternative were analyzed by first calculating the distance from the alignment center line at which each GRN future traffic would cause noise impacts at noise-sensitive receptor locations. Then, a 66-dBA noise contour line was placed along each alternative alignment to determine the number of noise-impacted areas per alternative. Each nonresidential receptor, such as schools and parks, is considered as one outdoor use receptor per 100 ft (30 m) of frontage outdoor use area along the roadway. Within each geographic Region, impacted noise-sensitive receptors were then grouped together as representative areas adjacent to the alignment. The noise abatement evaluation was then conducted for these identified areas.

8.2.6.1 Alternative 1

Year 2014 (Peak Construction and Peak Population)

Noise impacts during year 2014 would mostly be derived from construction activities. Construction noise impacts in each geographical Region would be similar. Because the Territory of Guam does not have an ordinance covering construction noise, the FHWA daytime construction noise limit for residential land uses is to be used for this project, as recommended in the 2009 FHWA Construction Noise Handbook (FHWA 2009). Table 8.2-7 summarizes the FHWA allowable construction noise levels. These limits are for 8-hour average noise levels (L_{eq}) at the property line of the nearest location to the construction site.

Table 8.2-7. Allowable Construction Noise Levels

Land Use	*Daytime (7 a.m. to 10 p.m.) L_{eq}, dBA*	*Nighttime (10 p.m. to 7 a.m.) L_{eq}, dBA*
Residential	80	70

Construction noise varies greatly depending on the construction process, type and condition of equipment used, and layout of the construction site. Many of these factors are traditionally left to the contractor's discretion, making it difficult to accurately estimate levels of construction noise. Overall, construction noise levels are governed primarily by the noisiest pieces of equipment. The engine, that is usually diesel, is the dominant noise source for most construction equipment.

Table 8.2-8 summarizes typical construction noise emission levels (L_{max}) of construction equipment operating at full power at a reference distance of 50 ft (15 m), and an estimated equipment usage factor (UF) based on experience with other similar construction projects. The UF is a fraction that accounts for the total time during an 8-hour day in which a piece of construction equipment is producing noise under full power. Although the noise levels in Table 8.2-8 represent typical values, there can be wide fluctuations in the noise emissions of similar equipment. Distance (D) is also considered in the construction noise analysis. In all areas between the alignment and noise sensitive receptors, a ground factor (G) of 0.0 was used. This factor represents an acoustically hard ground cover, representing the ground effect as the sound propagates from the source to the receptor. The calculation used to determine average construction noise exposure for each piece of equipment is based on the above factors using the following equation:

$$L_{eq} = L_{max} + 10\ Log(UF) - 20\ Log(D/50) - 10\ G\ Log(D/50)$$

Where:

- L_{eq} is the 8-hour average noise level in A-weighted decibels, dBA
- L_{max} is the maximum noise level at 50 ft in A-weighted decibels, dBA
- UF is the usage factor of the construction equipment
- D is the distance to the affected noise sensitive area
- G is the ground factor characterizing the sound absorption of the ground between the source and the receiver

After calculating noise exposure for each piece of equipment, the noise exposures for all equipment being used in a construction stage were combined together to determine the total noise impact. The equipment noise levels within a particular stage were combined together to obtain a total noise exposure for each stage (listed as shaded entries in Table 8.2-8. This total noise evaluation process does not combine noise levels of different stages because they would not occur at the same time in a given area. Because the distance between most of the noise-sensitive receptors and the construction site is greater than 75 ft (23 m), no noise impacts due to construction activities are anticipated except for a few areas where residences are located next to the roadway.

Table 8.2-8. Estimated Construction Noise Levels

No. of Items	*Equipment Type*	*Maximum Equipment of Noise Level at 50ft, dBA*	*8 Hour Equivalent Noise Level at 50 ft, dBA*	*8 Hour Equivalent Noise Level at 75 ft, dBA*	*8 Hour Equivalent Noise Level at 100 ft, dBA*
Full-Depth Reconstruction					
1	Wheel Loader	74	69	65	63
1	Scraper	76	71	67	65
1	Asphalt Zipper	80	72	68	66
2	Grader	76	68	64	62
2	Roller	78	73	69	67
2	Backhoe	81	76	72	70
1	Paving Machine	79	74	70	68
		Combined $L_{eq(h)}$	**83**	**79**	**77**
Mill and Overlay					
1	Milling Machine	81	73	69	67
2	Roller	78	73	69	67
1	Backhoe	81	76	72	70
1	Paving Machine	79	74	70	68
		Combined $L_{eq(h)}$	**81**	**77**	**75**
Widening					

No. of Items	*Equipment Type*	*Maximum Equipment of Noise Level at 50ft, dBA*	*8 Hour Equivalent Noise Level at 50 ft, dBA*	*8 Hour Equivalent Noise Level at 75 ft, dBA*	*8 Hour Equivalent Noise Level at 100 ft, dBA*
1	Wheel Loader	74	69	65	63
2	Scraper	76	71	67	65
1	Grader	76	68	64	62
2	Roller	78	73	69	67
2	Backhoe	81	76	72	70
1	Paving Machine	79	74	70	68
		Combined $L_{eq(h)}$	**82**	**79**	**76**

<u>Abatement Measures</u>

During the construction period, some of the sensitive receptors that are close to the roadway may be exposed to noise levels greater than 80 dBA. A combination of noise abatement techniques with equipment noise control and administrative measures may be selected to provide the most effective means to minimize effects of the construction activity noise as discussed below.

Equipment Noise Control:

- Ensure that all equipment items have the manufacturers' recommended noise abatement measures, such as mufflers, engine enclosures, and engine vibration isolators, intact and operational.
- All construction equipment should be inspected at periodic intervals to ensure proper maintenance and presence of noise control devices (e.g., mufflers and shrouding).
- Turn off idling equipment.

Administrative Measures:

- Implement a construction noise monitoring program to limit the impacts.
- Plan noisier operations during times least sensitive to receptors.
- Avoid scheduling construction during nighttime hours (10:00 p.m. to 7:00 a.m.) and on weekends.
- Keep noise levels relatively uniform and avoid impulsive noises.
- Maintain good public relations with the community to minimize objections to the unavoidable construction impacts. Provide frequent activity updates of all construction activities.

Application of these potential noise abatement measures would reduce the construction noise at the sensitive receptors; however, a temporary increase in noise would likely occur.

<u>Year 2030</u>

North

Under Alternative 1, potential noise impacts to noise-sensitive receptors were assessed for 16 representative areas within the North Region, and the number of impacts per area is shown in Table 8.2-9. There are 88 noise sensitive receptors that would experience sound levels approaching or exceeding the NAC of 66 dBA.

Table 8.2-9. Number of Potentially Impacted Receptors within the North Region, Alternative 1

Type of Noise Sensitive Receptors	*Number of Predicted Impacted Receptors*	
	Alternative 1	*No-Action Alternative*
Area 1: Single Family Residences and a Church	17	17
Area 2: Multi-Family Residences	0	0
Area 3: Single Family Residences	2	0
Area 4: Single Family Residences	4	0
Area 5: Single and Multi-Family Residences	0	0
Area 6: Military Outdoor Physical Training Area	4	0
Area 7: Single Family Residences	0	0
Area 8: Military Outdoor Recreational Area	12	0
Area 9: Single Family Residences and Golf Course	0	0
Area 10: Single Family Residences	1	0
Area 11: Single Family Residences, Multi-Family Residences, and a School	10	0
Area 12: Single Family Residences	7	7
Area 13: Single Family Residences	8	4
Area 14: Single and Multi-Family Residences	13	11
Area 15: School	0	0
Area 16: Single Family Residences and a Church	10	10
Total	**88**	**49**

The type and number of impacted noise-sensitive receptors for each area are described as follows:

- Area 1: Outdoor use areas for 16 single-family residences and one church within Area 1 would be impacted from traffic noise under Alternative 1. Sheets 1 and 2 in Appendix G-2 show the location of Area 1.
- Area 2: None of the outdoor use areas for the multi-family residences within Area 2 would be impacted from traffic noise under Alternative 1. Sheet 4 in Appendix G-2 shows the location of Area 2.
- Area 3: Outdoor use areas for two single-family residences within Area 3 would be impacted from traffic noise under Alternative 1. Sheets 3 and 4 in Appendix G-2 show the location of Area 3.
- Area 4: Outdoor use areas for four single-family residences within Area 4 would be impacted from traffic noise under Alternative 1. Sheets 4 and 5 in Appendix G-2 show the location of Area 4.
- Area 5: None of the outdoor use areas for single- and multi-family residences within Area 5 would be impacted from traffic noise under Alternative 1. Sheets 5, 6, and 7 in Appendix G-2 show the location of Area 5.
- Area 6: This area represents a military outdoor physical training site and has four frontage outdoor use areas. The four frontage outdoor use areas within Area 6 would be impacted from traffic noise under Alternative 1. Sheet 6 in Appendix G-2 shows the location of Area 6.
- Area 7: None of the outdoor use areas for the single-family residences within Area 7 would be impacted from traffic noise under Alternative 1. Sheets 7 and 8 in Appendix G-2 show the location of Area 7.
- Area 8: This area represents a military outdoor recreational site and has 12 frontage outdoor use areas. The 12 frontage outdoor use areas within Area 8 would be impacted from traffic noise under Alternative 1. Sheets 7 and 8 in Appendix G-2 show the location of Area 8.

- Area 9: None of the outdoor use areas for the single-family residences and the golf course within Area 9 would be impacted from traffic noise under Alternative 1. Sheets 9, 10, and 11 in Appendix G-2 show the location of Area 9.
- Area 10: Outdoor use areas for one single-family residence within Area 10 would be impacted from traffic noise under Alternative 1. Sheets 11 and 12 in Appendix G-2 show the location of Area 10.
- Area 11: Outdoor use areas for 10 single-family residences within Area 11 would be impacted from traffic noise under Alternative 1. Sheets 12, 13, and 14 in Appendix G-2 show the location of Area 11.
- Area 12: Outdoor use areas for seven single-family residences within Area 12 would be impacted from traffic noise under Alternative 1. Sheets 15 and 16 in Appendix G-2 show the location of Area 12.
- Area 13: Outdoor use areas for eight single-family residences within Area 13 would be impacted from traffic noise under Alternative 1. Sheets 15, 16, and 17 in Appendix G-2 show the location of Area 13.
- Area 14: Outdoor use areas for nine single- and four multi-family residences within Area 14 would be impacted from traffic noise under Alternative 1. Sheets 17, 18, and 19 in Appendix G-2 show the location of Area 14.
- Area 15: This area represents a school and has three frontage outdoor use areas. None of the school's outdoor recreational areas or its indoor use areas within Area 15 would be impacted from traffic noise under Alternative 1. Sheet 18 in Appendix G-2 shows the location of Area 15.
- Area 16: Outdoor use areas for nine single-family residences and one church within Area 16 would be impacted from traffic noise under Alternative 1. Sheet 19 in Appendix G-2 shows the location of Area 16.

Central

Under Alternative 1, potential noise impacts to noise-sensitive receptors were assessed for 48 representative areas within the Central Region. Table 8.2-10 shows the number of impacts per area. As shown on this table, there are 378 noise sensitive receptors that would experience sound levels approaching or exceeding the NAC of 66 dBA.

Table 8.2-10. Number of Potentially Impacted Receptors within the Central Region, Alternative 1

Type of Noise Sensitive Receptors	*Number of Predicted Impacted Receptors*	
	Alternative 1	*No-Action Alternative*
Area 17: Single Family Residences and a Multi-Family Residence	15	15
Area 18: Single Family Residences and a Park	17	17
Area 19: Park	8	0
Area 20: Single Family Residences and a Multi-Family Residence	4	4
Area 21: Park, a Single Family Residence, and a Multi-Family Residence	6	3
Area 22: Playground, a Single Family Residence, and a Multi-Family Residence	10	10
Area 23: Park and a Single Family Residence	7	4
Area 24: Multi-Family Residences	3	3
Area 25: Park and Single Family Residences	6	2
Area 26: Cemetery	6	0
Area 27: Park	20	11

Type of Noise Sensitive Receptors	*Number of Predicted Impacted Receptors*	
	Alternative 1	*No-Action Alternative*
Area 28: Park	2	2
Area 29: Park	4	4
Area 30: Park	9	9
Area 31: Park	4	4
Area 32: Multi-Family Residence	4	4
Area 33: Multi-Family Residence	0	0
Area 34: School	8	8
Area 35: Park, a Single Family Residence, and Multi-Family Residences	15	15
Area 36: One School and Two Churches	6	6
Area 37: Multi-Family Residences	0	0
Area 38: Multi-Family Residences	1	1
Area 39: Single Family Residences	21	21
Area 40: Multi-Family Residences	0	0
Area 41: Single Family Residences	0	0
Area 42: Single Family Residences	0	0
Area 43: Single Family Residences	18	18
Area 44: Single Family Residences	0	0
Area 45: Park, Single Family Residences, and Multi-Family Residences	30	30
Area 46: Single Family Residences	0	0
Area 47: Single Family Residences	12	12
Area 48: Single Family Residence, and Multi-Family Residences	9	7
Area 49: Single Family Residences and Multi-Family Residences	21	21
Area 50: Outdoor Sport Complex	9	9
Area 51: School	0	0
Area 52: Multi-Family Residence and Motel	9	8
Area 53: Multi-Family Residences	10	10
Area 54: Multi-Family Residences	0	0
Area 55: Single Family Residence and a Motel	1	1
Area 56: Single Family Residences and Multi-Family Residences	11	11
Area 57: Single Family Residences and Multi-Family Residences	11	11
Area 58: Military Outdoor Recreational Area	0	0
Area 59: Single Family Residences	6	6
Area 60: Single Family Residences	3	3
Area 61: Single Family Residences, Multi-Family Residences, and a Funeral Home	7	7
Area 62: Multi-Family Residences	0	0
Area 63: Single Family Residences, a Multi-Family Residence, and a Church	23	23
Area 64: Single Family Residences, Multi-Family Residences, and a School	22	22
Total	**378**	**342**

The type and number of impacted noise-sensitive receptors for each area are described in the following text:

- Area 17: Outdoor use areas for 13 single- and two multi-family residences within Area 17 would be impacted from traffic noise under Alternative 1. Sheets 20, 21, and 22 in Appendix G-2 show the location of Area 17.

- Area 18: Outdoor use areas for seven single-family residences and 10 frontage outdoor use areas for a park within Area 18 would be impacted from traffic noise under Alternative 1. Sheets 20, 21, and 22 in Appendix G-2 show the location of Area 18.
- Area 19: A park within Area 19 would have eight frontage outdoor use areas that would be impacted from traffic noise under Alternative 1. Sheets 22 and 23 in Appendix G-2 show the location of Area 19.
- Area 20: Outdoor use areas for two single- and two multi-family residences within Area 20 would be impacted from traffic noise under Alternative 1. Sheets 22 and 23 in Appendix G-2 show the location of Area 20.
- Area 21: Outdoor use areas for one single- and two multi-family residences and three frontage outdoor use areas for a park within Area 21 would be impacted from traffic noise under Alternative 1. Sheet 23 in Appendix G-2 shows the location of Area 21.
- Area 22: Outdoor use areas for seven single- and two multi-family residences, as well as one frontage outdoor use area for a playground, within Area 22 would be impacted from traffic noise under Alternative 1. Sheets 23 and 24 in Appendix G-2 show the location of Area 22.
- Area 23: Outdoor use area for one single-family residence and six frontage outdoor use areas for a park within Area 23 would be impacted from traffic noise under Alternative 1. Sheets 24 and 25 in Appendix G-2 show the location of Area 23.
- Area 24: Outdoor use areas for two multi-family residences within Area 24 would be impacted from traffic noise under Alternative 1. Sheet 25 in Appendix G-2 shows the location of Area 24.
- Area 25: Outdoor use areas for two single-family residences and four frontage outdoor use areas for a park within Area 25 would be impacted from traffic noise under Alternative 1. Sheets 25 and 26 in Appendix G-2 show the location of Area 25.
- Area 26: A cemetery within Area 26 would have six frontage outdoor use areas that would be impacted from traffic noise under Alternative 1. Sheet 25 in Appendix G-2 shows the location the location of Area 26.
- Area 27: A park within Area 27 would have 20 frontage outdoor use areas that would be impacted from traffic noise under Alternative 1. Sheets 27 and 28 in Appendix G-2 show the location of Area 27.
- Area 28: A park within Area 28 would have two frontage outdoor use areas that would be impacted from traffic noise under Alternative 1. Sheet 28 in Appendix G-2 shows the location of Area 28.
- Area 29: A park within Area 29 would have four frontage outdoor use areas that would be impacted from traffic noise under Alternative 1. Sheets 28 and 29 in Appendix G-2 show the location of Area 29.
- Area 30: A park within Area 30 would have nine frontage outdoor use areas that would be impacted from traffic noise under Alternative 1. Sheets 29, 30, and 31 in Appendix G-2 show the location of Area 30.
- Area 31: A park within Area 31 would have four frontage outdoor use areas that would be impacted from traffic noise under Alternative 1. Sheet 32 in Appendix G-2 shows the location of Area 31.
- Area 32: Outdoor use areas for four multi-family residences within Area 32 would be impacted from traffic noise under Alternative 1. Sheet 33 in Appendix G-2 shows the location of Area 32.
- Area 33: None of the multi-family residences outdoor use areas within Area 33 would be impacted from traffic noise under Alternative 1. Sheet 34 in Appendix G-2 shows the location of Area 33.
- Area 34: A school within Area 34 would have eight frontage outdoor use areas that would be impacted from traffic noise under Alternative 1; however, none of the school's indoor use areas

would be impacted from traffic noise under Alternative 1. Sheets 34 and 35 in Appendix G-2 show the location of Area 34.

- Area 35: Outdoor use areas for 11 multi-family residences and four frontage outdoor use areas for a park within Area 35 would be impacted from traffic noise under Alternative 1. Sheets 35 and 36 in Appendix G-2 show the location of Area 35.
- Area 36: A park with four frontage outdoor use areas and two churches within Area 36 would be impacted from traffic noise under Alternative 1. Sheets 36 and 37 in Appendix G-2 show the location of Area 36.
- Area 37: None of the multi-family residences outdoor use areas within Area 37 would be impacted from traffic noise under Alternative 1. Sheets 37 and 38 in Appendix G-2 show the location of Area 37.
- Area 38: None of the multi-family residences outdoor use areas and one frontage outdoor use area for a church within Area 38 would be impacted from traffic noise under Alternative 1. Sheet 38 in Appendix G-2 shows the location of Area 38.
- Area 39: Outdoor use areas for 21 single-family residences within Area 39 would be impacted from traffic noise under Alternative 1. Sheets 39 and 40 in Appendix G-2 show the location of Area 39.
- Area 40: None of the multi-family residences outdoor use areas within Area 40 would be impacted from traffic noise under Alternative 1. Sheet 41 in Appendix G-2 shows the location of Area 40.
- Area 41: None of the single-family residences outdoor use areas within Area 41 would be impacted from traffic noise under Alternative 1. Sheet 41 in Appendix G-2 shows the location of Area 41.
- Area 42: None of the single-family residences outdoor use areas within Area 42 would be impacted from traffic noise under Alternative 1. Sheets 41 and 42 in Appendix G-2 show the location of Area 42.
- Area 43: Outdoor use areas for 18 single-family residences within Area 43 would be impacted from traffic noise under Alternative 1. Sheet 42 in Appendix G-2 shows the location of Area 43.
- Area 44: None of the single-family residences outdoor use areas within Area 44 would be impacted from traffic noise under Alternative 1. Sheet 42 in Appendix G-2 shows the location of Area 44.
- Area 45: A park within Area 45 would have 30 frontage outdoor use areas that would be impacted from traffic noise under Alternative 1. Sheets 42, 43, and 44 in Appendix G-2 show the location of Area 45.
- Area 46: None of the single-family residences outdoor use areas within Area 46 would be impacted from traffic noise under Alternative 1. Sheet 44 in Appendix G-2 shows the location of Area 46.
- Area 47: Outdoor use areas for 12 single-family residences within Area 47 would be impacted from traffic noise under Alternative 1. Sheet 46 in Appendix G-2 shows the location of Area 47.
- Area 48: Outdoor use areas for seven single- and two multi-family residences within Area 48 would be impacted from traffic noise under Alternative 1. Sheet 48 in Appendix G-2 shows the location of Area 48.
- Area 49: Outdoor use areas for 17 single- and four multi-family residences within Area 49 would be impacted from traffic noise under Alternative 1. Sheets 50 and 51 in Appendix G-2 show the location of Area 49.
- Area 50: An outdoor sports complex within Area 50 would have nine frontage outdoor use areas that would be impacted from traffic noise under Alternative 1. Sheets 50 and 51 in Appendix G-2 show the location of Area 50.

- Area 51: None of the recreational outdoor use areas or indoor use areas for a school within Area 51 would be impacted from traffic noise under Alternative 1. Sheet 51 in Appendix G-2 shows the location of Area 51.
- Area 52: Outdoor use areas for eight multi-family residences and a motel within Area 52 would be impacted from traffic noise under Alternative 1. Sheet 53 in Appendix G-2 shows the location of Area 52.
- Area 53: Outdoor use areas for 10 multi-family residences within Area 53 would be impacted from traffic noise under Alternative 1. Sheet 53 in Appendix G-2 shows the location of Area 53.
- Area 54: None of the multi-family residences outdoor use areas within Area 54 would be impacted from traffic noise under Alternative 1. Sheet 54 in Appendix G-2 shows the location of Area 54.
- Area 55: Outdoor use area for one single-family residence within Area 55 would be impacted from traffic noise under Alternative 1. Sheet 56 in Appendix G-2 shows the location of Area 55.
- Area 56: Outdoor use areas for nine single- and two multi-family residences within Area 56 would be impacted from traffic noise under Alternative 1. Sheets 57 and 58 in Appendix G-2 show the location of Area 56.
- Area 57: Outdoor use areas for 10 single- and one multi-family residences within Area 57 would be impacted from traffic noise under Alternative 1. Sheets 59 and 60 in Appendix G-2 show the location of Area 57.
- Area 58: None of the 28 frontage outdoor use areas for a military outdoor recreational area within Area 58 would be impacted from traffic noise under Alternative 1. Sheets 59 and 60 in Appendix G-2 show the location of Area 58.
- Area 59: Outdoor use areas for six single-family residences within Area 59 would be impacted from traffic noise under Alternative 1. Sheet 62 in Appendix G-2 shows the location of Area 59.
- Area 60: Outdoor use areas for three single-family residences within Area 60 would be impacted from traffic noise under Alternative 1. Sheet 63 in Appendix G-2 shows the location of Area 60.
- Area 61: Outdoor use areas for five single- and two multi-family residences within Area 61 would be impacted from traffic noise under Alternative 1. Sheets 63 and 64 in Appendix G-2 show the location of Area 61.
- Area 62: None of the multi-family residences outdoor use areas within Area 62 would be impacted from traffic noise under Alternative 1. Sheets 65 and 66 in Appendix G-2 show the location of Area 62.
- Area 63: Outdoor use areas for 21 single- and two multi-family residences and a church within Area 63 would be impacted from traffic noise under Alternative 1. Sheets 67, 68, and 69 in Appendix G-2 show the location of Area 63.
- Area 64: Outdoor use areas for 18 single- and four multi-family residences within Area 64 would be impacted from traffic noise under Alternative 1. Sheets 67, 68, and 69 in Appendix G-2 show the location of Area 64.

Apra Harbor

No noise sensitive receptors are located within the proposed roadway improvement area in the Apra Harbor Region; therefore, no impacts from traffic noise under Alternative 1 would occur in this region.

South

While there are noise-sensitive land uses along the proposed roadway improvement routes in the South Region, noise from traffic would not impact the noise sensitive land uses as a result of Alternative 1 implementation.

Abatement Measures

North

Although many receptors within the North Region are expected to experience future traffic noise impacts under Alternative 1, noise abatement modeling was not performed for most of the impacted receptors because the locations where impacts would occur would require abatement measures that would not be feasible. Specifically, the land adjacent to Routes 1, 3, and 9 consists of several residential areas where many residences have driveways that provide direct access to the routes, thereby resulting in issues of sound wall discontinuity. For a sound wall to provide sufficient noise reduction, it must be high enough and long enough to shield the receptor from the road. Access openings in the noise barrier for streets, driveways, and maintenance severely reduce the effectiveness of the noise barrier to the point that it would not be feasible to construct a barrier. Furthermore, for most of the locations, there are not enough residences per area to allow a noise barrier to be reasonable due to the cost per benefitted receptor. Noise abatement analysis was not conducted for areas where there are no noise impacts due to traffic.

Noise abatement was analyzed for three locations within the North Region for Alternative 1 where predicted 2030 noise levels would cause an impact and where existing topography conditions and future roadway alignment would not prevent the construction of continuous sound walls. The results of this noise abatement analysis are shown in Tables 8.2-11 through 8.2-13. All of the barrier heights and locations are based on the latest available alignment information at the time of this study. These tables provide a summary of the barriers, the number of benefited residences, cost per benefited residence, and total cost per barrier. The three sound walls that were analyzed for noise impacts were for Areas 1, 6, and 8. Only the sound wall for Area 1 met both the feasible and reasonable requirements under the Traffic Noise Abatement Policy to be considered for construction.

Table 8.2-11. Predicted Future Noise and Barrier Analysis for Area 1

REC. NO.	LAND USE[2]	FUTURE PEAK HOUR NOISE LEVELS, Leq(h), dBA[1, 4]														
		EXISTING	PROJECT "NO BUILD" WITHOUT BARRIER	PROJECT "BUILD" WITHOUT BARRIER	ACTIVITY CATEGORY and NAC ( )	IMPACT TYPE (A/E or NONE)[3]	NOISE PREDICTION WITH BARRIER AND BARRIER INSERTION LOSS (I.L.)									
							8 ft		10 ft		12 ft		14 ft		16 ft	
							Leq(h)	I.L.	Leq(h)	I.L.	Leq(h)	I.L.	Leq(h)	I.L.	Leq(h)	I.L.
Area 1																
R 1	SFR	68	68	71	B (67)	A/E	65 R	6	64	7	64	7	64	7	63	8
R 2	SFR	68	68	71	B (67)	A/E	62 R	9	60	11	59	12	58	13	57	14
R 3	SFR	68	68	71	B (67)	A/E	65 R	6	60	11	64	7	64	7	63	8
Number of benefited receptors							11		11		11		11		11	
Total barrier cost							$247,360		$309,200		$371,040		$432,880		$494,720	
Cost per benefited receptor							$22,487		$28,109		$33,731		$39,353		$44,975	

Notes:
1 - Leq(h) are A-weighted, peak hour noise levels in decibels.
2 - Land Use: SFR - single-family residence; MFR multi-family residences; REC - Outdoor recreational areas.
3 - A/E = Approach or exceed NAC.
4 - Traffic noise from Route 3; other local noise sources are not included.
5 - Barrier height recommended to meet requirements of nearby receptor(s).
R - Recommended height to meet feasibility requirements of the Guam Public Works Noise Abatement Policy.
* - Second row residence.

Table 8.2-12. Predicted Future Noise and Barrier Analysis for Area 6

REC. NO.	LAND USE[2]	FUTURE PEAK HOUR NOISE LEVELS, Leq(h), dBA[1, 4]														
		EXISTING	PROJECT "NO BUILD" WITHOUT BARRIER	PROJECT "BUILD" WITHOUT BARRIER	ACTIVITY CATEGORY and NAC ( )	IMPACT TYPE (A/E or NONE)[3]	NOISE PREDICTION WITH BARRIER AND BARRIER INSERTION LOSS (I.L.)									
							8 ft		10 ft		12 ft		14 ft		16 ft	
							Leq(h)	I.L.	Leq(h)	I.L.	Leq(h)	I.L.	Leq(h)	I.L.	Leq(h)	I.L.
Area 6																
R 4	REC	59	60	68	B (67)	A/E	58 R	10	56	12	55	13	54	14	52	16
R 5	REC	59	60	68	B (67)	A/E	59 R	9	57	11	55	13	54	14	53	15
R 6	REC	59	60	68	B (67)	A/E	59 R	9	57	11	55	13	54	14	53	15
Number of benefited receptors							4		4		4		4		4	
Total barrier cost							$246,080		$307,600		$369,120		$430,640		$492,160	
Cost per benefited receptor							$61,520		$76,900		$92,280		$107,660		$123,040	

Notes:
1 - Leq(h) are A-weighted, peak hour noise levels in decibels.
2 - Land Use: SFR - single-family residence; MFR multi-family residences; REC - Outdoor recreational areas.
3 - A/E = Approach or exceed NAC.
4 - Traffic noise from Route 3; other local noise sources are not included.
5 - Barrier height recommended to meet requirements of nearby receptor(s).
R - Recommended height to meet feasibility requirements of the Guam Public Works Noise Abatement Policy.
* - Second row residence.

Table 8.2-13. Predicted Future Noise and Barrier Analysis for Area 8

REC. NO.	LAND USE[2]	FUTURE PEAK HOUR NOISE LEVELS, Leq(h), dBA[1, 4]														
		EXISTING	PROJECT "NO BUILD" WITHOUT BARRIER	PROJECT "BUILD" WITHOUT BARRIER	ACTIVITY CATEGORY and NAC ( )	IMPACT TYPE (A/E or NONE)[3]	NOISE PREDICTION WITH BARRIER AND BARRIER INSERTION LOSS (I.L.)									
							8 ft		10 ft		12 ft		14 ft		16 ft	
							Leq(h)	I.L.	Leq(h)	I.L.	Leq(h)	I.L.	Leq(h)	I.L.	Leq(h)	I.L.
Area 8																
R 7	REC	59	60	68	B (67)	A/E	60 R	8	58	10	57	11	57	11	56	12
R 8	REC	59	60	68	B (67)	A/E	59 R	9	57	11	55	13	54	14	53	15
R 9	REC	59	60	68	B (67)	A/E	60 R	8	58	10	57	11	57	11	56	12
Number of benefited receptors							12		12		12		12		12	
Total barrier cost							$529,280		$661,600		$793,920		$926,240		$1,058,560	
Cost per benefited receptor							$44,107		$55,133		$66,160		$77,187		$88,213	

Notes:

1 - Leq(h) are A-weighted, peak hour noise levels in decibels.
2 - Land Use: SFR - single-family residence; MFR multi-family residences; REC - Outdoor recreational areas.
3 - A/E = Approach or exceed NAC.
4 - Traffic noise from Route 3; other local noise sources are not included.
5 - Barrier height recommended to meet requirements of nearby receptor(s).
R - Recommended height to meet feasibility requirements of the Guam Public Works Noise Abatement Policy.
* - Second row residence.

- Area 1: Most of the Area 1 impacted residences have direct-access driveways to Route 3 that would prevent the construction of continuous sound walls required to provide feasible noise abatement; however, for the 11 single-family residences outdoor use areas between Lobo and Inda Roads, a sound wall 8 ft (2 m) in height and 775 ft (236 m) long located along the right-of-way (ROW) of the northbound side of Route 3 would provide feasible noise abatement for the outdoor use areas for these residences. Furthermore, the cost per benefited receptor is $22,487, which is below the Guam DPW $35,000 cost per benefited receptor requirement for a sound wall to be considered reasonable. The results of the noise abatement analysis for this sound wall are shown in Table 8.2-9, Sheet 2 in Appendix G-2 shows the location of the recommended sound wall for Area 1.
- Area 3: Outdoor use areas for two single-family residences within Area 3 are impacted from traffic noise under Alternative 1; however, these residences have direct-access driveways to Route 3 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheets 3 and 4 in Appendix G-2 show the location of Area 3.
- Area 4: Outdoor use areas for three single-family residences within Area 4 are impacted from traffic noise under Alternative 1; however, these residences have direct-access driveways to Route 3 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheets 4 and 5 in Appendix G-2 show the location of Area 4.
- Area 6: A sound wall 8 ft (2 m) in height and 770 ft (235 m) long located along the shoulder of the southbound side of Route 3 would provide feasible noise abatement for four impacted frontage outdoor use areas for the military outdoor physical training area within Area 6 from traffic noise under Alternative 1. However, the cost per benefited receptor is $61,520, which is above the Guam DPW $35,000 cost per benefited receptor requirement for a sound wall to be considered reasonable. The results of the noise abatement analysis for this sound wall are shown in Sheet 6 in Appendix G-2 shows the location of the sound wall for Area 6.
- Area 8: A sound wall 8 ft (2 m) in height and 1,655 ft (504 m) long located along the shoulder of the southbound side of Route 3 would provide feasible noise abatement for the 12 impacted frontage outdoor use areas for the military outdoor physical training area within Area 6 from traffic noise under Alternative 1. However, the cost per benefited receptor is $44,107, which is above the Guam DPW $35,000 cost per benefited receptor requirement for a sound wall to be considered reasonable. The results of the noise abatement analysis for this sound wall are shown in Table 8.2-13. Sheets 7 and 8 in Appendix G-2 show the location of the sound wall for Area 8.
- Area 10: Outdoor use area for one single-family residence within Area 10 would be impacted from traffic noise under Alternative 1. However, because there is only one impacted residence, a sound wall would have to be extended beyond the residence's property to provide feasible abatement, that is not possible because there are crossroads accessing Route 3 on the north and south side of this property. Sheets 11 and 12 in Appendix G-2 show the location of Area 10.
- Area 11: Outdoor use areas for 10 single- and multi-family residences within Area 11 would be impacted from traffic noise under Alternative 1. However, most of these residences have direct-access driveways to Route 9 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. In addition, building a sound wall for these residences would not be reasonable because they are scattered along the alignment and would exceed the cost per benefited receptor requirement. Sheets 12, 13, and 14 in Appendix G-2 show the location of Area 11.
- Area 12: Outdoor use areas for seven single-family residences within Area 12 would be impacted from traffic noise under Alternative 1. However, building a sound wall for these scattered residences along the alignment would not be reasonable because the sound wall cost would exceed the cost per benefited receptor requirement. Sheets 15 and 16 in Appendix G-2 show the location of Area 12.

- Area 13: Outdoor use areas for eight single-family residences within Area 13 would be impacted from traffic noise under Alternative 1. However, building a sound wall for these scattered residences along the alignment would not be reasonable because the sound wall cost would exceed the cost per benefited receptor requirement. Sheets 15, 16, and 17 in Appendix G-2 show the location of Area 13.
- Area 14: Outdoor use areas for 13 single- and multi-family residences within Area 14 would be impacted from traffic noise under Alternative 1. However, most of these residences have direct-access driveways to Route 1 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. In addition, building a sound wall for these scattered residences along the alignment would not be reasonable because the sound wall cost would exceed the cost per benefited receptor requirement. Sheets 17, 18, and 19 in Appendix G-2 show the location of Area 14.
- Area 16: Outdoor use areas for nine single-family residences and one church within Area 16 would be impacted from traffic noise under Alternative 1. However, most of these residences, as well as the church, have direct-access driveways to Route 1 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheet 19 in Appendix G-2 shows the location of Area 16.

Central

Although many receptors within the Central Region are expected to experience future traffic noise impacts under Alternative 1, noise abatement modeling was not performed for most of the impacted receptors because the locations where impacts would occur would require abatement measures that would not be feasible. Specifically, the land adjacent to Routes 1, 8, 10, 16, and 27 consists of several residential areas where many residences have driveways that provide direct access to the routes, thereby resulting in issues of sound wall discontinuity.

Noise abatement was analyzed for nine locations within the Central Region for Alternative 1 where predicted 2030 noise levels would cause an impact and existing topography conditions and future roadway alignment would not prevent the construction of continuous sound walls. The results of this noise abatement analysis are shown in Table 8.2-14 through Table 8.2-22. All barrier heights and locations are based on the latest available alignment information at the time of this study. These tables provide a summary of the barriers, the number of benefited residences, cost per benefited residence, and total cost per barrier. The 12 sound walls that were analyzed for noise impacts were for Areas 18, 23, 27, 34, 39, 43, 45, 49, and 53.

- Area 17: Outdoor use areas for 15 single- and multi-family residences within Area 17 would be impacted from traffic noise under Alternative 1. However, most of these residences have direct-access driveways to Route 1 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheets 20, 21, and 21 in Appendix G-2 show the location of Area 17.
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Table 8.2-14. Predicted Future Noise and Barrier Analysis for Area 18

REC. NO.	LAND USE[2]	FUTURE PEAK HOUR NOISE LEVELS, Leq(h), dBA[1, 4]														
		EXISTING	PROJECT "NO BUILD" WITHOUT BARRIER	PROJECT "BUILD" WITHOUT BARRIER	ACTIVITY CATEGORY and NAC ( )	IMPACT TYPE (A/E or NONE)[3]	NOISE PREDICTION WITH BARRIER AND BARRIER INSERTION LOSS (I.L.)									
							8 ft		10 ft		12 ft		14 ft		16 ft	
							Leq(h)	I.L.	Leq(h)	I.L.	Leq(h)	I.L.	Leq(h)	I.L.	Leq(h)	I.L.
Area 18																
R 10	REC	66	66	69	B (67)	A/E	62 R	7	61	8	61	8	60	9	60	9
R 11	REC	66	66	69	B (67)	A/E	61 R	8	60	9	58	11	58	11	57	12
R 12	REC	66	66	69	B (67)	A/E	64 R	5	63	6	63	6	63	6	63	6
Number of benefited receptors							10		10		10		10		10	
Total barrier cost							$338,880		$423,600		$508,320		$593,040		$677,760	
Cost per benefited receptor							$33,888		$42,360		$50,832		$59,304		$67,776	

Notes:

1 - Leq(h) are A-weighted, peak hour noise levels in decibels.
2 - Land Use: SFR - single-family residence; MFR multi-family residences; REC - Outdoor recreational areas.
3 - A/E = Approach or exceed NAC.
4 - Traffic noise from Route 1; other local noise sources are not included.
5 - Barrier height recommended to meet requirements of nearby receptor(s).
R - Recommended height to meet feasibility requirements of the Guam Public Works Noise Abatement Policy.
* - Second row residence.

Table 8.2-15. Predicted Future Noise and Barrier Analysis for Area 23

REC. NO.	LAND USE[2]	FUTURE PEAK HOUR NOISE LEVELS, Leq(h), dBA[1, 4]														
		EXISTING	PROJECT "NO BUILD" WITHOUT BARRIER	PROJECT "BUILD" WITHOUT BARRIER	ACTIVITY CATEGORY and NAC ( )	IMPACT TYPE (A/E or NONE)[3]	NOISE PREDICTION WITH BARRIER AND BARRIER INSERTION LOSS (I.L.)									
							8 ft		10 ft		12 ft		14 ft		16 ft	
							Leq(h)	I.L.	Leq(h)	I.L.	Leq(h)	I.L.	Leq(h)	I.L.	Leq(h)	I.L.
Area 23																
R 13	REC	70	70	70	B (67)	A/E	60 R	10	58	12	57	13	56	14	55	15
R 14	REC	66	66	67	B (67)	A/E	59 R	8	58	9	56	11	56	11	55	12
R 15	REC	66	66	67	B (67)	A/E	61 R	6	60	7	60	7	60	7	59	8
Number of benefited receptors							8		8		8		8		8	
Total barrier cost							$267,200		$334,000		$400,800		$467,600		$534,400	
Cost per benefited receptor							$33,400		$41,750		$50,100		$58,450		$66,800	

Notes:

1 - Leq(h) are A-weighted, peak hour noise levels in decibels.
2 - Land Use: SFR - single-family residence; MFR multi-family residences; REC - Outdoor recreational areas.
3 - A/E = Approach or exceed NAC.
4 - Traffic noise from Route 1; other local noise sources are not included.
5 - Barrier height recommended to meet requirements of nearby receptor(s).
R - Recommended height to meet feasibility requirements of the Guam Public Works Noise Abatement Policy.
* - Second row residence.

Table 8.2-16. Predicted Future Noise and Barrier Analysis for Area 27

REC. NO.	LAND USE[2]	FUTURE PEAK HOUR NOISE LEVELS, Leq(h), dBA[1, 4] EXISTING	PROJECT "NO BUILD" WITHOUT BARRIER	PROJECT "BUILD" WITHOUT BARRIER	ACTIVITY CATEGORY and NAC ( )	IMPACT TYPE (A/E or NONE)[3]	NOISE PREDICTION WITH BARRIER AND BARRIER INSERTION LOSS (I.L.) 8 ft Leq(h)	8 ft I.L.	10 ft Leq(h)	10 ft I.L.	12 ft Leq(h)	12 ft I.L.	14 ft Leq(h)	14 ft I.L.	16 ft Leq(h)	16 ft I.L.
Area 27																
R 16	REC	68	68	68	B (67)	A/E	61 R	7	59	9	59	9	58	10	57	11
R 17	REC	68	68	68	B (67)	A/E	60 R	8	58	10	57	11	55	13	55	13
R 18	REC	68	68	68	B (67)	A/E	62 R	6	61	7	61	7	60	8	60	8
Number of benefited receptors							12		12		12		12		12	
Total barrier cost							$404,160		$505,200		$606,240		$707,280		$808,320	
Cost per benefited receptor							$33,680		$42,100		$50,520		$58,940		$67,360	

Notes:
1 - Leq(h) are A-weighted, peak hour noise levels in decibels.
2 - Land Use: SFR - single-family residence; MFR multi-family residences; REC - Outdoor recreational areas.
3 - A/E = Approach or exceed NAC.
4 - Traffic noise from Route 1; other local noise sources are not included.
5 - Barrier height recommended to meet requirements of nearby receptor(s).
R - Recommended height to meet feasibility requirements of the Guam Public Works Noise Abatement Policy.
* - Second row residence.

Table 8.2-17. Predicted Future Noise and Barrier Analysis for Area 34

REC. NO.	LAND USE[2]	FUTURE PEAK HOUR NOISE LEVELS, Leq(h), dBA[1, 4] EXISTING	PROJECT "NO BUILD" WITHOUT BARRIER	PROJECT "BUILD" WITHOUT BARRIER	ACTIVITY CATEGORY and NAC ( )	IMPACT TYPE (A/E or NONE)[3]	NOISE PREDICTION WITH BARRIER AND BARRIER INSERTION LOSS (I.L.) 8 ft Leq(h)	8 ft I.L.	10 ft Leq(h)	10 ft I.L.	12 ft Leq(h)	12 ft I.L.	14 ft Leq(h)	14 ft I.L.	16 ft Leq(h)	16 ft I.L.
Area 34																
R 19	REC	67	68	71	B (67)	A/E	64 R	7	63	8	63	8	62	9	62	9
R 20	REC	67	68	71	B (67)	A/E	62 R	9	61	10	60	11	59	12	58	13
R 21	REC	67	68	71	B (67)	A/E	63 R	8	61	10	60	11	59	12	59	12
Number of benefited receptors							8		8		8		8		8	
Total barrier cost							$267,840		$334,800		$401,760		$468,720		$535,680	
Cost per benefited receptor							$33,480		$41,850		$50,220		$58,590		$66,960	

Notes:
1 - Leq(h) are A-weighted, peak hour noise levels in decibels.
2 - Land Use: SFR - single-family residence; MFR multi-family residences; REC - Outdoor recreational areas.
3 - A/E = Approach or exceed NAC.
4 - Traffic noise from Route 1; other local noise sources are not included.
5 - Barrier height recommended to meet requirements of nearby receptor(s).
R - Recommended height to meet feasibility requirements of the Guam Public Works Noise Abatement Policy.
* - Second row residence.

Table 8.2-18. Predicted Future Noise and Barrier Analysis for Area 39

REC. NO.	LAND USE[2]	FUTURE PEAK HOUR NOISE LEVELS, Leq(h), dBA[1, 4] EXISTING	PROJECT "NO BUILD" WITHOUT BARRIER	PROJECT "BUILD" WITHOUT BARRIER	ACTIVITY CATEGORY and NAC ( )	IMPACT TYPE (A/E or NONE)[3]	NOISE PREDICTION WITH BARRIER AND BARRIER INSERTION LOSS (I.L.) 8 ft Leq(h)	8 ft I.L.	10 ft Leq(h)	10 ft I.L.	12 ft Leq(h)	12 ft I.L.	14 ft Leq(h)	14 ft I.L.	16 ft Leq(h)	16 ft I.L.
Area 39																
R 22	SFR	62	68	71	B (67)	A/E	62 R	9	60	11	59	12	58	13	57	14
R 23	SFR	61	67	70	B (67)	A/E	61 R	9	60	10	59	11	58	12	57	13
R 24	SFR	62	68	71	B (67)	A/E	62 R	9	61	10	59	12	58	13	57	14
R 25	SFR	62	68	71	B (67)	A/E	62 R	9	61	10	59	12	58	13	58	13
R 26	SFR	62	68	71	B (67)	A/E	64 R	7	63	8	62	9	62	9	62	9
Number of benefited receptors							33		33		33		33		33	
Total barrier cost							$631,680		$789,600		$947,520		$1,105,440		$1,263,360	
Cost per benefited receptor							$19,142		$23,927		$28,713		$33,498		$38,284	

Notes:

1 - Leq(h) are A-weighted, peak hour noise levels in decibels.
2 - Land Use: SFR - single-family residence; MFR multi-family residences; REC - Outdoor recreational areas.
3 - A/E = Approach or exceed NAC.
4 - Traffic noise from Route 1; other local noise sources are not included.
5 - Barrier height recommended to meet requirements of nearby receptor(s).
R - Recommended height to meet feasibility requirements of the Guam Public Works Noise Abatement Policy.
* - Second row residence.

Table 8.2-19. Predicted Future Noise and Barrier Analysis for Area 43

REC. NO.	LAND USE[2]	FUTURE PEAK HOUR NOISE LEVELS, Leq(h), dBA[1, 4] EXISTING	PROJECT "NO BUILD" WITHOUT BARRIER	PROJECT "BUILD" WITHOUT BARRIER	ACTIVITY CATEGORY and NAC ( )	IMPACT TYPE (A/E or NONE)[3]	NOISE PREDICTION WITH BARRIER AND BARRIER INSERTION LOSS (I.L.) 8 ft Leq(h)	8 ft I.L.	10 ft Leq(h)	10 ft I.L.	12 ft Leq(h)	12 ft I.L.	14 ft Leq(h)	14 ft I.L.	16 ft Leq(h)	16 ft I.L.
Area 43																
R 27	SFR	63	65	66	B (67)	A/E	59	7	58	8	57 R	9	57	9	57	9
R 28	SFR	63	65	66	B (67)	A/E	58	8	56	10	55 R	11	54	12	53	13
R 29	SFR	63	65	66	B (67)	A/E	57	9	56	10	54 R	12	53	13	52	14
R 30	SFR	63	65	66	B (67)	A/E	57	9	56	10	54 R	12	53	13	52	14
R 31	SFR	61	63	64	B (67)	NONE	57	7	55	9	54 R	10	53	11	53	11
R 32	SFR	63	65	66	B (67)	A/E	60	6	59	7	59 R	7	59	7	59	7
Number of benefited receptors							18		22		29		29		29	
Total barrier cost							$447,040		$558,800		$670,560		$782,320		$894,080	
Cost per benefited receptor							$24,836		$25,400		$23,123		$26,977		$30,830	

Notes:

1 - Leq(h) are A-weighted, peak hour noise levels in decibels.
2 - Land Use: SFR - single-family residence; MFR multi-family residences; REC - Outdoor recreational areas.
3 - A/E = Approach or exceed NAC.
4 - Traffic noise from Route 1; other local noise sources are not included.
5 - Barrier height recommended to meet requirements of nearby receptor(s).
R - Recommended height to meet feasibility requirements of the Guam Public Works Noise Abatement Policy.
* - Second row residence.

Table 8.2-20. Predicted Future Noise and Barrier Analysis for Area 45

REC. NO.	LAND USE[2]	FUTURE PEAK HOUR NOISE LEVELS, Leq(h), dBA[1, 4] EXISTING	PROJECT "NO BUILD" WITHOUT BARRIER	PROJECT "BUILD" WITHOUT BARRIER	ACTIVITY CATEGORY and NAC ( )	IMPACT TYPE (A/E or NONE)[3]	NOISE PREDICTION WITH BARRIER AND BARRIER INSERTION LOSS (I.L.) 8 ft Leq(h)	8 ft I.L.	10 ft Leq(h)	10 ft I.L.	12 ft Leq(h)	12 ft I.L.	14 ft Leq(h)	14 ft I.L.	16 ft Leq(h)	16 ft I.L.
Area 45																
R 33	REC	63	66	67	B (67)	A/E	59 R	8	57	10	56	11	55	12	54	13
R 34	REC	63	66	67	B (67)	A/E	59 R	8	57	10	56	11	55	12	54	13
R 35	REC	63	66	67	B (67)	A/E	58 R	9	57	10	55	12	54	13	54	13
R 36	REC	63	66	66	B (67)	A/E	58 R	8	56	10	55	11	54	12	53	13
R 37	REC	63	65	67	B (67)	A/E	59 R	8	57	10	56	11	55	12	54	13
R 38	REC	63	66	67	B (67)	A/E	59 R	8	57	10	56	11	56	11	55	12
						Number of benefited receptors	28		28		28		28		28	
						Total barrier cost	$932,160		$1,165,200		$1,398,240		$1,631,280		$1,864,320	
						Cost per benefited receptor	$33,291		$41,614		$49,937		$58,260		$66,583	

Notes:
1 - Leq(h) are A-weighted, peak hour noise levels in decibels.
2 - Land Use: SFR - single-family residence; MFR multi-family residences; REC - Outdoor recreational areas.
3 - A/E = Approach or exceed NAC.
4 - Traffic noise from Route 1; other local noise sources are not included.
5 - Barrier height recommended to meet requirements of nearby receptor(s).
R - Recommended height to meet feasibility requirements of the Guam Public Works Noise Abatement Policy.
* - Second row residence.

Table 8.2-21. Predicted Future Noise and Barrier Analysis for Area 49

REC. NO.	LAND USE[2]	FUTURE PEAK HOUR NOISE LEVELS, Leq(h), dBA[1, 4] EXISTING	PROJECT "NO BUILD" WITHOUT BARRIER	PROJECT "BUILD" WITHOUT BARRIER	ACTIVITY CATEGORY and NAC ( )	IMPACT TYPE (A/E or NONE)[3]	NOISE PREDICTION WITH BARRIER AND BARRIER INSERTION LOSS (I.L.) 8 ft Leq(h)	8 ft I.L.	10 ft Leq(h)	10 ft I.L.	12 ft Leq(h)	12 ft I.L.	14 ft Leq(h)	14 ft I.L.	16 ft Leq(h)	16 ft I.L.
Area 49																
R 39	SFR	63	65	66	B (67)	A/E	60	6	59	7	58 R	8	58	8	58	8
R 40	SFR	63	65	66	B (67)	A/E	59	7	58	8	57 R	9	56	10	56	10
R 41	SFR	63	65	66	B (67)	A/E	59	7	58	8	58 R	8	57	9	57	9
R 42	SFR	63	65	66	B (67)	A/E	59	7	58	8	57 R	9	57	9	57	9
R 43	SFR	63	65	66	B (67)	A/E	58	8	57	9	55 R	11	55	11	54	12
R 44	SFR	63	64	64	B (67)	NONE	57	7	56	8	55 R	9	54	10	54	10
						Number of benefited receptors	10		10		15		15		16	
						Total barrier cost	$338,240		$422,800		$507,360		$591,920		$676,480	
						Cost per benefited receptor	$33,824		$42,280		$33,824		$39,461		$42,280	

Notes:
1 - Leq(h) are A-weighted, peak hour noise levels in decibels.
2 - Land Use: SFR - single-family residence; MFR multi-family residences; REC - Outdoor recreational areas.
3 - A/E = Approach or exceed NAC.
4 - Traffic noise from Route 27; other local noise sources are not included.
5 - Barrier height recommended to meet requirements of nearby receptor(s).
R - Recommended height to meet feasibility requirements of the Guam Public Works Noise Abatement Policy.
* - Second row residence.

Table 8.2-22. Predicted Future Noise and Barrier Analysis for Area 53

REC. NO.	LAND USE[2]	FUTURE PEAK HOUR NOISE LEVELS, Leq(h), dBA[1, 4] EXISTING	PROJECT "NO BUILD" WITHOUT BARRIER	PROJECT "BUILD" WITHOUT BARRIER	ACTIVITY CATEGORY and NAC ( )	IMPACT TYPE (A/E or NONE)[3]	NOISE PREDICTION WITH BARRIER AND BARRIER INSERTION LOSS (I.L.) 8 ft Leq(h)	8 ft I.L.	10 ft Leq(h)	10 ft I.L.	12 ft Leq(h)	12 ft I.L.	14 ft Leq(h)	14 ft I.L.	16 ft Leq(h)	16 ft I.L.
Area 53																
R 45	REC	69	69	71	B (67)	A/E	64 R	7	63	8	62	9	62	9	61	10
R 46	REC	69	69	71	B (67)	A/E	62 R	9	60	11	59	12	58	13	57	14
R 47	REC	64	64	65	B (67)	NONE	60 R	5	60	5	59	6	59	6	59	6
Number of benefited receptors							10		10		10		10		10	
Total barrier cost							$249,600		$312,000		$374,400		$436,800		$499,200	
Cost per benefited receptor							$24,960		$31,200		$37,440		$43,680		$49,920	

Notes:

1 - Leq(h) are A-weighted, peak hour noise levels in decibels.
2 - Land Use: SFR - single-family residence; MFR multi-family residences; REC - Outdoor recreational areas.
3 - A/E = Approach or exceed NAC.
4 - Traffic noise from Route 8; other local noise sources are not included.
5 - Barrier height recommended to meet requirements of nearby receptor(s).
R - Recommended height to meet feasibility requirements of the Guam Public Works Noise Abatement Policy.
* - Second row residence.

- Area 18: Outdoor use areas for seven single-family residences within Area 18 that are impacted have direct-access driveways to Route 1 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. However, a sound wall 8 ft (2 m) in height and 1,060 ft (323 m) long located along the shoulder of the southbound side of Route 1 would provide feasible noise abatement for the 10 impacted frontage outdoor use areas for a park within Area 18 from traffic noise under Alternative 1. Furthermore, the cost per benefited receptor is $33,880, which is below the Guam DPW $35,000 cost per benefited receptor requirement for a sound wall to be considered reasonable. The results of the noise abatement analysis for this sound wall are shown in Table 8.2-14. Sheet 21 in Appendix G-2 shows the location of the sound wall for Area 18.
- Area 19: There are eight impacted frontage outdoor use areas for a park within Area 19 from traffic noise under Alternative 1. However, most of these outdoor use areas have parking lots with direct access to Route 1 next to them that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheets 22 and 23 in Appendix G-2 show the location of Area 19.
- Area 20: Outdoor use areas for two single- and two multi-family residences within Area 20 would be impacted from traffic noise under Alternative 1. However, these residences have direct-access driveways to Route 1 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheets 22 and 23 in Appendix G-2 show the location of Area 20.
- Area 21: Outdoor use areas for three single-family residences and three frontage outdoor use areas for a park within Area 21 would be impacted from traffic noise under Alternative 1. However, these residences have direct-access driveways to Route 1, and the park's outdoor use areas have parking with direct access to Route 1 next to them that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheet 23 in Appendix G-2 shows the location of Area 21.
- Area 22: Outdoor use areas for nine single- and multi-family residences and one frontage outdoor use area for a playground within Area 22 would be impacted from traffic noise under Alternative 1. However, building a sound wall for these scattered residences along the alignment would not be reasonable because the sound wall cost would exceed the cost per benefited receptor requirement. Sheets 23 and 24 in Appendix G-2 show the location of Area 22.
- Area 23: A sound wall 8 ft (2 m) in height and 835 ft (255 m) long located along the shoulder of the southbound side of Route 1 would provide feasible noise abatement for seven impacted frontage outdoor use areas for a park within Area 23 from traffic noise under Alternative 1. Furthermore, the cost per benefited receptor is $33,400, which is below the Guam DPW $35,000 cost per benefited receptor requirement for a sound wall to be considered reasonable. The results of the noise abatement analysis for this sound wall are shown in Table 8.2-15. Sheet 25 in Appendix G-2 shows the location of the sound wall for Area 23.
- Area 24: Outdoor use areas for three of the multi-family residences within Area 24 are impacted from traffic noise under Alternative 1. However, these residences have direct-access driveways to Route 1 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheet 25 in Appendix G-2 show the location of Area 24.
- Area 25: Outdoor use areas for two single-family residences and four frontage outdoor use areas for a park within Area 25 would be impacted from traffic noise under Alternative 1. However, these residences have direct-access driveways to Route 1, and the park's outdoor use areas have parking lots with direct access to Route 1 between them and the alignment that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheets 25 and 26 in Appendix G-2 show the location of Area 25.

- Area 26: There are six impacted frontage outdoor use areas for a cemetery within Area 26 from traffic noise under Alternative 1. However, most of these outdoor use areas have parking lots with direct access to Route 1 next to them that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheet 25 in Appendix G-2 shows the location of Area 26.
- Area 27: A sound wall 8 ft (2 m) in height and 1,265 ft (386 m) long located along the shoulder of the southbound side of Route 1 would provide feasible noise abatement for 12 impacted frontage outdoor use areas for a park within Area 27 from traffic noise under Alternative 1. Furthermore, the cost per benefited receptor is $33,680, which is below the Guam DPW $35,000 cost per benefited receptor requirement for a sound wall to be considered reasonable. The results of the noise abatement analysis for this sound wall are shown in Table 8.2-16. Sheet 27 in Appendix G-2 shows the location of the sound wall for Area 27.
- Area 28: There are two impacted frontage outdoor use areas for a park within Area 28 from traffic noise under Alternative 1. However, because there are only two impacted areas, a sound wall would have to be extended beyond the park's property to provide feasible abatement, which would exceed the cost per benefited receptor requirement. Sheet 28 in Appendix G-2 shows the location of Area 28.
- Area 29: There are four impacted frontage outdoor use areas for a park within Area 29 from traffic noise under Alternative 1. However, because there are only four impacted areas, a sound wall would have to be extended beyond the park's property to provide feasible abatement, which would exceed the cost per benefited receptor requirement. Sheets 28 and 29 in Appendix G-2 show the location of Area 29.
- Area 30: There are nine impacted frontage outdoor use areas for a park within Area 30 from traffic noise under Alternative 1. However, building a sound wall for these scattered areas along the alignment would not be reasonable because the sound wall cost would exceed the cost per benefited receptor requirement. Sheets 29, 30, and 31 in Appendix G-2 show the location of Area 30.
- Area 31: There are four impacted frontage outdoor use areas for a park within Area 31 from traffic noise under Alternative 1. However, because there are only four impacted areas, a sound wall would have to be extended beyond the park's property to provide feasible abatement, which would exceed the cost per benefited receptor requirement. Sheet 32 in Appendix G-2 shows the location of Area 31.
- Area 32: Outdoor use areas for four of the multi-family residences within Area 32 are impacted from traffic noise under Alternative 1. However, these residences have direct-access driveways to Route 1 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheet 33 in Appendix G-2 show the location of Area 32.
- Area 34: A sound wall 8 ft (2 m) in height and 840 ft (256 m) long located along the shoulder of the southbound side of Route 1 would provide feasible noise abatement for eight impacted frontage outdoor use areas for a school within Area 34 from traffic noise under Alternative 1. Furthermore, the cost per benefited receptor is $33,480, which is below the Guam DPW $35,000 cost per benefited receptor requirement for a sound wall to be considered reasonable. The results of the noise abatement analysis for this sound wall are shown in Table 8.2-17. Sheet 35 in Appendix G-2 shows the location of the sound wall for Area 34.
- Area 35: Outdoor use areas for 11 multi-family residences and four frontage outdoor use areas for a park within Area 35 would be impacted from traffic noise under Alternative 1. However, these residences have direct-access driveways to Route 1, and the park's outdoor use areas have parking lots with direct access to Route 1 next to them that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheets 35 and 36 in Appendix G-2 show the location of Area 35.

- Area 36: A park with four frontage outdoor use areas and two churches within Area 36 would be impacted from traffic noise under Alternative 1. However, the churches have direct-access driveways to Route 1, and the park's outdoor use areas have parking lots between them and the alignment with direct access to Route 1 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheets 36 and 37 in Appendix G-2 show the location of Area 36.
- Area 38: There is one impacted frontage outdoor use areas for a church within Area 38 from traffic noise under Alternative 1. However, the church has a direct-access driveway to Route 1 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheet 38 in Appendix G-2 shows the location of Area 38.
- Area 39: A sound wall 8 ft (2 m) in height and 1,975 ft (602 m) long located along the shoulder of the southbound side of Route 1 would provide feasible noise abatement for 33 outdoor use areas for single-family residences within Area 39 from traffic noise under Alternative 1. Of the 33 benefited outdoor use areas, 20 are first-row residences that are impacted and 13 are second-row residences that are not impacted but are receiving a 5-dB noise reduction due to the recommended sound wall. Furthermore, the cost per benefited receptor is $19,142, which is below the Guam DPW $35,000 cost per benefited receptor requirement for a sound wall to be considered reasonable. The results of the noise abatement analysis for this sound wall are shown in Table 8.2-18. Sheets 39 and 40 in Appendix G-2 show the location of the sound wall for Area 39.
- Area 43: Two sound walls 12 ft (4 m) in height and 1,400 ft (427 m) in total length located along the shoulder of the southbound side of Route 1 would provide feasible noise abatement for 29 outdoor use areas for single-family residences within Area 43 from traffic noise under Alternative 1. Furthermore, the cost per benefited receptor is $23,123, which is below the Guam DPW $35,000 cost per benefited receptor requirement for a sound wall to be considered reasonable. Of the 29 benefited outdoor use areas, 18 are first-row residences that are impacted and 11 are second-row residences that are not impacted but are receiving a 5-dB noise reduction due to the recommended sound walls. The results of the noise abatement analysis for this sound wall are shown in Table 8.2-19. Sheets 41 and 42 in Appendix G-2 show the location of the sound wall for Area 43.
- Area 45: Two sound walls 8 ft (2 m) in height and 2,915 ft (888 m) in total length located along the shoulder of the southbound side of Route 1 would provide feasible noise abatement for 28 impacted frontage outdoor use areas for a park within Area 45 from traffic noise under Alternative 1. Furthermore, the cost per benefited receptor is $33,291, which is below the Guam DPW $35,000 cost per benefited receptor requirement for a sound wall to be considered reasonable. The results of the noise abatement analysis for this sound wall are shown in Table 8.2-20. Sheets 42, 43, and 44 in Appendix G-2 show the location of Area 45.
- Area 47: Outdoor use areas for 12 single-family residences within Area 47 would be impacted from traffic noise under Alternative 1. However, most of these residences have direct-access driveways to Route 1 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. In addition, building a sound wall for these scattered residences along the alignment would not be reasonable because the sound wall cost would exceed the cost per benefited receptor requirement. Sheet 46 in Appendix G-2 shows the location of Area 47.
- Area 48: Outdoor use areas for nine single- and multi-family residences within Area 48 would be impacted from traffic noise under Alternative 1. However, most of these residences have direct-access driveways to Route 1 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheet 48 in Appendix G-2 shows the location of Area 48.
- Area 49: Two sound walls 12 ft (4 m) in height and 1,060 ft (323 m) in total length located along the shoulder of the southbound side of Route 27 would provide feasible noise abatement for 15 outdoor

use areas for single-family residences within Area 49 from traffic noise under Alternative 1. Of the 15 benefited outdoor use areas, 10 are first-row residences that are impacted and five are second-row residences that are not impacted but are receiving a 5-dB noise reduction due to the recommended sound walls. Furthermore, the cost per benefited receptor is $33,824, which is below the Guam DPW $35,000 cost per benefited receptor requirement for a sound wall to be considered reasonable. The results of the noise abatement analysis for this sound wall are shown in Table 8.2-21. Sheets 50 and 51 in Appendix G-2 show the location of Area 49.

- Area 50: An outdoor sports complex within Area 50 would have nine frontage outdoor use areas that would be impacted from traffic noise under Alternative 1. However, most of these areas have parking lots between them and the alignment with direct access to Route 27 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheets 50 and 51 in Appendix G-2 show the location of Area 50.
- Area 52: Outdoor use areas for eight multi-family residences and a motel within Area 52 would be impacted from traffic noise under Alternative 1. However, most of these residences and motel have direct-access driveways to Route 8 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheet 53 in Appendix G-2 shows the location of Area 52.
- Area 53: A sound wall 8 ft (2 m) in height and 780 ft (238 m) long located along the shoulder of the northbound side of Route 8 would provide feasible noise abatement for 10 outdoor use areas for multi-family residences within Area 53 from traffic noise under Alternative 1. Furthermore, the cost per benefited receptor is $24,960, which is above the Guam DPW $35,000 cost per benefited receptor requirement for a sound wall to be considered reasonable. The results of the noise abatement analysis for this sound wall are shown in Table 8.2-22. Sheet 53 in Appendix G-2 shows the location of Area 53.
- Area 55: Outdoor use area for one single-family residence within Area 55 would be impacted from traffic noise under Alternative 1. However, because there is only one impacted residence, a sound wall would have to be extended beyond the residence's property to provide feasible abatement, which would exceed the cost per benefited receptor requirement. Sheet 56 in Appendix G-2 shows the location of Area 55.
- Area 56: Outdoor use areas for 11 single- and multi-family residences within Area 56 would be impacted from traffic noise under Alternative 1. However, most of these residences have direct-access driveways to Route 8 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. In addition, building a sound wall for these scattered residences along the alignment would not be reasonable because the sound wall cost would exceed the cost per benefited receptor requirement. Sheets 57 and 58 in Appendix G-2 show the location of Area 56.
- Area 57: Outdoor use areas for 11 single- and multi-family residences within Area 57 would be impacted from traffic noise under Alternative 1. However, most of these residences have direct-access driveways to Route 16 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. In addition, building a sound wall for these scattered residences along the alignment would not be reasonable because the sound wall cost would exceed the cost per benefited receptor requirement. Sheets 59 and 60 in Appendix G-2 show the location of Area 57.
- Area 59: Outdoor use areas for six single-family residences within Area 59 would be impacted from traffic noise under Alternative 1. However, most of these residences have direct-access driveways to Route 16 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheet 62 in Appendix G-2 shows the location of Area 59.

- Area 60: Outdoor use areas for three single-family residences within Area 60 would be impacted from traffic noise under Alternative 1. However, these residences have direct-access driveways to Route 8 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheet 63 in Appendix G-2 show the location of Area 60.
- Area 61: A funeral home and the outdoor use areas for seven single- and multi-family residences within Area 61 would be impacted from traffic noise under Alternative 1. However, most of these residences, as well as the funeral home, have direct-access driveways to Route 16 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheets 63 and 64 in Appendix G-2 show the location of Area 61.
- Area 63: Outdoor use areas for 23 single- and multi-family residences and a church within Area 63 would be impacted from traffic noise under Alternative 1. However, most of these residences, as well as the church, have direct-access driveways to Route 10 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. In addition, building a sound wall for these scattered residences along the alignment would not be reasonable because the sound wall cost would exceed the cost per benefited receptor requirement. Sheets 67, 68, and 69 in Appendix G-2 show the location of Area 63.
- Area 64: Outdoor use areas for 18 single- and four multi-family residences within Area 64 would be impacted from traffic noise under Alternative 1. However, most of these residences have direct-access driveways to Route 10 that would prevent the construction of a continuous sound wall required to provide feasible noise abatement. Sheets 67, 68, and 69 in Appendix G-2 show the location of Area 64.

Apra Harbor

Since there are no noise-sensitive receptors along the proposed roadway improvement projects within the Apra Harbor Region, no noise abatement modeling was performed for traffic noise under Alternative 1.

South

While there are noise-sensitive land uses along routes in the South Region, noise from traffic would not impact the noise-sensitive land uses under Alternative 1. Therefore, noise abatement modeling was not performed.

8.2.6.2 Alternative 2 (Preferred Alternative)

<u>Year 2014 (Peak Construction and Peak Population)</u>

Construction impacts and abatement measures of Alternative 2 are similar to those described under Alternative 1.

<u>Year 2030</u>

Results of the noise impact analysis indicate that under Alternative 2 noise impacts and abatement measures for each Region is similar to those described under Alternative 1.

8.2.6.3 Alternative 3

<u>Year 2014 (Peak Construction and Peak Population)</u>

Construction impacts and abatement measures of Alternative 3 are similar to those described under Alternative 1.

Year 2030

North

Under Alternative 3, potential noise impacts to noise-sensitive receptors would be the same as Alternative 1 for the North Region, even though there was a significant increase to the future traffic volume for GRN #8 and 9. There are 88 noise receptors that would experience sound levels approaching or exceeding the NAC of 66 dBA. The type and number of impacted noise-sensitive receptors are described in the North Region subsection of Alternative 1, except for the following noise sensitive sites that have updated sheets to show the change in the 66-dBA noise contour line due to the increased traffic volume for GRN# 8 and 9:

- Area 1: Outdoor use areas for 16 single-family residences and one church within Area 1 would be impacted from traffic noise under Alternative 1. Sheets 1B and 2B in Appendix G-2 show the location of Area 1.
- Area 2: None of the outdoor use areas for the multi-family residences within Area 2 would be impacted from traffic noise under Alternative 1. Sheet 4B in Appendix G-2 shows the location of Area 2.
- Area 3: Outdoor use areas for two single-family residences within Area 3 would be impacted from traffic noise under Alternative 1. Sheets 3B and 4B in Appendix G-2 show the location of Area 3.
- Area 4: Outdoor use areas for four single-family residences within Area 4 would be impacted from traffic noise under Alternative 1. Sheets 4B and 5B in Appendix G-2 show the location of Area 4.

Central

Under Alternative 3, potential noise impacts to noise-sensitive receptors for the Central Region would be the same as Alternative 1, even though there was a significant increase to the future traffic volume for GRN #18 and 19. There are 378 noise receptors that would experience sound levels approaching or exceeding the NAC of 66 dBA. The type and number of impacted noise sensitive receptors are described in the Central Region subsection of Alternative 1, except for the following noise-sensitive sites that have updated sheets to show the change in the 66-dBA noise contour line due to the increased traffic volume for GRN #18 and 19:

- Area 60: Outdoor use areas for three single-family residences within Area 60 would be impacted from traffic noise under Alternative 1. Sheet 63B in Appendix G-2 shows the location of Area 60.
- Area 61: A funeral home and the outdoor use areas for seven single- and multi-family residences within Area 61 would be impacted from traffic noise under Alternative 1. Sheets 65B and 66B in Appendix G-2 show the location of Area 61.
- Area 62: None of the multi-family residences outdoor use areas within Area 62 would be impacted from traffic noise under Alternative 1. Sheets 65B and 66B in Appendix G-2 show the location of Area 62.

Apra Harbor

Since there are no noise-sensitive receptors along the proposed roadway improvement projects within the Apra Harbor Region, no impacts from traffic noise under Alternative 3 would occur.

South

While there are noise-sensitive land uses along routes in the South Region, noise from traffic would not impact the noise sensitive land uses under Alternative 3.

<u>Abatement Measures</u>

North

Noise abatement analysis results within the North Region for Alternative 3 are the same as Alternative 1.

Central

Noise abatement analysis results within the Central Region for Alternative 3 are the same as Alternative 1.

Apra Harbor

Since there are no noise-sensitive receptors along the proposed roadway improvement projects within the Apra Harbor Region, no noise abatement modeling was performed for traffic noise under Alternative 3.

South

While there are noise-sensitive land uses along routes in the South Region, noise from traffic would not impact the noise-sensitive land uses under Alternative 3; therefore, noise abatement modeling was not performed.

8.2.6.4 Alternative 8

<u>Year 2014 (Peak Construction and Peak Population)</u>

Construction impacts and abatement measures of Alternative 2 are similar to those described under Alternative 1.

<u>Year 2030</u>

Noise impacts and abatement measures under Alternative 8 for each Region are similar to those described under Alternative 3.

8.2.6.5 No-Action Alternative

<u>2009</u>

There would be no specific construction for this alternative besides regular scheduled roadway maintenance work. Traffic noise levels would be as measured and calculated for the existing conditions.

<u>2014</u>

There would be no specific construction for this alternative besides regular scheduled roadway maintenance work. Traffic noise levels would be slightly higher than the measured and calculated for the existing conditions as a result of growth in traffic volumes.

<u>2030</u>

North

Under the no-action alternative, potential noise impacts to noise-sensitive receptors were assessed for 16 representative areas within the North Region, and the number of impacts per area is shown in Table 8.2-9. There are 49 noise-sensitive receptors that would experience sound levels approaching or exceeding the NAC of 66 dBA. The type and number of impacted noise sensitive receptors for each area are described in the following text:

- Area 1: Outdoor use areas for 16 single-family residences and one church within Area 1 would be impacted from traffic noise under the no-action alternative. Sheets 1 and 2 in Appendix G-2 show the location of Area 1.
- Area 2: None of the outdoor use areas for the multi-family residences within Area 2 would be impacted from traffic noise under the no-action alternative. Sheet 4 in Appendix G-2 shows the location of Area 2.
- Area 3: None of the outdoor use areas for the single-family residences within Area 3 would be impacted from traffic noise under the no-action alternative. Sheets 3 and 4 in Appendix G-2 show the location of Area 3.
- Area 4: None of the outdoor use areas for the single-family residences within Area 4 would be impacted from traffic noise under the no-action alternative. Sheets 4 and 5 in Appendix G-2 show the location of Area 4.
- Area 5: None of the outdoor use areas for the single- and multi-family residences within Area 5 would be impacted from traffic noise under the no-action alternative. Sheets 5, 6, and 7 in Appendix G-2 show the location of Area 5.
- Area 6: This area represents a military outdoor physical training site and has four frontage outdoor use areas. None of the military outdoor physical training areas within Area 6 would be impacted from traffic noise under the no-action alternative. Sheet 6 in Appendix G-2 shows the location of Area 6.
- Area 7: None of the outdoor use areas for the single-family residences within Area 7 would be impacted from traffic noise under the no-action alternative. Sheets 7 and 8 in Appendix G-2 show the location of Area 7.
- Area 8: This area represents a military outdoor recreational site and has 12 frontage outdoor use areas. None of the military outdoor recreational areas within Area 8 would be impacted from traffic noise under the no-action alternative. Sheets 7 and 8 in Appendix G-2 show the location of Area 8.
- Area 9: None of the outdoor use areas for the single-family residences and the golf course within Area 9 would be impacted from traffic noise under the no-action alternative. Sheets 9, 10, and 11 in Appendix G-2 show the location of Area 9.
- Area 10: None of the outdoor use areas for the single-family residences within Area 10 would be impacted from traffic noise under the no-action alternative. Sheets 11 and 12 in Appendix G-2 show the location of Area 10.
- Area 11: None of the outdoor use areas for the single- and multi-family residences or the school within Area 11 would be impacted from traffic noise under the no-action alternative. Furthermore, none of the schools indoor use areas would be impacted from noise under the no-action alternative. Sheets 12, 13, and 14 in Appendix G-2 show the location of Area 11.
- Area 12: Outdoor use areas for seven single-family residences within Area 12 would be impacted from traffic noise under the no-action alternative. Sheets 15 and 16 in Appendix G-2 show the location of Area 12.
- Area 13: Outdoor use areas for four single-family residences within Area 13 would be impacted from traffic noise under the no-action alternative. Sheets 15, 16, and 17 in Appendix G-2 show the location of Area 13.
- Area 14: Outdoor use areas for seven single- and four multi-family residences within Area 14 would be impacted from traffic noise under the no-action alternative. Sheets 17, 18, and 19 in Appendix G-2 show the location of Area 14.

- Area 15: This area represents a school and has three frontage outdoor use receptors. None of the school's outdoor recreational areas or its indoor use areas within Area 15 would be impacted from traffic noise under the no-action alternative. Sheet 18 in Appendix G-2 shows the location of Area 15.
- Area 16: Outdoor use areas for nine single-family residences and one church within Area 16 would be impacted from traffic noise under the no-action alternative. Sheet 19 in Appendix G-2 shows the location of Area 16.

Central

Under the no-action alternative, potential noise impacts to noise-sensitive receptors were assessed for 48 representative areas within the Central Region, and the number of impacts per area is shown in Table 8.2-10. There are 342 noise-sensitive receptors that would experience sound levels approaching or exceeding the NAC of 66 dBA. The type and number of impacted noise-sensitive receptors for each area are described in the following text:

- Area 17: Outdoor use areas for 13 single- and two multi-family residences within Area 17 would be impacted from traffic noise under the no-action alternative. Sheets 20, 21, and 22 in Appendix G-2 show the location of Area 17.
- Area 18: Outdoor use areas for seven single-family residences and 10 frontage outdoor use areas for a park within Area 18 would be impacted from traffic noise under the no-action alternative. Sheets 20, 21, and 22 in Appendix G-2 show the location of Area 18.
- Area 19: None of the frontage outdoor use areas for a park within Area 19 would be impacted from traffic noise under the no-action alternative. Sheets 22 and 23 in Appendix G-2 show the location of Area 19.
- Area 20: Outdoor use areas for two single- and two multi-family residences within Area 20 would be impacted from traffic noise under the no-action alternative. Sheets 22 and 23 in Appendix G-2 show the location of Area 20.
- Area 21: Outdoor use areas for one single- and two multi-family residences within Area 21 would be impacted from traffic noise under the no-action alternative. Sheet 23 in Appendix G-2 shows the location of Area 21.
- Area 22: Outdoor use areas for seven single- and two multi-family residences, as well as one frontage outdoor use area for a playground, within Area 22 would be impacted from traffic noise under the no-action alternative. Sheets 23 and 24 in Appendix G-2 show the location of Area 22.
- Area 23: Outdoor use area for one single-family residence and three frontage outdoor use areas for a park within Area 23 would be impacted from traffic noise under the no-action alternative. Sheets 24 and 25 in Appendix G-2 show the location of Area 23.
- Area 24: Outdoor use areas for three multi-family residences within Area 24 would be impacted from traffic noise under the no-action alternative. Sheet 25 in Appendix G-2 shows the location of Area 24.
- Area 25: Outdoor use areas for two single-family residences within Area 25 would be impacted from traffic noise under the no-action alternative. Sheets 25 and 26 in Appendix G-2 show the location of Area 25.
- Area 26: None of the six frontage outdoor use areas for a cemetery within Area 26 would be impacted from traffic noise under the no-action alternative. Sheet 25 in Appendix G-2 shows the location the location of Area 26.
- Area 27: A park within Area 27 would have 11 frontage outdoor use areas that would be impacted from traffic noise under the no-action alternative. Sheets 27 and 28 in Appendix G-2 show the location of Area 27.

- Area 28: A park within Area 28 would have two frontage outdoor use areas that would be impacted from traffic noise under the no-action alternative. Sheet 28 in Appendix G-2 shows the location of Area 28.
- Area 29: A park within Area 29 would have four frontage outdoor use areas that would be impacted from traffic noise under the no-action alternative. Sheets 28 and 29 in Appendix G-2 show the location of Area 29.
- Area 30: A park within Area 30 would have nine frontage outdoor use areas that would be impacted from traffic noise under the no-action alternative. Sheets 29, 30, and 31 in Appendix G-2 show the location of Area 30.
- Area 31: A park within Area 31 would have four frontage outdoor use areas that would be impacted from traffic noise under the no-action alternative. Sheet 32 in Appendix G-2 shows the location of Area 31.
- Area 32: Outdoor use areas for four multi-family residences within Area 32 would be impacted from traffic noise under the no-action alternative. Sheet 33 in Appendix G-2 shows the location of Area 32.
- Area 33: None of the multi-family residences outdoor use areas within Area 33 would be impacted from traffic noise under the no-action alternative. Sheet 34 in Appendix G-2 shows the location of Area 33.
- Area 34: A school within Area 34 would have eight frontage outdoor use areas that would be impacted from traffic noise under the no-action alternative; however, none of the school's indoor use areas would be impacted from traffic noise under the no-action alternative. Sheets 34 and 35 in Appendix G-2 show the location of Area 34.
- Area 35: Outdoor use areas for 11 multi-family residences and four frontage outdoor use areas for a park within Area 35 would be impacted from traffic noise under the no-action alternative. Sheets 35 and 36 in Appendix G-2 show the location of Area 35.
- Area 36: A park with four frontage outdoor use areas and two churches within Area 36 would be impacted from traffic noise under the no-action alternative. Sheets 36 and 37 in Appendix G-2 show the location of Area 36.
- Area 37: None of the multi-family residences outdoor use areas within Area 37 would be impacted from traffic noise under the no-action alternative. Sheets 37 and 38 in Appendix G-2 show the location of Area 37.
- Area 38: None of the multi-family residences outdoor use areas and one frontage outdoor use areas for a church within Area 38 would be impacted from traffic noise under the no-action alternative. Sheet 38 in Appendix G-2 shows the location of Area 38.
- Area 39: Outdoor use areas for 21 single-family residences within Area 39 would be impacted from traffic noise under the no-action alternative. Sheets 39 and 40 in Appendix G-2 show the location of Area 39.
- Area 40: None of the multi-family residences outdoor use areas within Area 40 would be impacted from traffic noise under the no-action alternative. Sheet 41 in Appendix G-2 shows the location of Area 40.
- Area 41: None of the single-family residences outdoor use areas within Area 41 would be impacted from traffic noise under the no-action alternative. Sheet 41 in Appendix G-2 shows the location of Area 41.
- Area 42: None of the single-family residences outdoor use areas within Area 42 would be impacted from traffic noise under the no-action alternative. Sheets 41 and 42 in Appendix G-2 show the location of Area 42.

- Area 43: Outdoor use areas for 18 single-family residences within Area 43 would be impacted from traffic noise under the no-action alternative. Sheet 42 in Appendix G-2 shows the location of Area 43.
- Area 44: None of the single-family residences outdoor use areas within Area 44 would be impacted from traffic noise under the no-action alternative. Sheet 42 in Appendix G-2 shows the location of Area 44.
- Area 45: A park within Area 45 would have 30 frontage outdoor use areas that would be impacted from traffic noise under the no-action alternative. Sheets 42, 43, and 44 in Appendix G-2 show the location of Area 45.
- Area 46: None of the single-family residences outdoor use areas within Area 46 would be impacted from traffic noise under the no-action alternative. Sheet 44 in Appendix G-2 shows the location of Area 46.
- Area 47: Outdoor use areas for 12 single-family residences within Area 47 would be impacted from traffic noise under the no-action alternative. Sheet 46 in Appendix G-2 shows the location of Area 47.
- Area 48: Outdoor use areas for seven single within Area 48 would be impacted from traffic noise under the no-action alternative. Sheet 48 in Appendix G-2 shows the location of Area 48.
- Area 49: Outdoor use areas for 17 single- and four multi-family residences within Area 49 would be impacted from traffic noise under the no-action alternative. Sheets 50 and 51 in Appendix G-2 show the location of Area 49.
- Area 50: An outdoor sports complex within Area 50 would have nine frontage outdoor use areas that would be impacted from traffic noise under the no-action alternative. Sheets 50 and 51 in Appendix G-2 show the location of Area 50.
- Area 51: None of the recreational outdoor use areas or indoor use areas for a school within Area 51 would be impacted from traffic noise under the no-action alternative. Sheet 51 in Appendix G-2 shows the location of Area 51.
- Area 52: Outdoor use areas for eight multi-family residences within Area 52 would be impacted from traffic noise under the no-action alternative. Sheet 53 in Appendix G-2 shows the location of Area 52.
- Area 53: Outdoor use areas for 10 multi-family residences within Area 53 would be impacted from traffic noise under the no-action alternative. Sheet 53 in Appendix G-2 shows the location of Area 53.
- Area 54: None of the multi-family residences outdoor use areas within Area 54 would be impacted from traffic noise under the no-action alternative. Sheet 54 in Appendix G-2 shows the location of Area 54.
- Area 55: Outdoor use area for one single-family residence within Area 55 would be impacted from traffic noise under the no-action alternative. Sheet 56 in Appendix G-2 shows the location of Area 55.
- Area 56: Outdoor use areas for nine single- and two multi-family residences within Area 56 would be impacted from traffic noise under the no-action alternative. Sheets 57 and 58 in Appendix G-2 show the location of Area 56.
- Area 57: Outdoor use areas for 10 single- and one multi-family residence within Area 57 would be impacted from traffic noise under the no-action alternative. Sheets 59 and 60 in Appendix G-2 show the location of Area 57.
- Area 58: None of the 28 frontage outdoor use areas for a military outdoor recreational area within Area 58 would be impacted from traffic noise under the no-action alternative. Sheets 59 and 60 in Appendix G-2 show the location of Area 58.
- Area 59: Outdoor use areas for six single-family residences within Area 59 would be impacted from traffic noise under the no-action alternative. Sheet 62 in Appendix G-2 shows the location of Area 59.

- Area 60: Outdoor use areas for three single-family residences within Area 60 would be impacted from traffic noise under the no-action alternative. Sheet 63 in Appendix G-2 shows the location of Area 60.
- Area 61: Outdoor use areas for five single- and two multi-family residences within Area 61 would be impacted from traffic noise under the no-action alternative. Sheets 63 and 64 in Appendix G-2 show the location of Area 61.
- Area 62: None of the multi-family residences outdoor use areas within Area 62 would be impacted from traffic noise under the no-action alternative. Sheets 65 and 66 in Appendix G-2 show the location of Area 62.
- Area 63: Outdoor use areas for 21 single- and two multi-family residences within Area 63 would be impacted from traffic noise under the no-action alternative. Sheets 67, 68, and 69 in Appendix G-2 show the location of Area 63.
- Area 64: Outdoor use areas for 18 single- and four multi-family residences within Area 64 would be impacted from traffic noise under the no-action alternative. Sheets 67, 68, and 69 in Appendix G-2 show the location of Area 64.

Apra Harbor

Since there are no noise-sensitive receptors along the proposed roadway improvement projects within the Apra Harbor Region, no impacts from traffic noise under the no-action alternative would occur.

South

While there are noise-sensitive land uses along routes in the South Region, noise from traffic would not impact the noise sensitive land uses under the no-action alternative.

8.2.6.6 Summary of Impacts

Table 8.2-23 summarizes the potential impacts of each action alternative and the no-action alternative.

Table 8.2-23. Summary of Potential Noise Impacts-Roadway Project

Potentially Impacted Resource	*Alternative 1*	*Alternative 2**	*Alternative 3*	*Alternative 8*
Construction Noise Impacts to Sensitive Receptors	LSI	LSI	LSI	LSI
Traffic Noise Impact on North Region Sensitive Receptors	SI	SI	SI	SI
Traffic Noise Impact on Central Region Sensitive Receptors	SI	SI	SI	SI
Traffic Noise Impact on Apra Harbor Region Sensitive Receptors	NI	NI	NI	NI
Traffic Noise Impact on South Region Sensitive Receptors	NI	NI	NI	NI

Legend: SI = Significant Impact, LSI = Less Than Significant Impact, NI = No Impact. *Preferred Alternative

A summary of noise-sensitive receptors that would be impacted is provided in Table 8.2-24 for the North Region and Table 8.2-25 for the Central Region, respectively.

Table 8.2-24. Summary of Potential Roadway Project Noise Impacts for the North Region

Type of Noise Sensitive Receptors	*Number of Predicted Impact Receptors*			
	Alternative 1	*Alternative 2*	*Alternative 3*	*Alternative 8*
Area 1: Single Family Residences and a Church	17	17	17	17
Area 2: Multi-Family Residences	0	0	0	0
Area 3: Single Family Residences	2	2	2	2
Area 4: Single Family Residences	4	4	4	4
Area 5: Single and Multi-Family Residences	0	0	0	0
Area 6: Military Outdoor Physical Training Area	4	4	4	4
Area 7: Single Family Residences	0	0	0	0
Area 8: Military Outdoor Recreation Area	12	12	12	12
Area 9: Single Family Residences and a Golf Course	0	0	0	0
Area 10: Single Family Residences	1	1	1	1
Area 11: Single Family Residences, Multi-Family Residences, and a school	10	10	10	10
Area 12: Single Family Residences	7	7	7	7
Area 13: Single Family Residences	8	8	8	8
Area 14: Single and Multi-Family Residences	13	13	13	13
Area 15:School	0	0	0	0
Area 16: Single Family Residences and a Church	10	10	10	10
Total	**88**	**88**	**88**	**88**

Table 8.2-25. Summary of Potential Roadway Project Noise Impacts for the Central Region

Type of Noise Sensitive Receptors	*Number of Predicted Impact Receptors*			
	Alternative 1	*Alternative 2*	*Alternative 3*	*Alternative 8*
Area 17: Single Family Residences and a Multi-Family Residence	15	15	15	15
Area 18: Single Family Residences and a Park	17	17	17	17
Area 19: Park	8	8	8	8
Area 20: Single Family Residences and a Multi-Family Residence	4	4	4	4
Area 21: Park, a Single Family Residence, and a Multi-Family Residence	6	6	6	6
Area 22: Playground, a Single Family Residence, and a Multi-Family Residence	10	10	10	10
Area 23: Park and a Single Family Residence	7	7	7	7
Area 24: Multi-Family Residences	3	3	3	3
Area 25: Park and Single Family Residences	6	6	6	6
Area 26: Cemetery	6	6	6	6
Area 27: Park	20	20	20	20
Area 28: Park	2	2	2	2

Type of Noise Sensitive Receptors	*Number of Predicted Impact Receptors*			
	Alternative 1	*Alternative 2*	*Alternative 3*	*Alternative 8*
Area 29: Park	4	4	4	4
Area 30: Park	9	9	9	9
Area 31: Park	4	4	4	4
Area 32: Multi-Family Residences	4	4	4	4
Area 33: Multi-Family Residences	0	0	0	0
Area 34: School	8	8	8	8
Area 35: Park, a Single Family Residence, and Multi-Family Residences	15	15	15	15
Area 36: One School and Two Churches	6	6	6	6
Area 37: Multi-Family Residences	0	0	0	0
Area 38: Multi-Family Residences and a Church	1	1	1	1
Area 39: Single Family Residences	21	21	21	21
Area 40: Multi-Family Residences	0	0	0	0
Area 41: Single Family Residences	0	0	0	0
Area 42: Single Family Residences	0	0	0	0
Area 43: Single Family Residences	18	18	18	18
Area 44: Single Family Residences	0	0	0	0
Area 45: Park, Single Family Residences, and Multi-Family Residences	30	30	30	30
Area 46: Single Family Residences	0	0	0	0
Area 47: Single Family Residences	12	12	12	12
Area 48: Single Family Residences, and Multi-Family Residences	9	9	9	9
Area 49: Single Family Residences and Multi-Family Residences	21	21	21	21
Area 50: Outdoor Sports Complex	9	9	9	9
Area 51: School	0	0	0	0
Area 52: Multi-Family Residences and a Motel	9	9	9	9
Area 53: Multi-Family Residences	10	10	10	10
Area 54: Multi-Family Residences	0	0	0	0
Area 55: Single Family Residences and a Motel	1	1	1	1
Area 56: Single Family Residences and Multi-Family Residences	11	11	11	11
Area 57: Single Family Residences and Multi-Family Residences	11	11	11	11
Area 58: Military Outdoor Recreational Area	0	0	0	0
Area 59: Single Family Residences	6	6	6	6
Area 60: Single Family Residences	3	3	3	3
Area 61: Single Family Residences, Multi-Family Residences, and a Funeral Home	7	7	7	7
Area 62: Multi-Family Residences	0	0	0	0
Area 63: Single Family Residences, Multi-Family Residences, and a Church	23	23	23	23
Area 64: Single Family Residences, Multi-Family Residences, and a School	22	22	22	22
Total	**378**	**378**	**378**	**378**

Future noise impacts for each of the alternatives were predicted by projecting a 66-dBA traffic noise contour line modeled using Traffic Noise Model 2.5 onto aerial photographs of the project alignment. No impacts were predicted for the Apra Harbor or South Regions. In addition, there are no beneficial impacts from any of the alignments. The sound walls presented in the abatement section were designed to reduce traffic noise levels by at least the minimum requirement of 5 dB.

Fifteen sound walls were analyzed for 12 areas throughout the alignment in the North Region where sound walls were determined to be feasible. Twelve of these sound walls were determined to be both feasible and reasonable. In the Central Region, a total of 123 sound walls were analyzed. The location and dimension of sound walls as presented are preliminary. Views of the impacted residents or recreational areas would be a major consideration in reaching a final decision on the abatement measures to be provided. If pertinent parameters change substantially during the final project design, reanalysis of the traffic noise impact may become necessary, and the noise abatements may be changed. A final decision of the construction of the noise abatements would be made upon completion of the project design. These sound walls would reduce the number of predicted impacted receptors from 466 to 316 for Alternatives 1, 2, 3, and 8. Noise impacts for the North and Central Regions are shown in Tables 8.2-26 and 8.2-27, respectively.

Table 8.2-26. Summary of Potential Roadway Project Noise Impacts with Proposed Abatement for the North Region

Type of Noise Sensitive Receptors	*Number of Predicted Impact Receptors*			
	Alternative 1	*Alternative 2*	*Alternative 3*	*Alternative 8*
Area 1: Single Family Residences and a Church	6	6	6	6
Area 2: Multi-Family Residences	0	0	0	0
Area 3: Single Family Residences	2	2	2	2
Area 4: Single Family Residences	4	4	4	4
Area 5: Single and Multi-Family Residences	0	0	0	0
Area 6: Military Outdoor Physical Training Area	0	0	0	0
Area 7: Single Family Residences	0	0	0	0
Area 8: Military Outdoor Recreation Area	0	0	0	0
Area 9: Single Family Residences and a Golf Course	0	0	0	0
Area 10: Single Family Residences	1	1	1	1
Area 11: Single Family Residences, Multi-Family Residences, and a school	10	10	10	10
Area 12: Single Family Residences	7	7	7	7
Area 13: Single Family Residences	8	8	8	8
Area 14: Single and Multi-Family Residences	13	13	13	13
Area 15:School	0	0	0	0
Area 16: Single Family Residences and a Church	10	10	10	10
Total	**61**	**61**	**61**	**61**

Table 8.2-27. Summary of Potential Roadway Project Noise Impacts with Proposed Abatement for the Central Region

Type of Noise Sensitive Receptors	*Number of Predicted Impact Receptors*			
	Alternative 1	*Alternative 2*	*Alternative 3*	*Alternative 8*
Area 17: Single Family Residences and a Multi-Family Residence	15	15	15	15
Area 18: Single Family Residences and a Park	7	7	7	7
Area 19: Park	8	8	8	8
Area 20: Single Family Residences and a Multi-Family Residence	4	4	4	4
Area 21: Park, a Single Family Residence, and a Multi-Family Residence	6	6	6	6
Area 22: Playground, a Single Family Residence, and a Multi-Family Residence	10	10	10	10
Area 23: Park and a Single Family Residence	0	0	0	0
Area 24: Multi-Family Residences	3	3	3	3
Area 25: Park and Single Family Residences	6	6	6	6
Area 26: Cemetery	6	6	6	6
Area 27: Park	8	8	8	8
Area 28: Park	2	2	2	2
Area 29: Park	4	4	4	4
Area 30: Park	9	9	9	9
Area 31: Park	4	4	4	4
Area 32: Multi-Family Residences	4	4	4	4
Area 33: Multi-Family Residences	0	0	0	0
Area 34: School	0	0	0	0
Area 35: Park, a Single Family Residence, and Multi-Family Residences	15	15	15	15
Area 36: One School and Two Churches	6	6	6	6
Area 37: Multi-Family Residences	0	0	0	0
Area 38: Multi-Family Residences and a Church	1	1	1	1
Area 39: Single Family Residences	1	1	1	1
Area 40: Multi-Family Residences	0	0	0	0
Area 41: Single Family Residences	0	0	0	0
Area 42: Single Family Residences	0	0	0	0
Area 43: Single Family Residences	0	0	0	0
Area 44: Single Family Residences	0	0	0	0
Area 45: Park, Single Family Residences, and Multi-Family Residences	2	2	2	2
Area 46: Single Family Residences	0	0	0	0
Area 47: Single Family Residences	12	12	12	12
Area 48: Single Family Residences, and Multi-Family Residences	9	9	9	9
Area 49: Single Family Residences and	11	11	11	11

Table 8.2-27. Summary of Potential Roadway Project Noise Impacts with Proposed Abatement for the Central Region

Type of Noise Sensitive Receptors	*Number of Predicted Impact Receptors*			
	Alternative 1	*Alternative 2*	*Alternative 3*	*Alternative 8*
Multi-Family Residences				
Area 50: Outdoor Sports Complex	9	9	9	9
Area 51: School	0	0	0	0
Area 52: Multi-Family Residences and a Motel	9	9	9	9
Area 53: Multi-Family Residences	0	0	0	0
Area 54: Multi-Family Residences	0	0	0	0
Area 55: Single Family Residences and a Motel	1	1	1	1
Area 56: Single Family Residences and Multi-Family Residences	11	11	11	11
Area 57: Single Family Residences and Multi-Family Residences	11	11	11	11
Area 58: Military Outdoor Recreational Area	0	0	0	0
Area 59: Single Family Residences	6	6	6	6
Area 60: Single Family Residences	3	3	3	3
Area 61: Single Family Residences, Multi-Family Residences, and a Funeral Home	7	7	7	7
Area 62: Multi-Family Residences	0	0	0	0
Area 63: Single Family Residences, Multi-Family Residences, and a Church	23	23	23	23
Area 64: Single Family Residences, Multi-Family Residences, and a School	22	22	22	22
Total	**255**	**255**	**255**	**255**

Not all of the impacted receptors could be abated. As stated in the abatement section, many of the receptors have direct access to the roadway that prevents the construction of a continuous sound wall required to provide feasible abatement. Furthermore, many of the impacted receptors are also scattered along different routes, preventing feasible abatement from being cost effective and, thus, not reasonable.

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CHAPTER 9.
AIRSPACE

9.1 INTRODUCTION

This chapter contains a discussion of the potential environmental consequences associated with implementation of the alternatives within the region of influence (ROI) for this resource. For a description of the affected environment for all resources, refer to the respective chapter of Volume 2 (Marine Corps Relocation – Guam). The locations described in that volume include the ROI for the utilities and roadway projects, and the chapters are presented in the same order as the resource areas contained in this volume.

9.2 ENVIRONMENTAL CONSEQUENCES

Airspace management is defined as directing, controlling, and handling aircraft flight operations in the volume of air that overlies the land and sea. For the related actions there would be no modifications to or construction of new tall structures, like power plant smokestacks, that would impact airspace use. In addition there is no proposed utilities and roadway project construction that would interfere with airfield operations. Therefore, there would be no impacts to airspace associated with the proposed utilities and roadway projects.

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CHAPTER 10.
LAND AND SUBMERGED LAND USE

10.1 INTRODUCTION

This section relies on the Volume 2 affected environment description of land and submerged land ownership and management for both civilian and Department of Defense (DoD) property. Submerged lands refer to areas in coastal waters extending from the Guam coastline into the ocean 3 nautical miles (nm) (5.6 kilometers) [km]), that is the limit of territorial jurisdiction. The focus of Chapter 10 is to address the land ownership and land use impacts associated with the related actions including large-scale utility projects and roadways. The methodology for impact analysis is as described in Volume 2.

Many of the related actions occur on non-DoD land in conjunction with existing Government of Guam (GovGuam) utilities and roadways. Collocation provides opportunities for maximum land use efficiency. Associated linear facilities such as transmission or distribution lines would be required. The potential impacts are described by alternatives and components, and the chapter concludes with identification and discussion of mitigation measures that apply to significant impacts.

The region of influence for land use is land and ocean in the Territory of Guam within 3 nm (5.6 km) off shore.

10.2 ENVIRONMENTAL CONSEQUENCES

10.2.1 Approach to Analysis

There are two components to the land use analysis: 1) land/submerged lands ownership and management, and 2) land/submerged land use. There are different criteria for assessing potential impacts under these two categories. Short-term impacts would be related to facility construction activities that would be located within the project footprint or on previously disturbed lands. No construction staging area has been designated away from the project site. These construction activities would have minimal and localized impacts on land use. All impacts related to land ownership and use are assumed to occur during the long-term operational phase of the proposed action as the changed conditions would alter the development and use of the current site and its vicinity.

The potential indirect impacts that would be due to changes in land ownership and use are addressed under other specific resource categories such as traffic, noise, natural resources and recreation. Incompatibility with adjacent land uses to the extent that public health and safety is impacted is addressed under public health and safety and noise resource sections. Federal actions on federal lands are not subject to local zoning or land management regulations; however, consistency with surrounding non-federal land uses is an important consideration in land use planning. Coastal Zone Management Act consistency determination assessment is being prepared for all Guam proposed actions and the correspondence will be included in the Final EIS/OEIS appendices.

Impacts for assessing impacts to land use differ slightly for the utilities and the roadways. The roadway analysis is subject to FHWA regulations.

10.2.1.1 Land Ownership/Management

<u>Utilities</u>

The impact assessment methodology for land/submerged land ownership and management is not dictated by regulatory authority or permit requirements. There is flexibility in the methodology and assumptions are made. The basic premise is that a release of federal lands/submerged lands to GovGuam or individuals has beneficial impacts on the new landowners. Conversely, the taking of land by the federal government may be considered an adverse impact on the entities that are losing ownership or control of their property. Taking property in this discussion refers to a situation where the property owner is legally required to sell property to the federal government. There may be some owners who are interested in selling or lease land to the federal government and would perceive the federal acquisition or lease of their property as a beneficial impact. Other owners who do not want to sell their property (or relocate) are likely to consider the forced sale or relocation as an adverse impact even though they are properly compensated. This situation is considered a significant adverse impact on the individual landowner. Until the land negotiations are complete, the impact analysis assumes a significant impact on the individual landowner. There are exceptions to this significant impact for minor rights-of-way and easements for utilities. Mitigation for the taking of property that is not acceptable to the land owner may be a long-term lease agreement instead of purchase where the property returns to the owner on termination of the lease.

The comments received during the scoping period did not support an increase in federal land on island and the increase is considered an adverse impact. The impacts of the proposed island-wide increase in federal land are being addressed in the Land Acquisition Impact Study portion of the Socioeconomic Impact Assessment Study that is being developed and will be available as part of the Final EIS/OEIS.

No indirect impacts are associated with changes in land ownership, except for those that would be discussed under other resource categories. For example, changes in land ownership may impact potential tax revenue to GovGuam.

The test for significance of the potential land ownership/management for utilities is based on the type of land acquisition. New land for industrial plants is considered a significant adverse impact because of the quantity of land required. Land ownership impacts due to proposed linear facilities is dependent on site-specific conditions, such as the availability of existing easements and utility corridors, location, land use, and quantity of land affected. Expansion of an existing utility corridor requiring modification of existing easements would be a less-than-significant impact. A new corridor through existing land uses that would require relocation may be considered a significant impact. A new corridor through undeveloped land may be considered a mitigable, significant impact.

Off Base Roadways

Impacts on land ownership, social, economic, right-of-way (ROW) acquisition, and relocation as a result of the proposed roadway improvement projects are addressed in the socioeconomics and general services chapter of this volume.

10.2.1.2 Land Use

Utilities

There are three criteria that are applied for assessing impacts on land and submerged land use:

- Consistency with Farmland Protection Policy Act (FPPA) of 1981 (not applicable to submerged lands).
- Consistency with current or documented planned land and submerged land use. Land use consistency includes impacts on access policies and loss of open space.
- Restrictions on access.

Land Use Criterion 1: FPPA

The FPPA (Public Law 97-98, 7 USC 4201 and 7 CFR 658) is intended for federal agencies to: 1) identify and take into account the potential adverse effects of federal programs on the preservation of farmland land; and 2) consider alternative actions, as appropriate, that could lessen such adverse effects; and assure that such federal programs, to the extent practicable, are compatible with state, unit of local government, and private programs and policies to protect farmland. The FPPA addresses prime and important farmlands. Actions that are not consistent with this FPPA are considered to have an adverse impact and determination of significance is a qualitative assessment of the value of the farmland affected. DoD lands on Guam are not currently used or planned for agricultural use and there would be no FPPA impact associated with changes in DoD land use within the property boundary. The non-DoD lands proposed for acquisition could potentially be used for farming and the potential impacts are assessed

Land Use Criterion 2: Consistency with Current or Documented Planned Land Use

Land use plans are intended to guide future development. Potential adverse land use impacts would result from a proposed land use that is incompatible with the existing land use or planned land use or if vacant (i.e., no modern manmade structures) land and open space is developed. It is possible for land uses to be inconsistent, but not necessarily incompatible. For example, residential development next to a park is inconsistent, but compatible, while an industrial facility proposed within a residential area would likely be incompatible and inconsistent. Potential adverse impacts would also result if there are incompatible changes in use within submerged lands. Changes in access policies may result from changes in land use and adverse impacts would result if the access became more restrictive to the public.

The test for impact significance is less rigorous for existing DoD land and submerged land, where limited land availability may result in less than ideal land use changes. Federal actions on federal lands/submerged lands are subject to Base Command approval, but are not required to conform with State/Territory land use plans or policies. The proposed action alternatives of this EIS/OEIS have been developed in consultation with Base Command planners. As a result, there would be no anticipated significant impact to land use within DoD parcel boundaries. Land use changes on existing DoD land could be the basis for significant impacts to other resources (such as visual resources, noise, traffic, recreation, cultural and biological resources) within and beyond DoD land boundaries. Impacts to these resources and others are addressed in other resource chapters of this EIS/OEIS.

Proposed land uses on newly acquired lands would have an adverse impact if they are not consistent with the existing or proposed land use at that site. Similarly, a change in use within non-DoD submerged land could have an adverse impact. The test for significance is the degree of incompatibility and is qualitative. For example, proposed military housing would be consistent with existing or planned civilian residential communities and there would be no adverse impact to land use. A proposed industrial facility in an area that is designated for public park would be a significant adverse impact, while the same facility in an area designated for heavy commercial land use would have no significant adverse impact.

While a proposed land use under the action alternatives may be consistent with existing land use, there is potential for adverse impacts due to changes in land use intensity. For example, a training range that is used once per month may have an adverse impact if it were to be used daily. Potential adverse impacts associated with changes in land use intensity such as increases in marine traffic (Chapter 14), noise (Chapter 6), and unexploded ordnance (Chapter 18) are addressed under other resource area discussions of this EIS/OEIS. No significance criterion is established for land use intensity impacts. Noise from airfields or training may be a land use constraint and is discussed.

Land Use Criterion 3: Restrictions on Access

Additional restrictions on public access due to changes in land use on federally-controlled lands/submerged lands would be a potential adverse impact. For example an increase in the setback distance from Navy ships for security purposes may restrict access to a SCUBA site. The test for significance is subjective and based on geographic area affected, the schedule or timing of the access restrictions (permanent or occasional), and the population affected.

Physical access restrictions can result if land acquisition by the federal government results in a pocket or island of non-federal land. This would be an adverse impact on the landowner(s) of the pocket of land. The significance of the impact is based on the extent to which the non-federal land is bordered by military land. Significant adverse impacts result when the private property is surrounded by military property because there would be access restrictions and other potential land use limitations to the private property. Similarly, pockets of civilian land use within a DoD installation is an adverse impact on military land use.

Roadways

Land use impacts as a result of the proposed roadway improvement projects are assessed following Federal Highway Administration Guidance for Preparing and Processing Environmental and Section 4(f) Documents (T 6640.8A). Land use impacts would involve project effects that would be inconsistent with the comprehensive development plans adopted for the area and other plans used in the development of the transportation plan.

Impacts to land use as a result of roadway improvements could be classified into short-term impacts and long-term impacts. Short-term impacts would occur during the peak construction period (2014) and would include disruption of current use activities such as access road blockage, temporary closure of public or private facilities, and business disruption. This type of impact would cease at the completion of construction activities. Long-term impacts (post-construction up to future year 2030) would involve changes in land use patterns, population density, and growth rate. Proposed projects that are inconsistent with applicable plans and policies are considered to cause an adverse long-term impact to land use as well.

10.2.1.3 Issues Identified During Public Scoping Process

Many of the scoping issues regarding land use overlap with other resource areas, such as noise and recreation, and are discussed under those sections. As part of the analysis, concerns related to land use that were mentioned by the public, including regulatory stakeholders, during the public scoping meetings were addressed. None of the land use issues were specific to utilities or roadways. The following are public, including regulatory agency, preferences:

- No increases of federal land ownership (although some landowners were interested to sell).
- No re-acquisition of lands that have been or are in the process of being released by the federal government.

- Retention of current public rights-of-way.

10.2.2 Power

10.2.2.1 Interim Alternative 1 (Preferred Alternative)

Interim Alternative 1 would recondition existing combustion turbines and upgrade T&D systems and would not require new construction or enlargement of the existing footprint of the facility. This work would be undertaken by the GPA on its existing permitted facilities. Reconditioning would be made to existing permitted facilities at the Marbo, Yigo, Dededo No. 1, and Macheche combustion turbines. These combustion turbines are not currently being used up to permit limits. T&D system upgrades would be on existing above ground and underground transmission lines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system

<u>Construction</u>

All impacts related to land ownership and use are assumed to occur during the long-term operational phase of the proposed action as the changed conditions would alter the development and use of the current site and its vicinity.

<u>Operation</u>

Under Interim Alternative 1, the land use footprint of generation and substation facilities would not extend beyond existing property boundaries. FPPA is not applicable because no farmland would be potentially impacted. No new uses in submerged lands are proposed. No acquisition of non-federal land is proposed, and no additional restrictions would be placed on public access. No construction would occur at these generation facilities. Some of the overhead transmission lines would require upgrading, with some remaining overhead and others being changed from overhead to underground. All of the transmission lines would follow current routings and would not negatively impact land ownership or use. The lines being converted from overhead to underground would potentially impact land use in a beneficial manner by eliminating overhead lines impact to surface land use. Some substations would require upgrades, which would occur on the current facilities without requiring expansion of their footprints. Therefore, there would be no adverse impacts and a potentially beneficial impact to land use.

Interim Alternative 1 would result in no impacts to land ownership or use.

<u>Potential Mitigation Measures</u>

As no significant impacts to land/submerged land ownership, management, or use were identified under Interim Alternative 1, no mitigation is necessary or proposed.

10.2.2.2 Interim Alternative 2

Interim Alternative 2 is a combination of reconditioning of existing permitted GPA facilities, an increase in operational hours for existing combustion turbines, and upgrades to existing T&D systems. Interim Alternative 2 would not require new construction or enlargement of the existing footprint of the facility. Reconditioning would be performed on the existing permitted GPA facilities at the Marbo, Yigo, and Dededo combustion turbines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system. No construction outside of the existing facility footprint would occur; therefore, there would be no construction impacts to land use.

Construction

All impacts related to land ownership and use are assumed to occur during the long-term operational phase of the proposed action as the changed conditions would alter the development and use of the current site and its vicinity.

Operation

Under Interim Alternative 2, the land use footprint of generation and substation facilities would not extend beyond existing property boundaries. FPPA is not applicable because no farmland would be potentially impacted. No new uses in submerged lands are proposed. No acquisition of non-federal land is proposed, and no additional restrictions would be placed on public access. Some of the overhead transmission lines would be upgraded, with some remaining overhead and others being changed from overhead to underground. All of the transmission lines would follow current routings and would not negatively impact land use. The lines being converted from overhead to underground would potentially impact land use in a beneficial manner by eliminating overhead lines impact to surface land use. Some substations would require upgrades, which would occur on the current facilities without requiring expansion of their footprints.

Interim Alternative 2 would result in no impacts to land ownership or use.

Potential Mitigation Measures

As no significant impacts to land/submerged land ownership, management, or use were identified under Interim Alternative 2, no mitigation is necessary or proposed.

10.2.2.3 Interim Alternative 3

Interim Alternative 3 is a combination of reconditioning existing GPA permitted facilities at Marbo, Yigo, and Dededo and upgrades to the DoD power plant at Orote. Upgrades would be made to existing T&D systems. The proposed reconditioning to the existing power generation facilities at Marbo, Yigo, and Dededo would not require new construction or enlargement of the existing footprint of the facility. For the Orote power plant, upgrades would include a new fuel storage facility to facilitate longer run times between refueling. This would disturb approximately 1 acre (4,047 square m) of DoD land. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Construction

All impacts related to land ownership and use are assumed to occur during the long-term operational phase of the proposed action as the changed conditions would alter the development and use of the current site and its vicinity.

Operation

Under Interim Alternative 3, the proposed reconditioning to facilities at Marbo, Yigo, and Dededo include overhauls of the existing generating systems that would not include new construction or enlargement of the existing footprint of the facility. No adverse land use impact is anticipated. FPPA is not applicable because no farmland would be potentially impacted. No new uses in submerged lands are proposed. No acquisition of non-federal land is proposed, and no additional access restrictions would be imposed on the public. The upgrades to the DoD generating facility at Orote would require construction of a new fuel storage tank but within the current facility boundary and would not impact land use. Some of the overhead transmission lines would require upgrading, with some remaining overhead and others being changed from overhead to underground. All of the transmission lines would follow current routings and would not negatively impact land use. The lines being converted from overhead to underground would potentially impact land use in a beneficial manner by eliminating overhead lines impact to surface land use. Some substations would require upgrades, which would occur on the current facilities without requiring expansion of their footprints.

Interim Alternative 3 would result in no impacts to land ownership or use.

Potential Mitigation Measures

As no significant impacts to land/submerged land ownership, management, or use were identified under Interim Alternative 3, no mitigation is necessary or proposed.

10.2.2.4 Summary of Impacts

Table 10.2-1 summarizes the potential impacts of each interim alternative. A text summary is provided below.

Table 10.2-1. Summary of Potential Land and Submerged Land Use Impacts-Power

Potentially Impact	*Interim Alternative 1**	*Interim Alternative 2*	*Interim Alternative 3*
Land Ownership			
Land	NI	NI	NI
Submerged Land	NI	NI	NI
Land Use			
1. FFPA	NI	NI	NI
2. Consistency with existing or proposed land use			
DoD land	NI	NI	NI
DoD submerged lands	NI	NI	NI
Non-DoD land	NI	NI	NI
Non-DoD submerged lands	NI	NI	NI
3. Public Access	NI	NI	NI

Legend: NI = No Impact. *Preferred Alternative.

The interim alternatives would have no impact on land or submerged land ownership or use.

10.2.3 Potable Water

10.2.3.1 Basic Alternative 1 (Preferred Alternative)

Basic Alternative 1 would consist of installation of up to 22 new potable water supply wells at Andersen Air Force Base (AFB), rehabilitation of existing wells, interconnection with the GWA water system, and associated T&D systems. A new 5 MG (19 ML) water storage tank would be constructed at ground level at Finegayan. Alternative 1 combines a number of water resource development options staged over 5 years, from 2010 to 2015. These options include new water supply wells, rehabilitation of existing wells, and interconnection with Guam Waterworks Authority (GWA). Alternative 1 would affect the north (water supply wells), and central (rehabilitation of Navy Regional Medical Center [NRMC] well).

Construction

All impacts related to land ownership and use are assumed to occur during the long-term operational phase of the proposed action as the changed conditions would alter the development and use of the current site and its vicinity.

Operation

Under Basic Alternative 1, no acquisition or long-term leasing of non-DoD land and no submerged land uses are proposed. No impact on land and submerged lands ownership would occur. Additional public access restrictions would not be imposed. No land use impacts to farmlands were identified.

At Andersen AFB, up to 22 new water wells including one contingency well would be installed. The wells are planned in clusters and are consistent with adjacent land uses. A 1,000-foot (ft) (305-meter [m]) wellhead protection arc is generated at each well that constrains land use within the arc. This constraint would not result in an adverse land use impact because the areas are vacant with no other planned land uses at or adjacent to the sites. The existing wells that are proposed for use or rehabilitation are also on DoD land, and no impact to land ownership or use was identified.

A new grade-level storage tank is proposed on NCTS Finegayan. The facilities would be sited in conjunction with the large scale development proposals of the proposed actions described in Volumes 2 and 5. They would be sited to be consistent with the proposed land uses. No adverse impacts to land use are anticipated. Transmission and distribution lines would be to be sited on DoD land or within existing right of ways along roads. This does not represent a change in land ownership or use.

Basic Alternative 1 would result in no impacts to land ownership or use.

Potential Mitigation Measures

As no significant impacts to land/submerged land ownership, management, or use were identified under Basic Alternative 1, no mitigation is necessary or proposed.

10.2.3.2 Basic Alternative 2

Basic Alternative 2 would consist of installation of up to 20 new potable water supply wells at Andersen AFB, up to 11 new potable water supply wells at Barrigada, rehabilitation of existing wells, interconnection with the GWA water system, associated transmission and distribution systems upgrades. Additionally, new 3.6 MG (13.6 ML) and 1 MG (3.8 ML) water storage tanks would be constructed at ground level at Finegayan and Barrigada, respectively.

Construction

All impacts related to land ownership and use are assumed to occur during the long-term operational phase of the proposed action as the changed conditions would alter the development and use of the current site and its vicinity.

Operation

No adverse land use impact is anticipated. FPPA is not applicable because no farmland would be potentially impacted. No new uses in submerged lands are proposed. No acquisition of non-federal land is proposed, and no additional access restrictions would be imposed on the public. The proposed new wells and storage facilities are on federally-controlled land. No land acquisition would be required. The areas proposed for development are vacant with no other planned land uses at or adjacent to the proposed facility sites. The upgrades to existing transmission lines would not require additional easements.

Basic Alternative 2 would result in no impacts to land or submerged land ownership or use.

Potential Mitigation Measures

As no impacts to land/submerged land ownership or use were identified for Basic Alternative 2, no mitigation is proposed.

10.2.3.3 Summary of Impacts

Table 10.2-2 summarizes the potential impacts of each basic alternative. A text summary is provided below.

Table 10.2-2. Summary of Potential Land and Submerged Land Use Impacts- Potable Water

Potentially Impact	*Basic Alternative 1**	*Basic Alternative 2*
Land Ownership		
Land	NI	NI
Submerged Land	NI	NI
Land Use		
1.FPPA	NI	NI
2.Consistency with existing or proposed land use		
DoD land	NI	NI
DoD submerged lands	NI	NI
Non-DoD land	NI	NI
Non-DoD submerged lands	NI	NI
3.Public Access	NI	NI

Legend: NI = No Impact. *Preferred Alternative.

The action alternatives are all on DoD land in vacant areas with no conflicting land uses identified at or adjacent to the project components. No land or submerged land ownership or use impacts were identified. No impacts to land use would occur.

10.2.4 Wastewater

10.2.4.1 Basic Alternative 1a (Preferred Alternative) and 1b

Basic Alternative 1 (Alternative 1a supports Main Cantonment Alternatives 1 and 2; and Alternative 1b supports Main Cantonment Alternatives 3 and 8) combines upgrade to the existing primary treatment facilities and expansion to secondary treatment at the Northern District Wastewater Treatment Plant (NDWWTP). The difference between Alternatives 1a and 1b is a requirement for a new sewer line from Barrigada housing to NDWWTP for Alternative 1b.

<u>Construction</u>

All impacts related to land ownership and use are assumed to occur during the long-term operational phase of the proposed action as the changed conditions would alter the development and use of the current site and its vicinity.

<u>Operation</u>

Under Basic Alternative 1a and 1b, the land use footprint of the NDWWTP would not extend beyond existing property boundary. Basic Alternative 1a requires a new gravity sewer from Finegayan to the NDWWTP. This new sewer would require acquisition of a utility easement on non-federal land, but would have minimal impact on land use as the sewer would be underground. Interim Alternative 1b requires an additional new sewer line with two pump stations from Barrigada housing to the NDWWTP. This new sewer would require acquisition of a utility easement on non-federal land. The utility easement acquisitions are assumed to be an adverse impact to the landowner, as described in the approach to analysis.

FPPA is not applicable because no farmland would be potentially impacted. No new uses in submerged lands are proposed. No impacts on existing public access policies are anticipated.

The new sewer line under Basic Alternative 1b impacts on land use are potentially adverse because they may constrain future land use, but the impacts would be less than significant because the facility would be underground and can be accommodated in land use planning. The less than significant impact is counter balanced by the construction of new infrastructure that could potentially be used by future development. The alignment would be selected to have minimal land use/ownership impact. No new uses in submerged lands are proposed.

Basic Alternatives 1a and 1b would result in less than significant impacts to land use because of the acquisition of new utility easements on non-federal land. For Basic Alternative 1b, an additional force main sewer line with two pump stations would be constructed from Barrigada to the existing sewer system serving the NDWWTP. The routes for the new sewer lines would require additional utility easements, but the lines would be underground and the pump stations would only utilize a small area.

Potential Mitigation Measures

Less than significant impacts to land/submerged land ownership, management, or use were identified under Basic Alternative 1, no mitigation is proposed. It is assumed that acquiring utility easements for the new sewer lines would be performed by Guam Water Authority and that the cost would be reflected in hook-up fees.

10.2.4.2 Summary of Impacts

Table 10.2-3 summarizes the potential impacts of each interim alternative. A text summary is provided below.

Table 10.2-3. Summary of Potential Land and Submerged Land Use Impacts- Wastewater

Potentially Impact	*Basic Alternative 1a*	*Basic Alternative 1b*
Land Ownership		
Land	LSI	LSI
Submerged Land	NI	NI
Land Use		
1.FPPA	NI	NI
2.Consistency with existing or proposed land use:		
DoD land	NI	NI
DoD submerged lands	NI	NI
Non-DoD land	LSI	LSI
Non-DoD submerged lands	NI	NI
3.Public Access	NI	NI

Legend: FPPA = Farmland Protection Policy Act;
LSI = Less Than Significant Impact, and, NI = No Impact. *Preferred Alternative.

The land use impacts identified are all less than significant, and there are no impacts to submerged land ownership or use. Less than significant impacts on land ownership and use are associated with use of non-DoD land for new underground sewer lines. The impacts are less than significant because the alignment would avoid conflicting land uses and can be included in plans for future land development. The impact on land ownership is less than significant because it is likely the routing would be along public roads and the utility easements would be negotiated instead of a purchase for the land to accommodate an underground line. An analysis of long-term alternatives was not developed because the alternatives are not ready for project-specific analysis.

10.2.5 Solid Waste

10.2.5.1 Basic Alternative 1 (Preferred Alternative)

The Preferred Alternative for solid waste would be the continued use of Navy Landfill at Apra Harbor until Layon Landfill is opened, which is scheduled for July 2011.

Construction

Under Basic Alternative 1, no construction would occur; therefore, there would be no construction impacts to land use.

Operation

Under Basic Alternative 1, no land acquisition or long-term leasing would occur. FPPA is not applicable because no farmland would be potentially impacted. No new uses in submerged lands are proposed. No land acquisition or long-term leasing is proposed, and no additional public access restrictions would be imposed. Therefore, Interim Alternative 1 would result in no impacts to land ownership or use.

Potential Mitigation Measures

As no significant impacts to land/submerged land ownership, management, or use were identified under Basic Alternative 1, no mitigation is necessary or proposed.

10.2.5.2 Summary of Impacts

Table 10.2.4 summarizes the potential impact of the Preferred Alternative. A text summary is provided below.

Table 10.2-4. Summary of Potential Solid Waste Impacts

Potentially Impact	*Basic Alternative 1**
Land Ownership	
Land	NI
Submerged Land	NI
Land Use	
1.FPPA	NI
2.Consistency with existing or proposed land use:	
DoD land	NI
DoD submerged lands	NI
Non-DoD land	NI
Non-DoD submerged lands	NI
3.Public access	NI

Legend: FPPA = Farmland Protection Policy Act.
NI = No Impact. *Preferred Alternative.

Since there is no construction involved in the alternative for solid waste, there are no impacts to land use or submerged lands.

10.2.6 Off Base Roadways

The *North and Central Guam Land Use Plan*, prepared by the Bureau of Statistics and Plans, GovGuam, has accounted for the DoD facility expansion and organic (natural) growth within the island of Guam over the next 20 years. Growth in the military sector would impact private-sector economic and residential growth and development. As part of the *North and Central Guam Land Use Plan* development, the public has been involved in identifying potential policies and changes needed to address future growth. The draft vision statement from the first round of public meetings states that "Guam is a sustainable tropical paradise that is safe, walkable, family and community-oriented, and protective of natural resources."

The 2030 Guam Transportation Plan (GTP) presents a comprehensive, long-term strategy to improve transportation infrastructure and operations throughout Guam. GovGuam, through its DPW and Department of Administration, Division of Public Transportation Services, and Federal Highway Administration, as well as the Federal Transit Administration have partnered to prepare this plan. The plan addresses Guam's anticipated multimodal transportation needs, including roadway, bicycle, pedestrian, and transit facilities. The GTP includes forecasts for population, employment, and traffic growth through the year 2030, including impacts associated with the potential DoD multiple services buildup. Sustainable financing and project implementation recommendations are also included in the plan.

Different types of roadway improvements are being proposed, including pavement strengthening, intersection improvement, road widening, road rehabilitation, bridge replacement, road relocation, and military access point improvements. Temporary impacts to current uses of land along the vicinity of the construction sites would normally occur as a result of construction equipment blockage and traffic lane closures that are typical of any public works project. A Traffic Management Plan (TMP) would minimize these temporary impacts.

Long-term impacts would involve changes in land use patterns, population density, and growth rate that have not been approved or planned by the Guam Bureau of Statistics and Plans. Adverse impacts are determined by the magnitude and types of conversion that are not consistent with the approved land use patterns. When possible, engineering design would be performed to avoid the acquisition or long-term leasing of public facilities, such as parkland.

Of the six different types of roadway improvements being proposed, pavement strengthening, and bridge replacement would normally occur within the existing ROW; therefore, they would not result in any impacts to land use. Road widening, intersection improvements, new road, and road relocation would have the potential to result in impacts to land use if ROW acquisition is required. Since military access point improvements consistent with respective installation general plans or Regional shore infrastructure plans would occur within DoD lands, impacts to land use are not anticipated with these improvements.

10.2.6.1 Alternative 1

The roadway projects that would be implemented for Alternative 1 are listed in Table 2.5-3, with the exception of Guam Road Network (GRN) #38 (MAP), 39 (MAP), 41 (MAP), 47 (MAP), 48 (MAP), 49 (MAP), 49A (MAP), 63 (pavement strengthening), and 74 (pavement strengthening). As stated above, the proposed GRN projects are consistent with the *North and Central Guam Land Use Plan* and the *2030 Guam Transportation Plan*. The following subsections described impacts to land use during the peak construction period and the future year 2030 due to the proposed roadway construction.

<u>Year 2014 (Peak Construction and Force flow)</u>

North

Improvements within the North Region consist of pavement strengthening, road widening, military access point, and a new road. Land uses in this Region along the proposed GRN projects are comprised mostly of DoD land and low-density residential. Implementation of Alternative 1 would require the acquisition of approximately 144 acres (ac) (58 hectares [ha]) of land area. Approximately 22 ac (9 ha) of residential property and 13 ac (5 ha) of nonresidential property would be acquired with the relocation of approximately four non-residential or business units. In addition, approximately 47 ac (19 ha) of military-owned land within the North Region would be acquired. More detailed information about ROW acquisition and relocation is presented in the Socioeconomics and General Services section of this report volume. This change of land use pattern has been addressed in the relevant planning documents. The impact from the required commercial and residential land conversion is considered significant, but could be mitigated to a less than significant level with the careful planning and, under unavoidable case, with the treatment of compensation measures.

The new two-lane Finegayan Connection that would run parallel to Routes 1 and 3 between the Route 1/16 intersection and South Finegayan is proposed to alleviate traffic on Routes 1 and 3, and the Route 1/3 intersection. Construction of this parallel road would require additional ROW north of Route 1 and west of Route 3, that is nearly vacant. According to the Draft North and Central GLUP, the area north of Route 1 and west of Route 3 has been designated as part of the Dos Amantes Planning Area, where hotel/resort and urban center would be the major land uses in the future. The proposed parallel road would support the future land uses planned under the Dos Amantes Planning Area; therefore, the proposed Finegayan Connection construction would be consistent with future uses of land.

Impacts to current uses of land from construction activities would be typical of a public works project. A TMP would be developed for implementation during construction activities. The impacts are not considered significant with incorporation of the TMP.

Central

Five intersection improvement and three road widening projects are proposed within the Central Region. Improvements are located along the major arterial running along the coastline and inland where major commercial and tourist activities are situated. To accommodate the construction, approximately 311 ac (126 ha) of land area would need to be acquired. Approximately 42 ac (17 ha) of residential property would be acquired, with approximately 51 residential units subject to relocation in the Region. Approximately 10 ac (4 ha) of nonresidential property would be acquired, with approximately seven nonresidential or business units subject to relocation. In addition, approximately 22 ac (9 ha) of military-owned land within the Central Region would be acquired. The impact from the required commercial and residential land conversion is considered significant, but could be mitigated to a less than significant level with the careful planning and, under unavoidable case, with the treatment of compensation measures.

Two existing parks along Route 1 would be affected by minor ROW acquisition to accommodate the proposed intersection improvements; however, no permanent closure of any public park or recreational facility would occur. In addition, the use of public parks for transportation projects would be considered a use of Section 4(f) resources. Impact on parkland is addressed in Chapter 11 and impact to Section 4(f) resources is addressed in Chapter 21 of Volume 6.

Although impacts to current uses of land from construction activities would be typical of a public works maintenance project, occasional disruption to business/commercial and tourist facilities could be expected. A TMP would be developed for implementation during construction activities. To further minimize the impacts to business/ commercial and tourist activities, close coordination with business owners and area residents would be required to keep them informed of the roadway improvement schedule. Construction schedules for the various proposed projects would be arranged to the extent practicable and economical so that no multiple projects would be under construction at the same time to avoid cumulative construction impacts.

Apra Harbor

Two intersection improvement projects are proposed within the Apra Harbor Region. No residential units are subject to relocation. Implementation of this alternative would not require acquisition or long-term leasing of nonresidential or military-owned property. No substantial impacts on commercial and residential land use conversion from the proposed improvement would occur. Impacts during the peak construction period within this geographic region would be similar to those described under the Central Region.

South

Two intersection improvement projects are proposed within the South Region. The improvement would occur within the existing ROW. No residential or nonresidential units would be relocated, and no lands would be acquired. No substantial impacts on commercial and residential land use conversion from the proposed improvement would occur. Impacts during the peak construction period within this geographic Region would be similar to those described under the North Region.

Potential Mitigation Measures

The GovGuam DPW would develop an outreach program to keep residents, businesses, and any service providers within the area informed, and to inform surrounding communities about the project construction schedule, relocation plans and assistance programs, traffic-impacted areas and the TMP, and other relevant project information.

<u>Year 2030</u>

North

The Draft North and Central GLUP has addressed the changes in future land use as a result of the proposed Guam and Commonwealth of the Northern Mariana Islands (CNMI) military relocation project, as well as other military facility expansions over the next 20 years. The proposed GRN improvement projects are intended to meet the projected traffic demand both under the proposed military expansion action and the no-action alternative (natural growth). The proposed GRN improvement projects are consistent with the Draft North and Central GLUP, that addresses the projected growth from the proposed military facility expansion on the island, and the 2030 GTP, that addresses the long-term strategy to improve transportation infrastructure and operations throughout Guam.

All construction activities of the proposed improvement within the North Region would have been completed by the year 2030. Since no farmland and parkland conversion to roadway use or the use of parkland are expected within this Region, no adverse impacts on land use or on farmland and parkland are anticipated.

Since no ocean use is situated within the vicinity of the proposed GRN projects, no impacts to submerged land via ocean use would occur.

Central

The proposed GRN improvement projects are consistent with the Draft North and Central GLUP, that addresses the projected growth from the proposed military facility expansion on the island, and the 2030 GTP, that addresses the long-term strategy to improve transportation infrastructure and operations throughout Guam.

All construction activities of the proposed improvement within the Central Region would have been completed by the year 2030. Since there would be no permanent closure of any parkland, no impacts to parkland use over the long term would occur. The roadway improvement would help enhance access to park and recreational facilities within the Central Region. The long-term impact pertaining to parkland use is beneficial.

Since there would be no farmland conversion to roadway use, no adverse impacts on farmland are anticipated.

The proposed roadway improvement projects would be confined within the existing roadway corridor; therefore, no permanent impacts to submerged land use would occur.

Apra Harbor

The proposed GRN improvement projects are consistent with the Draft North and Central GLUP, that addresses the projected growth from the proposed military facility expansion on the island, and the 2030 GTP, that addresses the long-term strategy to improve transportation infrastructure and operations throughout Guam.

The construction activities of the proposed improvement within the Apra Harbor Region would have been completed by the year 2030.

No farmland conversion to roadway use or the use of parkland are expected within this region, therefore no adverse impacts on farmland and parkland are anticipated.

The proposed roadway improvement projects would be confined within the existing roadway corridor; therefore, no permanent impacts to submerged land use would occur.

South

The proposed GRN improvement projects are consistent with the Draft North and Central GLUP, that addresses the projected growth from the proposed military facility expansion on the island, and the 2030 GTP, that addresses the long-term strategy to improve transportation infrastructure and operations throughout Guam.

The construction activities of the proposed improvement within the South Region would have been completed by the year 2030.

No farmland conversion to roadway use or the use of parkland are expected within this region, therefore no adverse impacts on farmland and parkland are anticipated.

Because no ocean use is situated within the vicinity of the proposed GRN projects, no impacts to submerged land use would occur.

Potential Mitigation Measures

Because the proposed GRN improvement projects are consistent with the Draft North and Central GLUP and the 2030 GTP, no mitigation measures would be required.

Most roadway improvements would be undertaken within the existing ROW, with some ROW acquisition or long-term leasing that would result in conversion of residential, commercial, and open space uses to public facility (transportation) use. The proposed roadway improvements are intended to meet the projected traffic demand based upon the local land use plans. Land use conversion from the required ROW acquisition would be addressed through the relevant planning agencies of GovGuam. Compensation as a result of land use disruption or acquisition or long-term leasing is addressed in the Socioeconomic and General Services section of this document.

10.2.6.2 Alternative 2 (Preferred Alternative)

The roadway projects that would be implemented for Alternative 2 are listed in Table 2.5-3, with the exception of GRN #38A (MAP), 39A (MAP), 41A (MAP), 47 through 49A (MAP), 63 (pavement strengthening), and 74 (pavement strengthening). Peak construction and permanent impacts on land uses under Alternative 2 would be similar to those described under Alternative 1 because the same projects are proposed under this alternative with the only difference is the gate location for the MAP projects which have no impact on existing commercial or residential uses. Potential mitigation measures for Alternative 2 would be the same as those proposed for Alternative 1.

Potential Mitigation Measures

Same as those described under Alternative 1.

10.2.6.3 Alternative 3

The roadway projects that would be constructed under Alternative 3 are listed in Table 2.5-3, with the exception of GRN #38A (MAP), 39A (MAP), 41 (MAP), 49A (MAP), 19 (pavement strengthening), 31 (pavement strengthening), and 124 (new roadway). In general, the MAP and pavement strengthening projects would not cause significant impact to existing commercial or residential uses. Impacts on land use disruption from construction activities under Alternative 3 in 2014 during peak construction would be slightly less than Alternatives 1 and 2 because no new roadway (GRN#124) would be constructed under this alternative. However, there would be no new roadway to support the planned land-use development within the Dos Amantes Planning Area in the long-term.

Potential Mitigation Measures

Potential mitigation measures for Alternative 3 would be the same as those proposed for Alternative 1.

10.2.6.4 Alternative 8

The roadway projects that would be constructed under Alternative 8 are listed in Table 2.5-3, with the exception of GRN #38 (MAP), 39 (MAP), 41 (MAP), 47 through 49 (MAP), 63 (pavement strengthening), and 74 (pavement strengthening). In general, the MAP and pavement strengthening projects would not cause significant impact to existing commercial or residential uses. Therefore, impacts on land use disruption under Alternative 8 in 2014 during peak construction would be similar to those described under Alternative 1. This is because the same projects are proposed under this alternative, with the only difference being the gate location for GRN# 38A and GRN# 49A, which are MAP projects. Land use impacts over the long-term (year 2030) of Alternative 8 would be similar to Alternative 1.

Potential Mitigation Measures

Potential mitigation measures for Alternative 8 would be the same as those proposed for Alternative 1.

10.2.6.5 No-Action Alternative

2009

Under the no-action alternative, only some roadway improvements would be constructed to support normal growth within the island. Based on the 2030 GTP, without the military buildup project, it is anticipated that committed improvements that are currently programmed for funding in the Territorial Transportation Improvement Plan would be constructed. The types of projects currently funded include safety improvements, bridge replacements, roadway rehabilitation, and traffic improvements; therefore, the no-action alterative is consistent with the Territorial Transportation Improvement Plan and 2030 GTP.

Construction activities for the improvement projects would be typical of public works maintenance projects, as described under the proposed Alternatives 1, 2, 3, and 8. Because the no-action alternative would include no roadway improvement project in year 2009 (baseline year), construction impacts on land use under this alternative would be less than with all of the build alternatives described above.

2014

Construction activities for the improvement projects would be typical of public works maintenance projects, as described under the proposed Alternatives 1, 2, 3, and 8. Because the no-action alternative would include only 7 roadway improvement projects (compared to 49 for Alternatives 1 and 2, 50 for Alternative 3, and 50 for Alternative 8) to be constructed during the year 2014, construction impacts on land use under this alternative would be less than significant with all of the build alternatives described above. Under the No-Action Alternative, no parkland and farmland conversion would be required; the impacts to parkland and farmland uses would be less than significant.

2030

As discussed previously, roadway improvements have been proposed and documented in the 2030 GTP. The no-action alternative, in the long-term, is consistent with the Territorial Transportation Improvement Plan and 2030 GTP.

Individual roadway improvement projects would occur over time. A standard TMP shall be developed for implementation during construction activities. The TMP shall identify and provide alternate traffic detour routes, construction materials hauling routes, bus stops, transit routes and operation hours, pedestrian routes, and residential and commercial access routes to be used during the construction period.

Under the no-action alternative, the proposed 20 roadway improvements would be phased for construction over the period between 2014 and 2030. Construction activities of the improvement projects would be typical of public works maintenance projects as described under the proposed Alternatives 1, 2, 3, and 8. Because the number of roadway improvements projects under the no-action alternative (20) is significantly less than with Alternatives 1, 2, 3, and 8 (ranging from 49 to 50), and because it would be spread over a long period of time, impacts to the use of land from this ongoing improvement are not anticipated.

Potential Mitigation Measures

Because the proposed GRN improvement projects are consistent with the 2030 GTP, no mitigation measures would be required.

10.2.6.6 Summary of Impacts

Table 10.2-5 summarizes the potential impacts of each interim alternative. An analysis on long-term alternatives was not developed because the alternatives are not ready for project-specific analysis. A text summary is provided below.

Table 10.2-5. Summary of Potential Land and Submerged Land Use Impacts – Roadway Project

Potentially Impacted Resource	*Alternative 1*	*Alternative 2**	*Alternative 3*	*Alternative 8*
Consistency with Approved Plans and Policies	NI	NI	NI	NI
Current Use of Land Disruption	SI-M	SI-M	SI-M	SI-M
Commercial and residential land conversion	SI-M	SI-M	SI-M	SI-M
Ocean Use	NI	NI	NI	NI
Farmland Conversion	NI	NI	NI	NI
Parkland Conversion	LSI	LSI	LSI	LSI

*Legend: SI-M = Significant Impact Mitigable to Less Than Significant, LSI = Less Than Significant Impact, NI = No Impact, *Preferred Alternative.*

The Draft North and Central GLUP has addressed the changes in future land use as a result of the proposed Guam and CNMI military relocation project, as well as other military facility expansions over the next 20 years. The proposed GRN improvement projects are intended to meet the projected traffic demand both under the proposed military expansion action and the no-action alternative (natural growth). The proposed GRN improvement projects are consistent with the Draft North and Central GLUP, that addresses the projected growth from the proposed military facility expansion on the island, and the 2030 GTP, that addresses the long-term strategy to improve transportation infrastructure and operations throughout Guam.

Implementation of the proposed roadway improvements project under each alternative would require some residential, non-residential, and military land acquisition or long-term leasing for ROW use. Some of the residential and business properties would be subject to relocation.

CHAPTER 11. RECREATIONAL RESOURCES

11.1 INTRODUCTION

This chapter discusses potential environmental consequences associated with implementation of the alternatives within the region of influence (ROI) for each resource. A description of the affected environment for each resource is provided in Volume 2 (Marine Corps Relocation – Guam). The locations described in Volume 2 include the ROI for the utilities and roadway projects with the chapters presented in the same order as in this volume.

11.2 ENVIRONMENTAL CONSEQUENCES

11.2.1 Approach to Analysis

11.2.1.1 Methodology

Utilities

Information on recreational resources on Guam and public access was collected through stakeholder meetings in April 2007, Geographic Information System data compiled and reviewed for this Environmental Impact Statement/Overseas Environmental Impact Statement/Overseas Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) literature review, personal communications, and limited visitor data that are available for a few specific locations on the island. A comprehensive recreational carrying capacity analysis—assessing the number of individuals who can be supported in a given area within natural resource limits without degrading the natural social, cultural, and economic environment (Global Development Research Center 2008)—was not conducted as part of this EIS/OEIS. Existing baseline data for conducting recreational resource impact analyses are somewhat limited because the Government of Guam, Department of Parks and Recreation does not collect visitor data (e.g. user counts, visitor satisfaction, user conflicts, visitor demands, etc.) for its recreational facilities (Personal obtained through site reconnaissance and communications with natural resource planners at AFB and park rangers at National Park Service. The analysis of potential impacts to recreational resources is based on the long-term (operational) effects – i.e., after construction has occurred and all buildings, facilities, and structures are in place. Construction-related activities would be relatively minimal in their impacts (i.e., earth-moving equipment clearing vegetation and constructing facilities and other structures).

Roadway Projects

Methodology used in assessing recreational resource impacts as a result of the proposed roadway improvements is generally the same as that described under Utilities subheading above. However, the analysis focuses on direct (e.g., land acquisitions, elimination of access, degradation of facilities) and indirect (e.g., degradation of use due to traffic delays), temporary (i.e., construction), and permanent (i.e., operation) effects that could result with implementation of the proposed Guam Road Network (GRN) under each alternative.

11.2.1.2 Determination of Significance

For the purpose of this EIS/OEIS, the proposed action and alternatives would cause a significant impact on recreational resources if they:

- Would impede access to recreational resources
- Would substantially reduce recreational opportunities
- Would cause substantial conflicts between recreational users
- Would cause substantial physical deterioration of recreational resources

Recreational impacts as a result of the proposed roadway improvement projects are assessed following Federal Highway Administration Guidance for Preparing and Processing Environmental and Section 4(f) Documents (T 6640 8A), which are similar to those listed above.

11.2.1.3 Issues Identified During Public Scoping Process

As part of the analysis, concerns related to recreational resources that were mentioned by the public, including regulatory stakeholders, during the public scoping meetings were addressed. These included the potential impact of the proposed action on civilian access to Department of Defense (DoD) facilities, recreation areas, Apra Harbor, and other locations, both in terms of construction and operations impacts.

11.2.2 Power

11.2.2.1 Interim Alternative 1 (Preferred Alternative)

Interim Alternative 1 would recondition existing combustion turbines and upgrade T&D systems and would not require new construction or enlargement of the existing footprint of the facility. This work would be undertaken by the GPA on its existing permitted facilities. Reconditioning would be made to existing permitted facilities at the Marbo, Yigo, Dededo No. 1, and Macheche combustion turbines. These combustion turbines are not currently being used up to permit limits. T&D system upgrades would be on existing above ground and underground transmission lines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

<u>Construction</u>

The proposed reconditioning of the existing GPA facilities at Marbo, Yigo, Mecheche, and Dededo No.1 would be confined to the existing locations, wherein general overhaul, capabilities testing, and controlled startups would be performed. Also transmission and distribution systems would be upgraded. This would include installation of larger wires on existing overhead distribution lines, moving some of the overhead lines to underground, and upgrades to existing substations within their current footprints. The proposed construction activities may inadvertently impede roadway access to recreational areas by way of coning off construction area and/or diverting traffic to other routes. Increased time traveling on affected roads may occur; however, direct impacts to recreational resources is not expected.

<u>Operation</u>

The proposed reconditioning of the existing GPA combustion turbines and transmission and distribution improvements would be confined to the existing locations and routes. At present, there are no recreational resources sited near the proposed (preexisting) location of the reconditioning and transmission and distribution upgrades. Therefore, Interim Alternative 1 would result in no impacts to recreational resources.

<u>Potential Mitigation Measures</u>

No mitigation measures are needed.

11.2.2.2 Interim Alternative 2

Interim Alternative 2 is a combination of reconditioning of existing permitted GPA facilities, an increase in operational hours for existing combustion turbines, and upgrades to existing T&D systems. Interim Alternative 2 would not require new construction or enlargement of the existing footprint of the facility. Reconditioning would be performed on the existing permitted GPA facilities at the Marbo, Yigo, and Dededo combustion turbines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Construction

The construction work associated with the proposed reconditioning of the existing permitted GPA generating facilities and upgrades to the existing T&D systems may inadvertently impede roadway access to recreational areas by way of coning off construction area and/or diverting traffic to other routes. Increased time traveling on affected roads may occur; however, direct impacts to recreational resources is not expected.

Operation

The proposed alterations to the existing GPA facilities would be confined to the existing locations and routings. Therefore, Interim Alternative 2 would result in no impacts to recreational resources.

Potential Mitigation Measures

No mitigation measures are needed.

11.2.2.3 Interim Alternative 3

Interim Alternative 3 is a combination of reconditioning existing GPA permitted facilities at Marbo, Yigo, and Dededo and upgrades to the Department of Defense power plant at Orote. Upgrades would be made to existing T&D. The proposed reconditioning to the existing power generation facilities at Marbo, Yigo, and Dededo would not require new construction or enlargement of the existing footprint of the facility. For the Orote power plant, upgrades would include a new fuel storage facility to facilitate longer run times between refueling. This would disturb approximately 1 acre (4,047 square m) and is within the current footprint of this facility. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Construction

The proposed reconditioning of the existing GPA permitted facilities at Marbo, Yigo, and Dededo, upgrades to the DoD power plant at Orote, and T&D upgrades may inadvertently impede roadway access to recreational areas by way of coning off construction area and/or diverting traffic to other routes. The upgrade of the existing Orote power plant is proposed to last six months. The work associated with the proposed upgrade (i.e., work on cooling towers and generator tune ups) would be confined to the existing site, which is on the Navy base. Increased time traveling on affected roads may occur; however, direct impacts to recreational resources is not expected.

Operation

There are no recreational resources in proximity of the GPA facilities in Yigo, Marbo, and Dededo, or to the Navy facility at Orote. Moreover, no interruptions to the existing recreational resources at the Apra Harbor Naval Reservation are anticipated. Therefore, Interim Alternative 3 would result in no impacts to recreational resources.

Potential Mitigation Measures

No mitigation measures are needed.

11.2.2.4 Summary of Impacts

Table 11.2-1 summarizes the potential impacts of each interim alternative.

Table 11.2-1. Summary of Potential Impacts to Recreational Resources-Power

*Interim Alternative 1**	*Interim Alternative 2*	*Interim Alternative 3*
NI Recreational Resources (trails, historic and cultural attractions, dive sites, game hunting, fishing/crabbing, scenic points, golf course, day use resorts, spelunking, parks, beaches)	NI Recreational Resources (trails, historic and cultural attractions, dive sites, game hunting, fishing/crabbing, scenic points, golf course, day use resorts, spelunking, parks, beaches)	NI Recreational Resources (trails, historic and cultural attractions, dive sites, game hunting, fishing/crabbing, scenic points, golf course, day use resorts, spelunking, parks, beaches)

Legend: NI = No Impact. *Preferred Alternative.

he interim power alternatives would recondition the existing GPA facilities, upgrade transmission and distribution systems, and upgrade the DoD generation facility at Orote. The upgraded distribution lines would be routed within the existing utility corridors and distribution system upgrades would occur within the footprint of existing substations. In as much as there are no identified recreational resources in proximity of the locations considered, the components of the proposed activities would be keeping with the existing environment and adverse impacts to recreational resources are not anticipated.

11.2.3 Potable Water

11.2.3.1 Basic Alternative 1 (Preferred Alternative)

Basic Alternative 1 would consist of installation of up to 22 new potable water supply wells at Andersen AFB, rehabilitation of existing wells, interconnection with the GWA water system, and associated T&D systems. A new 5 MG (19 ML) water storage tank would be constructed at ground level at Finegayan.

Construction

The implementation of Alternative 1 is limited to DoD lands where access is restricted to installation personnel and guests. Development of the proposed wells at Andersen AFB and the 5 MG ground-level water storage tank at Finegayan may inadvertently impede roadway access to recreational areas by way of coning off construction area and/or diverting traffic to other routes. Increased time traveling on affected roads may occur; however, direct impacts to recreational resources is not expected.

Operation

Operation of the existing water supply wells and water storage tank are not expected to affect the function of the existing recreational resources that are near the proposed site. Therefore, Alternative 1 would result in no impacts to recreational resources.

Potential Mitigation Measures

No mitigation measures are needed.

11.2.3.2 Basic Alternative 2

Basic Alternative 2 would consist of installation of up to 20 new potable water supply wells at Andersen AFB, up to 11 new potable water supply wells at Barrigada, rehabilitation of existing wells, interconnection with the GWA water system, associated transmission and distribution systems upgrades.

Additionally, new 3.6 MG (13.6 ML) and 1 MG (3.8 ML) water storage tanks would be constructed at ground level at Finegayan and Barrigada, respectively.

Construction

The development of the water supply wells at Andersen AFB and Barrigada, as well as the construction of the ground-level water storage tanks at Finegayan and Barrigada may inadvertently impede roadway access to recreational areas by way of coning off construction area and/or diverting traffic to other routes. Increased time traveling on affected roads may occur; however, direct impacts to recreational resources is not expected.

Operation

The implementation of Basic Alternative 2 is limited to DoD lands where access is restricted to installation personnel and guests. Operation of the existing water supply wells and water storage tanks at Finegayan and Air Force Barrigada would not affect the function of the existing recreational resources that are near the project. Therefore, Alternative 2 would result in no impacts to recreational resources.

Potential Mitigation Measures

No mitigation measures are needed.

11.2.3.3 Summary of Impacts

Table 11.2-2 summarizes the potential impacts of each interim alternative.

Table 11.2-2. Summary of Potential Impacts to Recreational Resources-Potable Water

*Basic Alternative 1**	*Basic Alternative 2*
NI Recreational Resources (trails, historic and cultural attractions, dive sites, game hunting, fishing/crabbing, scenic points, golf course, day use resorts, spelunking, parks, beaches)	NI Recreational Resources (trails, historic and cultural attractions, dive sites, game hunting, fishing/crabbing, scenic points, golf course, day use resorts, spelunking, parks, beaches)

Legend: NI = No Impact. *Preferred Alternative.

The proposed alternatives for potable water, wherein new water supply wells would be developed at Andersen AFB and at Barrigada, and the construction of ground-level water storage tanks at Finegayan and Barrigada, would be confined to areas not within proximity to recreational resources. During the construction period, there may be slight delays on public right-of-ways due to the presence of construction-related vehicles; however, no direct impacts to the existing recreational resources in the proximity of the project locations are anticipated. The operation of the proposed features under either alternative would have no effect on the existing recreational resources.

11.2.4 Wastewater

11.2.4.1 Basic Alternative 1a (Preferred Alternative) and 1b

Basic Alternative 1 (Alternative 1a supports Main Cantonment Alternatives 1 and 2; and Alternative 1b supports Main Cantonment Alternatives 3 and 8) combines upgrade to the existing primary treatment facilities and expansion to secondary treatment at the Northern District Wastewater Treatment Plant (NDWWTP). The difference between Alternatives 1a and 1b is a requirement for a new sewer line from Barrigada housing to NDWWTP for Alternative 1b.

Construction

The proposed upgrade of the existing primary treatment facilities and expansion of the secondary treatment at the NDWWTP would be confined to the existing location. Although the Tanguisson Beach and Hilaan coastline are within close proximity to the NDWWTP site, there is no expectation of loss of access and use to these recreational resources, specifically at Tanguisson beach and the Hilaan coastline.

Operation

The operation of the proposed features would not adversely affect recreational users at nearby Tanguisson beach and the Hilaan coastlines due to the considerable distance from the point of wastewater outfall discharge to the near-shoreline area where recreational uses occur (e.g. snorkeling, swimming, beachcombing). Therefore, Alternative 1a would not result in adverse impacts to recreational resources.

11.2.4.2 Basic Alternative 1b

Construction

In addition to a sewer line proposed under Alternative 1a, a new sewer line would be installed to convey wastewater generated from Barrigada housing to the NDWWTP. During construction period, there may be slight delays on public right-of-ways in or near the Barrigada site due to the presence of construction-related vehicles. Increased time traveling on affected roads may occur; however, direct impacts to recreational resources is not expected.

Operation

The effects during the operational phase would be similar to those described under Basic Alternative 1a.

Potential Mitigation Measures

No mitigation measures are needed.

11.2.4.3 Summary of Impacts

Table 11.2-3 summarizes the potential impacts of each interim alternative. An analysis of long-term alternatives was not developed because the alternatives are not ready for project-specific analysis.

Table 11.2-3. Summary of Potential Impacts to Recreational Resources-Wastewater

*Basic Alternative 1a**	*Basic Alternative 1b*
NI Recreational Resources (trails, historic and cultural attractions, dive sites, game hunting, fishing/crabbing, scenic points, golf course, day use resorts, spelunking, parks, beaches)	NI Recreational Resources (trails, historic and cultural attractions, dive sites, game hunting, fishing/crabbing, scenic points, golf course, day use resorts, spelunking, parks, beaches)

Legend: NI = No Impact. *Preferred Alternative.

The upgrade of the existing primary treatment facilities and the expansion of the secondary treatment facilities at the NDWWTP site involve site-specific work that would not impede the existing access to and the use of the recreational resources, which can be found at the nearby Tanguisson beach and the Hilaan coastline. The presence of construction-related vehicles on right-of-ways may impede the access to these recreational uses, but there is no expectation of these uses being adversely affected as the result of the implementation of the proposed actions. The proposed installation of the new sewer line from Barrigada housing to NDWWTP would have similar effect on the right-of-ways and persons traveling by car to the recreational resource in the Barrigada area—during the construction phase only; no impacts to the recreational resources near the Barrigada area is anticipated during the operational phase.

11.2.5 Solid Waste

11.2.5.1 Basic Alternative 1 (Preferred Alternative)

The Preferred Alternative for solid waste would be the continued use of Navy Landfill at Apra Harbor until Layon Landfill is opened, which is scheduled for July 2011.

Construction

The proposed construction efforts for the planned Layon Landfill would likely be completed before the relocation of the Marines and their dependents to Guam. No impacts to the recreational resources are anticipated.

Operation

This Alternative proposes the use of the existing Navy landfill until the completion of the new Layon Landfill in July 2011. Continued use of the existing Navy landfill is not expected to cause adverse impacts to the recreational resources as they are not situated within proximity. There are no recreational resources at the proposed Layon Landfill.

Potential Mitigation Measures

No mitigation measures are needed.

11.2.5.2 Summary of Impacts

Table 11.2-4 summarizes the potential impact of the Preferred Alternative. A text summary is provided below.

Table 11.2-4. Summary of Potential Impacts of the Preferred Alternative

Basic Alternative 1
NI Recreational Resources (trails, historic and cultural attractions, dive sites, game hunting, fishing/crabbing, scenic points, golf course, day use resorts, spelunking, parks, beaches)

Legend: NI = No Impact

The existing Navy Landfill near Apra Harbor is not situated in close proximity to the recreational resources in the area; adverse impacts to the access to and the use of these resources as the result of continued operation of the landfill is not anticipated. Similar to the Navy Landfill, there are no recreational resources at or near the proposed Layon Landfill site. There are no impacts to the recreational resources anticipated with the implementation of the proposed actions.

11.2.6 Off Base Roadways

This section addresses effects to non-public and public recreational facilities during the peak construction and post-construction periods (2014 to 2030). The analysis focuses on direct (e.g., land acquisitions, elimination of access, degradation of facilities) and indirect (e.g., degradation of use due to increased noise, traffic delays) temporary (i.e., construction) and permanent (i.e., operation) effects that could result with implementation of the proposed Guam Road Network (GRN) under each alternative. Because the GRN projects are public works-type improvements, such as pavement strengthening, intersection improvement, road widening, road rehabilitation, bridge replacement, road relocation, and Military Access Point (MAP) construction, they generally include small to medium work crews and machinery. Most of the proposed improvements would be constructed within the public right-of-way (ROW) or within existing DoD lands. Only a small number of projects that involve intersection improvement, road widening, and road relocation would require some ROW acquisition. Construction activities would include the identification and location of staging areas (e.g., machinery and material storage, equipment, trailers, employee parking); construction material and equipment transportation; site clearing and demolition, utility relocation, roadway/bridge construction, and finish work (e.g., landscaping, signage). Most of the environmental consequences associated with implementation of the proposed action would occur during construction. Once the proposed action is implemented, its operation would be tested, including traffic signal system, communications systems, and associated equipment (if any).

11.2.6.1 Alternative 1

The roadway projects that would be implemented for Alternative 1 are listed in Table 2.5-3, with the exception of GRN #38 (MAP), 39 (MAP), 41 (MAP), 47 (MAP), 48 (MAP), 49 (MAP), 49A (MAP), 63 (pavement strengthening), and 74 (pavement strengthening). The following subsections described impacts to recreation resources during the peak construction period and the future year 2030 due to the proposed roadway construction.

<u>Year 2014 (Peak Construction and Population)</u>

North

The proposed roadway improvement projects within the North Region are located along Routes 1, 3, 9, 15, and 28. There are no GRN projects that would result in either direct or indirect effects to recreational facilities located at Andersen AFB, including the Northwest Field area. These recreational facilities are located within the base north of the proposed GRN projects. In addition, access to these facilities is limited to installation personnel and their guests.

Route 3 provides the principal access to recreational opportunities in the western segment of the North Region (i.e., Dededo and Finegayan areas). Proposed improvements along Route 3 would include pavement strengthening, intersection improvements, road widening, and MAP. As previously noted, recreational opportunities within this area are almost exclusively focused along the coast approximately 1.5 miles (mi) (2.4 kilometers [km]) from Route 3. One of the most popular tourist attractions within the North Region is Two Lovers Point. This tourist attraction can be accessed from Routes 1 or 3.

Routes 1 and 15 provide the principal access to recreational opportunities in the eastern segment of the North Region (i.e., Spring Hill Subdivision, Perez Acres, Gayinero, and Lupog). Proposed improvements along Routes 1 and 15 are limited to pavement strengthening and MAP. Along Route 1, recreational activities are limited to a conservation reserve, golf course, and memorial park. Route 15 includes scenic vistas, historic/cultural attractions, and trails.

Temporary easements would be required along Routes 1, 3, 9, and 15 during the construction period. Temporary indirect impacts would result due to construction activities and may include traffic delays, lane closures, and rerouting of traffic. A Traffic Management Plan (TMP) would be developed for implementation during construction activities. The Department of Public Works (DPW) would closely coordinate with business and recreational facility owners to continuously provide them with information regarding construction schedules, anticipated traffic lane closures, and detour routes. The impacts are not considered adverse with incorporation of the TMP and coordination plan. Once the construction is completed the availability of improved roadway conditions would help enhance the recreation opportunities within the island.

In addition to traffic delays and access obstruction, it is anticipated that approximately 35,000 construction workers would be required for military facility construction during the peak construction period. Most of these workers would come from off-island. This growth has been addressed as part of the Guam and Commonwealth of the Northern Mariana Islands (CNMI) military relocation plan. Construction of the GRN projects would also require hundreds of workers on top of those required for military facility construction. These temporary workers and their family members would increase the use of recreational facilities during the peak construction period. Because the increase in the number of construction workers has been projected and addressed in relevant planning documents, the relevant planning agencies within the Island of Guam would be in a position to plan for this growth.

Central

Road improvements within the Central Region would occur along Routes 1, 7, 8, 8A, 10, 15, 16, 25, 26, and 27, and Chalan Lujuna Road. Most of the proposed improvements are pavement strengthening, with a few intersection improvements, road widening and road realignment.

There are no GRN projects that would result in either direct or indirect effects to recreational facilities contained on Navy Barrigada or Air Force Barrigada. These recreational facilities are located outside of the proposed GRN projects. In addition, access to these facilities is limited to installation personnel and their guests.

Route 1 provides the principal access to recreational opportunities in the western segment of the Central Region (i.e., Piti, Asan, Hagatna, Mongmong, and Tamuning). Proposed improvements along Route 1 include pavement strengthening, intersection improvements, bridge replacement, and MAP. Recreational opportunities along the western segment of the Central Region are largely comprised of beaches, trails, public parks, and scenic vistas. Portions of Route 1 are located immediately adjacent to or within close proximity to these areas. Traffic congestion and travel delays could be expected during the peak construction year. A Traffic Management Plan (TMP) would be developed for implementation during construction activities. The Department of Public Works (DPW) would closely coordinate with business and recreational facility owners to continuously provide them with information regarding construction schedules, anticipated traffic lane closures, and detour routes. The impacts are not considered adverse with incorporation of the TMP and coordination plan. Once the construction is completed the availability of improved roadway conditions would help enhance the recreation opportunities within the island.

Based on preliminary engineering design information, some minor parkland acquisition would be required to be taken from three parks located along Route 1 to accommodate roadway construction, as summarized below.

- **Paseo de Susana Park** would be affected by GRN #3 (Agana Bridge Replacement) (see Figure 11.2-1). The bridge replacement limits are very conceptual at this stage, and the affected land cannot be accurately estimated; however, based on the preliminary drawing, approximately 4,800 ft^2 or 0.10-ac (0.004 ha) of land may be required.
- **Buffer Strip Park** would be affected by GRN #7 and GRN #6 intersection widening at Routes 1 and 27, and Routes 1 and 26 (see Figure 11.2-2). While the widening currently depicted can likely be adjusted to avoid most of the linear impact, the existing roadway at the intersection with Route 27 appears to encroach on the park ROW by approximately 500 ft^2 or 0.010 ac (0.004 ha).

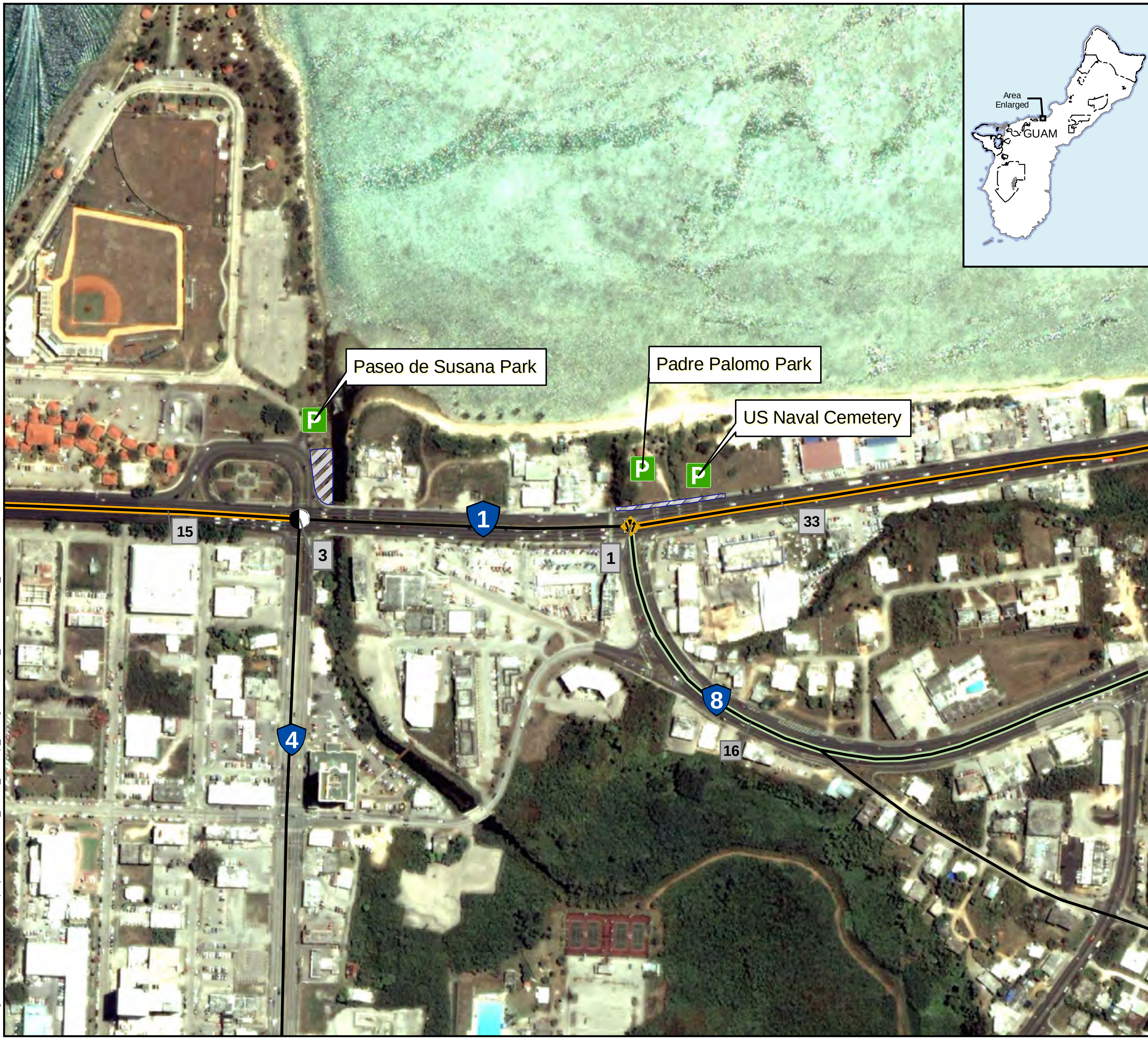

Figure 11.2-1
Potentially Affected Parkland in Central Region
Sheet 1

Legend

- Military Installation
- Route Number
- Project Locations and GRN#
- Bridge Replacement
- Intersection Improvement
- Pavement Strengthening
- Widening/ Pavement Strengthening
- Park Locations
- Park Takes

N S E W

Feet 0 220 440
0 60 120 Meters

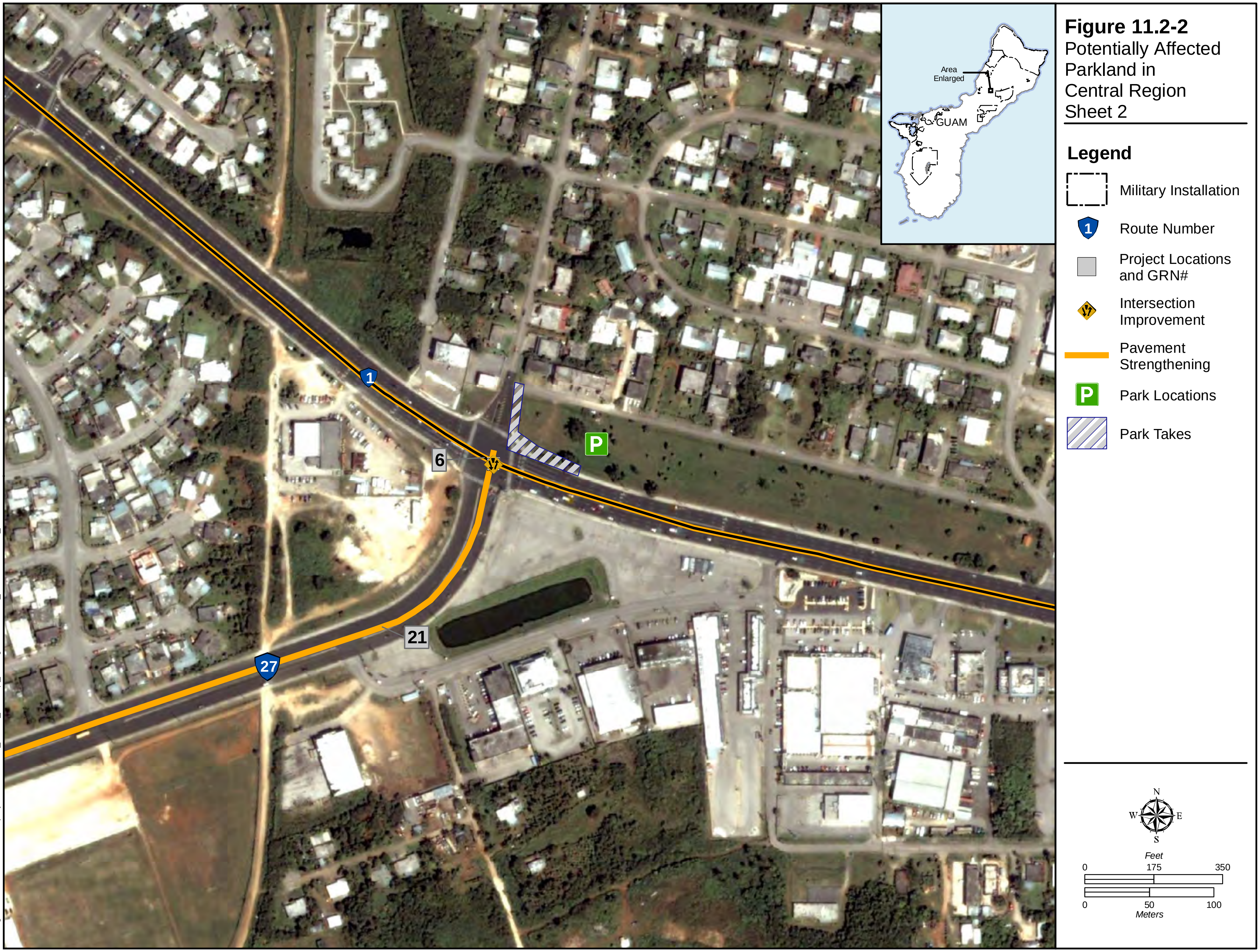

Figure 11.2-2
Potentially Affected Parkland in Central Region
Sheet 2

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Figure 11.2-3
Potentially Affected Parkland in Central Region Sheet 3

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- **Chinese Park** would be affected by GRN #33 intersection widening at Routes 1 and 14 (see Figure 11.2-3). The existing ROW parcel line appears to indicate that the existing roadway is built partially inside the park ROW. Approximately 15,900 ft^2 or 0.36-ac (0.15-ha) of land would need to be acquired to correct this situation and to allow the intersection improvements.

Note that the above information is subject to change during the detailed engineering design phase. Some design adjustment could also avoid impacts to the existing parkland. Any acquisition of parkland would be coordinated between DPW and Department of Parks and Recreation. Because construction of the proposed improvement projects would be centered on the roadway intersection and corridor, no park closure is anticipated during the peak construction year. The impacts are not considered adverse with incorporation of the TMP and coordination plan described above. It should also be noted that the use of public parks for transportation projects would be considered a use of Section 4(f) resources. Impacts on Section 4(f) resources are addressed in Volume 6 Chapter 21.

Routes 10 and 15 provide principal access to recreational opportunities in the eastern segment of the Central Region (i.e., Barrigada, Asbeco, and Adacao). Proposed improvements along Routes 10 and 15 include pavement strengthening, intersection improvements, road realignment, and MAP. As previously noted, recreational opportunities within this area are almost exclusively focused along the coast approximately 0.5-mi (0.8-km) to 1.5 mi (2.4 km) from Route 15.

Effects during the construction period within the Central Region would be similar to those described for the North Region. Once the construction is completed the availability of improved roadway conditions would help enhance the recreation opportunities within the island.

Apra Harbor

Road improvements within the Apra Harbor Region would occur along Routes 1, 2A, and 11. These improvements are limited to pavement strengthening, intersection improvements, and MAP.

There are no GRN projects that would result in either direct or indirect effects to recreational facilities within Naval Base Guam. These recreational facilities are located outside of the proposed GRN projects. In addition, access to these facilities is limited to installation personnel and their guests.

Routes 1 and 11 provide the principal access to recreational opportunities in the Apra Harbor Region (i.e., Piti). Proposed improvements along Route 1 include pavement strengthening, intersection improvements, rehabilitation, and MAP. Recreational opportunities in the Apra Harbor Region are largely limited to the Sasa Bay area and immediately northwest of Piti, that contains marine reserves and fishing areas. Portions of Routes 1 and 11 are located immediately adjacent to or within close proximity to these areas.

Effects during the construction period within the Apra Harbor Region would be similar to those described for the North Region. The impacts are not considered adverse with incorporation of the TMP and coordination plan described above. Once the construction is completed the availability of improved roadway conditions would help enhance the recreation opportunities within the island.

South

Road improvements within the South Region include two pavement strengthening projects on Route 5, a intersection improvement on Route 2, and a MAP project on Route 12 in the village of Santa Rita.

There are no GRN projects that would result in either direct or indirect effects to recreational facilities contained on the NMS. These recreational facilities are located outside of the proposed GRN projects. In addition, access to these facilities is limited to installation personnel and their guests.

Routes 2 and 17 provide the principal access to recreational opportunities in the South Region (i.e., Santa Rita, Agat, and Merizo). Proposed improvements along Route 2 are limited to intersection improvements. There are no improvements proposed for Route 17. Recreational opportunities in the South Region are largely limited to hiking trails, scenic vistas, and beaches/parks. Portions of Route 2 are located immediately adjacent to or within close proximity to these areas.

Effects during the construction period within the South Region would be similar to those described for the North Region. The impacts are not considered adverse with incorporation of the TMP and coordination plan described above. Once the construction is completed the availability of improved roadway conditions would help enhance the recreation opportunities within the island.

Best Management Practices (BMPs)

- The GovGuam DPW would develop a TMP for implementation during construction activities. The TMP would identify and provide alternate traffic detour routes, construction materials hauling routes, bus stops, transit routes and operation hours, pedestrian routes, and residential and commercial access routes to be used during the construction period.
- The GovGuam DPW would develop an outreach program to keep residents, businesses, and any service providers within the area informed, and to inform surrounding communities about the project construction schedule, relocation plans and assistance programs, traffic-impacted areas and the TMP, and other relevant project information.
- To the extent applicable, engineering design would take into consideration avoidance of acquisition of public recreational facilities, such as parkland.

Potential Mitigation Measures

No mitigation measures would be required.

Year 2030

North

As described previously, the proposed GRN improvements are largely public works-type projects that are designed to enhance and improve the roadway system of Guam. No land acquisitions or permanent access closures for either public or non-public facilities are proposed that would result in permanent adverse effects to recreational opportunities contained within the North Region. In certain instances, some roadway improvements may result in long-term beneficial effects where access may previously be limited or in poor condition.

Central

As mentioned in the impact section under Year 2014, three public parks located along Route 1 would be affected by minor ROW acquisitions to accommodate the proposed intersection improvements and road widening; however, no permanent closure of these parks is anticipated. Land acquisition would be required that would affect the existing three parks, however, the land to be acquired is small and would not affect the use of the facilities in the long-term.

Apra Harbor

Effects during the operation period within the Apra Harbor Region would be similar to those described for the North Region.

South

Effects during the operation period within the South Region would be similar to those described for the North Region.

Potential Mitigation Measures

No mitigation measures would be required.

11.2.6.2 Alternative 2 (Preferred Alternative)

The roadway projects that would be implemented for Alternative 2 are listed in Table 2.5-3, with the exception of GRN #38A (MAP), 39A (MAP), 41A (MAP), 47 through 49A (MAP), 63 (pavement strengthening), and 74 (pavement strengthening). Peak construction and long-term impacts on recreation resources under Alternative 2 would be similar to those described under Alternative 1 because the same projects are proposed under this alternative with the only difference is the gate location for the MAP projects which have no impact on existing recreational resources. BMPs as listed in Alternative 1 would be implemented

Potential Mitigation Measures

No mitigation measures would be required.

11.2.6.3 Alternative 3

The roadway projects that would be constructed under Alternative 3 are listed in Table 2.5-1, with the exception of GRN #38 (MAP), 39A (MAP), 41 (MAP), 49A (MAP), 19 (pavement strengthening) 20 (pavement strengthening), 31 (pavement strengthening), and 124 (new roadway). Impacts on recreation from construction activities under Alternative 3 in 2014 during peak construction would be slightly less than Alternatives 1 and 2 because no new roadway (GRN#124) would be constructed under this alternative. However, beneficial impacts on recreational enhancement would be slightly less than Alternatives 1 and 2 due to unavailability of roadway to support the planned land-use development within the Dos Amantes Planning Area. BMPs as listed in Alternative 1 would be implemented.

Potential Mitigation Measures

No mitigation measures would be required.

11.2.6.4 Alternative 8

The roadway projects that would be constructed under Alternative 8 are listed in Table 2.5-1, with the exception of GRN #38 (MAP), 39 (MAP), 41 (MAP), 47 through 49 (MAP), 63 (pavement strengthening), and 74 (pavement strengthening). In general, the MAP and pavement strengthening projects would not cause significant impact to recreational facilities; therefore, impacts on recreation under Alternative 8 in 2014 during peak construction would be similar to those described under Alternative 1 because the same projects are proposed under this alternative with the exception of GRN# 49A, which is a MAP project. In the long-term beneficial impacts to recreation facilities under Alternative 8 would be similar to Alternatives 1 and 2. BMPs as listed in Alternative 1 would be implemented.

Potential Mitigation Measures

No mitigation measures would be required.

11.2.6.5 Summary of Impacts

Table 11.2-5 summarizes the potential impacts of each alternative. Implementation of the proposed roadway improvement projects would cause disruption to recreational opportunities situated along the roadway corridors during the construction period. This impact would be temporary and would cease after the construction activity is complete. To accommodate the proposed improvements, some parkland along certain roadway corridors would be subject to acquisition, but none of them would result in severe disruption to recreation opportunities or permanent closure of any parkland. Roadway improvements around the island would essentially enhance the recreation opportunities around the island of Guam in the long-term.

11.2.6.6 Summary of Potential Impacts to Recreational Resources-Roadway Project

Table 11.2-5. Summary of Potential Impacts to Recreational Resources-Roadway Project

Potentially Impacted Resource	*Alternative 1*	*Alternative 2**	*Alternative 3*	*Alternative 8*
Disruption of Recreation Opportunities during Peak Construction	SI-M	SI-M	SI-M	SI-M
Disruption of Long-term Recreation Opportunities	LSI	LSI	LSI	LSI
Enhancement of Long-Term Recreation Opportunities	BI	BI	BI	BI

Legend: SI-M = Significant Impact Mitigable to Less Than Significant, LSI = Less Than Significant Impact, BI = Beneficial Impactt. *Preferred Alternative.

CHAPTER 12. TERRESTRIAL BIOLOGICAL RESOURCES

12.1 INTRODUCTION

This chapter contains a discussion of the potential environmental consequences associated with implementation of the alternatives within the region of influence (ROI) for this resource. For a description of the affected environment for all resources, refer to the respective chapter of Volume 2 (Marine Corps Relocation – Guam). The locations described in that volume include the ROI for the utilities and roadway projects, and the chapters are presented in the same order as the resource areas contained in this volume.

Species mentioned in this section are described using the common name when there is an English common name that is in relatively common use on Guam (all wildlife and some plants). Common names are cross-referenced to scientific names in Appendix G. Where there is no commonly used English name for plants, the scientific name is used with the Chamorro name in parentheses when first used.

12.2 ENVIRONMENTAL CONSEQUENCES

12.2.1 Approach to Analysis

12.2.1.1 Methodology

The affected environment for terrestrial biological resources for the proposed roadway improvement projects is described in Volume 2 of this Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS).

Biological resource issues and concerns include the potential direct, indirect, and cumulative impacts of the proposed actions and alternatives during the construction and operation phases. Impacts may be either temporary (reversible) or permanent (irreversible). Direct and indirect impacts are distinguished as follows.

Direct impacts are associated with proposed construction activities (e.g., ground-disturbing activities) and operations (e.g., noise and lighting). Potential types of direct impacts include, but are not limited to:

- Loss of habitat due to vegetation removal during construction.
- Temporary loss of habitat during construction from noise, lighting, and human activity.
- Potential loss of habitat due to disturbance of species in areas surrounding operations from noise, lighting, and human activity.
- Injury or mortality to wildlife or special-status species caused by the action that occur at the same time and place as the action.

Indirect impacts are caused by or result from project-related activities, are usually later in time, and are reasonably forseeable (e.g., increased likelihood of invasive species moving into the area after disturbance). Potential indirect impacts include, but are not limited to:

- All disturbance from human activity, noise, and lighting that would potentially impact unoccupied suitable habitat for special-status species.
- Introduction of new non-native species or increased dispersal of existing non-native species on Guam.
- Dispersal of existing non-native species from Guam to the CNMI, Hawaii, or other destinations.
- Adverse effects from pollutants that are released from construction or military operations.

General principles used to evaluate impacts are:

- The extent, if any, that the action would permanently lessen ecological habitat qualities that ESA-listed species depend upon, and which partly determines the species' prospects for conservation and recovery.
- The extent, if any, that the action would diminish population sizes, distribution, or habitat of regionally important native plant or animal species.
- The extent, if any, that the action would be likely to jeopardize the continued existence of any ESA-listed species.
- The extent, if any, that the action would be inconsistent with the goals of USFWS recovery plans, Navy and Air Force INRMPs, or the Guam CWCS.

Many of the proposed roadway improvement projects were excluded from further analysis of direct impacts if such projects would not require road widening, where all proposed improvements would occur within the existing impervious cover footprint because these projects would not directly or indirectly affect terrestrial biological resources (i.e., vegetation communities, wildlife resources, or special-status species). In addition, roadway projects were excluded from further direct impact analysis if they would occur in developed areas with no appreciable effect to terrestrial biological resources (i.e., vegetation communities, wildlife resources, or special-status species). These types of projects would require clearing of vegetation, but the area required for clearing has been so heavily degraded, modified, or characterized by urban vegetation that the loss of the area would not appreciably affect terrestrial biological resources (i.e., vegetation communities, wildlife resources, or special-status species). The analysis of indirect impacts for roadways considers the potential for runoff, sedimentation, and non-point source pollution inputs into freshwater (non-marine) aquatic environments and surrounding vegetation communities.

12.2.1.2 Determination of Significance

Significance of impacts to vegetation, wildlife, and special-status species were determined using guidelines in the previous section. Special-status species are defined as ESA- and Guam-listed species and species that are designated candidates for ESA listing. Specific significance criteria are discussed below. If significant impacts are determined, then mitigation may be proposed to offset the impacts. For this EIS/OEIS, a major consideration for mitigation is biosecurity. This issue is discussed under mitigation measures after the evaluation of impacts (see Section 10.2.2.3).

<u>Vegetation</u>

Impacts would be determined significant if any primary limestone forest (mature forest dominated by native species) would be cleared, unless determined to be very minor in the context of the surrounding forest areas. Any loss of this forest vegetation community would be considered significant because of the large historical and continuing losses of this forest type on Guam. Loss of wetland or mangrove vegetation would also be considered potentially significant.

<u>Wildlife</u>

Impacts would be determined significant if native wildlife species are present and the proposed project results in diminished population sizes or distributions of regionally important native animal species. These wildlife species include those designated as SOGCN in the Guam CWCS. Invasive species impacts that exceed the criteria specified above are evaluated. Historical impacts from non-native species have been severe, particularly from the BTS (see discussion in Volume 2). Although the proposed action would not result in additional impacts from BTS on Guam, the concern is that the BTS would be inadvertently introduced to other islands throughout the Pacific. This concern is addressed comprehensively for all actions proposed in this EIS/OEIS with mitigation measures described in Section 10.2.2.3.

Migratory Birds

For migratory birds, the MBTA prohibits the taking, killing, or possession of migratory birds, with an exemption for military readiness activities (as defined in federal regulations) provided they do not result in a significant adverse effect on a population of a migratory bird species. Congress defined military readiness activities as all training and operations of the Armed forces that relate to combat and the adequate and realistic testing of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat use. Military readiness activities do not include: (A) routine operation of installation support functions such as administrative offices, military exchanges, water treatment facilities, schools, housing, storage facilities, and morale, welfare, and recreation activities; (B) the operation of industrial activities; and (C) the construction or demolition of facilities used for a purpose described in A or B (50 CFR Part 21).

The DoD must consult with the USFWS if it is determined that a military readiness activity would have a significant adverse effect on a population of a migratory bird species. An activity has a significant adverse effect if, over a reasonable period of time, it diminishes the capacity of a population of a migratory bird species to maintain genetic diversity, to reproduce, and to function effectively in its native ecosystem.

Migratory bird conservation relative to non-military readiness activities is addressed separately in a Memorandum of Understanding developed in accordance with EO 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds*. The Memorandum of Understanding between the DoD and USFWS was signed in July 2006 and DoD responsibilities included, but are not limited to: (1) incorporating conservation measures addressed in regional or state bird conservation plans and INRMPs; (2) managing military lands and activities other than military readiness in a manner that supports migratory bird conservation; and (3) avoiding or minimizing impacts to migratory birds, including incidental take and the pollution or detrimental alteration of the environments used by migratory birds.

The following species that occur on Guam are considered non-migratory birds and are not covered under the MBTA: black francolin, black drongo, Eurasian tree sparrow, island-collard dove (previously known as Philippine turtle dove), common pigeon, and king quail.

Special-Status Species

The presence of Special-Status species in the project areas was described in Volume 2. Background information is presented in the species profiles in Appendix G. Impacts would be determined significant if special-status species are present in the project area and any project action is likely to result in harassment or harm of an individual, population or species. Impacts to ESA-listed species would include vegetation clearing of designated undeveloped Overlay Refuge habitat, or recognized essential habitat or recovery zones, unless it is determined that the removal of habitat or other affect is minor when considering all the remaining habitat and quality of habitat available to that species and considering USFWS recovery plan goals. Significant impacts would also include disturbing ESA- and Guam-listed species due to noise, lighting, or human activity. If species are currently present in a proposed project area, noise, lighting, and general human activity are considered direct impacts for the purposes of this analysis, even though it is recognized that some of the impacts from the proposed actions may be indirect, rather than direct. If unoccupied but recognized habitat is affected by noise, lighting, or human activity, impacts would be considered indirect and would be determined significant unless the area affected is considered minor when considering all the remaining habitat and quality of habitat available to that species.

For ESA-listed species, federal agencies are required to ensure that their actions do not jeopardize the continued existence of an endangered or threatened species or its critical habitat. Analyses of potential impacts are based on review of plans for the proposed action and the available current and historical distributional data for each species. In accordance with Section 7 of the ESA, a Biological Assessment (BA) is being prepared by the Navy to analyze the potential impacts on ESA-listed and candidate species and critical habitat under the jurisdiction of the USFWS.

The BA and the subsequent Biological Opinion (BO) issued by the USFWS after their review of the BA, will be the final determination of impacts to ESA-listed species that are being evaluated in this EIS/OEIS. Candidate species must also be evaluated in the BA; however, if they are not formally listed by the time the BO is issued and the proposed action would not result in their listing, no determination for these species will be made in the BO. The BO will provide an Incidental Take Statement that will list the amount or extent of take anticipated. Based on that take it will specify Terms and Conditions that the action proponent must comply with to be exempt from the prohibitions of Section 9 of the ESA. These are non-discretionary requirements. The BO will also specify Conservation Recommendations that are discretionary proponent activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The USFWS effects determinations from the BO will be incorporated into the Final EIS/OEIS.

12.2.1.3 Issues Identified during Public Scoping Process

Terrestrial biological resource issues identified by the public, including regulatory stakeholders, during the public scoping process that are applicable to the proposed action include the following:

- Activities associated with the military expansion (i.e., construction, expansion, renovation projects, and military training activities) may result in habitat loss and physical disturbance of federally listed endangered species and other federal trust species.
- Potential for harm to fragile ecosystems on Guam and in the Marianas from the introduction of non-native species due to increased traffic among the islands from the movement of personnel and materials. Such species include the brown tree snake (BTS), flatworms, various insects, and some plants. The EIS/OEIS should outline inspection and sanitary procedures to prevent this movement.
- Existing control and containment activities at air and sea ports for the BTS are insufficient to deal with the risk associated with the increased cargo and personnel movement from Guam to other vulnerable destinations. The issue "of utmost concern" is BTS interdiction and an effective, enforceable, and fail-proof procedure for inspecting all military cargo, personnel, and equipment entering the Commonwealth of the Northern Mariana Islands (CNMI) must be instituted. The Navy must ensure funding to sustain a 100% inspection rate of all cargo, vehicles, munitions, and household goods. Guam regulation protocols 505 and 506 should be incorporated into a BTS control plan to be included as part of the EIS/OEIS.

12.2.2 Power

12.2.2.1 Interim Alternative 1 (Preferred Alternative)

Interim Alternative 1 would recondition existing combustion turbines and upgrade T&D systems and would not require new construction or enlargement of the existing footprint of the facility. This work would be undertaken by the GPA on its existing permitted facilities. Reconditioning would be made to existing permitted facilities at the Marbo, Yigo, Dededo No. 1, and Macheche combustion turbines. These combustion turbines are not currently being used up to permit limits. T&D system upgrades would be on existing above ground and underground transmission lines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Terrestrial biological resources would not be impacted under this alternative as proposed activities involve only upgrades to existing facilities and infrastructure and installation of underground powerlines in already developed areas.

12.2.2.2 Interim Alternative 2

Interim Alternative 2 is a combination of reconditioning of existing permitted GPA facilities, an increase in operational hours for existing combustion turbines, and upgrades to existing T&D systems. Interim Alternative 2 would not require new construction or enlargement of the existing footprint of the facility. Reconditioning would be performed on the existing permitted GPA facilities at the Marbo, Yigo, and Dededo combustion turbines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Terrestrial biological resources would not be impacted under this alternative as proposed activities involve only upgrades to existing facilities and infrastructure and installation of underground powerlines in already developed areas.

12.2.2.3 Interim Alternative 3

Interim Alternative 3 is a combination of reconditioning existing GPA permitted facilities at Marbo, Yigo, and Dededo and upgrades to the Department of Defense power plant at Orote. Upgrades would be made to existing T&D. The proposed reconditioning to the existing power generation facilities at Marbo, Yigo, and Dededo would not require new construction or enlargement of the existing footprint of the facility. For the Orote power plant, upgrades would include a new fuel storage facility to facilitate longer run times between refueling. This would disturb approximately 1 acre (4,047 square m). This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Terrestrial biological resources would not be impacted under this alternative as proposed activities involve only upgrades to existing facilities and infrastructure and construction and placement of powerlines in already developed areas.

12.2.2.4 Summary of Impacts

Table 12.2-1 summarizes the potential impacts of each interim alternative.

Table 12.2-1. Summary of Potential Impacts to Terrestrial Biological Resources-Power

*Interim Alternative 1**	*Interim Alternative 2*	*Interim Alternative 3*
Vegetation		
NI • No impacts to vegetation	NI • No impacts to vegetation	NI • No impacts to vegetation
Wildlife		
NI • No impacts to wildlife	NI • No impacts to wildlife	NI • No impacts to wildlife
Special-Status Species		
NI • No impacts to special-status species	NI • No impacts to special-status species	NI • No impacts to special-status species

Legend: NI = No Impact.*Preferred Alternative

There would be no impacts to any terrestrial biological resources because each of the proposed alternatives involves only upgrades to existing facilities and construction and installation of powerlines in already developed areas.

12.2.3 Potable Water

As discussed in Volume 6 Chapter 2 (Section 2.2.2), potable water alternatives are not distinguished as interim or long-term. Impacts from proposed potable water waterlines that run along public roadways are not evaluated since roadway improvements that would disturb these same areas are being evaluated for impacts in Chapter 4 of this EIS/OEIS and no additional impact beyond construction is anticipated.

12.2.3.1 Basic Alternative 1 (Preferred Alternative)

Basic Alternative 1 would consist of installation of up to 22 new potable water supply wells at Andersen Air Force Base (AFB), rehabilitation of existing wells, interconnection with the GWA water system, and associated T&D systems. A new 5 MG (19 ML) water storage tank would be constructed at ground level at Finegayan.

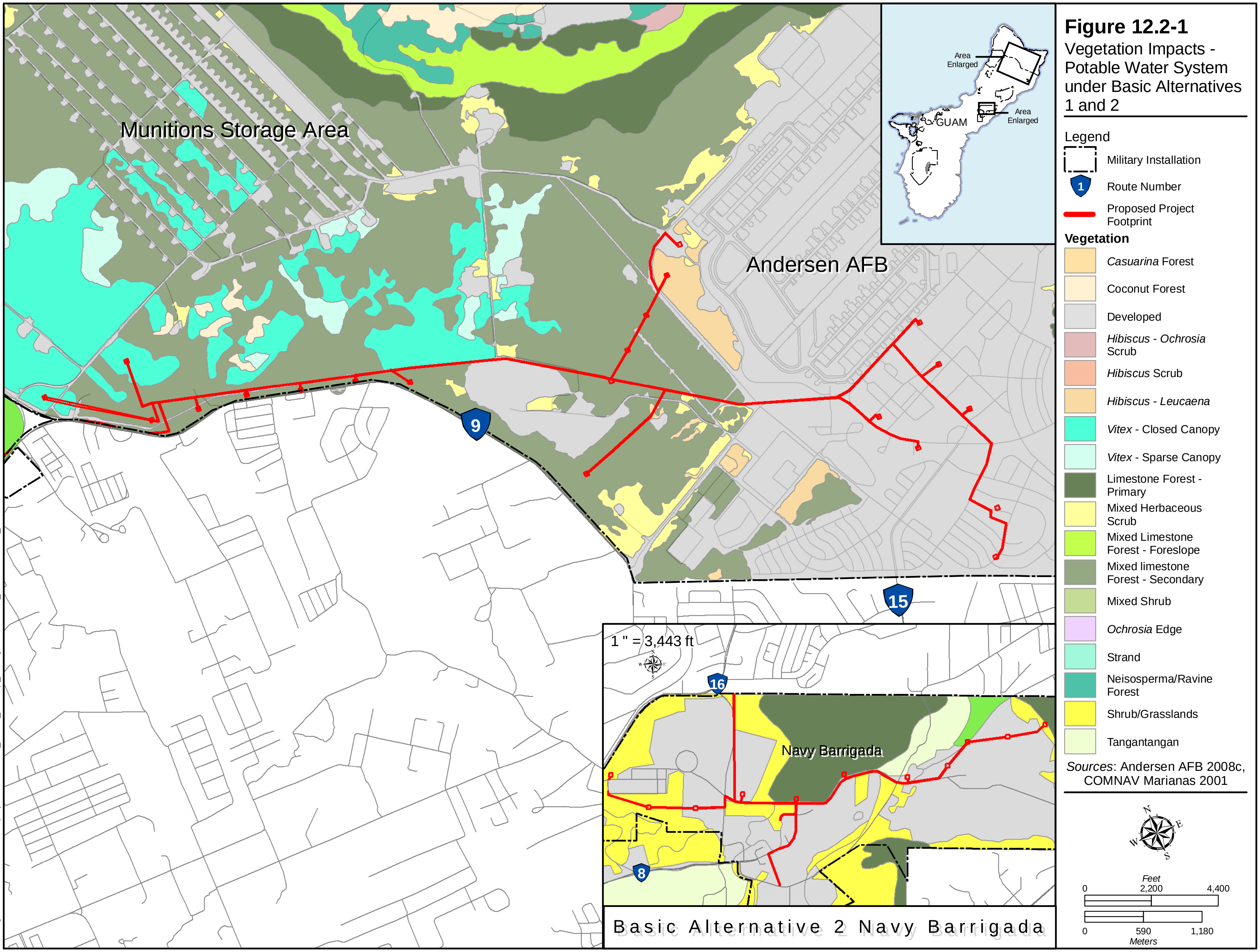
<u>Construction</u>

Vegetation

The vegetation associated with the various components under Alternative 1 that would be removed is shown in Figure 12.2-1 and listed in Table 12.2-2. Disturbed limestone vegetation community types on Andersen AFB that would be affected are primarily mixed limestone forest – plateau/secondary and vitex – closed canopy forest. At NCTS Finegayan, all water system components would be placed in areas already included in the proposed developed cantonment area so that there would be no additional impacts to vegetation. Impacts to vegetation at Andersen AFB and Andersen South would be less than significant because minimal primary limestone forest would be removed. Vegetation removed does provide habitat for wildlife and special-status species. These impacts are evaluated in subsequent sections.

Wildlife

Based on studies by others and observations in other similar areas on Andersen AFB, NCTS Finegayan, and Andersen South (discussed in Volume 2, Section 10.1), the only native bird species likely to be present in the project areas are the yellow bittern and possibly the Pacific golden plover in open areas; both species are ubiquitous throughout Guam. Native species of skinks and geckos have not been reported in the project areas in any recent studies (within the past 10 years) and were not observed in surveys conducted in project areas for this EIS/OEIS.



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Proposed construction activities would displace the species and other wildlife from suitable habitat in the proposed project areas. Smaller, less-mobile species and those seeking refuge in burrows could inadvertently be killed during construction activities; however, long-term, permanent impacts to populations of such species would not result because the species known to be present are abundant in surrounding areas. There would be no diminished population sizes or distributions of migratory birds or regionally important native animal species. Therefore, impacts to wildlife due to proposed construction activities at Andersen AFB would be less than significant under Alternative 1.

Table 12.2-2. Potential Direct Impacts to Vegetation Communities with Implementation of Potable Water Basic Alternative 1

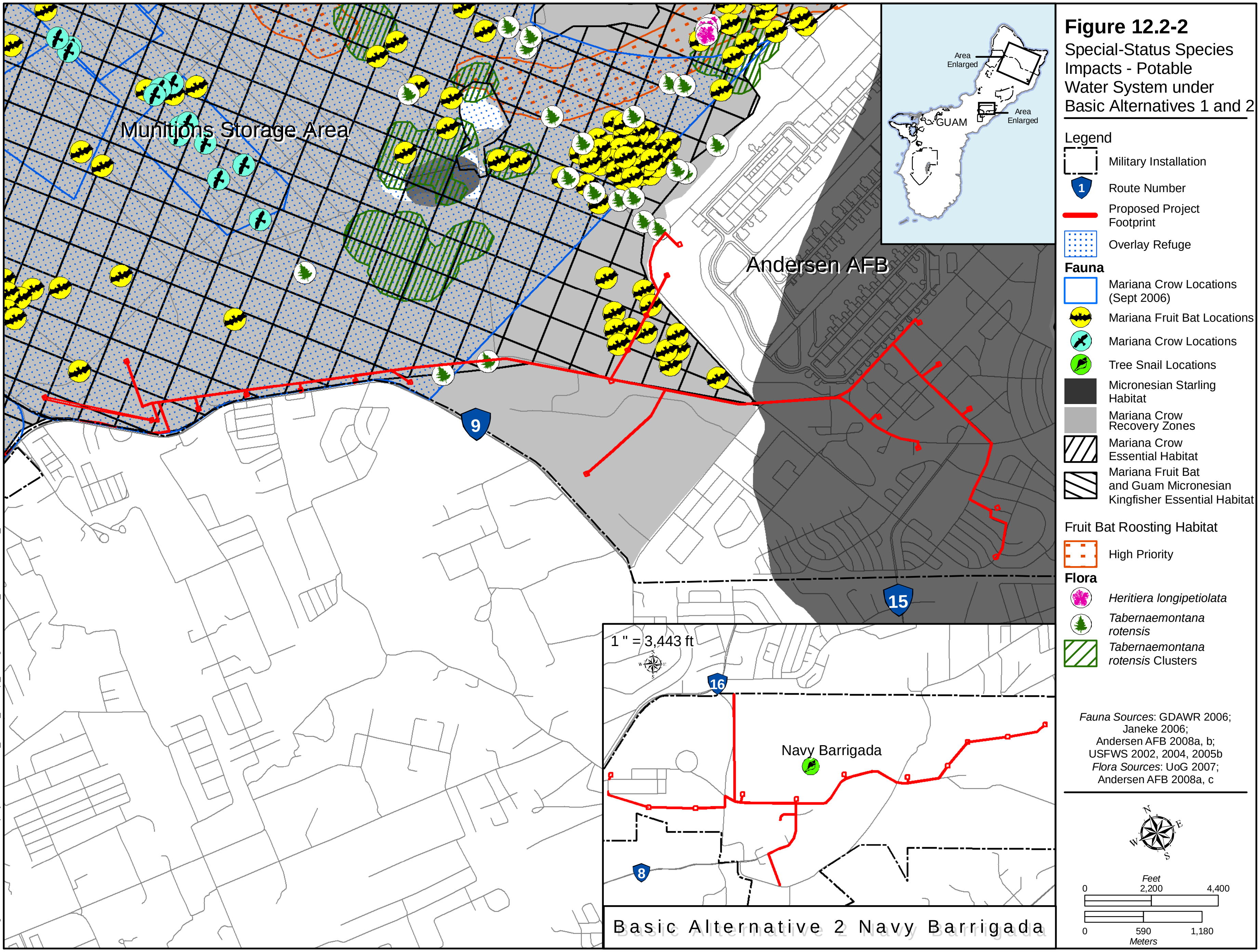
Parcel and Activity	*Limestone Forest, Disturbed ac (ha)*	*Leucaena (Tangan tangan), Casuarina ac (ha)*	*Shrub/ Grasslands, Savanna ac (ha)*	*Developed ac (ha)*
Andersen AFB				
Water Wells	2.9 (1.2)	0.2 (0.1)	0	1.9 (0.8)
Waterlines	11 (4.5)	0.4 (0.2)	0	16 (6.5)
Andersen South				
Waterlines	2.3 (0.9)		0.1 (0.04)	0.1 (0.04)
Total area removed	**16 (6.5)**	**0.6 (0.2)**	**0.1 (0.04)**	**18 (7.3)**

Special-Status Species

Specific designated habitat areas would be removed under Alternative 1 for potable water, including (NWR overlay); essential habitat for the federal- and Guam-listed Mariana fruit bat, Mariana crow, and Micronesian kingfisher; and Mariana crow recovery zone habitat (Figure 12.2-2). The amount of these habitats that would be removed are shown in Table 12.2-3. At NCTS Finegayan and FAA, all water system components would be in areas already included in the proposed developed cantonment area so that there would be no additional impacts to habitat areas. Based on the removal of these habitat areas at Andersen AFB, there would be significant impacts to the three species. Several wells and connecting waterlines in the eastern cluster would be constructed in habitat of the Micronesian starling, a Guam-listed species (Figure 12.2-2) but loss if this small amount of habitat would result in less than significant impacts to this species.

Areas potentially impacted are shown in Table 12.2-3. Special-status species present in the area are discussed below.

Mariana Fruit Bat. Specific designated habitat areas would be removed under Alternative 1 for potable water, including Overlay Refuge and essential habitat for the fruit bat (Figure 12.2-2, Table 12.2-3). There would be no temporary direct impacts from noise and activity during construction at Andersen AFB to roosting and nesting activities of the Mariana fruit bat because construction would only occur during the daytime. Based on the removal of Overlay Refuge and essential habitat areas, there would be significant impacts to the fruit bat. This significant impact would be mitigated to less than significant with measures described in Volume 2, Section 10.2.2.



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Mariana Crow. Specific designated habitat areas would be removed under Alternative 1, including Overlay Refuge and essential habitat for the crow (Figure 12.2-2, Table 12.2-3). The Mariana crow is not currently present in areas where these projects would occur so there would be no impacts from construction. Based on the removal of habitat areas, there would be significant impacts to the Mariana crow. This significant impact would be mitigated to less than significant with measures described in Volume 2, Section 10.2.2.

Micronesian Kingfisher. Specific designated habitat areas would be removed under Alternative 1, including Overlay Refuge and essential habitat for the kingfisher (Figure 12.2-2, Table 12.2-3). Based on the removal of habitat areas, there would be significant impacts to the Micronesian kingfisher. This significant impact would be mitigated to less than significant with measures described in Volume 2, Section 10.2.2.

Guam Rail. The rail survives only in captivity at this time. Proposed construction activities would include the loss of shrub/grassland habitat that is potential foraging and nesting habitat for the Guam rail. No specific areas of essential habitat have been described for this species. Because the Guam rail is currently extirpated in the wild and most of Guam has habitat that is potentially suitable for the recovery of the species, removal of these areas due to construction would result in a less than significant impact.

Micronesian Starling. Several wells and connecting waterlines in the eastern cluster would be constructed in habitat of the Micronesian starling, a Guam-listed species (see Figure 12.2-2). The loss of small areas of habitat would result in less than significant impacts to this species.

Mariana Eight Spot Butterfly. The two host plant species for this species were not observed in field work conducted in project areas in September 2009. Furthermore, these host plants are generally associated with primary limestone forest in areas of pinnacle karst (karren) which is not present in the project areas. Therefore, it is unlikely the eight spot butterfly is present in the project area so removal of these areas due to construction would have no impact on the species.

Table 12.2-3. Potential Impacts to Special-Status Species Habitat with Implementation of Potable Water – Basic Alternative 1

Parcel and Activity	*Overlay Refuge ac (ha)*	*Essential Habitat – Bat and Kingfisher* ac (ha)*	*Essential Habitat – Crow* ac (ha)*	*Recovery Zone – Crow * ac (ha)*
Direct Impacts from Construction – Habitat Removed				
Andersen AFB				
Water Wells	2.0 (1.0)	2.2 (0.9)	2.2 (0.9)	2.9 (1.2)
Waterlines	9.4 (3.8)	12 (4.9)	12 (4.9)	16 (6)
Total area removed	**11 (4.5)**	**14 (5.7)**	**14 (5.7)**	**19 (7.7)**
Percentage of Habitat on Guam that would be Removed	<0.1 %	<0.1 %	<0.1 %	<0.1 %

Note: *Each habitat category is considered independently of others and is not additive.

Operation

Terrestrial biological resources would not be impacted under this alternative because, once installed, the potable water lines and wells will require minimal maintenance.

Potential Mitigation Measures

Impacts to special-status species habitat resulting from proposed potable water projects would be mitigated with a suite of protection and conservation measures for all impacts on Guam described in this

EIS/OEIS. See Volume 2, Section 10.2.2 for a description of these measures.

BMPs that would be employed during all project construction and operations are described in Volume 7.

12.2.3.2 Basic Alternative 2

Basic Alternative 2 would consist of installation of up to 20 new potable water supply wells at Andersen AFB, up to 11 new potable water supply wells at Barrigada, rehabilitation of existing wells, interconnection with the GWA water system, associated transmission and distribution systems upgrades. Additionally, new 3.6 MG (13.6 ML) and 1 MG (3.8 ML) water storage tanks would be constructed at ground level at Finegayan and Barrigada, respectively.

Impacts at each facility are discussed below.

Andersen AFB and Andersen South

Construction

Vegetation. Impacts would be the same as those under Alternative 1 except that two water wells and associated piping would not be installed. Acreages affected are shown in Table 12.2-4. Impacts would be less than significant because no primary limestone forest would be removed.

Wildlife. Impacts would be the same as those under Alternative 1

Special-Status Species. Impacts would be the same as those under Alternative 1 except that two water wells and associated piping would not be installed so less habitat would be affected. Acreages affected are shown in Table 12.2-5.

Operation

Terrestrial biological resources would not be impacted under this alternative because, once installed, the potable water lines, tanks, and wells will require minimal maintenance.

Table 12.2-4. Potential Direct Impacts to Vegetation Communities with Implementation of Potable Water – Basic Alternative 2

Parcel and Activity	*Limestone Forest, Primary ac (ha)*	*Limestone Forest, Disturbed ac (ha)*	*Leucaena (Tangan tangan or Casuarina ac (ha)*	*Shrub/ Grasslands, Savanna ac (ha)*	*Developed ac (ha)*
Andersen AFB					
Water Wells	0	2.1 (0.8)	0.2 (0.1)	0	1.4 (0.6)
Waterlines	0	11 (4.5)	0.4 (0.2)	0	16 (6.5)
Andersen South					
Waterlines	0	2.3 (0.9)	0	0.1 (0.04)	0.1 (0.04)
Navy Barrigada					
Water Wells and Waterlines	0.5 (0.2)*	0	0	2.8 (1.1)	9.8 (4.0)
Air Force Barrigada					
Water Storage Tank	0	0	0.8 (0.3)	0	0.1 (0.04)
Waterlines	0	0	1.0 (0.04)	0	1.1 (0.4)
Total area removed	**0.5 (0.2)**	**15 (6.1)**	**2.4 (1.0)**	**2.9 (1.2)**	**29 (12)**

Note: *This primary limestone forest removal is already accounted for in the development of the Army Cantonment in Volume 5, Alternative 2.

Table 12.2-5. Potential Impacts to Special-Status Species Habitat with Implementation of Potable Water - Alternative 2

Parcel and Activity	*Overlay Refuge ac (ha)*	*Essential Habitat – Bat and Kingfisher* ac (ha)*	*Essential Habitat – Crow* ac (ha)*	*Recovery Zone – Crow* ac (ha)*
Direct Impacts from Construction – Habitat Removed				
Andersen AFB				
Water Wells	1.5 (0.6)	1.6 (0.9)	1.6 (0.9)	2.1 (0.8)
Waterlines	9.4 (3.8)	12 (4.9)	12. (4.9)	16 (6.5)
Total area removed	**11 (4.5)**	**14 (5.7)**	**14 (5.7)**	**19 (7.7)**
Percentage of Habitat on Guam that is Removed	<0.1 %	<0.1 %	<0.1 %	<0.1 %

Note: *Each habitat category is considered independently of others and is not additive.

<u>Barrigada</u>

Construction

Vegetation. The vegetation associated with Navy and Air Force Barrigada components under Alternative 2 that would be removed are listed in Table 12.2-4. Two water wells would be constructed within the limestone forest but they would be at the edge of the forest, near the road. Habitat near the roads are typically partially invaded by non-native species so the forest is of lower quality. Because of the size and location of the forest that would be removed, impacts to the primary limestone forest would be less than significant.

Wildlife. Wildlife species that currently occur at Barrigada are native and non-native species that are common elsewhere on Guam such as Pacific golden plover, yellow bittern, island collared dove, western cattle egret, black francolin, Eurasian tree sparrow, blue-tailed skink, mutilating gecko, and mourning gecko. All these species are common on Guam. Proposed construction activities would displace wildlife from suitable habitat in the proposed project areas. Smaller, less mobile species, and those seeking refuge in burrows, could inadvertently be killed during construction activities; however, long-term, permanent impacts to populations of such species would not result because these species are abundant in surrounding areas and would rapidly repopulate suitable portions of the affected area. Therefore, the impacts to wildlife would be less than significant.

Construction activities for the operation buildings would generate noise. Only a few, widespread migratory bird species are present that would be affected. They would move away from the construction areas but there are other areas of suitable habitat nearby. There would be no diminished population sizes or distributions of migratory birds or regionally important native animal species. Therefore, impacts to wildlife due to proposed construction activities at Andersen AFB would be less than significant under Alternative 1.

Special-Status Species. Proposed construction activities at Navy and Air Force Barrigada would not impact any designated habitat areas. There would be no indirect impacts to special-status species. Species that would be directly affected are described below.

Guam Tree Snail. The Guam tree snail, an ESA candidate species, was documented in the primary limestone forest on one transect during site-specific surveys in 2008 in support of this EIS/OEIS (see Figure 12.2-2). The distribution and numbers of tree snails at the site is unknown. Proposed construction activities would remove 0.5 ac (0.2 ha) of primary limestone forrest habitat. This area would be surveyed prior to removal of vegetation and if present, tree snails would be relocated. With this mitigation, impacts would be less than significant.

Operation

Terrestrial biological resources would not be impacted under this alternative because, once installed, the potable water lines, wells, and tanks will require minimal maintenance.

Potential Mitigation Measures

Potential mitigation measures for Andersen AFB, and Finegayan components would be the same as for Alternative 1. Mitigation for Navy Barrigada would be part of overall conservation measures that are described in Volume 2 Chapter 10, Alternative 3 for Navy Barrigada.

12.2.3.3 Summary of Impacts

Table 12.2-6 provides a summary of the potential impacts of each alternative.

Table 12.2-6. Summary of Potential Impacts to Terrestrial Biological Resources - Potable Water

*Basic Alternative 1**	*Basic Alternative 2*
Vegetation	
LSI • No primary limestone forest would be removed	LSI • A minimal amount of primary limestone forest (0.5 acre [0.2 ha]) would be removed along the forest edge
Wildlife	
LSI • Less than significant impacts to wildlife	LSI • Less than significant impacts to wildlife
Special-Status Species	
SI-M • Significant direct impacts due to removal of essential habitat for several endangered species at Andersen AFB, mitigated to less than significant; habitat is also NWR Overlay	SI-M • Significant direct impacts due to removal of essential habitat for several endangered species at Andersen AFB, mitigated to less than significant; habitat is also NWR Overlay • Significant impacts due to possible presence of the Guam tree snail that has been found in the area, mitigated to less than significant

Legend: LSI = Less Than Significant Impact, SI-M = Significant impact mitigable to less than significant.
*Preferred Alternative.

Impacts would be less than significant to vegetation because no limestone forest would be removed. Impacts to wildlife would be less than significant because there would be no diminished population sizes or distributions of migratory birds or regionally important native animal species. Significant impacts would result from construction of water wells and waterlines at Andersen AFB because some of the areas where they would be placed is Overlay Refuge and recognized essential habitat for the Mariana fruit bat, Micronesian kingfisher, and Mariana crow. These impacts would be mitigated to less than significant with measures described in Volume 2, Section 10.2.2.

12.2.3.4 Summary of Potential Mitigation Measures

Table 12.2-7 provides a summary of the potential mitigation measures of each alternative.

Table 12.2-7. Summary of Potential Terrestrial Biological Mitigation – Potable Water

Alternatives 1 and 2	*Alternative 2 Additional*	*No-Action Alternative*
Vegetation		
None specifically for vegetation.	None	None
Wildlife and Special-Status Species		
At Andersen AFB the construction period would be limited if Mariana crows were present and there would be no work at night to avoid impacts to the Mariana fruit bat	Conduct survey in limestone forest water well footprint at Navy Barridage and, if found, translocation of Guam tree snails	None
Biological surveys would be conducted for crows and bat before clearing		
Natural resource awareness briefings would be conducted for construction personnel		
The existing Navy Ungulate Management Plans would be updated to include the new lands to be used for training and cantonment areas and additional project-specific actions that would be necessary to ensure sensitive ecological resources are protected (general mitigation item - same item as Volume 2 mitigation)		
A BioSecurity Plan (comprehensive for all actions on Guam and CNMI) would be developed and implemented (general mitigation item - same item as Volume 2 mitigation)		
Invasive insect management options would be investigated for the ESA-listed fire tree and SOGCN cycad (general mitigation item - same item as Volume 2 mitigation)		
Establishment or expansion of new ecological reserves and conservation areas would be considered (general mitigation item - same item as Volume 2 mitigation)		
Sea Turtle natural history studies would be undertaken to better understand the species and benefit long-term military mission planning (general mitigation item - same item as Volume 2 mitigation)		
High-quality habitat areas would be fenced to exclude invasive species and foraging plots would be established within (general mitigation item - same item as Volume 2 mitigation)		
Fencing, patrols, or cameras would be used to prevent poaching (general mitigation item - same item as Volume 2 mitigation)		
Greenbelt development would be considered for watershed protection, wildfire control, and restoration of habitat (general mitigation item - same item as Volume 2 mitigation)		

12.2.4 Wastewater

12.2.4.1 Basic Alternative 1a (Preferred Alternative) and 1b

Basic Alternative 1 (Alternative 1a supports Main Cantonment Alternatives 1 and 2; and Alternative 1b supports Main Cantonment Alternatives 3 and 8) combines upgrade to the existing primary treatment facilities and expansion to secondary treatment at the Northern District Wastewater Treatment Plant (NDWWTP). The difference between Alternatives 1a and 1b is a requirement for a new sewer line from Barrigada housing to NDWWTP for Alternative 1b.

Construction

Vegetation

Construction of a new sewer line from the former FAA parcel to the NDWWTP would require a 24 ft (7.3 m) corridor approximately 8,300 ft (2,530 m) in length for a total of 4.6 ac (1.9 ha). The sewer line would follow trails that are evident on aerial photographs and traverse primarily through shrub/grassland and tangantangan habitat. Based on vegetation mapping by the USFS (2006), at most 1,000 ft (305 m) would traverse through disturbed limestone habitat, although there are also open trails in through these areas that would be used for some some of the pipeline corridor. Assuming the entire 1,000 ft (305 m) would need to be cleared, 0.6 ac (0.2 ha) disturbed limestone forest would be cleared, in addition to areas of shrub/grassland and tangantangan. Impacts from this removal would be less than significant because no primary limestone forest would be removed.

Wildlife

Based on studies by others and observations in other similar areas on the former FAA parcel and South Finegayan, (discussed in Volume 2, Section 10.1), the only native bird species likely to be present in the project areas are the yellow bittern and possibly the Pacific golden plover in open areas; both species are ubiquitous throughout Guam. Native species of skinks and geckos have not been reported in nearby project areas and were not observed in surveys conducted in project areas for this EIS/OEIS.

Proposed construction activities would displace the species and other wildlife from suitable habitat in the proposed project areas. Smaller, less-mobile species and those seeking refuge in burrows could inadvertently be killed during construction activities; however, long-term, permanent impacts to populations of such species would not result because the species known to be present are abundant in surrounding areas. There would be no diminished population sizes or distributions of migratory birds or regionally important native animal species. Therefore, impacts to wildlife due to proposed construction activities at Andersen AFB would be less than significant under Alternative 1a.

Special-Status Species

No special-status species have been identified in the area in historical studies or in recent project-specfic surveys in similary nearby areas at South Finegayan, former FAA parcel, and the GLUP77 parcel. There would be no impacts to special-status species.

Operation

Terrestrial biological resources would not be impacted under this alternative as proposed activities involve only upgrades to existing facilities and infrastructure and sewer pipelines will be placed underground.

12.2.4.2 Basic Alternative 1b

Under Basic Alternative 1b, the existing primary treatement system at NDWWTP will be refurbished and upgraded to accept additional wastewater flow and load from both central and northern Guam, and new sewer lines and lift pump stations. In addition to the sewer line proposed in Basic Alternative 1a, a new sewer line and pump stations would be installed to convey wastewater generated from Barrigada housing to the NDWWTP.

Construction

Vegetation

The new sewer line and pump from Barrigada would traverse existing roadway or utility corridors with heavily disturbed vegetation or no vegetation. Impacts from the sewer line in the Finegayan area would be the same as for Alternative 1a. Impacts to vegetation would be less than significant.

Wildlife

The new sewer line and pump from Barrigada would traverse existing roadway or utility corridors where there would be minimal wildlife. Impacts from the sewer line in the Finegayan area would be the same as for Alternative 1a. Impacts to wildlife would be less than significant.

Special-Status Species

The new sewer line and pump from Barrigada would traverse existing roadway or utility corridors. Impacts from the sewer line in the Finegayan area would be the same as for Alternative 1a. There would be no impacts to special-status species.

Operation

Terrestrial biological resources would not be impacted under this alternative as proposed activities involve only upgrades to existing facilities and infrastructure, sewer pipelines will be placed underground, and the pump station will be located within already developed area.

12.2.4.3 Summary of Impacts

Table 12.2-8 summarizes summarizes the potential impacts of each alternative.

Table 12.2-8. Summary of Potential Impacts to Terrestrial Biological Resources-Wastewater

*Basic Alternative 1a**	*Basic Alternative 1b*
Vegetation	Vegetation
LSI • Less than significant impacts to vegetation	LSI • Less than significant impacts to vegetation
Wildlife	Wildlife
LSI • Less than significant impacts to wildlife	LSI • Less than significant impacts to wildlife
Special-Status Species	Special-Status Species
NI • No impacts to special-status species	NI • No impacts to special-status species

Legend: NI = No Impact. *Preferred Alternative.

Installation of a new sewer line from former FAA to the NDWWTP would traverse disturbed and developed vegetation in areas with wildly distributed wildlife species so impacts would be less than significant. No special-status species or recognized habitat areas are in the area so there would be no impact.

12.2.5 Solid Waste

12.2.5.1 Basic Alternative 1 (Preferred Alternative)

The Preferred Alternative for solid waste would be the continued use of the Navy Landfill at Apra Harbor until Layon Landfill is opened, which is scheduled for July 2011.

The existing Navy landfill and landfill extent would be used and not expanded until the government of Guam landfill was ready. Since operations will not change substantially from present conditions, terrestrial biological resources would not be impacted under this alternative. The proposed Layon landfill and its impacts were analyzed in a separate environmental impact statement by the GovGuam.

12.2.5.2 Summary of Impacts

Table 12.2-9 summarizes the potential impacts of Alternative 1.

Table 12.2-9. Summary of Potential Impacts to Terrestrial Biological Resources-Solid Waste

*Basic Alternative 1**
Vegetation
NI • No impact to vegetation
Wildlife
NI • No impacts to wildlife
Special-Status Species
NI • No impact to special-status species

Legend: NI = No Impact. *Preferred Alternative.

There would be no impacts to any terrestrial biological resources because the proposed alternative involves no expansion of the fill area of the existing Navy landfill that would be used until the new government of Guam landfill opens. No special-status species are know from the area of the landfill. The proposed Layon landfill and its impacts were analyzed in a separate environmental impact statement by the GovGuam.

12.2.6 Off Base Roadways

As discussed in Volume 6 Chapter 2.5, some Guam Road Network (GRN) projects involve road widening, bridge replacements, new road construction or roadway realignment, and pavement strengthening projects. This section addresses the potential direct and indirect impacts of the proposed GRN projects to terrestrial biological resources and also describes mitigation measures to avoid or minimize these potential impacts. Each project included under the alternatives described in Volume 6 Chapter 2.5 is analyzed below and grouped by each region (North, Central, Apra Harbor, and South). The type and duration of the impact may vary depending on the project location and the project description. For instance, projects that involve pavement strengthening would occur within the existing roadway corridor on previously developed surfaces and no direct impacts to terrestrial biological resources are anticipated; however, surrounding areas outside of the roadway corridor may be subject to indirect impacts associated with runoff during the construction phase of the pavement strengthening activity. Other project types may potentially directly or indirectly impact terrestrial biological resources. Potential runoff impacts would be addressed with BMPs. Table 12.2-10 describes the direct and indirect impacts for each type of roadway project (non-widening pavement strengthening, intersection improvements, projects that require vegetation removal [e.g. roadway widening, new road construction, and roadway realignment projects], military access point modification or construction, and bridge replacements). Table 12.2-11 describes potential direct and indirect impacts for each roadway improvement project within the North Region. Table 12.2-12, Table 12.2-13, and Table 12.2-14 describe the same information for projects within the Central, Apra Harbor, and South regions, respectively.

Table 12.2-10. GRN Project Type and Potential Impacts to Terrestrial Biological Resources

Project Type[1]	*Type of Impact Evaluated*	*Potential Impact Description*[2]
Pavement Strengthening	Indirect impacts during construction phase	Uncontrolled runoff may impact down stream or down gradient vegetation communities, wildlife, and special status species that utilize these areas during the construction phase. Construction noise may disturb special status species and wildlife within the vicinity of construction activity.
Intersection Improvements		
Roadway Widening, New Road Construction (Finegayan Connection), Military Access Point Modifications / Construction, &Road Realignment (Route 15)	Direct impacts	Removal of vegetation. Some vegetation may support special status species habitat, and displacement of wildlife.
	Indirect impacts-construction phase	Uncontrolled runoff may impact down gradient vegetation communities, wildlife, and special status species that utilize these areas during the construction phase. Construction noise may disturb special status species and wildlife within the vicinity of construction activity.
	Indirect impacts-operational phase	Additional impervious cover would contribute runoff to adjacent terrestrial habitats. Increased potential for wildland fires and invasive species encroachment along new edges.
Bridge Replacements (Agana, Atantano, Fonte, Laguas, & Sasa Bridges)	Direct impacts	Removal of vegetation on streambed slopes adjacent to bridge structures. Disturbance of aquatic habitats under and adjacent to the bridge structures during construction.
	Indirect impacts-construction phase	Uncontrolled runoff may impact down stream aquatic communities, wildlife, and special status species that utilize these areas during the construction phase. Construction noise may disturb special status species and wildlife within the vicinity of the bridge replacement.
	Indirect impacts-operational phase	Alteration of the hydraulic conveyance due to the new bridge design may impact downstream aquatic habitats.

Note [1]: The GRN project descriptions are included in Volume 6 Chapter 2.5.
Note [2]: Mitigation measures are included later in this chapter that minimize or avoid potential direct or indirect impacts

Table 12.2-11. North Region GRN Projects, Alternatives, and Potential Impacts

GRN #	*Alternatives*[1]				*Potential Impact Type and Description*[2]	
	1	*2*	*3*	*8*	*Indirect*	*Direct*
8	x	x	x	x	Runoff during the construction phase for this project and construction noise in areas north of Okkodo School (e.g. Navy Refuge Overlay unit).	***None:*** this project does not require widening, only pavement strengthening, to modify the access to Okkodo High School on the interior portion of the road.

<table>
<tr><th rowspan="2">GRN #</th><th colspan="4">Alternatives[1]</th><th colspan="2">Potential Impact Type and Description[2]</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>8</th><th>Indirect</th><th>Direct</th></tr>
<tr><td>9</td><td>x</td><td>x</td><td>x</td><td>x</td><td rowspan="2">Runoff during the construction phase for this project and construction noise in areas west of Route 3 (e.g. Navy Refuge Overlay unit and Andersen AFB Refuge Overlay unit). Increased potential for invasive species encroachment and wildland fires along new edges after construction.</td><td>Wildlife displacement and removal of vegetation communities through the road widening areas from NCTS Finegayan to Route 28 along Route 3, including Navy Refuge Overlay lands, essential habitat areas, and lands designated as recovery zones.</td></tr>
<tr><td>10</td><td>x</td><td>x</td><td>x</td><td>x</td><td>Wildlife displacement and removal of vegetation communities through the road widening areas from NCTS Finegayan to Route 9 along Route 3.</td></tr>
<tr><td>22</td><td>x</td><td>x</td><td>x</td><td>x</td><td>Runoff during the construction phase for this project and construction noise in areas north of Route 9 (e.g. Andersen AFB Refuge Overlay units). Increased potential for invasive species encroachment and wildland fires along new edges after construction.</td><td>Wildlife displacement and removal of vegetation communities through the road widening areas from Route 3 to the proposed Andersen AFB North Gate along Route 9.</td></tr>
<tr><td>22A</td><td>X</td><td>x</td><td>x</td><td>x</td><td>Runoff during the construction phase for the medians and shoulders and construction noise in areas north of Route 9 (e.g. Andersen AFB Refuge Overlay units).</td><td>Although this project is a pavement strengthening project, medians and shoulders would be added, that would expand the project footprint into forested areas of Andersen AFB along Route 9 between the Andersen AFB North Gate and the Andersen AFB Main Gate.</td></tr>
<tr><td>23</td><td>x</td><td>x</td><td>x</td><td>x</td><td rowspan="8">Runoff during the construction phase for these projects and construction noise in areas north of Route 9 (e.g. Andersen AFB Refuge Overlay units). Increased potential for invasive species encroachment and wildland fires along new edges after construction.</td><td>None: This project does not require widening, only pavement strengthening, from Chalan Lujuna to Route 9.</td></tr>
<tr><td>38</td><td></td><td>x</td><td>x</td><td></td><td rowspan="2">These military access point projects would require the removal of limestone forest within essential habitat areas for the Mariana crow, Mariana fruit bat, and Micronesian kingfisher.</td></tr>
<tr><td>38A</td><td>x</td><td></td><td></td><td>x</td></tr>
<tr><td>39</td><td></td><td>x</td><td>x</td><td></td><td rowspan="2">These military access point projects would require the removal of limestone forest within essential habitat areas for the Mariana crow, Mariana fruit bat, and Micronesian kingfisher.</td></tr>
<tr><td>39A</td><td>x</td><td></td><td></td><td>x</td></tr>
<tr><td>41</td><td></td><td>x</td><td></td><td></td><td rowspan="2">These military access point projects would require the removal of limestone forest within essential habitat areas for the Mariana crow, Mariana fruit bat, and Micronesian kingfisher.</td></tr>
<tr><td>41A</td><td>x</td><td></td><td></td><td>x</td></tr>
<tr><td>42</td><td>x</td><td>x</td><td>x</td><td>x</td><td>This military access point project, although within limestone forests, was analyzed as part of the Intelligence, Surveillance, and Reconnaissance/Strike Final EIS (Andersen AFB 2006).</td></tr>
</table>

GRN #	Alternatives[1]				Potential Impact Type and Description[2]	
	1	2	3	8	Indirect	Direct
57	x	x	x	x	Runoff during the construction phase for these projects.	This road widening project would require the removal of scrub forest vegetation, that may contain important resources for the recovery of special-status species.
117	x	x	x	x		***None:*** This intersection project would occur in previously developed lands with no disturbance of vegetation communities other than urban cultivated areas.
124	x	x		x	Runoff during the construction phase for this project and construction noise in areas along the new road corridor (e.g. Navy Refuge Overlay unit). Increased potential for invasive species encroachment and wildland fires along new edges after construction.	The Finegayan connector road would require clearing through limestone forest, scrub forests, and tangantangan thickets. Although most of the road corridor is through previously developed areas, the limestone and scrub forest communities may contain important resources for the recovery of special-status species.

Note [1]: The GRN project descriptions and alternatives are described in detail in Volume 6 Chapter 2.5.
Note [2]: Mitigation measures are included later in this chapter that minimize or avoid potential direct or indirect impacts

Table 12.2-12. Central Region GRN Projects, Alternatives, and Potential Impacts

GRN #	Alternatives[1]				Potential Impact Type and Description[2]	
	1	2	3	8	Indirect	Direct
1	x	x	x	x	***None:*** The proposed intersection improvement for Route 1 and 8 (GRN # 1) and Route 1 and 3 (GRN # 2) would occur in a previously developed commercial area in Hagatna. Runoff or construction noise would not impact terrestrial biological resources (i.e., vegetation communities, wildlife, or special-status species).	***None:*** Intersection improvements Routes 1/8 and Routes 1/3 on previously cleared land in developed areas and would not directly impact terrestrial biological resources.
2	x	x	x	x		
3	x	x	x	x	Potential sedimentation along the 260 feet (80 m) streambed of the Agana River between Agana Bridge and the river terminus (between East Hagatna Beach and Paseo de Susana Park).	The Agana bridge replacement occurs over riverine aquatic habitat away from sea turtle nesting and other special status species locations, therefore, no direct impacts to special status species. Construction activities would remove vegetation and alter aquatic habitats in the immediate project footprint.
6	x	x	x	x	***None:*** The proposed road widening would occur in previously developed mixed commercial / light industrial areas (e.g. Tumon Tank Farm). Runoff or construction noise would not impact terrestrial biological resources.	***None:***Construction (road-widening) on previously cleared land and would not impact terrestrial biological resources.

GRN #	Alternatives[1]				Potential Impact Type and Description[2]	
	1	2	3	8	Indirect	Direct
7	x	x	x	x	***None:*** The proposed road widening would occur in previously developed mixed commercial / light industrial areas (e.g. Micronesia Mall). Runoff or construction noise would not impact terrestrial biological resources.	
11	x	x	x	x	***None:*** the proposed roadway improvement along Chalan Lujuna would occur in residential areas (e.g. Perez Acres subdivision). Potential runoff or noise would not impact terrestrial biological resources.	***None:*** This project does not require widening, only pavement strengthening, from Route 1 to Route 15 along Chalan Lujuna to improve flow for truck traffic.
12	x	x	x	x	Runoff during the construction phase for this project. Special status species are not expected to utilize the area, so construction noise would not impact special status species.	***None:*** This project does not require widening, only pavement strengthening, from the Smith Quarry to Chalan Lujuna on Route 15 to Route 3 along Chalan Lujuna.
13	x	x	x	x	Runoff during the construction phase for this project, particularly into Asan River. Special status species are not expected to utilize the area, so construction noise would not impact special status species.	***None:*** These projects do not require widening, only pavement strengthening along Route 1 from 11 to Asan Bridge (GRN # 13), Asan Bridge to Route 6 (GRN # 14), and Route 6 to Route 4.
14	x	x	x	x		
15	x	x	x	x		
16	x	x	x	x	***None:*** the proposed roadway improvements along Route 8 would occur in commercial (Home Depot) and industrial (Airport) areas. Potential runoff or noise would not impact terrestrial biological resources.	***None:*** These projects do not require widening, only pavement strengthening from Tiyan Parkway to Route 1 along Route 8 (GRN # 16) and Route 10 to Tiyan Parkway (GRN # 17).
17	x	x	x	x		
18	x	x	x	x	***None:*** the proposed roadway improvements along Route 8 would occur in commercial areas (e.g. Harmon Flea Market, Compadres Mall) and industrial areas (e.g. Guam Power Authority substations). Potential runoff or noise would not impact terrestrial biological resources.	***None:*** These projects do not require widening, only pavement strengthening along Route 16 from Route 27 to Route 10A (GRN # 18), Route 10A to Sabana Barrigada Drive (GRN # 19), Sabana Barrigada Drive to Route 8/10 (GRN # 20).
19	x	x		x		
20	x	x		x		
21	x	x	x	x	***None:*** the proposed roadway improvements along Route 27 would occur in commercial areas (e.g. Compadres Mall), residential areas (e.g Las Palmas Subdivision), and recreational areas (e.g. Robbie Webber Soccer Field). Potential runoff or noise would not impact terrestrial biological resources.	***None:*** This project does not require widening, only pavement strengthening along Route 27.
28	x	x	x	x	***None:***the proposed roadway improvements along Route 26 would occur in commercial areas (e.g. Dededo Mall), and residential areas (e.g. Summer Place Subdivision). Potential runoff or noise would not impact terrestrial biological resources.	***None:*** This project does not require widening, only pavement strengthening along Route 26 between Route 1 and route 15.

GRN #	*Alternatives[1]*				*Potential Impact Type and Description[2]*	
	1	*2*	*3*	*8*	*Indirect*	*Direct*
29	x	x	x	x	***None:*** the proposed roadway improvements along Route 25 would occur in residential areas, and some open fields of tangantangan of no value to special status species or wildlife resources.	***None:*** Although road widening is necessary for this project, the project occurs in previously developed areas and would not impact terrestrial biological resources.
30	x	x	x	x	***None:*** the proposed roadway improvements along Route 10 would occur in residential areas, and some open fields of tangantangan of no value to special status species or wildlife resources.	***None:*** This project does not require widening, only pavement strengthening along Route 10 between Route 15 and route 18.
31	x	x		x	***None:*** the proposed roadway improvements along Route 10 would occur in residential areas, and some open fields of tangantangan of no value to special status species or wildlife resources.	***None:*** This project does not require widening, only pavement strengthening along Route 8A between Route 16 and the NAVCAMS Barrigada.
32	x	x	x	x	***None:*** the proposed roadway improvements along this section of Route 15 would occur along residential areas, recreational areas (Navy recreational fields), and open fields of tangantangan of no value to special status species or wildlife resources.	***None:*** This project does not require widening, only pavement strengthening and intersection improvements along Route 15 between Route 10 to Chalan Lujuna.
33	x	x	x	x	Portions of the proposed roadway improvements along Route 1 are adjacent to Asan Bay and Hagatna beaches, however sea turtle nesting is not known to occur here. Potential for runoff into Agana River and stormwater drainages that terminate into Tumon Bay and Tumon Bay Marine Preserve.	***None:*** This project does not require widening, only pavement strengthening and intersection improvements along Route 1 between Route 8 to Route 13.
35	x	x	x	x	Potential sedimentation between each bridge and the spanned river terminus. Laguas Bridge and Sasa Bridge replacements are upstream of mangrove and estuarine areas of Sasa Bay Marine Preserve. These habitats are not preferred Mariana common moorhen habitat, but may occasionally support foraging habitat for this species.	The bridges proposed for replacement occur over riverine aquatic habitats that may directly or indirectly impact wetland communities within the drainage. Furthermore, these areas may represent Mariana common moorhen habitat.
36	x	x	x	x	Runoff during the construction phase for this project and construction noise in areas, primarily to the south (down gradient) of the proposed route. Increased potential for invasive species encroachment and wildland fires along new edges after construction.	The relocation of Route 15 would require clearing through limestone forest, scrub forests, and tangantangan thickets. Although most of the road corridor is through previously developed areas, the limestone and scrub forest communities may contain important resources for the recovery of special-status species.

GRN #	Alternatives[1]				Potential Impact Type and Description[2]	
	1	2	3	8	Indirect	Direct
44	x	x	x	x	***None:*** The proposed military access point improvement would occur in previously developed and degraded areas of Andersen South. Runoff or construction noise would not impact terrestrial biological resources.	***None:*** This military access point project would occur in previously developed lands with no disturbance of vegetation communities other than degraded tangantangan thickets.
46	x	x	x	x		
47			x		***None:***The proposed military access point improvement would occur in a previously developed and degraded areas of Barrigada (Navy). Runoff or construction noise would not impact terrestrial biological resources.	***None:*** These military access point projects would occur in previously developed lands with no disturbance of vegetation communities other than urban cultivated areas.
48			x			
49			x		***None:*** The proposed military access point improvement would occur in a previously developed and degraded areas of Barrigada (Air Force). Runoff or construction noise would not impact terrestrial biological resources.	***None:*** These military access point projects would occur in previously developed lands with no disturbance of vegetation communities other than urban cultivated areas in the vicinity of Barrigada (Air Force).
49A				x		
63			x			
74			x			
113	x	x	x	x		

Note [1]: The GRN project descriptions and alternatives are described in detail in Volume 6 Chapter 2.5.
Note [2]: Mitigation measures are included later in this chapter that minimize or avoid potential direct or indirect impacts

Table 12.2-13. Apra Harbor GRN Projects, Alternatives, and Potential Impacts

GRN #	Alternatives[1]				Potential Impact Type and Description[2]	
	1	2	3	8	Indirect	Direct
4	x	x	x	x	***None:*** The proposed military access point improvement would occur in a previously developed and degraded areas along Route 11. Runoff or construction noise would not impact terrestrial biological resources.	***None:*** The proposed improvements along Route 11 between the commercial port and Route 1 (GRN # 4) do not require road widening (only pavement strengthening); therefore, no terrestrial biological resources would be impacted because all work would be confined within the existing road corridor. The addition of the weigh station would require some vegetation removal (tangantangan thickets and grasses), but there are no biological resources along Route 11 that would be impacted by the proposed project. The Route 11 and Route 1 intersection improvement (GRN #5) would be constructed on grounds that have been previously cleared and would not impact terrestrial biological resources
5	x	x	x	x		
24	x	x	x	x	Portions of the proposed roadway improvements along Route 1 are adjacent to Sasa Bay Marine Preserve (on the west side of Route 1) and freshwater wetlands (on the east side of Route 1). Potential for runoff during the construction phase into Sasa Bay and Sasa River, Laguas River, Aguada River, and Atantano River, which terminate at Sasa Bay or Inner Apra Harbor.	***None:*** These projects do not require road widening (only pavement strengthening); therefore, no terrestrial biological resources would be impacted because all work would be confined within the existing road corridor with no gain in impervious cover.

GRN #	Alternatives[1]				Potential Impact Type and Description[2]	
	1	2	3	8	Indirect	Direct
26	x	x	x	x	Portions of the proposed roadway improvements along Route 2A are adjacent freshwater wetlands formed by the Atantano River. Potential for runoff during the construction phase into the these wetlands and other stormwater drainages that terminate at Inner Apra Harbor.	
50	x	x	x	x	***None:*** The proposed military access point improvement would occur in a previously developed and degraded areas of Naval Base Guam. Runoff or construction noise would not impact terrestrial biological resources.	***None:*** This military access point project would occur in previously developed lands with no disturbance of vegetation communities around the proposed location at Naval Base Guam.

Note [1]: The GRN project descriptions and alternatives are described in detail in Volume 6 Chapter 2.5.
Note [2]: Mitigation measures are included later in this chapter that minimize or avoid potential direct or indirect impacts

Table 12.2-14. South Region GRN Projects, Alternatives, and Potential Impacts

GRN #	Alternatives[1]				Potential Impact Type and Description[2]	
	1	2	3	8	Indirect	Direct
25	x	x	x	x	Although most of the portions of the proposed roadway improvements along Route 5 are adjacent to residential areas (e.g. Apra Heights), some portions have potential for construction runoff into freshwater wetlands formed by the Namo River near the Agat Commercial Center. The Namo River terminates at Agat Bay.	***None:*** These projects do not require widening, only pavement strengthening along Route 5 from Route 2A to Route 17 (GRN # 25), and Route 17 to the NMS. (GRN # 27).
27	x	x	x	x		
52	x	x	x	x	Potential for runoff during the construction phase into upper reaches of the Namo River.	***None:*** This military access point project at NMS would occur in previously disturbed lands with no disturbance of vegetation communities other than degraded tangantangan thickets.
110	x	x	x	x	***None:*** The proposed intersection improvement for Route 2 and 12 would occur near commercial and light industrial areas (e.g. Agat Commercial Center). Runoff or noise during the construction phase would not impact terrestrial biological resources.	***None:*** The Route 2 and Route 12 intersection improvement would be constructed on grounds that have been previously cleared and would not impact terrestrial biological resources

Notes [1]: The GRN project descriptions and alternatives are described in detail in Volume 6 Chapter 2.5; [2]: Mitigation measures are included later in this chapter that minimize or avoid potential direct or indirect impacts

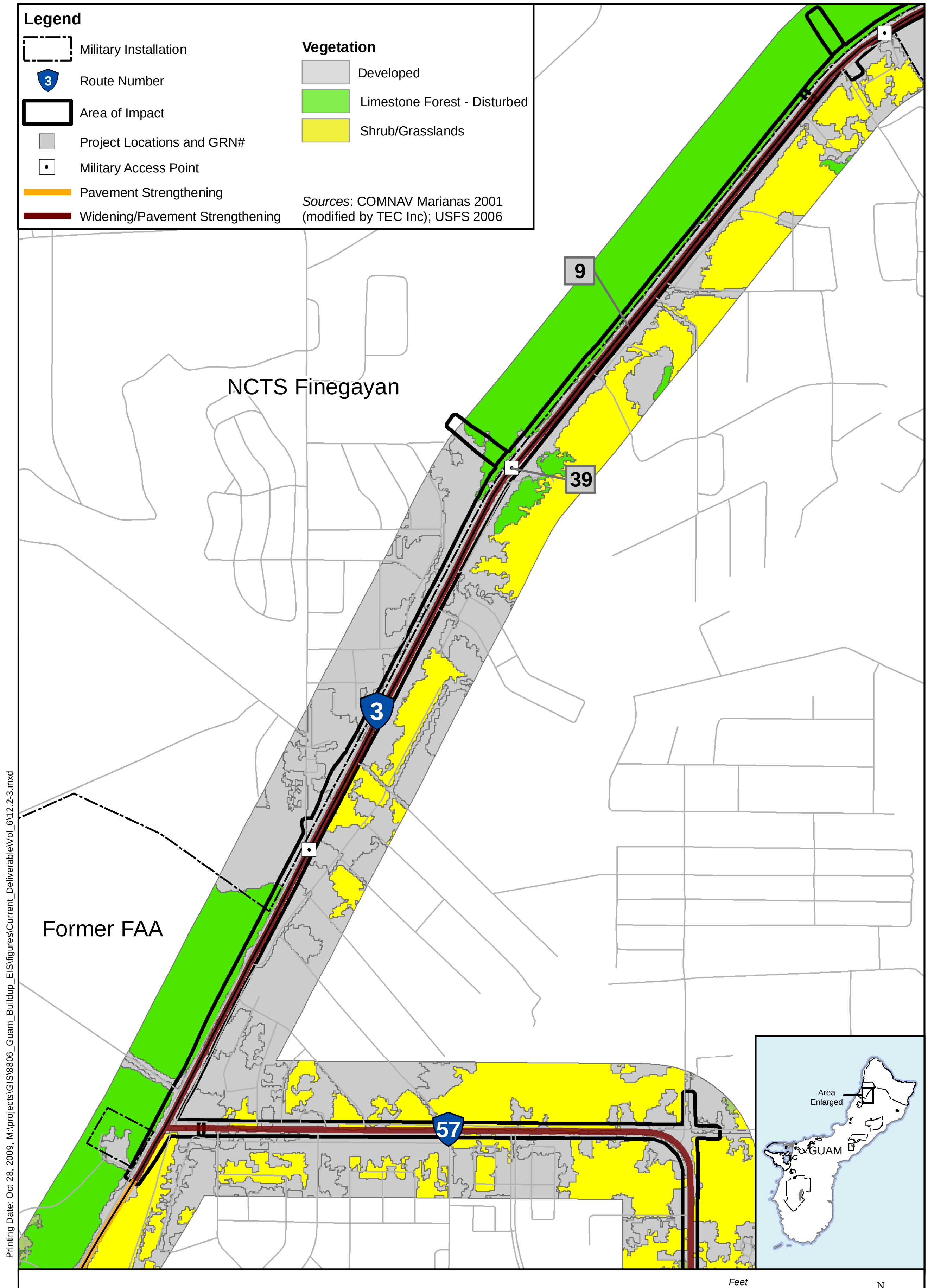

Figure 12.2-3
GRN Projects in the North Region Considered for Analysis - Map 1

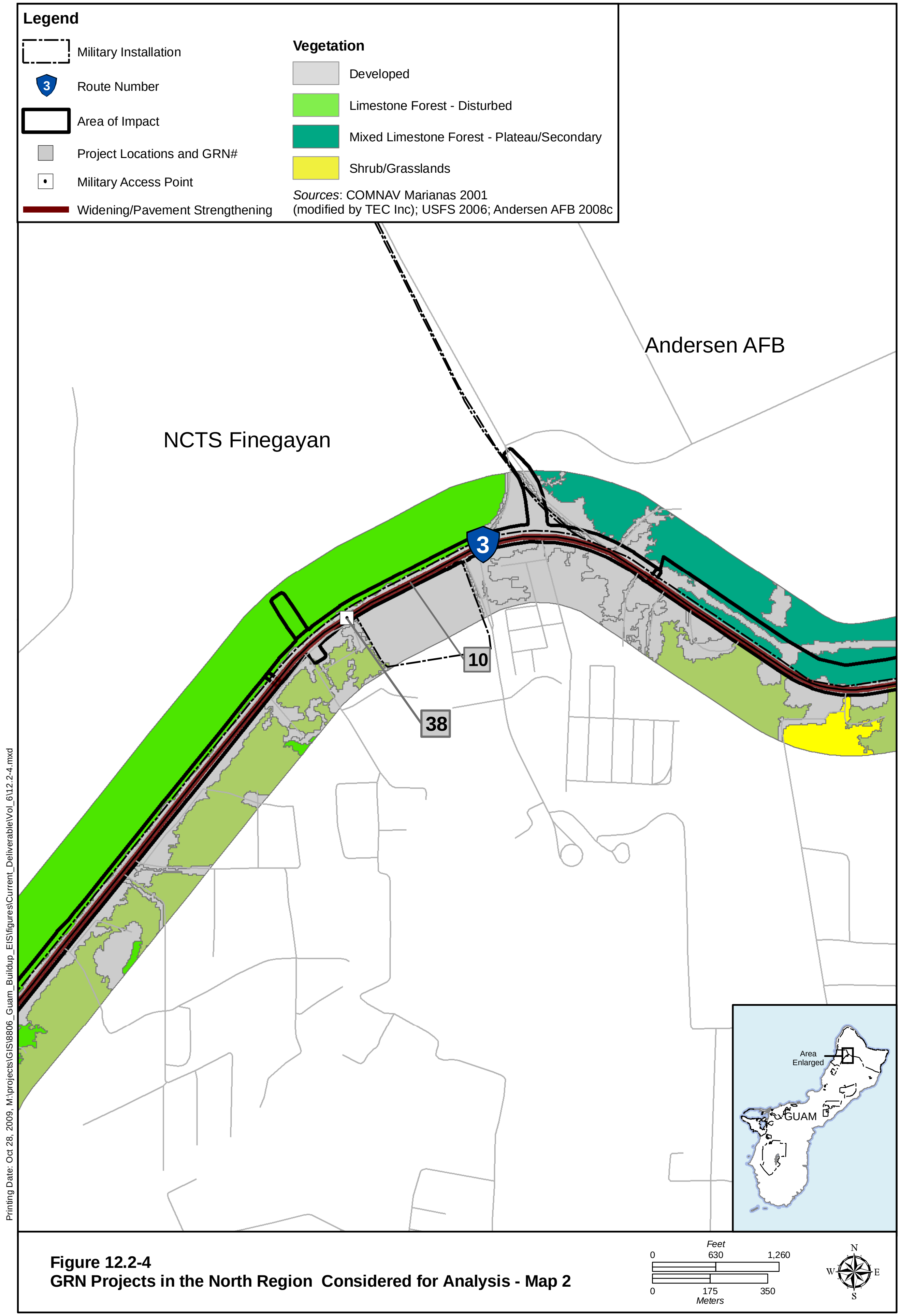

Figure 12.2-4
GRN Projects in the North Region Considered for Analysis - Map 2

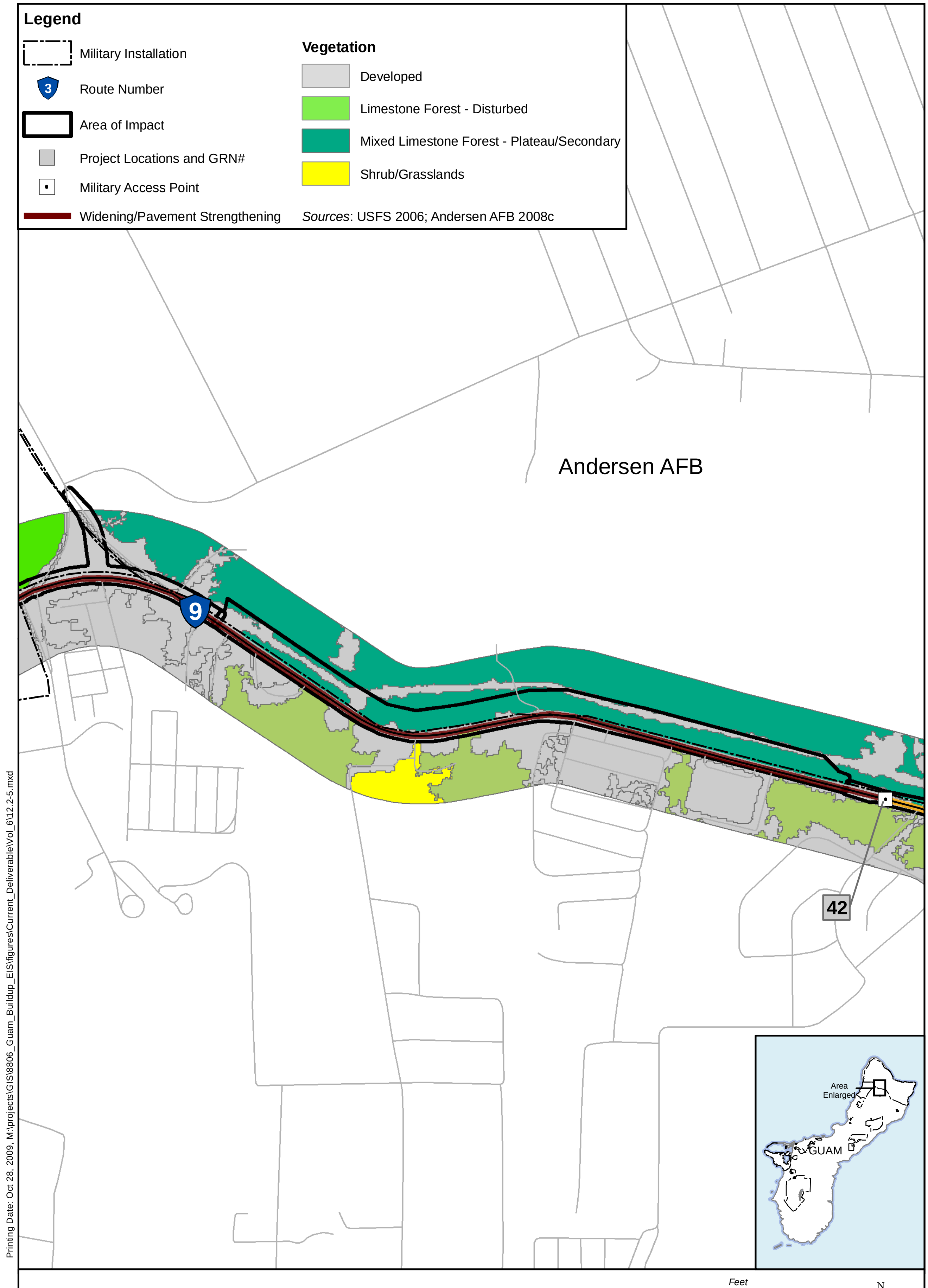

Figure 12.2-5
GRN Projects in the North Region Considered for Analysis - Map 3

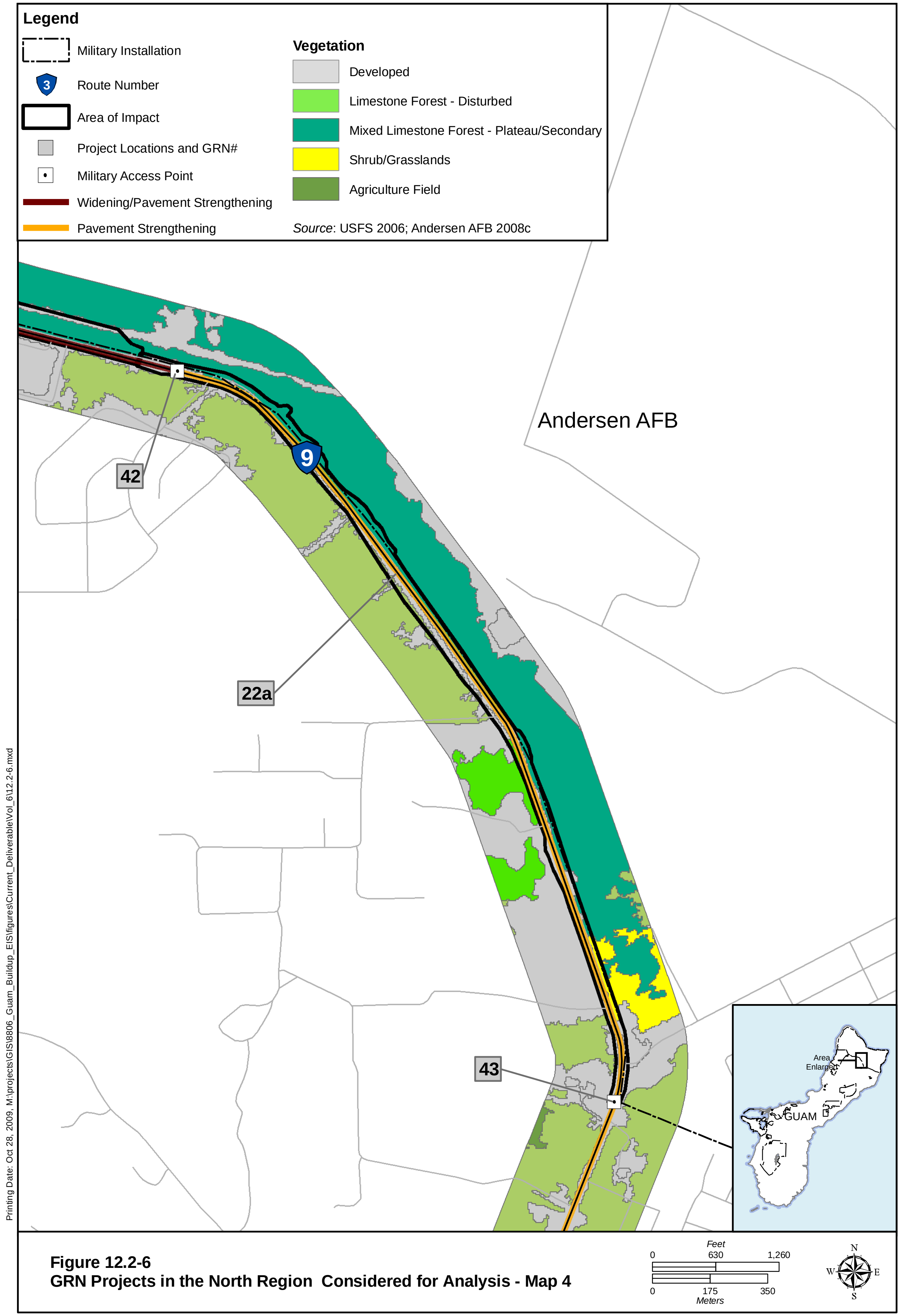

Figure 12.2-6
GRN Projects in the North Region Considered for Analysis - Map 4

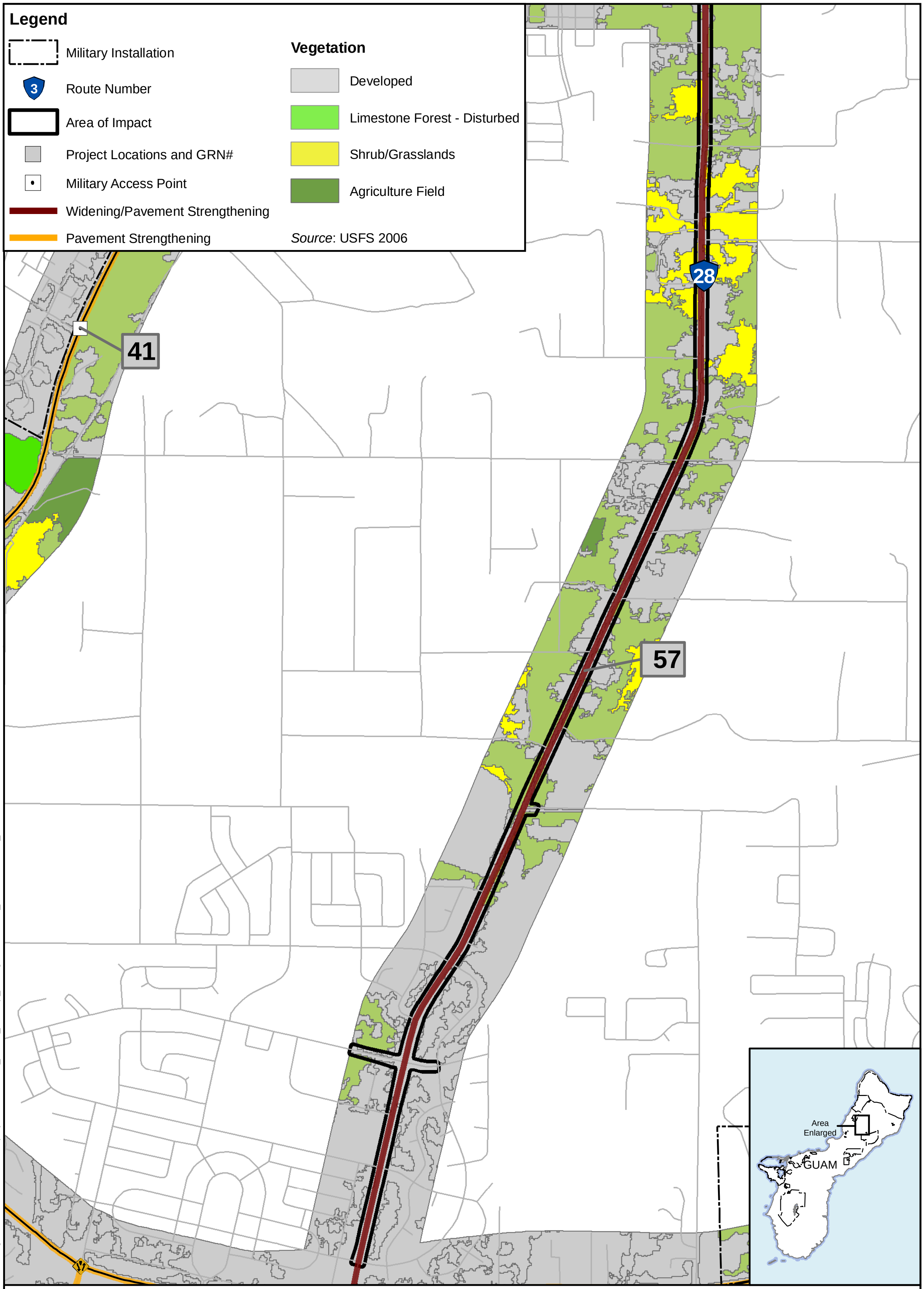

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Figure 12.2-7
GRN Projects in the North Region Considered for Analysis - Map 5

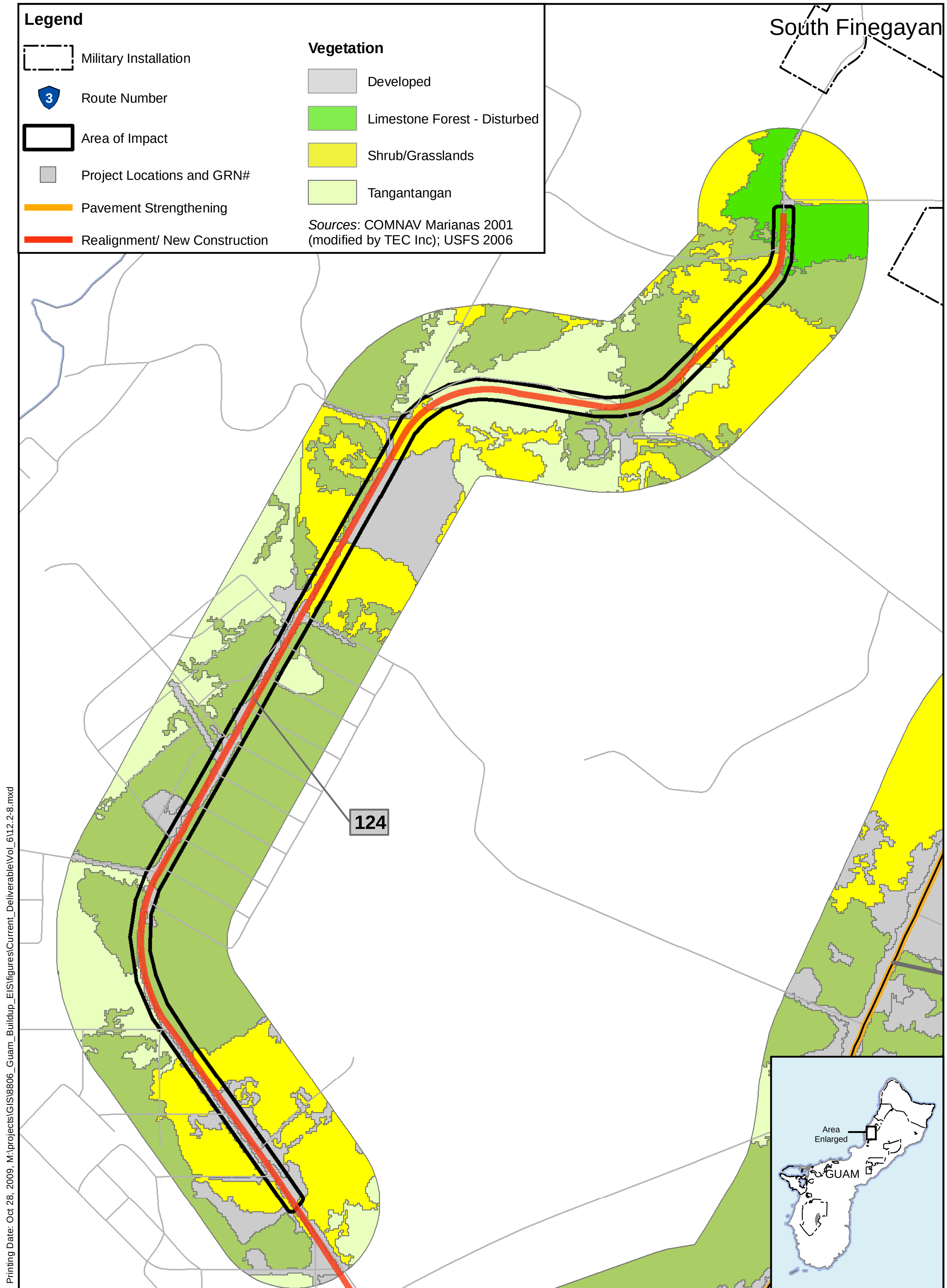

Figure 12.2-8
GRN Projects in the North Region Considered for Analysis - Map 6

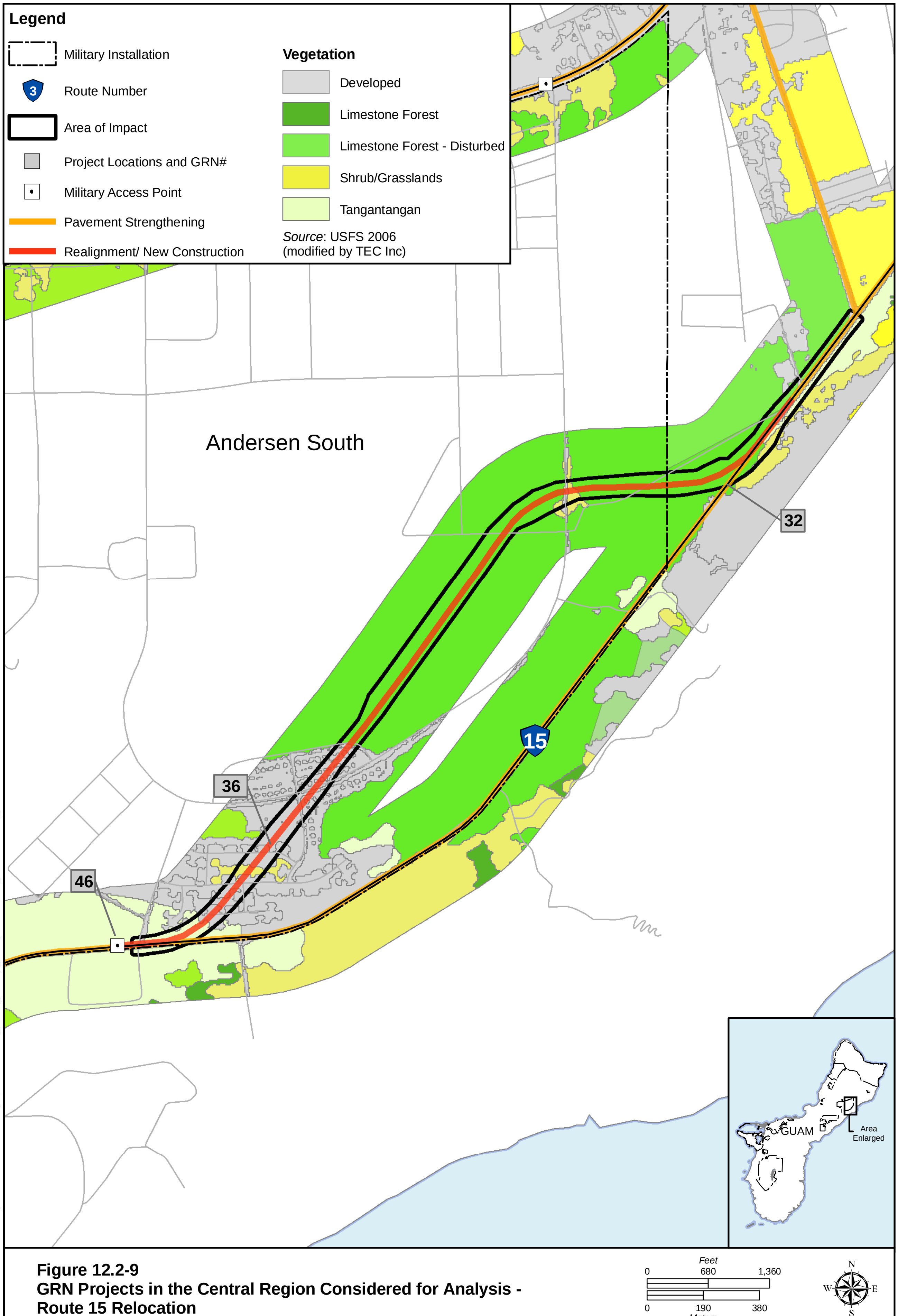

Figure 12.2-9
GRN Projects in the Central Region Considered for Analysis - Route 15 Relocation

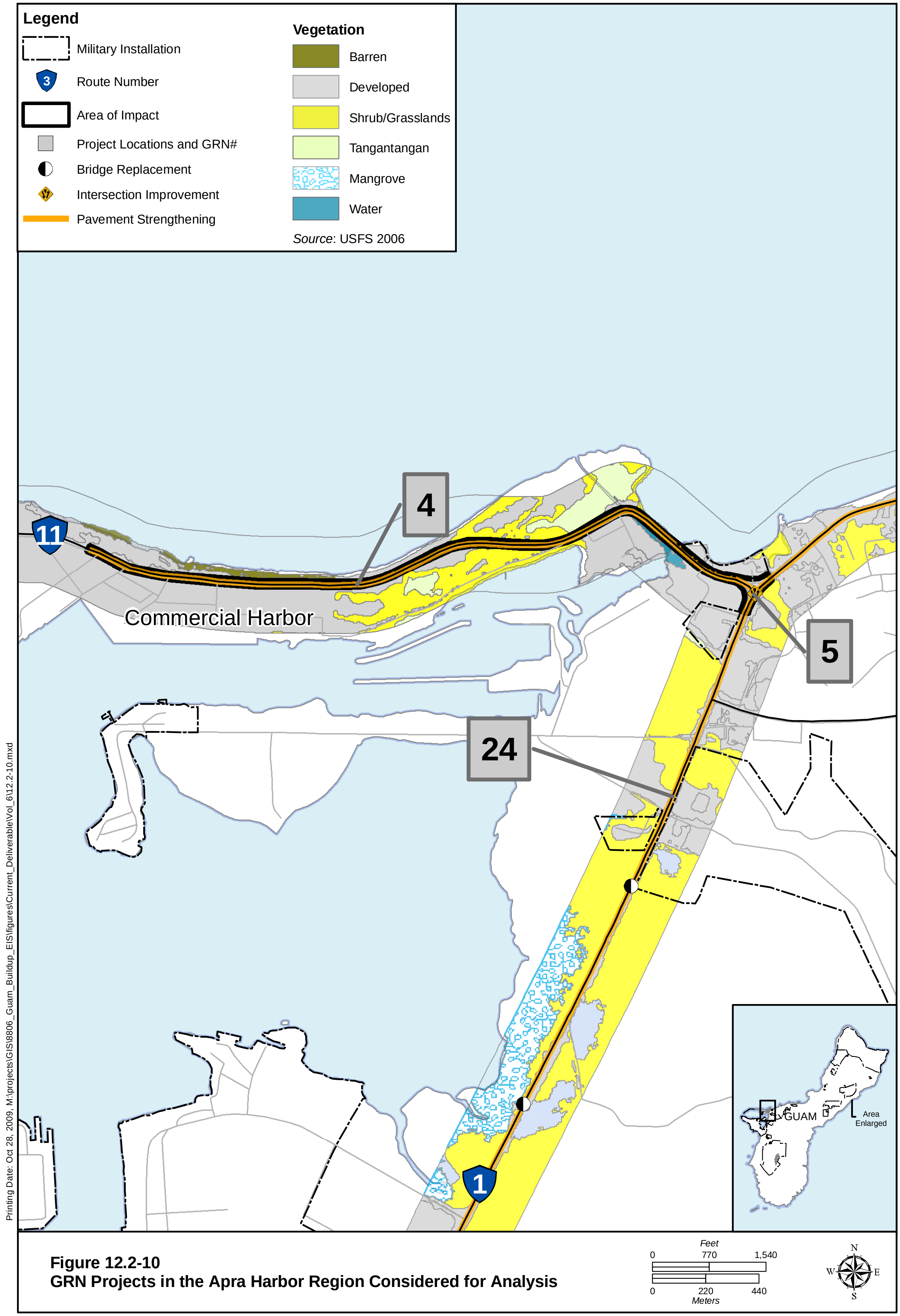

Figure 12.2-10
GRN Projects in the Apra Harbor Region Considered for Analysis

12.2.6.1 Alternative 1

Volume 6 Chapter 2.5 of this EIS/OEIS describes Alternative 1 for the proposed GRN and how they relate to alternatives associated with the proposed military buildup. As described earlier , GRN #9, 10, 22, 22A, 38A, 39A, 41, 42A, 57, and 124 were identified as having potential impacts to terrestrial biological resources within the North Region.

North

Vegetation

Direct impacts associated with these projects include clearing vegetation, primarily on the northern side of Route 9 and the western side of Route 3, and other road projects within the North Region. The vegetation community types subject to removal for each road project proposed for the North Region are listed in Table 12.2-15.

Impacts to vegetation would be less than significant because no primary limestone forest would be removed. Vegetation removed does provide habitat for wildlife and special-status species. These impacts are evaluated in subsequent sections.

Table 12.2-15. Potential Direct Impacts to Vegetation Communities with Implementation of Roadways Alternative 1

GRN #	*Limestone Forest, Disturbed ac (ha)*	*Mixed Limestone Forest-Plateau/ Secondary ac (ha)*	*Tangantangan (Leucaena) ac (ha)*	*Scrub Forest ac (ha)*	*Mixed Herbaceous Scrub ac (ha)*	*Developed Land ac (ha)*
Option A						
09 (North)	16 (6.5)	0	0	1.1 (0.4)	0	34 (14)
10 (North)	6.8 (2.8)	1.0 (0.4)	0	0.0	0	13 (5.3)
22 (North)	0.3 (0.1)	30 (12.1)	0	0.4 (0.2)	0	14 (5.7)
22A (North)	0	13 (5.3)	0	1.2 (0.5)	1.1 (0.4)	16 (6.5)
38A (North)	1.6 (0.7)	0	0	0	0	0
39A (North)	0	0	0	0	0	2.4 (1.0)
41 (North)	1.9 (0.8)	0	0	0	0.2 (0.1)	0.3 (0.1)
42A (North)	0	1.4 (0.6)	0	0	0	0.2 (0.1)
57 (North)	0	0	0	13 (5.3)	2.5 (1.0)	58 (23)
124 (North)	0.9 (0.4)	0	5.9 (2.4)	11 (4.5)	7.7 (3.1)	12 (4.9)
3 (Central)*	0	0	0	0	<0.1 (<0.1)	<0.1 (<0.1)
35 (Central)*	0	0	0	0	0.2 (<0.1)	0.2 (<0.1)
36 (Central)	30 (12.1)	0	5.5 (2.2)	8.2 (3.3)	2.4 (1)	16 (6.5)
Totals	58 (23.3)	46 (19)	11 (4.5)	35 (14)	14 (5.7)	166 (67)
Option B (identical to Option A except removing GRN #36 (Rt 15 realignment)						
Totals	28 (11)	46 (19)	5.9 (2.4)	27 (11)	12 (4.9)	150 (61)

Note: Impacts associated with bridge replacement projects, such as GRN # 3 (Agana Bridge) and GRN # 35 (Atantano, Fonte, Laguas, and Sasa Bridges), are shown in Table 12.2-17.

Wildlife

Based on observations during field visits and observations in other similar areas on Andersen AFB, NCTS Finegayan, and Andersen South (discussed in Volume 2, Section 10.1), the only native bird species likely to be present in the project areas are the yellow bittern and possibly the Pacific golden plover in open areas; both species are ubiquitous throughout Guam. Also abundant throughout Guam are the blue-tailed skink, mutilating gecko, and mourning gecko found in the area.

Proposed construction activities would displace the species and other wildlife from suitable habitat in the proposed project areas. Smaller, less-mobile species and those seeking refuge in burrows could inadvertently be killed during construction activities; however, long-term, permanent impacts to populations of such species would not result because the species known to be present are abundant in surrounding areas. Therefore, impacts to wildlife would be less than significant with implementation of Alternative 1 roadways.

Special-Status Species

The species potentially affected by the removal of habitat include the Mariana fruit bat, the Mariana crow, and the Guam Micronesian kingfisher. Table 12.2-16 lists the areas subject to removal of overlay refuge lands, essential habitat, and recovery zones for special-status species.

Mariana Fruit Bat. Specific designated habitat areas would be removed under Alternative 1 including Overlay Refuge and essential habitat for the fruit bat (Table 12.2-16).There would be no temporary direct impacts from noise and activity during construction at Andersen AFB to roosting and nesting activities of the Mariana fruit bat because construction would only occur during the daytime. Based on the removal of Overlay Refuge and essential habitat areas, there would be significant impacts to the fruit bat. This significant impact would be mitigated to less than significant with measures described in Volume 2, Section 10.2.2.

Mariana Crow. Specific designated habitat areas would be removed under Alternative 1, including Overlay Refuge and essential habitat for the crow (Table 12.2-16). The Mariana crow is not currently present in areas where these projects would occur so there would be no noise or disturbance impacts from construction. Based on the removal of habitat areas, there would be significant impacts to the Mariana crow. This significant impact would be mitigated to less than significant with measures described in Volume 2, Section 10.2.2.

Micronesian Kingfisher. Specific designated habitat areas would be removed under Alternative 1, including Overlay Refuge and essential habitat for the kingfisher (Table 12.2-16). Based on the removal of habitat areas, there would be significant impacts to the Micronesian kingfisher. This significant impact would be mitigated to less than significant with measures described in Volume 2, Section 10.2.2.

Guam Rail. The rail survives only in captivity at this time. Proposed construction activities would include the loss of shrub/grassland habitat that is potential foraging and nesting habitat for the Guam rail. No specific areas of essential habitat have been described for this species. Only a very small portion of the Overlay Refuge habitat is scrub and shrublands that would be suitable for reintroduction of the rail. Because of minimal loss of habitat for a species not currently presnet, removal of these areas due to construction would result in a less than significant impact.

Pacific Slender-Toed Gecko. The gecko was found in recent surveys (NR Survey Report, in preparation) in northeastern NCTS Finegayan in a forested area. However, because the roadway impacts would be in or along adjacent disturbed areas, the species would be unlikely to be present in the project areas. Impacts would be less than significant.

The DoD is engaged in Section 7 ESA consultation with the USFWS Pacific Islands Field Office to avoid, minimize, or offset the potential direct and indirect impacts associated with Alternative 1. These measures are discussed below under "Potential Mitigation Measures".

Table 12.2-16. Potential Direct Impacts to Special Status Species Habitat with Implementation of Roadways Alternative 1

GRN#	*EssentialHabitat – Bat and Kingfisher and Crow* ac (ha)*	*Recovery Zone– Crow* ac (ha)*	*Overlay Refuge ac (ha)*	*Overlay Unit Name*
Options A and B				
09 (North)	0.1 (0.04)	5.1 (2.1)	8.1 (3.3)	Navy (NCTS Finegayan)
10 (North)	5.3 (2.1)	5.3 (2.1)	8.1 (3.3)	Navy (NCTS Finegayan)
22 (North)	27 (11)	27 (11)	30 (12)	Andersen AFB
22A (North)	0.7 (0.3)	10 (4.0)	3.1 (1.3)	Andersen AFB
38A (North)	1.6 (0.6)	1.6 (0.6)	1.6 (0.6)	Navy (NCTS Finegayan)
39A (North)	2.4 (1.0)	2.4 (1.0)	2.4 (1.0)	Navy (NCTS Finegayan)
41A (North)	2.4 (1.0)	2.4 (1.0)	2.4 (1.0)	Navy (NCTS Finegayan)
42 (North)	1.7 (0.7)	1.7 (0.7)	1.7 (0.7)	Andersen AFB
Totals	**41 (17)**	**56 (23)**	**57 (23)**	**NA**

Note: *Each habitat category is considered independently of others and is not additive.
NA – Not applicable.

Indirect impacts associated with these projects may further degrade limestone forests that are important to species recovery efforts. The indirect impacts may include: increasing edge effect of limestone forests, thereby facilitating the further encroachment of aggressive non-native vines and herbaceous vegetation; possible facilitation of access to poachers into habitat areas for the Mariana fruit bat during construction phases; increased wildland fire risk in fine fuels due to construction activities (canopy fires are not expected in northern Guam) that would encourage non-native species encroachment; increased noise and activity levels during construction and operation; and displacement of ungulates (i.e., Philippine deer and feral pig), along with other invasive predators and pests (e.g., brown treesnake, feral cat, feral dog, rat, cane toad) into adjacent habitats. However, since roadways projects are along existing transportation corridors and heavily disturbed habitat, these impacts are expected to be less than significant with standard BMPs employed.

Central

Vegetation

Direct impacts associated with these projects include the proposed clearing of vegetation through the relocated Route 15 road corridor and five bridge replacements proposed for the Central Region. The vegetation community types subject to removal for each road project proposed for the Central Region are listed in Table 12.2-15. The proposed Route 15 relocation would clear areas that transition from disturbed limestone forest in the west to scrub forest towards the east of the proposed route. Some areas of the Andersen South parcel, especially the southeast and southwest corners of the parcel, contain mature vegetation canopy layers with some areas dominated by native species. Reconnaissance surveys in support of this EIS/OEIS and separate reconnaissance surveys conducted in support of the proposed Route 15 relocation indicate a high feral pig population, as evidenced by heavy damage to substrates, vegetation impacts, and numerous wallows.

Impacts to vegetation associated with the road improvements and bridge replacements would be less than significant because minimal primary limestone forest would be removed. Vegetation removed does provide habitat for wildlife and special-status species. These impacts are evaluated in subsequent sections.

Wildlife

Impacts to aquatic environments associated with the bridge replacements are shown in Table 12.2-17. The five bridge replacements are proposed to span crossings along Route 1 over the Agana River, Atantano River, Laguas River, Sasa River, and Fonte Rivers. These rivers are considered perennial (flowing water for all or most of the year). As shown in Table 12.2-17, construction activities associated with the five bridge replacements would temporarily remove a total area of approximately 1 ac (0.4 ha). Temporary direct impacts associated with construction activities include the potential for increased erosion associated with grading into the subsoil within and outside the stream channel and potential impacts to aquatic communities in the immediate area of the bridge replacement.

Table 12.2-17. Potential Direct Impacts to Special Status Species Habitat with Implementation of Roadways Alternative 1

GRN Project #	*Bridge Name*	*Potential Direct Impacts to Aquatic Habitats[1]*		*Potential Indirect Impacts to Freshwater Aquatic Habitats[2]*
		Square Feet	*Acres*	
3	Agana Bridge	5,777.1	0.13	Potential sedimentation along the 260 feet (80 m) streambed of the Agana River between Agana Bridge and the river terminus (between East Hagatna Beach and Paseo de Susana Park).
35	Atantano Bridge	5,286.6	0.12	Potential sedimentation along the 1,600 feet (480 m) streambed of the Atantano River between Atantano Bridge and the river terminus (Inner Apra Harbor).
	Fonte Bridge	11,920.0	0.27	Potential sedimentation along the 290 feet (90 m) streambed of the Fonte River between Fonte Bridge and and the river terminus (between West Hagatna Beach and the Governor's Complex).
	Laguas Bridge	5,801.0	0.13	Potential sedimentation inputs along the 1,600 feet (480 m) streambed of the Sasa River between Sasa Bridge and and the river terminus and 800 feet (240 m) streambed of the Laguas River to the river terminus. Both rivers flow through the Sasa Bay Marine Preserve, which supports the largest mangrove forested area within the Mariana Islands.
	Sasa Bridge	6,062.0	0.14	
	Total Area	**34,846.6**	**0.80**	**-NA-**

Note [1]: Stream channel widths were calculated by averaging the width of four cross-stream lines between observed ordinary high water marks (OHWM) for each bridge. Two upstream lines and two downstream lines were measured for each bridge.
The estimated area of direct impacts to potential waters of the U.S. was calculated by the following equation: (Stream channel width) x (Structure width) + (Assumed area of upstream channel modifications [30']) + (Assumed area of downstream channel modifications [30']).
Note [2]: Potential indirect impacts are considered temporary for construction activities. Mitigations (BMPs) are in development as a joint effort between GEPA , FHWA, and FHWA design contractors to minimize or avoid impacts during and after the construction phase. Examples of mitigative BMPs are included in CNMI and Guam Stormwater Management Manual (CNMI and Guam 2006).

Indirect impacts may occur further downstream outside of the immediate construction area and be prolonged in time. These indirect effects may include degradation of stream channel aquatic habitats and marine habitats supporting coral communities and fisheries. FHWA and GEPA have mandated standard operating procedures and BMPs specific to sediment control that accounts for storm water runoff and other Guam-specific criteria for pollution prevention during construction and operation of the proposed roads. Hydraulic conveyance under the new bridge replacements would improve, which may benefit downstream stream segments, wetland areas and open water habitats by decreasing scour along the stream bank near the bridge replacements and decreasing sediment inputs into downstream freshwater and marine habitats. In summary, the bridge replacement would potentially impact approximately 1 ac (0.4 ha) of riverine aquatic habitats and indirectly impact aquatic habitats downstream; however, the impacts would be minimized through individual BMPs cooperatively developed by the FHWA and GEPA, the temporary nature of the impact, and possible improved hydraulic conveyance under the proposed bridge replacements. With the BMPs, impacts would be less than significant.

Based on observations during field visits and observations in other similar areas on Andersen AFB, NCTS Finegayan, and Andersen South (discussed in Volume 2, Section 10.1), the only native bird species likely to be present in the inland project areas are the yellow bittern and Pacific golden plover. At the bridge crossings near the coast various migratory birds are likely to utilize the area, and tidal influences (e.g. exposed tidal mudflats) and estuarine banks provide seasonal foraging and loafing habitat. Annual migrants to Guam that might be found there are Pacific golden plover, greenshank, Mongolian plover, gray-tailed tattler, whimbrel, ruddy turnstone, and cattle egret (COMNAV Marianas 2008, Eggleston 2009, NR Survey Report in preparation). A recent field survey of the proposed bridge crossings (NR Survey Report in preparation) did not record any native bird species. The species likely to regularly use the area, particularly near roadways, would be species ubiquitous on Guam.

During recent surveys conducted in support of this EIS/OEIS, three native reptile species were found within the forested areas at Polaris Point: Pacific blue-tailed skink, mourning gecko, and mutilating gecko (NR Survey Report in preparation). Native land hermit crabs and coconut crabs are present on the base in coastal and estuarine areas (COMNAV Marianas 2008). The presence of these species is unknown in the BRSA.

Proposed construction activities would displace these species of wildlife from suitable habitat in the proposed project areas. Smaller, less-mobile species and those seeking refuge in burrows could inadvertently be killed during construction activities; however, long-term, permanent impacts to populations of such species would not result because the area impacted does not expand greatly from presently disturbed areas and would be very small in comparison to the total habitat available. In addition, most species known to be present are abundant in surrounding areas (with the possible exception of the coconut crab). Overall, impacts to wildlife would be less than significant with implementation of Alternative 1 roadways.

Special-Status Species

Construction within the Central Region does not require the removal of essential habitat for the Mariana fruit bat, Mariana crow, or Guam Micronesian kingfisher; areas designated as Mariana crow recovery zones, or Overlay Refuge. The shrub/grassland habitat that would be removed is potential habitat for reintroduction of the Guam rail in the future, but the areas removed have no special habitat designation. Direct impacts to special-status species in the Central Region would be less than significant.

Potential indirect impacts associated with these projects that could include increasing edge effects for invasive species, displacement of ungulates, increased noise and activity levels, and wildland fire risk are expected to be less than significant because these projects are along existing roadway corridors and heavily disturbed habitat.

Apra Harbor

There were no projects proposed for the Apra Harbor Region identified as having potential to impact terrestrial biological resources under Alternative 1. Therefore, there would be no significant impacts to terrestrial biological resources (vegetation communities, wildlife resources, and special-status species) associated with Alternative 1.

South

There were no projects proposed for the South Region identified as having potential to impact terrestrial biological resources under Alternative 1; therefore, there would be no significant impacts to terrestrial biological resources (i.e., vegetation communities, wildlife resources, and special-status species) associated with Alternative 1 implementation.

Potential Mitigation Measures

Impacts to vegetation communities and special-status species habitat resulting from proposed roadway projects would be mitigated with a suite of protection and conservation measures for all impacts on Guam described in this EIS/OEIS. See Volume 2, Section 10.2.2 for a description of these measures.

Impacts to freshwater aquatic environments would be mitigated with actions that avoid or minimize direct and/or indirect effects associated with during the construction and operational phases of each roadway project. These mitigation measures are in development as part of a cooperative effort between GEPA, FHWA, and DPW. As part of this effort, each GRN project would have specific mitigation measures that cater to the individual project type and environemental context (e.g. adjacency to sensitive ecological areas, slope of surrounding terrain). The specific mitigative actions would be completed as the GRN project designs near completion. The CNMI and Guam Stormwater Management Manual (CNMI and Guam 2006) provides examples of BMPs that would be included in the planning, design, and construction for all proposed road improvement projects. A Storm Water Runoff Drainage System Plan is required for a Building Permit by the Guam DPW when the area to be graded is more than 5,000 square feet (464 square meters) or a proposed cut or fill is greater than 5.0 ft (1.5 m) in height. This stormwater plan would describe the potential impacts and proposed mitigation associated runoff and drainage.

12.2.6.2 Alternative 2 (Preferred Alternative)

Volume 6, Chapter 2, of this EIS describes Alternative 2 for the proposed GRN and how this alternative relates to the alternatives associated with the proposed military buildup. Alternative 2 differs from Alternative 1 in the way that NCTS Finegayan would be utilized. Proposed road projects under Alternative 2 are the same as the proposed road projects under Alternative 1, with the exception of military access point locations at NCTS Finegayan and Andersen AFB. These military access point projects that are included as part of Alternative 2 (GRN # 38, 39, and 41) would have the same direct and indirect impacts as those military access point projects included as part of Alternative 1 (GRN # 38A, 39A, and 41A); therefore, impacts to terrestrial biological resources of Alternative 2 are similar to Alternative 1 for each region.

Potential Mitigation Measures

The mitigation measures for Alternative 2 are the same as those for Alternative 1.

12.2.6.3 Alternative 3

Volume 6, Chapter 2, of this EIS/OEIS describes Alternative 3 for the proposed GRN and how this alternative relates to the alternatives associated with the proposed military buildup. Alternative 3 differs from Alternative 1 and 2 in the way that NCTS Finegayan would be utilized, as well as other federal parcels. The land use differences require a different configuration of the proposed GRN military access point configurations. Proposed road projects under Alternative 3 are the same as the proposed road projects under Alternative 1, except that Alternative 3 includes GRN #38, 47, 48, 49, 63, and 74, and it excludes GRN #19, 20, 31, 38A, 39A, 41A, and 124. GRN # 47, 48 and 49 are associated with new access to Barrigada (Navy and Air Force); however, these projects would occur in previously disturbed areas of no value to special status species or wildife. Further, indirect impacts associated with increased impervious cover (e.g. runoff during the construction phase of the projects) would not degrade these habitats. Gate locations for Alternative 3 are the same for Alternative 1, except that NCTS Finegayan Main Gate and commercial gate locations (GRN # 38 and 39) are in different locations than the Main Gate and commercial gate locations in Alternative 1 (GRN #38A and 39A). The GRN # 38 and 39 locations would have the same direct and indirect impacts as GRN # 38A and 39A. Therefore, impacts to terrestrial biological resources of Alternative 3 are similar to Alternative 1 for each region.

<u>Potential Mitigation Measures</u>

The mitigation measures for Alternative 3 are the same as those for Alternative 1.

12.2.6.4 Alternative 8

Volume 6 Chapter 2, of the EIS/OEIS describes Alternative 8 for the proposed GRN and how this alternative relates to the alternatives associated with the proposed military buildup. Alternative 8 differs from Alternative 1 in the way that NCTS Finegayan would be utilized, as well as other federal parcels. Proposed road projects under Alternative 8 are the same as the proposed road projects under Alternative 1, with the exception of the military access point location at Barrigada (Air Force). This gate location project included as part of Alternative 8 (GRN # 49A) would have the same direct and indirect impacts as the military access point project included as part of Alternative 3 (GRN # 49); therefore, impacts to terrestrial biological resources of Alternative 8 are similar to Alternatives 1 and 3 for each region.

<u>Potential Mitigation Measures</u>

The mitigation measures for Alternative 8 are the same as those for Alternative 1.

12.2.6.5 Firing Range Option

The alternatives described in Volume 2 Chapter 2, for the relocation include the Main Cantonment action alternatives with either a Firing Range Option A or B. Option A would require the realignment of Route 15 (GRN #36), while Option B does not require realignment of Route 15; therefore, by choosing Option B, the impacts associated with proposed road projects within the Central Region study area to terrestrial biological resources would not occur.

12.2.6.6 Summary of Impacts

Table 12.2-18 summarizes the potential impacts of each alternative.

Table 12.2-18. Summary of Potential Impacts to Terrestrial Biological Resources, Roadway Projects

Alternative 1	*Alternative 2**	*Alternative 3*	*Alternative 8*
Vegetation			
LSI • There would be no removal of primary limestone forest	LSI • There would be no removal of primary limestone forest	LSI • There would be no removal of primary limestone forest	LSI • There would be no removal of primary limestone forest
Wildlife			
LSI • Less than significant impacts to wildlife	LSI • Less than significant impacts to wildlife	LSI • Less than significant impacts to wildlife	LSI • Less than significant impacts to wildlife
Special-Status Species			
SI-M • Significant direct impact due to the removal of recognized essential habitat for 3 endangered species and Overlay Refuge, mitigated to less than significant	SI-M • Significant direct impact due to the removal of designated essential habitat for 3 endangered species and Overlay Refuge, mitigated to less than significant	SI-M • Significant direct impact due to the removal of designated essential habitat for 3 endangered species and Overlay Refuge, mitigated to less than significant	SI-M • Significant direct impact due to the removal of designated essential habitat for 3 endangered species and Overlay Refuge, mitigated to less than significant

Legend: SI-M = Significant impact mitigable to less than significant, LSI = Less Than Significant Impact.
*Preferred Alternative.

There would be no removal of primary limestone forest habitat, therefore impacts to vegetation would be less tha significant. Wildlife species that are are documented as present are common species and the proposed roadway improvements would not affect populations of these species so impacts would be less than significant. The removal of essential habitat for ESA-listed species in the North Region would be a significant impact, mitigated to less than significant. The encroachment would also remove habitat from the Refuge Overlay units on Finegayan and Andersen AFB.

CHAPTER 13.
MARINE BIOLOGICAL RESOURCES

13.1 INTRODUCTION

This chapter contains a discussion of the potential environmental consequences associated with implementation of the alternatives within the region of influence (ROI) for this resource. For a description of the affected environment for all resources, refer to the respective chapter of Volume 2 (Marine Corps Relocation – Guam). The locations described in that volume include the ROI for the utilities and roadway projects, and the chapters are presented in the same order as the resource areas contained in this volume.

13.2 ENVIRONMENTAL CONSEQUENCES

13.2.1 Approach to Analysis

13.2.1.1 Methodology

Utilities

The methodology for identifying, evaluating, and mitigating impacts to marine biological resources was based on federal laws and regulations including the Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), Magnuson-Stevens Act (M-SA), Section 404(b)(1) of the Clean Water Act (CWA), and Executive Order (EO) 13089, *Coral Reef Protection*. Significant marine biological resources include all special-status species including species that are ESA-listed as threatened and endangered or candidates for listing under ESA, species protected under the MMPA, or species with designated EFH or Habitat Areas of Potential Concern (HAPC) established under the M-SA. The M-SA defines EFH as "...those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." 'Waters' include aquatic areas and their associated physical, chemical, and biological properties that are used by fish. 'Substrate' includes sediment, hard bottom, structures underlying the waters, and associated biological communities. 'Necessary' means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem, and 'spawning, breeding, feeding, or growth to maturity' covers a species' full life cycle (16 USC 1801 et seq.). Additionally, at least one or more of the following criteria established by the National Marine Fisheries Service (NMFS) must be met for HAPC designation: 1) the ecological function provided by the habitat is important; 2) the habitat is sensitive to human-induced environmental degradation; 3) development activities are, or will be, stressing the habitat type; or 4) the habitat type is rare. It is possible that an area can meet one HAPC criterion and not be designated an HAPC. The Western Pacific Regional Fisheries Management Council (WPRFMC) used a fifth HAPC criterion, not established by NMFS, that includes areas that are already protected, such as Overlay Refuges (WPRFMC 2005). Section 404(b)(1) Guidelines (Guidelines) of the CWA is in essence a Memorandum of Agreement (MOA) between the United States (U.S.) Environmental Protection Agency (USEPA) and U.S. Department of the Army (Army), to articulate policies and procedures to be used in the determination of the type and level of mitigation necessary to demonstrate CWA compliance. The MOA is specifically limited to the Section 404 regulatory program and does not change substantive Section 404 guidance. The MOA expresses the intent of the Army and USEPA to implement the objective of the CWA to restore and maintain the chemical, physical, and biological integrity of the Nation's waters, including special aquatic sites (SAS). SAS are those sites identified in 40 CFR 230, Subpart E (i.e., sanctuaries and refuges, wetlands, mud flats, vegetated shallows, coral reefs, and riffle and pool complexes). They are geographic areas, large or small, possessing special ecological characteristics of productivity, habitat, wildlife protection, or other important and easily disrupted ecological values. These areas are generally recognized as significantly influencing or positively contributing to the general overall environmental health or vitality of the entire ecosystem of a region.

In general, the main intentions of the three federal acts listed above are as follows:

- The ESA establishes protection over and conservation of threatened and endangered species and the ecosystems upon which they depend, and requires any action that is authorized, funded, or carried out by a federal entity to ensure its implementation would not jeopardize the continued existence of listed species or adversely modify critical habitat.
- The MMPA was established to protect marine mammals by prohibiting take of marine mammals without authorization in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S.
- The M-SA requires NMFS and regional fishery management councils to minimize, to the extent practicable, adverse effects to EFH caused by fishing activities. The M-SA also requires federal agencies to consult with NMFS about actions that could damage EFH.
- The CWA Guidelines set forth a goal of restoring and maintaining existing aquatic resources, including SAS (i.e. coral reefs, wetlands etc.).

The ESA, MMPA, and M-SA require that NMFS and/or the USFWS be consulted when a proposed federal action may adversely affect an ESA-listed species, a marine mammal, EFH or HAPC. In addition, while all habitats are important to consider, ‘coral reef ecosystems’ are perhaps the most important habitats and the analysis of this SAS is included under EFH. As a note, EO 13089 also mandates preservation and protection of U.S. coral reef ecosystems that are defined as “… those species, habitats and other natural resources associated with coral reefs in all maritime areas and zones subject to the jurisdiction and control of the U.S.”.

The CWA guidelines and the subsequent MOA require the USEPA and Army to implement the objectives of the CWA. For dredging activities, the U.S. Army Corps of Engineers (USACE) first makes a determination that potential impacts have been avoided to the maximum extent practicable (striving to avoid adverse impacts); remaining impacts would be mitigated the extent appropriate and practicable by requiring steps to reduce impacts; and finally, compensate for aquatic resource values. This sequence is considered satisfied where the proposed mitigation is in accordance with specific provisions of a USACE and USEPA approved comprehensive plan that ensures compliance with the compensation requirements of the Guidelines Determination of Significance.

13.2.1.2 Determination of Significance

This section analyzes the potential for impacts to marine biological resources from implementation of the action alternatives and the no-action alternative. Factors considered in the analysis of potential impacts to marine biological resources include: (1) importance (i.e., legal, commercial, recreational, ecological, or scientific) of the resource; (2) proportion of the resource that would be affected relative to its occurrence in the region; (3) sensitivity of the resource to proposed activities; and (4) duration of ecological ramifications. The factors used to assess significance of the effects to marine biological resources include the extent or degree that implementation of an alternative would result in permanent loss or long-term degradation of the physical, chemical, and biotic components that make up a marine community. The following significance criteria were used to assess the impacts of implementing the alternatives:

- The extent, if any, that the action would diminish suitable habitat for a special-status species or permanently lessen designated EFH or HAPC for the sustainment of managed fisheries.

- The extent, if any, that the action would disrupt the normal behavior patterns or habitat of a federally listed species, and substantially impede the Navy's ability to either avoid jeopardy or conserve and recover the species.
- The extent, if any, that the action would diminish population sizes or distribution of special- status species or designated EFH or HAPC.
- The extent, if any, that the action would be likely to jeopardize the continued existence of any special-status species or result in the destruction or adverse modification of habitat of such species or designated EFH or HAPC.
- The extent, if any, that the action would permanently lessen physical and ecological habitat qualities that special-status species depend upon, and which partly determines the species' prospects for conservation and recovery.
- The extent, if any, that the action would result in a substantial loss or degradation of habitat or ecosystem functions (natural features and processes) essential to the persistence of native flora or fauna populations.
- The extent, if any, that the action would be inconsistent with the goals of the Navy's Integrated Natural Resources Management Plan (INRMP).
- The MMPA generally defines harassment as Level A or Level B, and these levels are defined uniquely for acts of military readiness such as the proposed action. Public Law 108-136 (2004) amended the MMPA definition of Level A and Level B harassment for military readiness events, which applies to this action.
- Level A harassment includes any act that injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild.
- Level B harassment is now defined as "any act that disturbs or is likely to disturb a marine mammal or marine mammal stock by causing disruption of natural behavioral patterns including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering to a point where such behaviors are abandoned or significantly altered." Unlike Level A harassment, which is solely associated with physiological effects, both physiological and behavioral effects may cause Level B harassment.

ESA specifically requires agencies not to "jeopardize" the continued existence of any ESA-listed species, or destroy or adversely modify habitat critical to any ESA-listed species. Under Section 7, "jeopardize" means to engage in any action that would be expected to reduce appreciably the likelihood of the survival and recovery of a listed species by reducing its reproduction, numbers, or distribution. Section 9 of the ESA defines "take" as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect.

Effects determination for EFH are either "no adverse effect on essential fish habitat" or "may adversely affect essential fish habitat" (WPRFMC 2005). Pursuant to 50 CFR 600.910(a), an "adverse effect" on EFH is defined as any impact that reduces the quality and/or quantity EFH. Adverse effects to EFH require further consultation if they are determined to be permanent versus temporary (NMFS 1999). To help identify Navy activities falling within the adverse effect definition, the Navy has determined that temporary or minimal impacts are not considered to "adversely affect" EFH. 50 CFR 600.815(a)(2)(ii) and the EFH Final Rule (67 FR 2354) were used as guidance for this determination, as they highlight activities with impacts that are more than minimal and not temporary in nature, opposed to those activities resulting in inconsequential changes to habitat. Temporary effects are those that are limited in duration and allow the particular environment to recover without measurable impact (67 FR 2354). Minimal effects are those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions (67 FR 2354). Whether an impact is minimal would depend on a number of factors (Navy 2009a):

- The intensity of the impact at the specific site being affected
- The spatial extent of the impact relative to the availability of the habitat type affected
- The sensitivity/vulnerability of the habitat to the impact
- The habitat functions that may be altered by the impact (e.g., shelter from predators)
- The timing of the impact relative to when the species or life stage needs the habitat

The analysis of potential impacts to marine biological resources considers direct, indirect, and cumulative impacts. The *Council on Environmental Quality (CEQ)*, *Section 1508.08 Effects,* defines direct impacts as those caused by the action and occurs at the same time and place, while indirect impacts occur later in time or farther removed in distance, but are still reasonably foreseeable. CEQ defines cumulative impacts as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other action”.

Direct impacts may include: the removal of coral and coral reef habitat, the “taking” of special-status species, increased noise, decreased water quality, lighting impacts resulting from construction or operation activities.

Indirect impacts, for the purposes of this evaluation, may include any sedimentation/siltation of coral reef ecosystems resulting from construction or operational activities (i.e., dredging, resuspension of sediment via propeller wash), recreational activities in the vicinity of the resource that may lead to impacts to special-status species and EFH.

If marine biological or aquatic resources could be significantly impacted by proposed project activities, potential impacts may be reduced or offset through implementation of appropriate Best Management Practices (BMPs) and/or mitigation measures. "Significantly" as used in NEPA Per (per 43 FR 56003, Nov. 29, 1978; 44 FR 874, Jan. 3, 1979) requires considerations of both context and intensity:

- Context. This means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the proposed action. For instance, in the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant.
- Intensity. This refers to the severity of impact. Responsible officials must bear in mind that more than one agency may make decisions about partial aspects of a major action. The following should be considered in evaluating intensity:

    1. Impacts that may be both beneficial and adverse. A significant effect may exist even if the federal agency believes that on balance the effect will be beneficial.
    2. The degree to which the proposed action affects public health or safety.
    3. Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.
    4. The degree to which the effects on the quality of the human environment are likely to be highly controversial.

5. The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.
6. The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.
7. Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.
8. The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places (NRHP) or may cause loss or destruction of significant scientific, cultural, or historical resources.
9. The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act (ESA) of 1973.
10. Whether the action threatens a violation of federal, state, or local law or requirements imposed for the protection of the environment.

Impacts associated with the fouling communities within Inner Apra Harbor (repair of waterfront facilities) were not included in the Habitat Equivalency Analysis (HEA) Volume 9. These communities are not considered to be coral reef (per USACE definition of what constitutes a coral reef), and therefore are not subject to compensatory mitigation.

Off Base Roadways

The approach to analysis for assessing potential impacts of proposed road projects is the same as the approach to analysis described above for utilities.

The affected environment for marine biological resources for the proposed roadway improvement projects on Guam is described in Volume 2 Chapter 11. Many of the road projects proposed do not occur near streams or marine environments, therefore, no direct or indirect impacts to marine biological resources (i.e., marine flora, invertebrates and associated EFH, fish and associated EFH, special-status species, and non-native species introductions) are anticipated. Projects were excluded from further analysis if they were proposed in areas not adjacent to or away from coastlines and drainages so that direct and indirect effects of the new road would not impact marine resources downstream. As an example, the proposed relocation of Route 15 does not occur over any, streams or drainages areas and would be surrounded by ample corridors of vegetation. These two factors would obviate inclusion in the analysis because they mitigate the effects associated with increased impervious cover and runoff.

However, some of the proposed projects include bridge refurbishing near Apra Harbor, where the proposed improvements would occur near streams that may impact coastal waters. Because these projects may indirectly affect marine biological resources downstream they will be discussed in this section where appropriate. In summary, only indirect impacts from certain GRN projects are anticipated and analyzed.

13.2.1.3 Issues Identified During Public Scoping Process

The following analysis focuses on possible effects to marine biological resources that could be impacted by the proposed action. As part of the analysis, concerns relating to marine biological resources that were mentioned by the public, including regulatory stakeholders, during scoping meetings were addressed. A general account of these comments includes the following:

- Potential impacts on the Apra Harbor marine environment from aircraft carrier berthing, fully documenting impacts from dredging (acreage and ecosystem characteristics of affected area, depth of dredging operations, duration of affects)
- Potential impacts to endangered species (including nesting habitats), species of concern, and federal trust species such as corals and marine mammals
- Potential impacts from military expansion from all project sites on the marine resources, including removal or disturbance of the marine habitat
- Impacts to culturally significant marine-related areas for subsistence fishing and beliefs
- Increased "high impact" recreational use that would damage the ecosystem and impact fish habitat (e.g., Sasa Bay Marine Reserve)
- Increased land runoff impacting beaches and marine life (erosion and sediment stress)
- Increased anthropogenic factors impacting the coral reef ecosystem and concerns about the education and training that would be provided for newly arriving military and their dependents regarding reef protection
- Potential mitigation measures and non-structural alternatives to avoid and minimize impacts to coral reefs

13.2.2 Power

13.2.2.1 Interim Alternative 1 (Preferred Alternative)

Interim Alternative 1 would recondition existing combustion turbines and upgrade T&D systems and would not require new construction or enlargement of the existing footprint of the facility. This work would be undertaken by the GPA on its existing permitted facilities. Reconditioning would be made to existing permitted facilities at the Marbo, Yigo, Dededo No. 1, and Macheche combustion turbines. These combustion turbines are not currently being used up to permit limits. T&D system upgrades would be on existing above ground and underground transmission lines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

It is anticipated that these units would require general overhaul, capabilities testing, and controlled startup that could take up to 12 months. The amount of reconditioning would not be known until the units are inspected and tested. Upgrades would also be required to the distribution system. No direct impact to marine biological resources is expected by this alternative. Indirect impacts include increased maritime traffic transporting construction materials into Apra Harbor for distribution. This "vessel movement" impact is described in detail in Volume 2, Chapter 11.

Alternative 1 would result in less than significant impacts to marine biological resources. Table 13.2-1 summarizes the sensitive months for certain species at Apra Harbor. This table used in concert with Figure 13.2-1 would minimize impacts to ESA-listed and sensitive EFH species.

<u>Potential Mitigation Measures</u>

No measures identified at this time.

Table 13.2-1. Sensitive Months for Certain Species within Apra Harbor and Coastal Waters of Naval Computer and Telecommunications Station Finegayan

Species	*Status*	*Location*	*Months*
Green Sea Turtle	ESA-listed, Threatened	see Figure 13.2-1 and 2	Nesting (Jan – Mar)
Hawksbill Sea Turtle	ESA-listed, Endangered	see Figure 13.2-1 and 2	Nesting (Apr – Jul)
Green and Hawksbill Sea Turtles	ESA-listed	see Figure 13.2-1 and 2	Foraging (Jan – Dec)
Adult Bigeye Scad	EFH-CHCRT	see Figure 13.2-1	Jun – Dec
Scalloped Hammerhead	EFH-PHCRT	aircraft carrier turning basin - see Figure 13.2-1	Spawning (Jan – Mar)
Juvenile Fish*	EFH	Sasa Bay and other nearshore environments	Nursery (Jan – Dec)
Hard Corals	EFH-PHCRT	Apra Harbor	Full Moon Spawning (July-Aug)

Legend: CHCRT = Current Harvested Coral Reef Taxa; PHCRT = Potentially Harvested Coral Reef Taxa.
Note: *Includes barracudas, emperors, goatfishes, groupers, mullets, parrotfishes, puffers, snappers, surgeonfishes, wrasses, and small-toothed whiptails.

13.2.2.2 Interim Alternative 2

Interim Alternative 2 is a combination of reconditioning of existing permitted GPA facilities, an increase in operational hours for existing combustion turbines, and upgrades to existing T&D systems. Interim Alternative 2 would not require new construction or enlargement of the existing footprint of the facility. Reconditioning would be performed on the existing permitted GPA facilities at the Marbo, Yigo, and Dededo combustion turbines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Upgrades would also be required to the distribution system consisting of new 34.5 kilovolt (kV) lines for Yigo to Harmon and Dededo to Andersen and Harmon and other lines. Road upgrades would also occur but would be minimal. Impacts to the area include subgrade construction, cut/fill activities, and brush clearing that are not associated with the marine environment.

No direct impact to marine biological resources is expected by this alternative. Indirect impacts include increased maritime traffic transporting construction materials into Apra Harbor for distribution. This "vessel movement" impact is described in detail in Volume 2 Chapter 11.

Interim Alternative 2 would result in less than significant impacts to marine biological resources. Figure 13.2-1 summarizes the sensitive months for certain species at Apra Harbor. This table used in concert with Table 3.2-1 would minimize impacts to ESA-listed and sensitive EFH species.

<u>Potential Mitigation Measures</u>

No measures identified at this time.

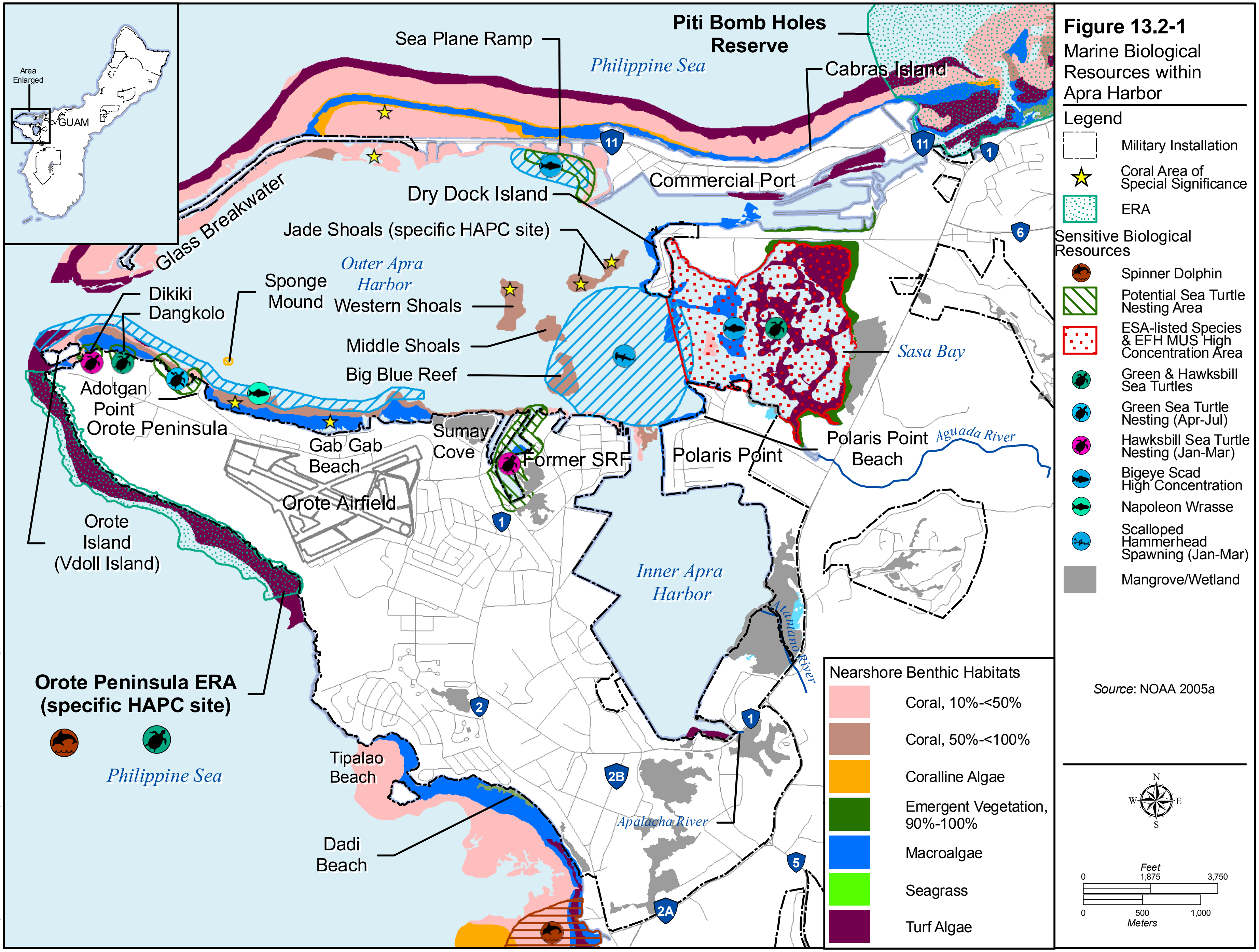

Figure 13.2-1
Marine Biological Resources within Apra Harbor

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13.2.2.3 Interim Alternative 3

Interim Alternative 3 is a combination of reconditioning existing GPA permitted facilities at Marbo, Yigo, and Dededo and upgrades to the Department of Defense (DoD) power plant at Orote. Upgrades would be made to existing T&D. The proposed reconditioning to the existing power generation facilities at Marbo, Yigo, and Dededo would not require new construction or enlargement of the existing footprint of the facility. For the Orote power plant, upgrades would include a new fuel storage facility to facilitate longer run times between refueling. This would disturb approximately 1 acre (4,047 square m). This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Activities associated with Interim Alternative 3 include upgrades to existing GPA permitted facilities at Marbo, Yigo, and Dededo. It is anticipated that these units would require general overhaul, capabilities testing, and controlled startup that could take up to 1 year. The amount of reconditioning necessary to meet operation for baseload or intermediate load generation duty would not be known until the units are inspected and tested. Upgrades would be required to the distribution system as well, including burial of upgraded 34.5-kV line from Yigo to Harmon and Dededo to Andersen and Harmon. Impacts to the area include subgrade construction, cut/fill activities, and brush clearing that are not associated with the marine environment.

No direct impact to marine biological resources is expected by this alternative. Indirect impacts include increased maritime traffic transporting construction materials into Apra Harbor for distribution. This "vessel movement" impact is described in detail in Volume 2 Chapter 11. Interim Alternative 3 would result in a less than significant impact to marine biological resources. Table 13.2-1 summarizes the sensitive months for certain species at Apra Harbor. This table used in concert with Figure 13.2-1 would minimize impacts to ESA-listed and sensitive EFH species.

<u>Upgrade Department of Defense (DoD) Orote Power Plant</u>

Activities associated with Interim Alternative 3 also include upgrading the DoD Orote Power Plant. The distribution upgrades would consist of 34.5-kV line and 115-kV line to Piti, new capacitor bank at the Orote substation (13.8 kV), and new Orote substation with 112-megavolt ampere power transformer. Impacts to the area include subgrade construction, cut/fill activities, and brush clearing.

The location of the Orote Power Plant and proposed upgrades, although in close proximity to Inner Apra Harbor shoreline, is not anticipated to impact marine biological resources as long as compliance with all federal, Commonwealth of the Northern Mariana Islands (CMNI), and military orders, laws, and regulations (see Volume 1, Chapter 4) takes place. No direct impact to marine biological resources is expected by this alternative. Indirect impacts include increased maritime traffic transporting construction materials into Apra Harbor for distribution; however, would be negligible with adherence to maritime measures and Navy policies. This "vessel movement" impact is described in detail in Volume 2, Chapter 11.

Therefore, there would be minimal impacts to marine flora and invertebrates, no adverse effects to fish and EFH, no significant adverse impacts to special-status species (i.e. the action would not "jeopardize" or "take" an ESA-listed or marine mammal species per ESA Section 7 and 9 or Section 3 [16 USC 1362] of MMPA), and minimal impacts regarding introduction of non-native species into the marine environment with appropriate maritime policies.

Interim Alternative 3 would result in a less than significant impact to marine biological resources. Table 13.2-1 summarizes the sensitive months for certain species at Apra Harbor. This table used in concert with Figure 13.2-1 would minimize impacts to ESA-listed and sensitive EFH species.

Potential Mitigation Measures

No measures identified at this time.

Summary of Impacts

Table 13.2-2 summarizes the impacts. A text summary is provided below.

Table 13.2-2. Summary of Potential Impacts to Marine Biological Resources-Power

*Interim Alternative 1**	*Interim Alternative 2*	*Interim Alternative 3*
Marine Biological Resources		
LSI • Indirect impacts from increased barge traffic	LSI • Indirect impacts from increased barge traffic	LSI • Indirect impacts from increased barge traffic • Indirect impacts from runoff, decreasing water quality
Fish and EFH		
LSI • Indirect impacts from increased barge traffic • Indirect impacts from runoff, decreasing water quality	LSI • Indirect impacts from increased barge traffic • Indirect impacts from runoff, decreasing water quality	LSI • Indirect impacts from increased barge traffic • Indirect impacts from runoff, decreasing water quality
Special Status Species		
LSI • Indirect impacts from increased barge traffic	•LSI • Indirect impacts from increased barge traffic	LSI • Indirect impacts to sea turtles from increased barge traffic • Indirect impacts from runoff, decreasing water quality
Non-native Species		
LSI • Indirect impacts from increased barge traffic	LSI • Indirect impacts from increased barge traffic	LSI • Indirect impacts from increased barge traffic

Legend: LSI = Less Than Significant Impact. *Preferred Alternative.

All the Alternatives have potential long-term impacts on marine biological resources through increased maritime shipments, transfer and handling of construction- and operation-related materials in Apra Harbor. The following is a summary of those impacts for each Alternative.

- Interim Alternative 1 does not have the potential to affect marine biological resources, except through increased maritime shipments and associated activities
- Interim Alternative 2 does not have the potential to affect marine biological resources, except through increased maritime shipments and associated activities
- Interim Alternative 3, considering its close proximity to Inner Apra Harbor, this alternative has the potential to affect, but not significantly affect marine biological resources, specifically marine flora and invertebrates, EFH, and sea turtles. This potential increased affect, over existing conditions, can be further reduce/or eliminated by the implementation and enforcement of appropriate federal and local CWA regulations, permits and BMPs (see Volume 1, Section 4). A less than significant impact is assumed from short-term disturbances to the nearshore marine waters from potential stormwater run off during construction-related activities and pollution spills from industrial activities, and increased disturbances from vessel movements

13.2.3 Potable Water

As discussed in Volume 6 Chapter 2, potable water alternatives are not distinguished as interim or long-term but are basic alternatives that address both interim and long-term potable water demand.

13.2.3.1 Basic Alternative 1 (Preferred Alternative)

Basic Alternative 1 would consist of installation of up to 22 new potable water supply wells at Andersen Air Force Base (AFB), rehabilitation of existing wells, interconnection with the GWA water system, and associated T&D systems. A new 5 MG (19 ML) water storage tank would be constructed at ground level at Finegayan.

New Water Supply Facilities

Activities associated with Basic Alternative 1 include constructing up to 22 wells in the Andersen AFB area. Two wells located at the Naval Hospital would be rehabilitated to supplement the local supply and to the Navy island-wide water system. Impacts to the areas include subgrade construction, cut/fill activities, and brush clearing. No structures would be modified or demolished for this action.

New Water Storage and Distribution Facilities

Many components are associated with the new water storage and distribution facilities for Basic Alternative 1. These include constructing pumps at each well station, installing two treated water transmission mains (including a connection to the GWA system), constructing a network of water distribution pipes on both DoD and non-DoD lands, and installation of one grade level water storage tank at Finegayan. Impacts to the areas include tree removal, cut/fill activities, and subgrade construction.

No direct impact to marine biological resources is expected by this alternative. Indirect impacts include increased maritime traffic transporting construction- and operation-related materials into Apra Harbor for distribution. This “vessel movement” impact is described in detail in Volume 2 Chapter 11. Therefore, this action would result in a less than significant impact to marine biological resources.

Potential Mitigation Measures

No measures identified at this time.

13.2.3.2 Basic Alternative 2

Basic Alternative 2 would consist of installation of up to 20 new potable water supply wells at Andersen AFB, up to 11 new potable water supply wells at Barrigada, rehabilitation of existing wells, interconnection with the GWA water system, associated transmission and distribution systems upgrades. Additionally, new 3.6 MG (13.6 ML) and 1 MG (3.8 ML) water storage tanks would be constructed at ground level at Finegayan and Barrigada, respectively.

New Water Supply Facilities

Activities associated with Alternative 2 are the same as for Basic Alternative 1 for the new water supply facilities. Impacts to the areas include subgrade construction, cut/fill activities, and brush clearing.

The construction-related activities associated with this alternative are not associated with the marine environment; therefore, no impacts would occur to marine biological resources.

New Water Storage and Distribution Facilities

Many components are associated with the new water storage and distribution facilities for Alternative 2. These include constructing pumps at each well station, installing two treated water transmission mains (including a connection to the GWA system), construct a network of water distribution pipes on both DoD and non-DoD lands, and two grade level water storage tanks (one at Finegayan and one at Air Force Barrigada). Impacts to the areas include tree removal, cut/fill activities, and subgrade construction.

Volume 6, Chapter 2 figures provide the proposed project locations in relation to the marine environment on Andersen AFB, Finegayan, Andersen South, and Barrigada. This alternative and its actions are not associated with the marine environment. No direct impact to marine biological resources is expected by this alternative. Indirect impacts include increased maritime traffic transporting construction and operation-related materials into Apra Harbor for distribution. This "vessel movement" impact is described in detail in Volume 2 Chapter 11. Therefore, this action would result in a less than significant impact to marine biological resources.

13.2.3.3 Summary of Impacts

Table 13.2-3 summarizes the impacts. A text summary is provided below.

Table 13.2-3. Summary of Potential Impacts to Marine Biological Resources-Potable Water

*Basic Alternative 1**	*Basic Alternative 2*
Marine Biological Resources	
LSI • General overall indirect impact from increased barge traffic into Apra Harbor	LSI • General overall indirect impact from increased barge traffic into Apra Harbor

Legend: LSI = Less Than Significant Impact. *Preferred Alternative.

Basic Alternatives 1 and 2 do not have construction or operation-related actions that are associated with the marine environment; however there would be an associated increase in barge traffic into Apra Harbor carrying construction- and operation-related materials. Therefore Alternative 1 and 2 would result in less than significant impacts to marine biological resources.

13.2.4 Wastewater

13.2.4.1 Basic Alternative 1a (Preferred Alternative) and 1b

Basic Alternative 1 (Alternative 1a supports Main Cantonment Alternatives 1 and 2; and Alternative 1b supports Main Cantonment Alternatives 3 and 8) combines upgrade to the existing primary treatment facilities and expansion to secondary treatment at the Northern District Wastewater Treatment Plant (NDWWTP).The difference between Alternatives 1a and 1b is a requirement for a new sewer line from Barrigada housing to NDWWTP for Alternative 1b. Because Basic Alternative 1 a and 1b differ only in the placement of on-shore sewer lines which would not result in a difference in wastewater characteristics or difference in discharges to the marine environment, the alternatives are assessed together for potential marine resource impacts.

The NDWWTP is designed to provide primary treatment for an average daily flow of 12 million gallons per day (mgd) (45 million liters per day [mld]) with peak hourly flow of 27 mgd (102 mld). The proposed Marine Corps relocation would increase the average and peak wastewater flows to 11.54 mgd and 25.97 mgd (43.67 mld and 98.30 mld), respectively, at the completion of the DoD buildup. During the buildup, there would be a higher flow estimated at 12.8 mgd (46.6 mld) at the peak year of 2014.

The potential affects to marine biological resources associated with only the increased discharge flows described earlier are evaluated below.

Figure 13.2-2 provides the existing outfall extension in relation to sensitive marine biological resources in the area. Potential receptors of ocean outfall effluent constituents include a wide variety of marine flora and fauna living in or near coastal or marine waters, including humans (addressed in Public Health and Safety, Chapter 18).

The Navy is conducting a study to evaluate potential impacts on water quality and the marine environment from the GPA NDWWTP wastewater discharge at its new ocean outfall. The study, *Draft Guam Northern District Outfall Assessment, October 2009* was still in draft form at the time of this Draft Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) publication, but will be finalized before publication of the FEIS. Pertinent data and information from the draft study was used in this DEIS, along with other available information, to evaluate the water quality and marine environment impacts in this Chapter. The study assesses impacts to the receiving marine environment resulting from the primary and secondary treatment and disposal of wastewater, including additional wastewater loadings associated with the military buildup on Guam.

Effluent from the proposed Northern District WWTP discharges into marine waters through a new ocean outfall. Computer modeling was conducted to predict how water quality might be affected by the discharge in the immediate vicinity of the outfall (termed "nearfield") and further away from the outfall (termed "farfield"). Environmental and biological impact assessments were also performed. Parameters used to assess the environmental impacts on the receiving marine waters include:

- Comparison with the Guam Water Quality Standards (GWQS)
- Effects to the ecological life and environment of the receiving marine waters

Comparison with the Guam Water Quality Standards

In nearshore tropical marine waters, phosphorus appears to be more limiting for primary production (Hawarth et al. 1995), while tropical open ocean is nitrogen-limited (Corredor et al. 1999). Nutrients regulated under the Guam Water Quality Standards include ammonia, nitrate, nitrite, and orthophosphate. These utilized by phytoplankton for primary production.

Initial dilution (nearfield) and farfield modeling performed in the study indicates that the discharge of 12 MGD of primary treated effluent from a new NDWWTP outfall will impact the receiving water quality in the vicinity of the facility's outfall. For the study, plume models were developed with ocean and wind data collected through field visits and used to develop the theoretical ambient receiving water conditions near the outfall. The initial dilution factor for the new NDWWTP outfall has been determined by the study to be 300, despite GWA's use of 200 as the basis of design for the new outfall. The resulting ambient water quality conditions based on this modeling are summarized in Table 13.2-4.

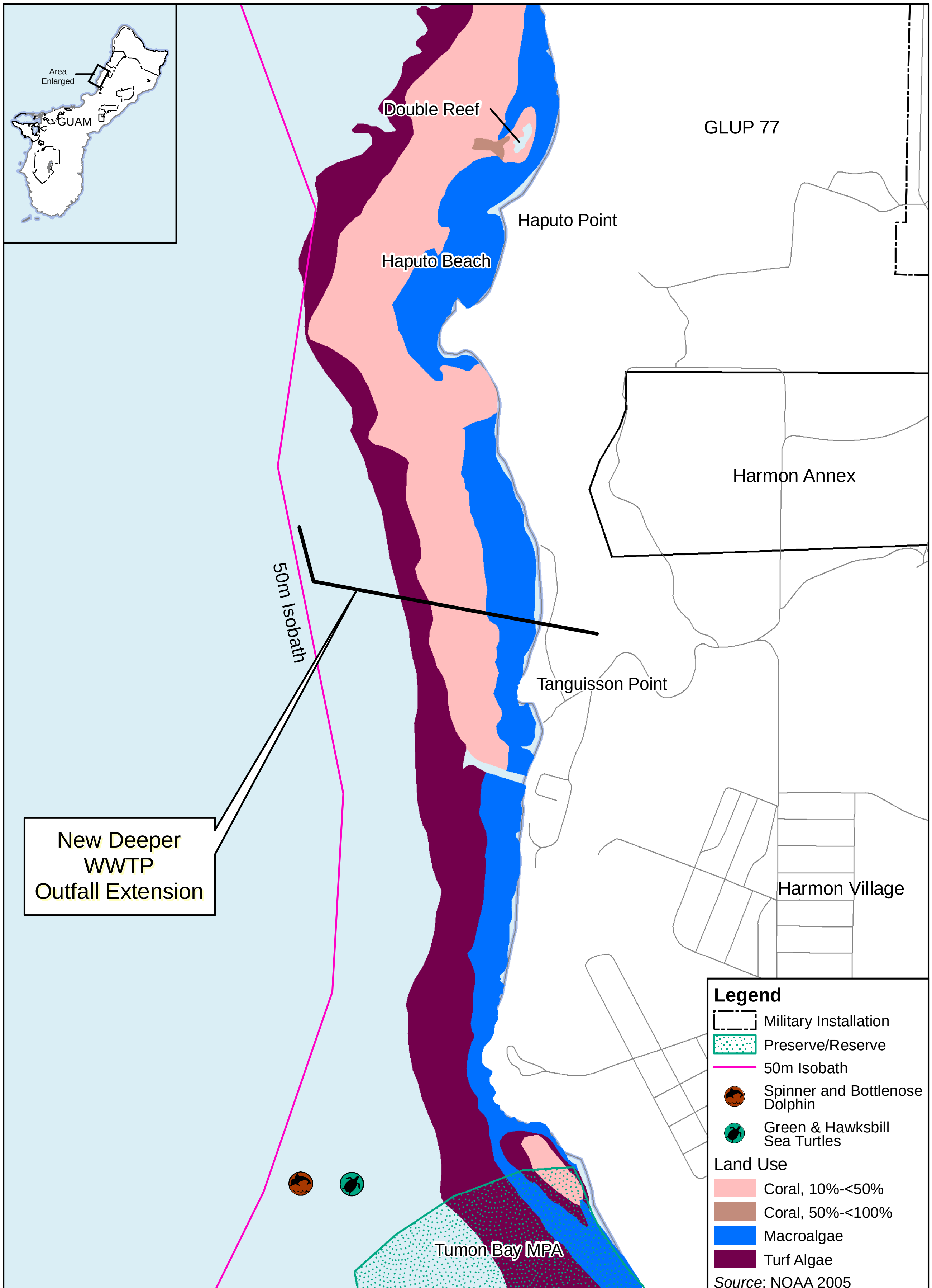

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Figure 13.2-2
NDWWTP Outfall Extension and Sensitive Marine Biological Resources

Table 13.2-4. Comparison of Guam Water Quality Standards to Modeled Primary and Secondary Treatment Effluent at NDWWTP"

Constituents Regulated by the GWQS	*Unit*	*GWQS for Marine-2 Waters*	*Background* [1]	*Primary Treatment*		*Secondary Treatment*	
				End of Pipe	*After Initial Dilution* [2]	*End of Pipe*	*After Initial Dilution* [2]
Enterococcus	MPN/100ml	104	0	240000	800	15	0.1
Turbidity	NTU	1	0.25	59	0.4	16	0.3
TSS	mg/L	20	5.6	80	5.8	9	5.6
Ortho-P	µgP/L	50	5	2620	13.7	1640	10.5
Nitrate+Nitrite	µgN/L	200	1.1	9	1.1	14900	50.8
Ammonia	µgN/L	20	0	18400	61.3	3500	11.7
Total Sulfide	µg/L	5	0	140	0.5	140	0.5
Lead	µg/L	8.1	0	4.94	0	4.43	0
Copper	µg/L	3.1	0	68.3	0.2	54.6	0.2
Zinc	µg/L	86	0	276	0.9	72.6	0.2
Total Nitrogen	µgN/L	None	151	47600	309.2	23950	230.3
Total Phosphorus	µgP/L	None	13	3850	25.8	3760	25.5

[1] Background concentrations in receiving waters not influenced by the existing NDWWTP discharges.
[2] Initial dilution for NDWWTP outfall = S10 = 300

Modeling results shown in Table 13.2-4 indicate that water quality standards for *Enterococcus* (a bacteria) and Ammonia will be exceeded for discharge of primary treated effluent from the new NDWWTP. *Enterococcus* levels in the surfacing plume at the new NDWWTP outfall are predicted to be 800 colonies per milliliter (NPN/100ml), and would exceed the water quality standard of 104 MPN/100ml. Ammonia levels in the surfacing plume at the new NDWWTP outfall are predicted to be 61 micrograms per liter (µgN/L), and would exceed the water quality standard of 20 µgN/L.

On September 30, 2009 USEPA Region 9 issued a denial of the secondary treatment variance that had been allowed for the NDWTP. USEPA Region 9's decision document about this denial included information on water quality impacts from the current NDWWTP discharge. That decision document found that the discharge of 12MGD will likely attain the applicable water quality criteria for Dissolved Oxygen (based on Biological Oxygen Demand loading), Total Suspended Solids, Turbidity, pH, Temperature and Salinity at and beyond the Zone of Initial Dilution, assuming that a new diffuser is installed on the new outfall as has been proposed by GWA. The USEPA also noted that primary treatment alone does not reduce bacteria levels to the extent that would be required to meet GWQS for *Enterococci*. USEPA did not have information necessary for adequately assessing whether the proposed discharge will meet water quality criteria for nutrients at the site.

As shown in Table 13.2-4, modeling results from the *Draft Guam Northern District Outfall Assessment, October 2009* validate USEPA's conclusion that upgrading the NDWWTP to secondary treatment would result in all water quality standards being met. This includes water quality standards that would not be met with just primary treatment, namely *Enterococcus* and Ammonia. With secondary treatment installed at the NDWWTP, *Enterococcus* levels are expected to be 0.1 MPN/100ml, well below the water quality standard of 104 MPN/100 ml. Ammonia levels are expected to be 11.7 µgN/L, well below the water quality standard of 20 µgN/L.

GWA has expressed a need to expand the NDWWTP to 18 MGd to meet future projected wastewater flows from natural population growth after the completion of the military buildup on Guam (e.g.: beyond the year 2019). A detailed assessment of water quality impacts that could occur for an 18 MGd wastewater treatment plant were not evaluated in this study. Although a detailed assessment has not been conducted, the treatment system for a larger 18 MGd plant would have the same treatment processes as a 12 MGd plant, and would be required to meet the same pollutant removal efficiencies, and meet water quality standards at the discharge. Therefore, it is expected that the impacts to water quality from an 18 MGd plant would be the same as for a 12 MGd plant.

<u>Effects to the Ecological Life and Environment of the Receiving Marine Waters</u>

The three components of sewage effluent found to be most detrimental to marine life and coral reefs are nutrients, sediments, and toxic substances. Tropical ocean waters are typically characterized as low in nutrients and particulates. Therefore, the discharge of high levels of nutrients and particulates may have detrimental impacts to the receiving marine waters.

The following analysis from the *Draft Guam Northern District Outfall Assessment, October 2009* is derived from a review of existing studies performed by others in the vicinity of the NDWWTP outfall, supplemented by investigations performed at other marine outfalls located in Guam and Hawaii.

Water Column Impacts

The nearfield plume analysis indicates that the discharge from the diffuser rises quickly, with minimal horizontal dispersion before reaching the surface. The elapsed time for this initial mixing and rise of the fluids is short, occurring in minutes. Therefore, there is minimum interaction with the extant assemblage of organisms in the water column.

Phytoplankton may assimilate some nutrients present in the farfield plume. Since phytoplankton requires several days to replicate and the plume will likely disperse over a wide area in a matter of hours, however, the increase in biomass is not likely to be a concern. The low phytoplankton biomass (based on the low level of chlorophyll α) also suggests that any increase resulting from phytoplankton productivity will be rapidly grazed by herbivorous zooplankters. Therefore, detectable changes in phytoplankton or herbivorous zooplankton biomass are not anticipated.

Enterococcus and ammonia in the surfacing plume will exceed the GWQS. These anticipated constituent concentrations are based on the modeling results and do not take into account the degradation of constituents, die-off of organisms, or uptake of the pollutants by existing aquatic life.

Enterococcus in the discharge plume will eventually be diluted to near zero. Unfavorable conditions provided by the marine environment will likely destroy these bacteria and most others from the wastewater. Factors such as pH, temperature, solar (UV) radiation, predation, osmotic stress, nutrient deficiencies, particulate levels, turbidity, oxygen concentrations, and microbial community composition affect bacteria inactivation.

The toxicity of ammonia is dependent on pH. Dissolved in water, ammonia will react with hydrogen ions (H+) to form non-toxic ammonium ions (NH4 -). When mixed with the higher pH level of the receiving marine water, ammonia present in the wastewater discharge will increase in toxicity. Toxicity is still a function of concentration and, since the initial dilution of ammonia in the rising primary treatment plume is around 60 µgN/L, this value is nearly two orders of magnitude (or about 1/100) of the concentration found to be toxic to most fishes (USEPA 1972). Secondary treatment brings this concentration down to just over half of the Guam Water Quality Standard of 20 µgN/L.

Marine Flora, Invertebrates, and Associated Essential Fish Habitat

Benthic impacts are associated with the sedimentation of particulates entrained in the discharge plume. Sources of the particulates in the wastewater discharge plume include particulates in the effluent, particulates produced in the environment from nutrient enrichment, and natural seston.

Based on several studies performed on deep ocean outfalls off Oahu in the Hawaiian Islands, no significant impacts have been reported on the benthic faunal. Impacts to polychaete assemblage and the crustacean and soft bottom communities were found to be limited. Since the conditions off Tanguisson Point are similar to those off the Oahu deep ocean outfalls, adverse impacts to the receiving marine waters are not anticipated with the discharge of effluent from the NDWWTP outfall. Additionally, the nearfield plume analysis indicates that the discharge from the diffuser rises quickly, with minimal horizontal dispersion before reaching the surface. The elapsed time for this initial mixing and rise of the fluids is short; occurring on a time scale of minutes, so the impact associated with sedimentation and ammonia concentrations is not anticipated to be significant. The impacts associated with increased wastewater treatment flows from this alternative would be long-term; however, due to the analysis above and the fact that flora and invertebrates are generally more resistant to ammonia toxicity than fish (Ankley et al. 1996), and the operational goal of expansion to secondary treatment by 2015) would considerably improve water quality and is anticipated to meet GWQS, the impacts would be negligible. Therefore, Interim Alternative 1a would result in less than significant impacts to Marine Flora, Invertebrates, and Associated EFH.

Fish and Associated EFH

As reported above, the nearfield plume rises quickly with minimal horizontal dispersion before reaching the surface; therefore, minimal interaction occurs with the extant assemblages of organisms in the water column. Phytoplankton may assimilate some of the nutrients present in the near and farfield plume; however, phytoplankton requires several days to replicate, and the plume would likely disperse over a wide area in a matter of hours. The increase in biomass is not likely to be a concern, considering the low phytoplankton biomass around Guam and the vicinity (based on the low levels of chlorophyll), any increase resulting from phytoplankton productivity would be rapidly grazed by herbivorous zooplankton and fish. Detectable changes in phytoplankton or herbivorous zooplankton biomass are not anticipated, but should be monitored (Navy 2005, Navy 2009).

Detrimental impacts to the coral reef ecosystems associated with excessive nutrient-loading, bacteria, and sediment abrasion have been documented in Johannes 1975, Pastorok and Bilyard 1985, Smith et al. 1981. Long-term potential impacts to marine flora and invertebrates in the surrounding area from increased outfall discharges (12 mgd [45 mld] to 24 mgd [91 mld]) include increased turbidity, decreased water quality, and sedimentation in an undefined area adjacent to the diffuser and north based on wind and current data studies at the site (Navy 2009 ES-5 to ES-9). However, these impacts are dependent on the flushing properties of the receiving waters and characteristics of the sediments (Navy 2009). Pastorok and Bilyard (1985) studied the impacts of sewage effluent on the coral reef ecosystem. The findings of this paper indicated that the discharge of sewage had little or no impact on the coral reef ecosystems in well-flushed waters along open coasts (Navy 2009).

Most of the literature describing negative impacts of sewage discharge on coral reefs is limited to studies of lagoons or embayment environments with relatively long residence times that can result in buildup of nutrients and sediments to detrimental levels (Johannes 1975, Pastorok and Bilyard 1985, Smith et al. 1981). In coastal areas, discharge of treated sewage effluent may have no negative effect on coral community structure and may in fact enhance coral growth and benefit coral reef community by providing nutrient subsidies and additional surface area that is suitable for settlement and growth.

Figure 13.2-3 shows two photographs taken off Tanguisson Point in 1994 that are associated with the two diffuser ports of the Tanguisson sewage outfall (NDWWTP outfall). The outfall diffuser that was made up of 17 elevated diffuser ports (with 33-ft [10-m] separation) was aligned parallel to shore at a depth of about 66 ft (20 m). At this time period, the NDWWTP was reportedly discharging 3 to 4 mgd (11 to 15 mld) of primary treated domestic effluent, coral colonies, predominantly *Porities* (*Synaraea*) *rus* have covered the discharge ports and adjacent reef areas that were excavated for placement of the diffuser pipe in the 10 years since the outfall was constructed. Effective engineering design of diffusers that maximizes dispersion, mixing, and dilution of treated plumes, and placement of outfalls in open coastal areas with high rates of water exchange appear to be important factors in preventing negative impacts to coral reef communities (Dollar 1994).

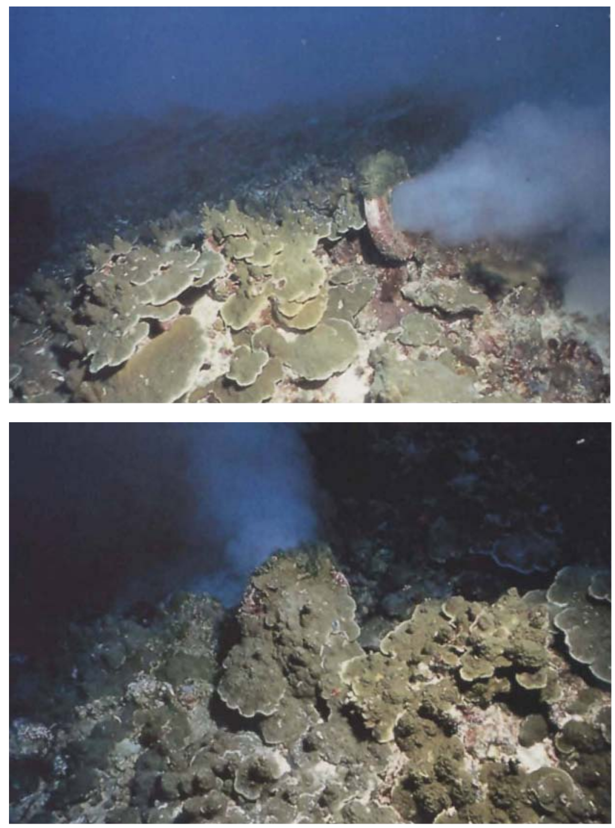

Photo credit: Dollar, S. SOAEST, UH 1994.

Figure 13.2-3. Former Tanguisson Point Primary WWTP Outfall and Coral Growth

It is anticipated that motile animals would exit the area during any in-water work being performed, but return shortly after; therefore, short-term and localized impacts from increased turbidity and noise are expected to fish and EFH.

Increasing the flow from 12 mgd (45 mld) to 17.63 mgd (66.74 mld) would result in higher nutrient and particulate values in the surfacing plume and ammonia levels from 67 µgN/L to 88 µgN/L. The biological impacts associated with this increase may be significant to finfish species. These increased impacts may be mitigable to less than significant by installation and redesign of the diffuser system; however, anticipated ammonia levels are still estimated to be above GWQS, until NDWWTP expansion to secondary treatment. Additionally, combined effects of ammonia and other stressors, such as low dissolved oxygen and high temperature, are highly complex and can be difficult to separate from the toxic effects caused by ammonia alone, especially in sensitive finfish species (Ankley et al. 1996). The impacts associated with increased wastewater treatment flows from this alternative may adversely affect EFH, specifically finsfish species, until GWQS are met with the anticipated operational expansion goal to secondary treatment by 2015. Therefore, Basic Alternative 1a may adversely affect Fish and Associated EFH in the short term until the secondary treatment capability would be installed and operational.

<u>Special-Status Species</u>

The four special-status species identified in Volume 2 (green and hawksbill sea turtles, and spinner and bottlenose dolphins) are anticipated to occur in the area. Since these species are air breathing, increased turbidity should not adversely impact their respiration or biological functions (NOAA 2007). Sea turtles may forage in shallower waters but not at the new deeper NDWWTP outfall; therefore, any affect would be short-term and negligible as they pass through the area. Sea turtles and marine mammals would most likely exit the areas during any in-water work. Appropriate construction and maritime mitigation measures would be implemented by the Navy during in-water outfall expansion activities accordingly for the protection of marine mammals and ESA-listed sea turtles (see Volume 7). No evidence exists that special-status species would be significantly impacted from actions under this alternative.

The short-term and periodic impacts associated with Basic Alternative 1 actions are likely to affect, but are not likely to adversely affect, ESA-listed sea turtles. Basic Alternative 1 would not "jeopardize" or "take" ESA-listed sea turtles as defined under Sections 7 and 9 of ESA. No serious injury or mortality of any marine mammal species (spinner dolphins) is reasonably foreseeable and no adverse effects on the annual rates of recruitment or survival of any of the species and stocks is expected with the implementation of Basic Alternative 1.

Therefore, Basic Alternative 1 would result in less than significant impacts to Special-Status Species.

<u>Non-native Species</u>

No vessel operation or in-water construction work is anticipated with this alternative; however, if outfall extension is performed under this alternative, the following is appropriate.

Potential impacts to the marine habitat associated with the coastal areas from non-native marine organisms, pathogens, or pollutants taken up with ship ballast water (or attached to vessel hulls) are a real threat.

The impacts from introduction may be lessened or even prevented through mitigation measures and existing Navy and U.S. Coast Guard policies. The Navy would also prepare a Regional Biosecurity Plan with Risk Analysis to address terrestrial and marine non-native species threats and mitigation measures (see Volume 7 for more details).

<u>Potential Mitigation Measures</u>

See Volume 7 for a comprehensive list for in-water construction activities and for vessels underway.

A Biosecurity Risk Assessment & Biosecurity Plan (or non-native species plan) would be developed in conjunction with the National Invasive Species Council (USFWS, U.S. Department of Agriculture, Guam Division of Aquatic and Wildlife Resources, and other interested parties to facilitate a comprehensive approach to control non-native species export, import, and spread. The plan would be comprehensive for all Marine Corps and Navy actions on Guam, including those being proposed in the (EIS/OEIS) for Marine Corps actions on Guam and CNMI.

13.2.4.2 Summary of Impacts

Table 13.2-5 summarizes the impacts. A text summary is provided below.

Table 13.2-5. Summary of Potential Impacts to Marine Biological Resources-Wastewater

*Basic Alternative 1a**	*Basic Alternative 1b*
Marine Flora and Invertebrates	
LSI • Long-term, minimal impacts from decreased water quality and siltation. Increased nutrients may improve flora production	LSI • Long-term, minimal impacts from decreased water quality and siltation. Increased nutrients may improve flora production
Fish and EFH	
SI • Short-term, localized significant impacts from decreased water quality, exceeding GWQS for multiple constituents, specifically ammonia nitrogen. • Short-term, may increase herbivore foraging area from nutrient loading LSI • Long-term, assumes operational goal of expansion to secondary treatment by 2015	SI • Short-term, localized significant impacts from decreased water quality, exceeding GWQS for multiple constituents, specifically ammonia nitrogen. This component can be toxic to sensitive finfish species • Short-term, may increase herbivore foraging area from nutrient loading LSI • Long-term, assumes operational goal of expansion to secondary treatment by 2015
Special-Status Species	
LSI • Short-term, localized impacts from decreased water quality • Long-term, localized minimal impacts from decreased water quality	LSI • Short-term localized impacts during in-water work • Long-term, localized minimal impacts from decreased water quality
Non-Native Species	
LSI • Potential introduction during in-water construction phase	LSI • Potential introduction during in-water construction phase

Legend: SI = Significant Impact, LSI = Less Than Significant Impact. *Preferred Alternative.

Basic Alternative 1 has the potential to significantly impact fish and EFH, specifically finfish, due to elevated concentration levels of ammonia nitrogen within the near and farfield plume exceeding GWQS.

Additional data to assess whether or not a long-term, chronic, or cumulative adverse effect on marine organisms would occur at the site is needed and may include the following:

- Monitoring of benthic communities in the plume track and adjacent areas
- Tissue studies of bioaccumulation in the food chain
- Monitoring of primary production and nutrient uptake and cycling
- Tracer studies of the sources of ammonia nitrogen (and possibly other nutrients) being utilized by phytoplankton

13.2.5 Solid Waste

13.2.5.1 Basic Alternative 1 (Preferred Alternative)

The Preferred Alternative for solid waste would be the continued use of Navy Landfill at Apra Harbor until Layon Landfill is opened, which is scheduled for July 2011. No construction or changes in current operations would occur besides an increase in the volume of solid waste.

This alternative and its actions are not associated with the marine environment; therefore, no impacts would occur to marine biological resources. Although close in proximity to Agat Bay, continued use of the Apra Harbor landfill should not change any current impact to the nearshore environment.

Therefore, Alternative 1 would result in less than significant impacts to marine biological resources.

Potential Mitigation Measures

No mitigation measures are deemed necessary.

13.2.5.2 Summary of Impacts

Table 13.2-6 summarizes the potential impacts of Alternative 1. A text summary is provided below.

Table 13.2-6. Summary of Potential Impacts to Marine Biological Resources-Solid Waste

Basic Alternative 1
LSI • Indirect impacts from increased barge traffic • Indirect impacts from runoff, infiltration, potentially decreasing water quality

Legend: LSI = Less Than Significant Impact. *Preferred Alternative.

Alternative 1 would have less than significant impacts to marine biological resources.

13.2.6 Off Base Roadways

As discussed in Volume 6 Chapter 2.5, some Guam Road Network (GRN) projects involve road widening, bridge replacements, new road construction or roadway realignment, and pavement strengthening projects. This section addresses the potential indirect impacts of the proposed GRN projects to marine biological resources and also describes mitigation measures to avoid or minimize these potential impacts. As discussed in Volume 6 Chapter 6.6, all proposed roadway improvements would occur above elevation 3.5 ft (1.1 m) mean lower low water (GUVD04 vertical datum). The high tide line has been estimated at 2.7 ft (0.8- m) above mean lower low water; therefore, no direct impacts to marine environments are anticipated for any proposed improvement project in any of the four regions. Based on the criteria described in the Methodology Section, no projects within the North region would have the potential to affect marine biological resources; therefore, no analysis is required. Table 13.2-7 describes the direct and indirect impacts for each type of roadway project (non-widening pavement strengthening, intersection improvements, projects that require vegetation removal [e.g. roadway widening, new road construction, and roadway realignment projects], military access point modification or construction, and bridge replacements). Figure 13.2-4, Table 13.2-8, Table 13.2-9, Table 13.2-10 list the roadway projects and potential indirect and/or direct impacts on marine biological resources for the Central, Apra Harbor, and South regions, respectively.

Table 13.2-7. GRN Project Type and Potential Impacts to Marine Biological Resources

Project Type[1]	*Type of Impact Evaluated*	*Potential Impact Description*[2]
Pavement Strengthening	Indirect impacts - construction phase	No impact in areas without an impervious surface and/or drainage connection with marine environments (e.g. northern Guam). Uncontrolled runoff in other areas (Central, Apra Harbor, and South Regions) may impact marine communities down stream or down gradient during the construction phase. Sedimentation and non-point pollution inputs into marine waters, particularly near termini of rivers and stormwater outflows.
Intersection Improvements		
Roadway Widening, New Road Construction (Finegayan Connection), Military Access Point Modifications / Construction, & Road Realignment (Route 15)	Direct impacts	None: New road construction (Finegayan Connection) and Route 15 realignment would occur in upland areas with no direct removal or disturbance of marine communities.
	Indirect impacts- construction phase	None: New road construction (Finegayan Connection) and Route 15 realignment would occur in upland areas of northern Guam with no impervious surface and/or drainage connection with marine environments.
	Indirect impacts- operational phase	
Bridge Replacements (Agana, Atantano, Fonte, Laguas, & Sasa Bridges)	Direct impacts	None: Bridge proposed for replacement span riverine habitats with no direct removal or disturbance of marine communities.
	Indirect impacts - construction phase	Uncontrolled runoff may impact marine communities down stream during the construction phase. Sedimentation and non-point pollution inputs into marine waters, particularly near termini of rivers and stormwater outflows
	Indirect impacts- operational phase	Alteration of the hydraulic conveyance due to the new bridge design may impact downstream marine communities.

Note 1: The GRN project descriptions are included in Volume 6 Chapter 2.5.
Note 2: Mitigation measures are included later in this chapter that minimize or avoid potential direct or indirect impacts

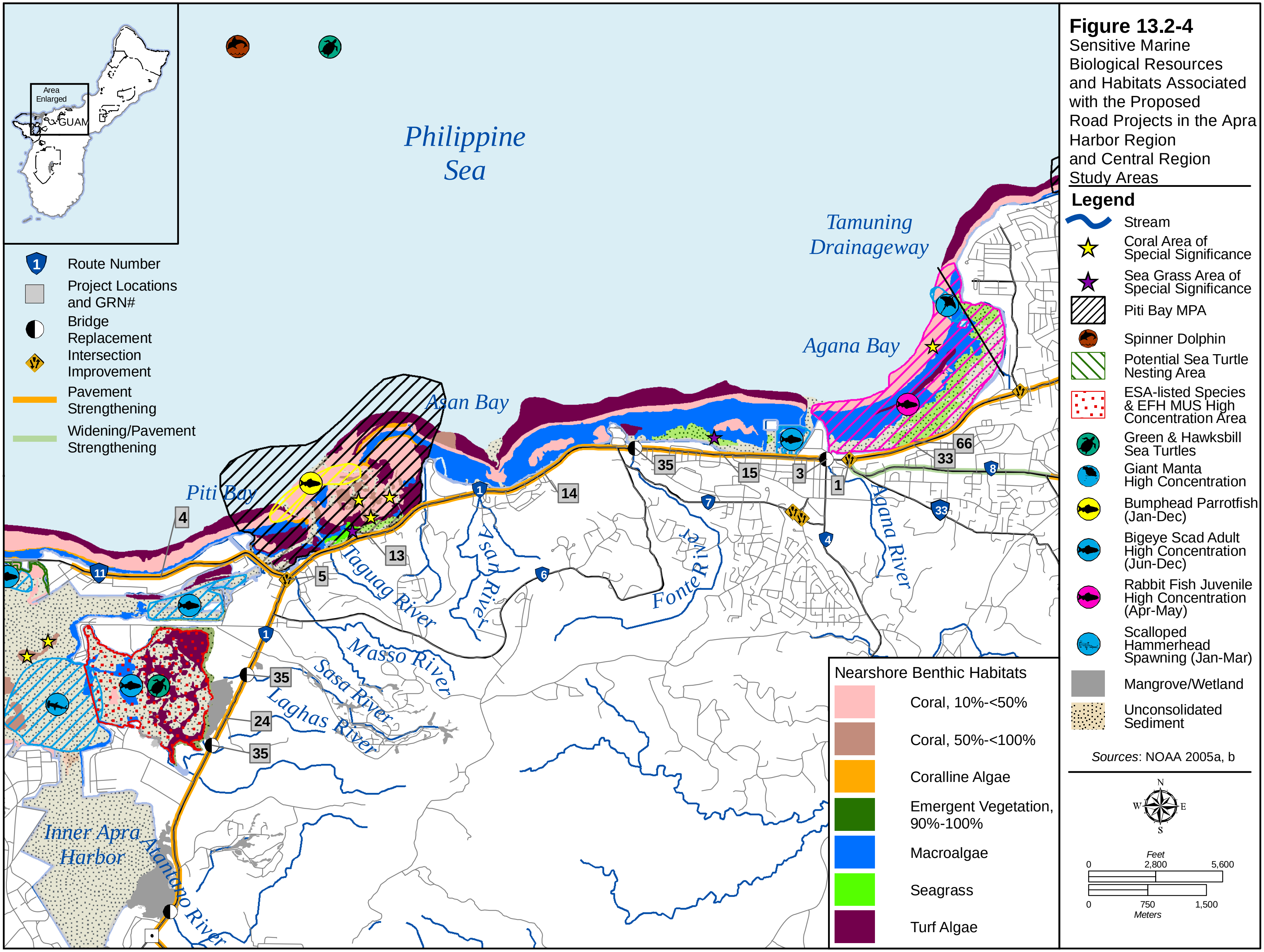

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Table 13.2-8. Central Region GRN Projects, Alternatives, and Potential Impacts

GRN #	Alternatives[1]				Potential Impact Type and Description[2]	
	1	2	3	8	Indirect	Direct
1	x	x	x	x	Potential for uncontrolled runoff during the construction phase, non point-source pollutants and/or sedimentation inputs into marine communities of East Hagatna Bay.	None: The proposed road and intersection improvements in the Central region are all proposed to occur in upland non-marine environments. Therefore, no direct effects to marine environments are anticipated.
2	x	x	x	x		
3	x	x	x	x		
6	x	x	x	x	Potential for uncontrolled runoff during the construction phase, non point-source pollutants and/or sedimentation inputs into marine communities of Tumon Bay via stormwater drainages.	
7	x	x	x	x		
11	x	x	x	x	None: the proposed roadway improvement along Chalan Lujuna would occur over pervious limestone substrates and limited potential for non-point source pollutant inputs into marine communities.	
12	x	x	x	x	None: the proposed roadway improvement along Route 15 would occur over pervious limestone substrates and limited potential for non-point source pollutant inputs into marine communities.	
13	x	x	x	x	Potential for uncontrolled runoff during the construction phase, non point-source pollutants and/or sedimentation inputs into marine communities of Asan Bay and Piti Bay, including Piti Bomb Holes Marine Preserve.	
14	x	x	x	x		
15	x	x	x	x		
16	x	x	x	x	Potential for uncontrolled runoff during the construction phase, non point-source pollutants and/or sedimentation inputs into marine communities of Hagtna Bay via stormwater drainages.	
17	x	x	x	x		
18	x	x	x	x	Potential for uncontrolled runoff during the construction phase, non point-source pollutants and/or sedimentation inputs into marine communities of Tumon Bay via stormwater drainages.	
19	x	x		x		
20	x	x		x		
21	x	x	x	x		
28	x	x	x	x		
29	x	x	x	x		
30	x	x	x	x	None: the proposed roadway improvement along Route 10 would occur over pervious limestone substrates and limited potential for non-point source pollutant inputs into marine communities.	
31	x	x		x		
32	x	x	x	x	None: the proposed roadway improvement along Route 15 would occur over pervious limestone substrates and limited potential for non-point source pollutant inputs into marine communities.	

GRN #	*Alternatives*[1]				*Potential Impact Type and Description*[2]	
	1	*2*	*3*	*8*	*Indirect*	*Direct*
33	x	x	x	x	Potential for uncontrolled runoff during the construction phase, non point-source pollutants and/or sedimentation inputs into marine communities of Tumon Bay via impervious surfaces, stormwater drainages, and/or Agana River drainages that terminate at Tumon Bay and Tumon Bay Marine Preserve.	
35	x	x	x	x	Potential for uncontrolled runoff during the construction phase, non point-source pollutants and/or sedimentation inputs into marine communities of Sasa Bay Marine Preserve (via Laguas and Sasa Rivers) and Inner Apra Harbor (via Fonte and Atantano Rivers).	None: The proposed bridge replacements occur over riverine (non-marine) environments; therefore, no direct effects to marine environments are anticipated.
36	x	x	x	x	None: Potential for uncontrolled runoff from the Route 15 realignment; however, runoff would attenuate due to thick vegetation and highly pervious limestone. No surface stormwater drainage connection to marine communities around Pagat Point.	None: The proposed road and intersection improvements in the Central region are all proposed to occur in upland non-marine environments. Therefore, no direct effects to marine environments are anticipated.
44	x	x	x	x	None: Potential for uncontrolled runoff; however, runoff from the access gate construction area would attenuate due to thick vegetation and highly pervious limestone. No surface stormwater drainage connection to marine communities around Pagat Point.	
46	x	x	x	x		
47			x		None: the access gate at Barrigada (Navy) would occur over pervious limestone substrates and limited potential for non-point source pollutant inputs into marine communities.	
48			x			
49			x		None: the access gate at Barrigada (Air Force) would occur over pervious limestone substrates and limited potential for non-point source pollutant inputs into marine communities.	
49A				x		
63			x			
74			x			
113	x	x	x	x		

Note [1]: The GRN project descriptions and alternatives are described in detail in Volume 6 Chapter 2.5.
Note [2]: Mitigation measures are included later in this chapter that minimize or avoid potential direct or indirect impacts

Table 13.2-9. Apra Harbor GRN Projects, Alternatives, and Potential Impacts

<table>
<tr><th rowspan="2">GRN #</th><th colspan="4">Alternatives[1]</th><th colspan="2">Potential Impact Type and Description[2]</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>8</th><th>Indirect</th><th>Direct</th></tr>
<tr><td>4</td><td>x</td><td>x</td><td>x</td><td>x</td><td rowspan="2">Potential for uncontrolled runoff during the construction phase, non point-source pollutants and/or sedimentation inputs into marine communities of Outer Apra Harbor (to the south) and outside the breakwater.</td><td rowspan="6">None: The proposed road and intersection improvements in the Apra Harbor region are all proposed to occur in upland non-marine environments. The addition of the weigh station associated with GRN #4) would also occur in upland non-marine environments. Therefore, no direct effects to marine environments are anticipated.</td></tr>
<tr><td>5</td><td>x</td><td>x</td><td>x</td><td>x</td></tr>
<tr><td>24</td><td>x</td><td>x</td><td>x</td><td>x</td><td>Portions of the proposed roadway improvements along Route 1 are adjacent to Sasa Bay Marine Preserve (on the west side of Route 1) and freshwater wetlands (on the east side of Route 1) Potential for runoff during the construction phase into Sasa Bay and Sasa River, Laguas River, Aguada River, and Atantano River, which terminate at Sasa Bay or Inner Apra Harbor. Potential for uncontrolled runoff during the construction phase, non point-source pollutants and/or sedimentation.</td></tr>
<tr><td>26</td><td>x</td><td>x</td><td>x</td><td>x</td><td>Portions of the proposed roadway improvements along Route 2A are adjacent freshwater wetlands formed by the Atantano River. Potential for runoff during the construction phase into the wetlands and other stormwater drainages that terminate at Inner Apra Harbor. Potential for uncontrolled runoff during the construction phase, non point-source pollutants and/or sedimentation.</td></tr>
<tr><td>50</td><td>x</td><td>x</td><td>x</td><td>x</td><td>Potential for uncontrolled runoff during the construction phase, non point-source pollutants and/or sedimentation into marine communities of Inner Apra Harbor.</td></tr>
</table>

Note [1]: The GRN project descriptions and alternatives are described in detail in Volume 6 Chapter 2.5.
Note [2]: Mitigation measures are included later in this chapter that minimize or avoid potential direct or indirect impacts

Table 13.2-10. South Region GRN Projects, Alternatives, and Potential Impacts

<table>
<tr><th rowspan="2">GRN #</th><th colspan="4">Alternatives[1]</th><th colspan="2">Potential Impact Type and Description[2]</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>8</th><th>Indirect</th><th>Direct</th></tr>
<tr><td>25</td><td>x</td><td>x</td><td>x</td><td>x</td><td rowspan="2">Although most of the portions of the proposed roadway improvements along Route 5 are adjacent residential areas (e.g. Apra Heights), some portions have potential for construction runoff into freshwater wetlands formed by the Namo River near the Agat Commercial Center. The Namo River terminates at Agat Bay.</td><td rowspan="4">None: The proposed road and intersection improvements in the South region are all proposed to occur in upland non-marine environments. Therefore, no direct effects to marine environments are anticipated.</td></tr>
<tr><td>27</td><td>x</td><td>x</td><td>x</td><td>x</td></tr>
<tr><td>52</td><td>x</td><td>x</td><td>x</td><td>x</td><td>Potential for runoff during the construction phase into upper reaches of the Namo River.</td></tr>
<tr><td>110</td><td>x</td><td>x</td><td>x</td><td>x</td><td>None: The proposed intersection improvement for Route 2 and 12 would occur near commercial and light industrial areas (e.g. Agat Commercial Center). Runoff or noise during the construction phase would not impact terrestrial biological resources.</td></tr>
</table>

Note [1]: The GRN project descriptions and alternatives are described in detail in Volume 6 Chapter 2.5.
Note [2]: Mitigation measures are included later in this chapter that minimize or avoid potential direct or indirect impacts

13.2.6.1 Alternative 1

Year 2014 (Peak Construction and Population)

North

None of the proposed roadway projects within the North region would have the potential to directly or indirectly impact marine biological resources (i.e., marine flora and invertebrates, fish and EFH, special-status species, and non-native species introductions). Runoff from these projects would attenuate due to thick vegetation and highly pervious limestone and none are proposed to occur within the marine environment.

Central

Because no GRN project is proposed to occur within marine environments in the Central region, no direct impacts would occur to marine biological resources. The proposed road improvement projects for Alternative 1 in the Central region that have the potential to indirectly impact marine biological resources include GRN # 1, 2, 3, 6, 7, 13 - 21, 28, 29, 33, and 35. Impacts from construction activities may include loss of sediment into coastal waters and non-point source inputs into marine environments. Particular areas of concern are designated marine preserve areas, such as Sasa Bay Marine Preserve, Piti Bomb Holes Marine Preserve, and Tumon Bay Marine Preserve, although non-designated bays are also important marine environments. As discussed within this chapter, the downstream termini of drainages and rivers that would potentially carry pollutants and sediments into marine environments are important, although degraded, marine communities.

Apra Harbor

Because no Apra Harbor region GRN projects are proposed to occur associated with the marine environment, no direct impacts to marine biological resources would occur; all proposed projects (GRN # 4, 5, 24, 26, and 50) within the Apra Harbor region have the potential to indirectly impact marine biological resources through runoff or pollutants carried downstream. Portions of the proposed roadway improvements along Route 1 are adjacent to Sasa Bay Marine Preserve (on the west side of Route 1) and freshwater wetlands (on the east side of Route 1). These projects have the potential for runoff during the construction phase into Sasa Bay and Sasa River, Laguas River, Aguada River, and Atantano River, which terminate at Sasa Bay or Inner Apra Harbor. Other areas of concern include Outer Apra Harbor (south side of Route 11), and open water to the north of Route 11).

South

Because no South region GRN projects are proposed to occur within marine environments, no direct impacts to marine biological resources would occur; projects (GRN # 25, 27, and 52) within the South Region have the potential to indirectly impact marine biological resources. Although most of the portions of the proposed roadway improvements along Route 5 are adjacent residential areas (e.g. Apra Heights subdivision), some portions have potential for construction runoff into freshwater wetlands formed by the Namo River near the Agat Commercial Center. The Namo River terminates at Agat Bay, which would be considered a pathway for inputs into Agat Bay.

Year 2030

North

None of the proposed roadway projects within the North Region would have the potential to impact marine biological resources.

Central

In the long-term, none of the proposed roadway projects within the Central Region would have the potential to impact marine biological resources because there would be no net increase in impervious cover over existing conditions after the construction is complete.

Apra Harbor

In the long-term, none of the proposed roadway projects within the Apra Harbor Region would have the potential to impact marine biological resources because there would be no net increase in impervious cover over existing conditions after the construction is complete.

South

In the long-term, none of the proposed roadway projects within the South Region would have the potential to impact marine biological resources because there would be no net increase in impervious cover over existing conditions after the construction is complete.

In conclusion, implementation of Alternative 1 would not substantially impact marine biological resources within the North, Central, Apra Harbor, or South regions. Any potential affects from construction

Potential Mitigation Measures

The indirect impacts to marine environments associated with road improvement projects would be mitigated with actions that avoid or minimize effects associated with the construction and operational phases of each roadway project. These mitigations are in development as part of a cooperative effort between GEPA, Federal Highway Administration (FHWA), and FHWA design contractors. As part of this effort, each GRN project would have specific mitigation measures that cater to the individual project type and environmental context (e.g. adjacency to sensitive ecological areas, slope of surrounding terrain). The specific mitigative actions would be completed as the GRN project designs near completion.

The CNMI and Guam Stormwater Management Manual (CNMI and Guam 2006) provide examples of BMPs that would be included in the planning, design, and construction for all proposed road improvement projects. A Storm Water Runoff Drainage System Plan is required for a Grading Permit by the Guam DPW when the area to be graded is more than 5,000 square ft (464 square meters) or a proposed cut or fill is greater than 5.0 ft (1.5 m) in height. This stormwater plan would describe the potential impacts and proposed mitigation associated runoff and drainage. Standard procedures and BMPs would minimize sediment runoff during construction, and there would not be a net gain in impervious cover associated with the roads analyzed under Alternative 1 for potential impacts to marine biological resources. These BMPs are required for FHWA-funded projects and include such measures as silt fencing installation and other stormwater pollution prevention planning measures. Because the Navy has determined that Alternative 1 road construction would not cause significant impacts to marine biological resources (i.e., marine flora, invertebrates and associated EFH, fish and Associated EFH, special-status species, and non-native species introductions), no specific mitigation measures are proposed.

13.2.6.2 Alternative 2 (Preferred Alternative)

Proposed road projects under Alternative 2 are the same as the proposed road projects under Alternative 1, with the exception of military access point locations at NCTS Finegayan. The difference in locations of these access gates does not vary the potential impact of Alternative 2 relative to Alternative 1. Therefore, impacts to marine biological resources for Alternative 2 are the same as those for Alternative 1 for each region.

<u>Potential Mitigation Measures</u>

The mitigation measures for Alternative 2 are the same as those for Alternative 1.

13.2.6.3 Alternative 3

The proposed road projects under Alternative 3 are the same as the proposed road projects under Alternative 1, except that Alternative 3 includes GRN #38, 39, 47, 48, 49, 63, and 74, and it excludes GRN #19, 20, 31, 38A, 39A, 41, and 124. GRN # 47 and 48 are associated with new access to Barrigada (Navy); however, these projects would occur in upland areas where stormwater runoff would be expected to attenuate before reaching marine habitats. Gate locations for Alternative 3 are the same for Alternative 1, except that NCTS Finegayan Main Gate and commercial gate locations (GRN # 38 and 39) are in different locations than the Main Gate and commercial gate locations in Alternative 1 (GRN # 38A and 39A). Again, these gate locations are within upland areas where stormwater runoff would be expected to attenuate before reaching marine habitats. Therefore, impacts to marine biological resources of Alternative 3 are similar to Alternative 1 for each region.

<u>Potential Mitigation Measures</u>

The mitigation measures for Alternative 3 are the same as those for Alternative 1.

13.2.6.4 Alternative 8

The proposed road projects under Alternative 8 are the same as those under Alternative 1 with the exception of the military access gate location at Barrigada (Air Force). The impact conclusion for this gate location project included as part of Alternative 8 (GRN # 49A) is the same for the access gate project included as part of Alternative 3 (GRN # 49); therefore, impacts to marine biological resources of Alternative 8 are similar to Alternative 1 and Alternative 3 for each region.

Potential Mitigation Measures

The mitigation measures for Alternative 8 are the same as those for Alternative 1.

13.2.6.5 Firing Range Options

The alternatives described in Volume 2, Chapter 2, for the relocation include the Main Cantonment action alternatives with either a Firing Range Option A or B. Option A would require the realignment of Route 15 (GRN #36), while Option B does not require realignment of Route 15. Neither option would impact marine biological resources.

13.2.6.6 Summary of Impacts

Table 13.2-11 summarizes the potential impacts of each alternative. The proposed road projects in the North and South regions would not directly or indirectly impact marine biological resources. Only projects within the Apra Harbor and Central regions were assessed for potential impacts to marine biological resources, and the projects within these study areas do not require construction within coastal waters.

Table 13.2-41 Summary of Potential Impacts

Potentially Impacted Resource	*Alternative 1*	*Alternative 2**	*Alternative 3*	*Alternative 8*
Marine Flora, Invertebrates and Associated EFH	LSI	LSI	LSI	LSI
Fish and Associated EFH	LSI	LSI	LSI	LSI
Special-Status Species	LSI	LSI	LSI	LSI
Non-native Species Introductions	LSI	LSI	LSI	LSI

Legend: LSI = Less Than Significant Impact.* Preferred Alternative

CHAPTER 14.
CULTURAL RESOURCES

14.1 INTRODUCTION

This chapter describes the potential environmental consequences to cultural resources associated with implementation of the alternatives within the region of influence (ROI). For a description of the affected environment for all resources, refer to the respective chapter of Volume 2 (Marine Corps Relocation – Guam). The locations described in that volume include the ROI for the utilities and roadway related project components of the proposed action. The chapters are presented in the same order as the resource areas contained in this volume.

14.2 ENVIRONMENTAL CONSEQUENCES

14.2.1 Approach to Analysis

14.2.1.1 Methodology

Utilities

The methodology for identifying, evaluating, and mitigating impacts to cultural resources has been established through federal laws and regulations including the National Historic Preservation Act (NHPA) and the Archaeological Resource Protection Act.

A significant resource is a cultural resource eligible or listed on the National Register of Historic Places (NRHP). A project affects a NRHP-eligible or listed resource when it alters the resource's characteristics, including relevant features of its environment or features that qualify it for inclusion on the NRHP. Adverse effects may include the following: physical destruction, damage, or alteration of all or part of the resources; alteration of the character of the surrounding environment that contributes to the resource's qualifications for the NRHP; introduction of visual, audible, or atmospheric elements that are out of character with the resource; neglect of the resource resulting in its deterioration or destruction; and transfer, lease, or sale of the property (36 Code of Federal Regulations [CFR] 800.5[a][2]) without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance.

Analysis of potential impacts to cultural resources considers both direct and indirect impacts. Direct impacts are those that may occur during either the construction or operations phase of the project. They may be the result of increased noise during operations or ground disturbing activities involving construction, modification, or the use and maintenance of facilities. Indirect impacts are those that may occur as a result of the completed project such as increased vehicular or pedestrian traffic in the vicinity of the resource that may lead to vandalism or increased erosion from ground disturbing activities. Vandalism is considered to be a significant impact because it damages the integrity of the site that is the major determinant of NRHP-eligibility. The evidence they left in archaeological sites is finite and cannot renew itself once it has been disturbed. For this reason, federal activities that open areas up to the public or that involve personnel traveling through an area may have an adverse impact if vandalism to NRHP-eligible or listed resources in the vicinity occur.

Roadway Projects

All project areas of potential effect (APE) were inspected by cultural resources experts and Guam Historic Preservation Office (GHPO) personnel. In some cases, more fieldwork would be required, as described in the section discussing the Programmatic Agreement (PA). Probability areas were determined in consultation with the GHPO, after review of relevant literature, fieldwork and GHPO records.

NHPA Section 106 allows for projects to result in a finding of "no historic properties affected" (sometimes listed as "no effect"), "no adverse effect," or "adverse effect," as defined below.

- **No Historic Properties Affected (No Effect):** There are either no historic properties present in the APE, or there are historic properties present in the APE, but the undertaking would have no effect on them as defined in 36 CFR 800.16(i).
- **No Adverse Effect:** There could be an effect on a historic property, but the effect would not be harmful to those characteristics that qualify the property for inclusion in or eligibility for the NRHP.
- **Adverse Effect:** Project impacts may directly or indirectly alter any of the characteristics that qualify the property for inclusion in the NRHP in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association, or a property's ability to offer research potential.

The criteria of adverse effect described in the guidelines for NHPA Section 106 (36 CFR 800.5[a]) define adverse effects to significant cultural resources as any of the following actions, regardless of whether they occur singly or in combination with one another:

- Physical destruction of or damage to all or part of the resource
- Alteration of a resource, including restoration, rehabilitation, repair, maintenance, stabilization, hazardous material remediation, and provision of handicapped access that is not consistent with the Secretary's standards for the treatment of historic properties (36 CFR 68) and applicable guidelines
- Removal of the resource from its historic location
- Change of the character of the resource's use or of physical features within the setting that contribute to its historic significance
- Introduction of visual, atmospheric, or audible elements that diminish the integrity of the property's significant historic features
- Neglect of a property that causes its deterioration, except where such neglect and deterioration are recognized qualities of a property of religious and cultural significance to an Indian tribe

Programmatic Agreement

Some properties, such as archaeological sites, may be buried beneath dense vegetation or considerable deposition, and they may not be discovered through archival research and surface surveys. This means that the normal procedures for Section 106 compliance may not identify all properties within the affected environment. For that reason, a PA between the Federal Highway Administration (FHWA) and GHPO is being developed to govern these situations. The Advisory Council on Historic Preservation (ACHP) and National Park Service (NPS) may be invited signatories as well. Through the PA, roadway projects would be designated by their potential to affect undocumented historic properties. This assessment would be compiled using previous archaeological investigations, historic maps, interviews, ethno-historic accounts, and an understanding of post-depositional site formation processes.

Roadways would be characterized as (1) No/Low Probability Areas, (2) Medium Probability Areas, or (3) High Probability Areas.

- **No/Low Probability Areas:** These areas contain no surface sites and include reclaimed fill lands or heavily disturbed areas. No/Low Probability Areas are also areas that have been previously tested and were found not to contain subsurface resources and are areas not likely to contain subsurface materials based on known social practices or history of the area.
- **Medium Probability Areas:** These areas have not been surveyed and may have the potential to contain sites or are areas that contain no surface sites but have the potential to encounter subsurface historic resources based on known social practices or history of the area.
- **High Probability Areas:** These areas contain known surface and/or subsurface sites or are areas where old maps, documents, or legends indicate former villages, towns, or other types of activity areas.

These probability statements refer to the potential for an area to hold undocumented resources. Some types of roadway projects would not affect such a site, even if one were present. Thus, some areas may be designated High Probability Areas, and they may also be listed with No Historic Properties Affected because of the nature of the proposed project. No further review under Section 106 would be required for areas designated as No/Low Probability Areas. Medium Probability Areas would be subject to inventory, monitoring, or testing. Prior to any disturbance or excavation, work plans would be developed and reviewed by the appropriate GHPO. In High Probability Areas, sites would be avoided if possible. If sites are impacted, a mitigation plan would be developed and concurred upon by the GHPO.

All evaluations would be completed in consultation with the GHPO and appropriate cultural resources stakeholders. The PA would also provide stipulations for treatment in case of emergency discoveries, the review process, and report requirements.

14.2.1.2 Determination of Significance

A historic property is a property that is eligible for or listed on the NRHP. For cultural resources a significant adverse impact is one that disturbs the integrity of a historic property. If a project disturbs the characteristics that make the property eligible for or listed on the NRHP, then it is also considered to be a significant adverse impact.

The Regional Integrated Cultural Resources Management Plan (ICRMP) for Navy property on Guam has established Standard Operating Procedures for protecting known NRHP-eligible or listed cultural resources; procedures for managing the inadvertent discovery of archaeological resources, inadvertent discovery of human remains, inadvertent disturbance to historic properties; and distributing permits for archaeological investigations (Tomonari-Tuggle et al. 2005). In addition, agreements on limitations in training have been made as part of the Mariana Islands Training Range Complex Environmental Impact Statement PA (Navy 2009). Areas with limited or no training stipulations at Apra Harbor and the Naval Munitions Site (NMS) are presented in Volume 2, Chapter 12, Cultural Resources (Figure 12.1-1 for Apra Harbor and Figure 12.1-2 for the NMS).

As part of the Section 106 consultation process for the Joint Guam buildup, a PA for all military training activities, construction, and operations proposed under the proposed action, preferred alternative that includes additional mitigation measures and procedures is being prepared. Current signatories to this PA are: the Department of Defense (DoD) (Joint Region Marianas; DoD Representative Guam, Commonwealth of the Northern Mariana Islands [CNMI], Federated States of Micronesia, and Republic of Palau; Marines; Navy; Army; Air Force), other federal agencies (U.S. Environmental Protection Agency [USEPA], Advisory Council for Historic Preservation [ACHP], and the NPS), and local government agencies (Guam Historic Preservation Officer [HPO], Commonwealth of the Northern

Mariana Islands HPO). The PA is scheduled for signature in October 2009 prior to the release of the Final Environmental Impact Statement and the signed PA would be incorporated into the Final Environmental Impact Statement. Stipulations in the PA include the following:

- The DoD would ensure that the identification and evaluation of historic properties within the APE for the project is completed prior to the initiation of any part of the project with the potential to impact historic properties.
- For areas or properties that have not been inventoried for historic properties, the DoD would record surface sites and, when possible, areas would also be archaeologically sampled for subsurface sites when easily obtainable (i.e., without having to demolish existing facilities or infrastructure).
- Archaeological probability maps have been generated for all current Navy and Air Force DoD lands on the Island of Guam. For all other areas and islands impacted by the project, archaeological probability maps would be generated that predict the probability of encountering subsurface cultural resources in three categories (no/low, medium, and high). These maps would be compiled using previous archaeological investigations, maps, interviews, and ethnohistoric accounts and in consultation with the HPOs and the NPS.
- *No/Low Probability Areas.* These areas contain no surface sites and include reclaimed fill lands or heavily disturbed areas. No/low probability areas are also areas that have been previously tested and were found not to contain subsurface resources based on known social practices or history of the area.
- *Medium Probability Areas.* These areas have not been surveyed and may have the potential to contain sites (surface and/or subsurface). Also included are areas that contain no surface sites, but have the potential to encounter subsurface archaeological resources based on known social practices or history of the area.
- *High Probability Areas.* These areas contain known surface and/or subsurface sites, or are areas where old maps, documents, or legends indicate former villages, towns, or other types of similar activity.
- Any properties not evaluated shall be assessed for NRHP eligibility. These historic properties would be incorporated into existing ICRMPs as they are revised or updated or if a new ICRMP is developed in consultation with the appropriate HPOs.

Any updates to the existing geographical information system cultural resource layers, such as shape files showing the locations of known archaeological sites and buildings and structures, would be shared with the appropriate HPO or NPS (if a property is associated with a National Historic Landmark in accordance with 36 CFR 800.11(c)). The HPOs and the NPS recognize that these layers may contain sensitive information and would not disseminate or make them available to the public without obtaining permission of the appropriate responsible person whose jurisdiction that historic property is under. Maps of all areas with archaeological potential and sensitivity for the presence of NRHP-eligible or listed resources would be appended to the PA. No further review under Section 106 is required for areas designated as No/Low probability areas. Potential mitigation measures for Medium and High probability areas are stipulated as follows:

- High Probability Areas would be avoided if possible. If sites are impacted, a mitigation plan would be developed and reviewed by the appropriate HPO and then data recovery excavations would take place.
- Medium Probability Areas would be subject to monitoring or testing. Prior to any disturbance or excavation, work plans would be developed and reviewed by the appropriate HPO.

In recognition of the significance that many historic properties within the APE of the proposed action has to various cultural groups, DoD would generally look favorably on affording access to archaeological sites to individuals and organizations that attach significance to these historic properties where security requirements are not prohibitive. The PA also provides stipulations for treatment in case of emergency discoveries, the review process, and report requirements. The Standard Operating Procedures (SOPs) in the current regional ICRMP would be updated, revised, and attached to the PA. Although probability maps would be generated based on the likelihood of archaeological resources, treatment of known architectural resources and traditional cultural properties as a result of the proposed action would also be stipulated in the PA.

14.2.1.3 Issues Identified During Public Scoping Process

The following analysis focuses on possible impacts to cultural resources; archaeological, architectural, and traditional cultural properties that could be affected by the proposal. As part of the analysis, concerns relating to cultural resources that were mentioned by the public, including regulatory stakeholders, during the public scoping meetings were addressed. These include:

- Access to cultural sites
- Construction impacts to cultural resources
- Thorough and adequate data collection
- Public participation in the planning process relating to cultural resources

14.2.2 Power

14.2.2.1 Interim Alternative 1 (Preferred Alternative)

Interim Alternative 1 would recondition existing combustion turbines and upgrade T&D systems and would not require new construction or enlargement of the existing footprint of the facility. This work would be undertaken by the GPA on its existing permitted facilities. Reconditioning would be made to existing permitted facilities at the Marbo, Yigo, Dededo No. 1, and Macheche combustion turbines. These combustion turbines are not currently being used up to permit limits. T&D system upgrades would be on existing above ground and underground transmission lines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Construction at Finegayan has the potential to require the removal of dukduk trees, a traditional resource used by canoe builders.

It is anticipated that these facilities would require general overhaul, capability testing, and controlled startup that could take up to 12 months. The amount of improvements needed would not be known until the units are inspected and tested. The NRHP eligibility of the GPA power plants is unknown; however, most are between 15 to 20 years old.

Interim Alternative 1 would also involve transmission and distribution upgrades both above ground and below ground. These upgrades would take place in areas of low, medium, and high archaeological probability in addition to areas that have not been surveyed for archaeological resources.

The locations of the utilities in relation to archaeological probability areas are shown in Figure 14.2-1, 14.2-2, 14.2-3, and Figure 14.2-4. Aside from Marbo on Andersen South, the affected areas have not been surveyed. Marbo has a low probability for archaeological resources.

However, given that the other areas are located on non-DoD lands, it is unlikely that they have been surveyed for archaeological resources. Surveys are currently being conducted in these areas and more information will be provided in the FEIS.

Operations of Interim Alternative 1 would not have significant impacts on cultural resources, as operations would not bring an influx of people into the area and operational activities are unlikely to cause erosion. Because it is an existing activity, operations would not change the visual or audible setting near NRHP-eligible or listed resources that are important for these reasons.

Potential Mitigation Measures

Areas where new construction would take place on non-DoD lands would follow the stipulations of the PA. For areas or properties that have not been inventoried for historic properties, the DoD would record surface sites and, when possible, areas would also be archaeologically sampled for subsurface sites when easily obtainable (i.e., without having to demolish existing facilities or infrastructure). Any properties that have not been previously evaluated would be assessed for eligibility for inclusion on the NRHP. If NRHP eligible sites are impacted, data recovery excavation would take place as necessary.

Traditional resources such as the dukduk tree, ifit tree, and da'ok tree, are recognized by the DoD and would be made available to local people prior to their removal for construction of the proposed action.

14.2.2.2 Interim Alternative 2

Interim Alternative 2 is a combination of reconditioning of existing permitted GPA facilities, an increase in operational hours for existing combustion turbines, and upgrades to existing T&D systems. Interim Alternative 2 would not require new construction or enlargement of the existing footprint of the facility. Reconditioning would be performed on the existing permitted GPA facilities at the Marbo, Yigo, and Dededo combustion turbines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Impacts to the area include subgrade construction, cut and fill activities, and brush clearing.

Interim Alternative 2 would also involve transmission and distribution upgrades both above ground and below ground. These upgrades would take place in areas of low, medium, and high archaeological probability in addition to areas that have not been surveyed for archaeological resources. These upgrades have the potential to impact NRHP-eligible archaeological sites.

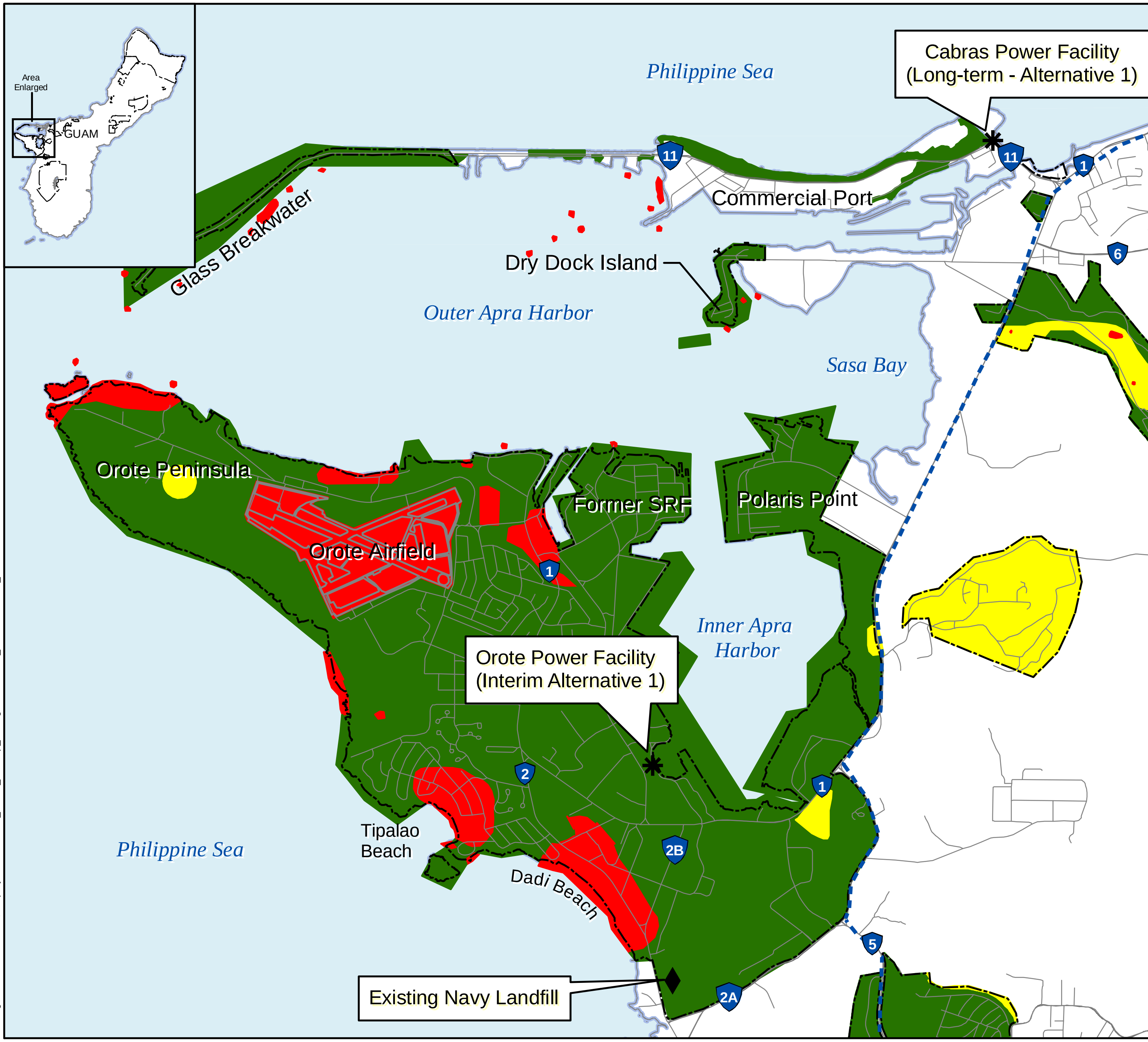

Figure 14.2-1
Proposed Utilities with Archaeological Probability Areas at Apra Harbor

Legend
- Military Installation
- Route Number
- Power Facility
- Existing Navy Landfill
- Proposed Water Main Replacement

Archaeological Probability Areas
- High
- Medium
- Low

Sources: **Tomonari-Tuggle et al. 2005, TEC 2009**

N W E S

Feet 0 1,875 3,750
0 500 1,000 Meters

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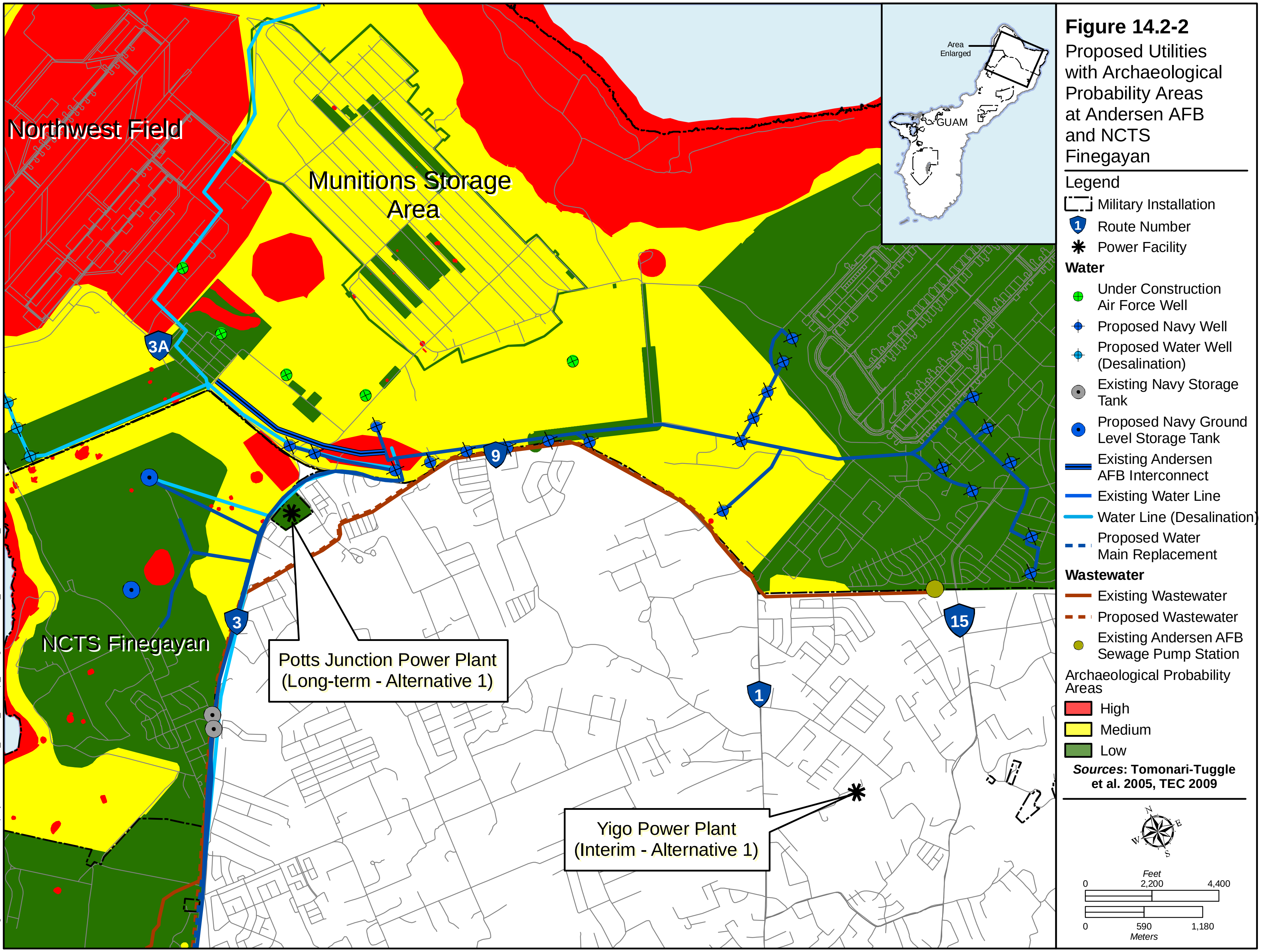

Figure 14.2-2
Proposed Utilities with Archaeological Probability Areas at Andersen AFB and NCTS Finegayan

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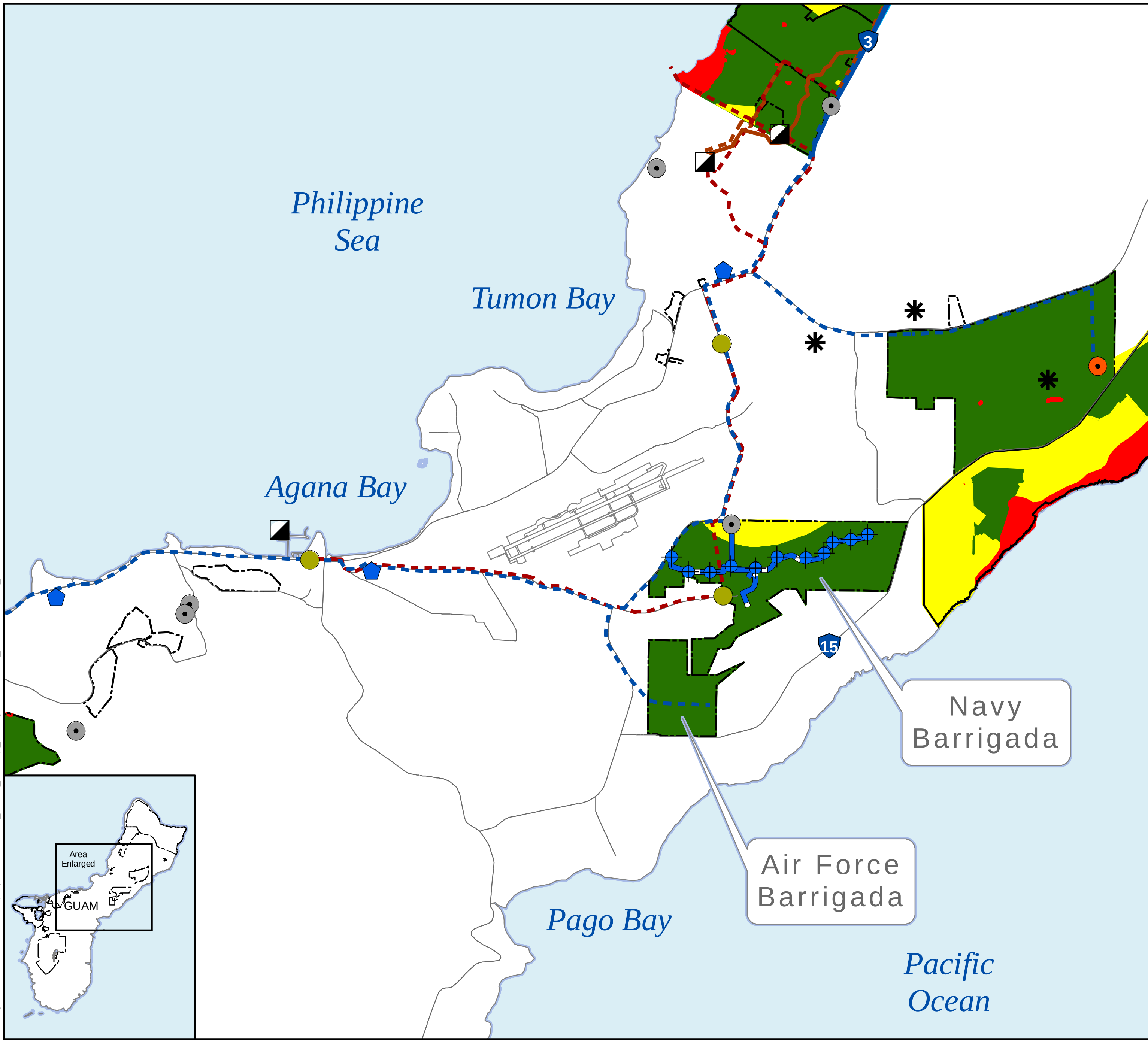

Figure 14.2-3
Proposed Utilities with Archaeological Probability Areas in Central Guam

Legend

- Military Installation
- Route Number
- Power Facility

Water

- Proposed Navy Well
- Existing Storage Tank #4
- Existing Navy Storage Tank
- Proposed Navy Ground Level Storage Tank
- Navy Island Wide System Station
- Proposed Water Main Replacement
- Proposed Basic Alternative 2 Water

Wastewater

- Existing Wastewater
- Proposed Wastewater
- Sewage Pump Station
- Proposed WWTP

Archaeological Probability Areas

- High
- Medium
- Low

***Sources*: Tomonari-Tuggle et al. 2005, TEC 2009**

N W E S

Miles
0.8 0 0.8
1 0 1
Kilometers

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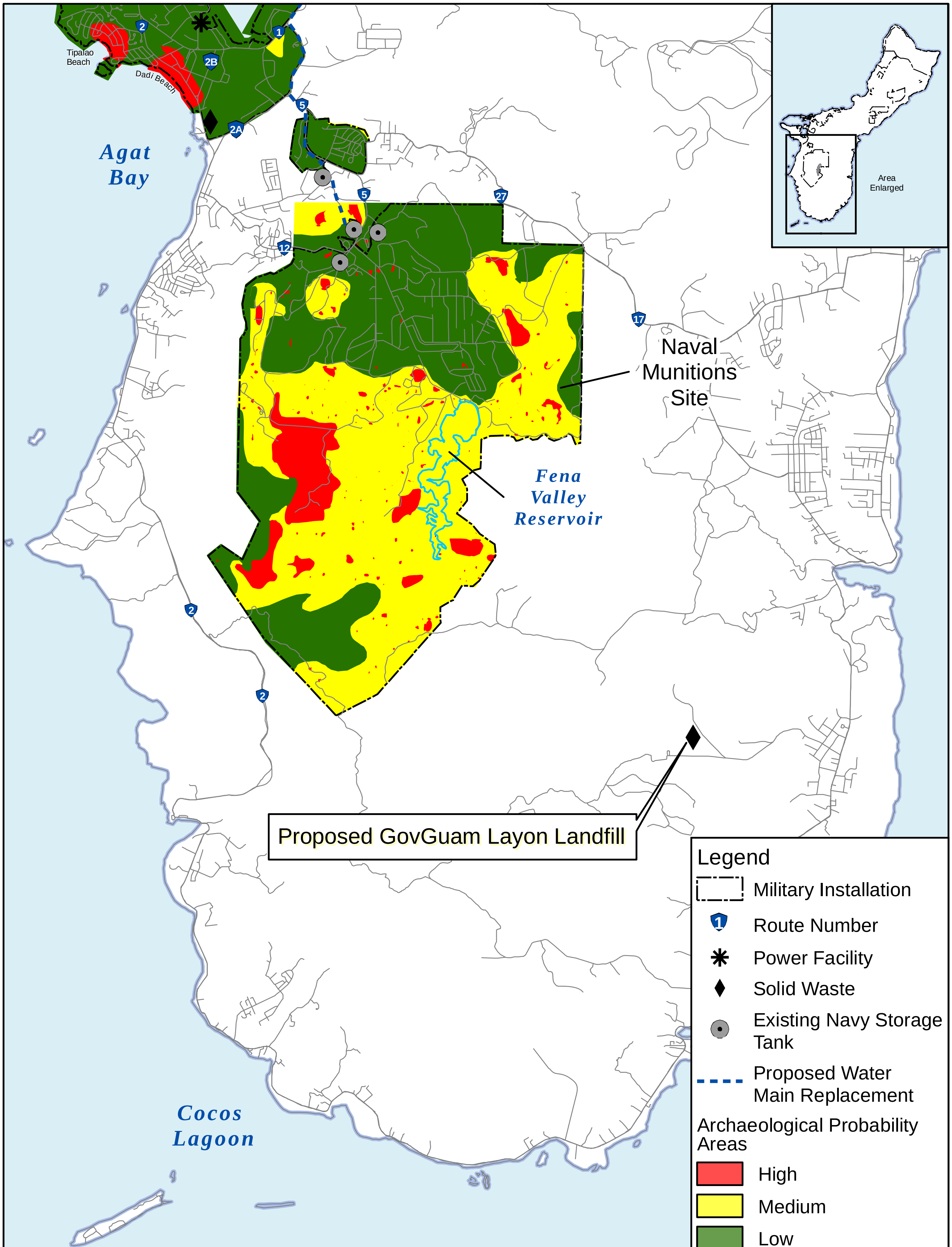

Figure 14.2-4
Proposed Utilities with Archaeological Probability Areas in South Guam

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The locations of the utilities in relation to archaeological probability areas are shown in Figure 14.2-1 and 14.2-2. Other than Marbo on Andersen South, the affected areas have not been surveyed. Marbo has a low probability for archaeological resources. However, given that the other areas are located on non-DoD lands, it is unlikely that they have been surveyed for archaeological resources. Surveys are currently being conducted in these areas and more information will be provided in the FEIS. Therefore, the impacts from subgrade construction, cut and fill activities, and brush clearing on historic properties are unknown.

Operations of Interim Alternative 2 would not have significant impacts on cultural resources in the area, as operations would not bring an influx of people into the area and operational activities are unlikely to cause erosion. Because it is an existing activity, operations would not change the visual or audible setting near NRHP-eligible or listed resources that are important for these reasons.

Potential Mitigation Measures

Areas where new construction would take place on non-DoD lands would follow the stipulations of the PA. For areas or properties that have not been inventoried for historic properties, the DoD would record surface sites and, when possible, areas would also be archaeologically sampled for subsurface sites when easily obtainable (i.e., without having to demolish existing facilities or infrastructure). Any properties that have not been previously evaluated would be assessed for eligibility for inclusion on the NRHP. If NRHP eligible sites are impacted, data recovery excavation would take place as necessary.

Traditional resources such as the dukduk tree, ifit tree, and da'ok tree, are recognized by the DoD and would be made available to local people prior to their removal for construction of the proposed action.

14.2.2.3 Interim Alternative 3

Interim Alternative 3 is a combination of reconditioning existing GPA permitted facilities at Marbo, Yigo, and Dededo and upgrades to the DoD power plant at Orote. Upgrades would be made to existing T&D. The proposed reconditioning to the existing power generation facilities at Marbo, Yigo, and Dededo would not require new construction or enlargement of the existing footprint of the facility. For the Orote power plant, upgrades would include a new fuel storage facility to facilitate longer run times between refueling. This would disturb approximately 1 acre (4,047 square m). This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Interim Alternative 3 would also involve transmission and distribution upgrades both above ground and below ground. These upgrades would take place in areas of low, medium, and high archaeological probability in addition to areas that have not been surveyed for archaeological resources. Surveys are currently being conducted in these areas and more information will be provided in the FEIS. These upgrades have the potential to impact NRHP-eligible archaeological sites.

Locations of utilities in relation to archaeological probability areas are shown in Figure 14.2-1 and 14.2-2. Other than Marbo, that has a low probability for archaeological resources, the affected areas have not been surveyed. Therefore, potential impacts from subgrade construction, cut and fill activities, and brush clearing on historic properties are unknown.

Figure 14.2-1 shows the proposed project location in relation to the archaeological probability areas at Apra Harbor. The location of the Orote Power Plant is in a low probability area for archaeological resources. No archaeological or traditional cultural properties are known in this area. Therefore, no direct or indirect impacts to NRHP-eligible or listed cultural resources in the area would result from implementation of this component of the alternative.

Operations of Interim Alternative 3 would not have significant impacts on cultural resources in the area, as operations would not bring an influx of people into the area and operational activities are unlikely to cause erosion.

Potential Mitigation Measures

Areas where new construction would take place on non-DoD lands would follow the stipulations of the PA. For areas or properties that have not been inventoried for historic properties, the DoD would record surface sites and, when possible, areas would also be archaeologically sampled for subsurface sites when easily obtainable (i.e., without having to demolish existing facilities or infrastructure). Any properties that have not been previously evaluated would be assessed for eligibility for inclusion on the NRHP. If NRHP eligible sites are impacted, data recovery excavation would take place as necessary.

Traditional resources such as the dukduk tree, ifit tree, and da'ok tree, are recognized by the DoD and would be made available to local people prior to their removal for construction of the proposed action.

14.2.2.4 Summary of Impacts

Table 14.2-1 summarizes the potential impacts of each interim alternative. A text summary is provided below.

Table 14.2-1. Summary of Potential Impacts to Cultural Resources- Power

*Interim Alternative 1**	*Interim Alternative 2*	*Interim Alternative 3*
Archaeological Resources		
SI-M • Unknown impacts at Finegayan and on non-DoD land in areas that have not been previously surveyed	SI-M • Unknown impacts on non-DoD land in areas that have not been previously surveyed	SI-M • Unknown impacts on non-DoD land in areas that have not been previously surveyed
Architectural Resources		
NI • No adverse impacts to architectural resources at North, South, or Central Guam	NI • No adverse impacts to architectural resources at North, South, or Central Guam	NI • No adverse impacts to architectural resources at North, South, or Central Guam
Submerged Resources		
NI • No adverse impacts to submerged resources or objects	NI • No adverse impacts to submerged resources or objects	NI • No adverse impacts to submerged resources or objects
Traditional Cultural Properties		
NI • Traditional resources such as the dukduk tree, ifit tree, and da'ok tree, are recognized by the DoD and would be made available to local people prior to their removal for construction of the proposed action	NI • No adverse impacts to Traditional Cultural Properties	NI • Traditional resources such as the dukduk tree, ifit tree, and da'ok tree, are recognized by the DoD and would be made available to local people prior to their removal for construction of the proposed action

Legend: SI-M = Significant Impact Mitigable to Less than Significant, NI = No Impact. *Preferred Alternative.

Construction and operation of Power Interim Alternative 1 could result in significant impacts to unknown archaeological sites in areas that have not been surveyed. However these impacts are mitigable to less than significant levels through consultation as stipulated by the PA. No impacts to architectural, submerged resources, or traditional cultural properties are expected. Mitigation would include avoidance, survey, monitoring during construction, evaluation, and data recovery, documentation if appropriate.

Construction and operation of Power Interim Alternative 2 could result in significant impacts to unknown archaeological sites in areas that have not been surveyed through ground disturbance. However these impacts are mitigable to less than significant through consultation as stipulated by the PA. No impacts to architectural, submerged resources or traditional cultural properties are expected. Mitigation would include avoidance, survey, monitoring during construction, evaluation, and data recovery, documentation if appropriate.

Interim Alternative 3 could result in significant impacts to archaeological resources. However, these impacts are mitigable to less than significant through consultation as stipulated by the PA. No impacts to submerged resources, architectural resources, or traditional cultural properties are expected.

14.2.3 Potable Water

14.2.3.1 Basic Alternative 1 (Preferred Alternative)

Basic Alternative 1 would consist of installation of up to 22 new potable water supply wells at Andersen AFB, rehabilitation of existing wells, interconnection with the GWA water system, and associated T&D systems. A new 5 MG (19 ML) water storage tank would be constructed at ground level at Finegayan.

Impacts to the areas include subgrade construction, cut and fill activities, and brush clearing. No structures would be modified or demolished for this action.

Figure 142-2 shows the proposed project locations in relation to the archaeological probability areas at Andersen AFB. Overall, this area is considered to have low and high probability for archaeological resources, although most areas are low. One well is in a high probability area and would impact two NRHP-eligible archaeological resources—Torres Farmhouse (PN-2) and the Guerrero Water Catchment (081344). A second well is located near a high probability area but the site located near this well can be avoided by project activities. The remainder of the wells are located in low probability areas and would not have an adverse impact on archaeological, architectural, or traditional cultural properties. There are many new water storage components in Alternative 1. These components include installing two treated water transmission mains (including a connection to the Guam Waterworks Authority [GWA] system), constructing a network of water distribution pipes on both DoD and non-DoD lands, and one ground level water storage tank at Finegayan). Impacts to the areas include tree removal, cut and fill activities, and subgrade construction.

Figure 4.2-2 and 4.2-3 show the proposed project locations in relation to archaeological probability areas on Andersen AFB and Finegayan. Overall, the areas affected by this component are located in low, medium, and some high probability areas. Approximately 10 ac (4 ha) of medium probability area would be impacted by the proposed water line on Andersen AFB and 4 ac (1.6 ha) would be impacted on NCTS Finegayan. The archaeological probability is unknown for the locations of the water distribution systems on non-DoD lands because they have not been surveyed for archaeological resources. The storage tank at Finegayan has the potential to impact one site, 1024 a mortar/*lusong.* Construction at Finegayan has the potential to require the removal of dukduk trees, a traditional resource used by canoe builders. A water main that runs along the northern boundary of Andersen South would be replaced. The water main along the eastern border would also be replaced. A traditional cultural property (Latte Park, site 811) is located approximately 0.5 mile (0.8 kilometer) away in South Finegayan and would not be impacted by construction of the new water distribution pipes.

Operation of the new water supply and water storage facilities would take place at various locations under Basic Alternative 1 and would bring additional personnel into these areas. This increase in personnel in these areas could increase site vandalism that would be an indirect impact to NRHP-eligible or listed sites.

Potential Mitigation Measures

In accordance with the PA under Section 106 of the NHPA, where the potential is low, no mitigation measures or further review under Section 106 are required for archaeology. However, the areas that have medium probability would be subject to survey (areas on Andersen AFB) or monitoring (on NCTS Finegayan). Prior to any disturbance or excavation, work plans would be developed and reviewed by the appropriate HPO. Sites would be avoided if possible in areas with high probability. If sites are impacted, data recovery excavations would take place.

Areas where new construction would take place on non-DoD lands would follow the stipulations of the PA. For areas or properties that have not been inventoried for historic properties, the DoD would record surface sites and, when possible, areas would also be archaeologically sampled for subsurface sites when easily obtainable without having to demolish existing facilities or infrastructure. Any that have properties not been previously evaluated would be assessed for NRHP eligibility.

Traditional resources such as the dukduk tree, ifit tree, and da'ok tree, are recognized by the DoD and would be made available to local people prior to their removal for construction of the proposed action.

14.2.3.2 Basic Alternative 2

Basic Alternative 2 would consist of installation of up to 20 new potable water supply wells at Andersen AFB, up to 11 new potable water supply wells at Barrigada, rehabilitation of existing wells, interconnection with the GWA water system, associated transmission and distribution systems upgrades. Additionally, new 3.6 MG (13.6 ML) and 1 MG (3.8 ML) water storage tanks would be constructed at ground level at Finegayan and Barrigada, respectively.

Figure 14.2-2 shows the proposed project locations in relation to the archaeological probability areas at Andersen AFB. Overall, this area is considered to have low and high probability for archaeological resources, although most areas are low. One well is in a high probability area and would impact two NRHP-eligible archaeological resources—Torres Farmhouse (PN-2) and the Guerrero Water Catchment (081344). A second well is located near a high probability area but the site located near this well can be avoided by project activities. The remainder of the wells are located in low probability areas and would not have an adverse impact on archaeological, architectural, or traditional cultural properties.

The storage tank at Finegayan has the potential to impact one site, 1024 a mortar/*lusong.* Construction at Finegayan has the potential to require the removal of dukduk trees, a traditional resource used by canoe builders. The new storage tank at AF Barrigada would be installed in an area of low archaeological probability and would therefore have no impact to cultural resources. Likewise the new wells at Navy Barrigada would be located in areas of low archaeological probability and would therefore have no impact to cultural resources.

Potential Mitigation Measures

In accordance with the stipulations of the PA where the potential is low, no mitigation measures or further review under Section 106 is required for archaeology. However, the areas that have medium probability would be subject to survey (Andersen AFB) or monitoring (Finegayan). Prior to any disturbance or excavation, work plans would be developed and reviewed by the appropriate HPO. Sites would be avoided, if possible, in areas with high probability. If NRHP-eligible sites are impacted, data recovery excavations would take place. Areas where new construction would take place on non-DoD lands would follow the PA under Section 106 of the NHPA. For areas or properties that have not been inventoried for historic properties, the DoD would record surface sites and, when possible, areas would also be archaeologically sampled for subsurface sites when easily obtainable (i.e., without having to demolish existing facilities or infrastructure). Any properties not evaluated would be assessed for NRHP eligibility.

Traditional resources such as the dukduk tree, ifit tree, and da'ok tree, are recognized by the DoD and would be made available to local people prior to their removal for construction of the proposed action.

14.2.3.3 Summary of Impacts

Table 14.2-2 summarizes the potential impacts of each action alternative.

Table 14.2-2. Summary of Potential Impacts to Cultural Resources-Potable Water

*Basic Alternative 1**	*Basic Alternative 2*
Archaeological Resources	
SI-M • Direct and indirect impacts to 1archaeological sites at Finegayan and 2 at Andersen AFB and areas with medium archaeological probability at Andersen AFB, Finegayan.	SI-M • Direct and indirect impacts to 1 archaeological sites at Finegayan and 2 at Andersen AFB and areas with medium archaeological probability at Andersen AFB, Finegayan, and Barrigada.
Architectural Resources	
NI • No adverse impacts to architectural resources at North, South, or Central Guam	NI • No adverse impacts to architectural resources at North, South, or Central Guam
Submerged Resources	
NI • No adverse impacts to submerged resources or objects	NI • No adverse impacts to submerged resources or objects
Traditional Cultural Properties	
SI-M • Traditional resources such as the dukduk tree, ifit tree, and da'ok tree, are recognized by the DoD and would be made available to local people prior to their removal for construction of the proposed action.	SI-M • Traditional resources such as the dukduk tree, ifit tree, and da'ok tree, are recognized by the DoD and would be made available to local people prior to their removal for construction of the proposed action.

Legend: SI-M = Significant Impact Mitigable to Less Than Significant, NI = No Impact. *Preferred Alternative.

Construction and operation of Basic Alternative 1 would result in significant impacts to three NRHP-eligible or listed archaeological resources. Construction of new water supply wells and water storage facilities could result in significant impacts to archaeological sites in areas with medium archaeological probability. However, these impacts are mitigable to less than significant through consultation as stipulated by the PA. This alternative would not affect architectural resources, submerged resources, or traditional cultural properties. Mitigation would include avoidance, survey, monitoring during construction, evaluation, and data recovery.

Construction and operation of Basic Alternative 2 would result in significant impacts to archaeological resources. Construction of new water supply wells and water storage facilities would result in significant impacts to three NRHP-eligible archaeological sites and areas with medium archaeological probability. However, these impacts are mitigable to less than significant through consultation as stipulated by the PA. This alternative would not affect architectural resources, submerged resources, or traditional cultural properties. Mitigation would include avoidance, survey, monitoring during construction, evaluation, and data recovery, documentation if appropriate.

14.2.4 Wastewater

14.2.4.1 Basic Alternative 1a (Preferred Alternative) and 1b

Basic Alternative 1 (Alternative 1a supports Main Cantonment Alternatives 1 and 2; and Alternative 1b supports Main Cantonment Alternatives 3 and 8) combines upgrade to the existing primary treatment facilities and expansion to secondary treatment at the Northern District Wastewater Treatment Plant (NDWWTP). The difference between Alternatives 1a and 1b would be a requirement for a new sewer line from Barrigada housing to NDWWTP for Alternative 1b.

There would be no impacts to cultural resources during the construction. The construction of the collection system from Finegayan would take place in areas of low, medium and high archaeological sensitivity and areas that have not yet been surveyed for cultural resources. Surveys of utility corridors are on-going and more information will be provided in the FEIS. The construction of the sewer line has the potential to impact NRHP-eligible cultural resources. Operations of Basic Alternative 1 would not have significant impacts on cultural resources in the area, as operations would not bring an influx of people into the area and operational activities are unlikely to cause erosion.

<u>Potential Mitigation Measures</u>

Areas where new construction would take place on non-DoD lands would follow the stipulations of the PA. For areas or properties that have not been inventoried for historic properties, the DoD would record surface sites and, when possible, areas would also be archaeologically sampled for subsurface sites when easily obtainable (i.e., without having to demolish existing facilities or infrastructure). Any properties that have not been previously evaluated would be assessed for eligibility for inclusion on the NRHP. If NRHP eligible sites are impacted, data recovery excavation would take place as necessary.

Traditional resources such as the dukduk tree, ifit tree, and da'ok tree, are recognized by the DoD and would be made available to local people prior to their removal for construction of the proposed action.

14.2.4.2 Basic Alternative 1b

Under Basic Alternative 1b, the only difference with Basic Alternative 1a would be the additional new sewer and pump stations to convey wastewater from Barrigada to NDWWTP.

This sewer line would pass through areas that have not been surveyed for archaeological resources. Surveys of utility corridors are on-going and more information will be provided in the FEIS. The construction of the sewer line has the potential to impact NRHP-eligible cultural resources. Operations of Basic Alternative 1b would not have significant impacts on cultural resources in the area, as operations would not bring an influx of people into the area and operational activities are unlikely to cause erosion.

<u>Potential Mitigation Measures</u>

Areas where new construction would take place on non-DoD lands would follow the stipulations of the PA. For areas or properties that have not been inventoried for historic properties, the DoD would record surface sites and, when possible, areas would also be archaeologically sampled for subsurface sites when easily obtainable (i.e., without having to demolish existing facilities or infrastructure). Any properties that have not been previously evaluated would be assessed for eligibility for inclusion on the NRHP. If NRHP eligible sites are impacted, data recovery excavation would take place as necessary.

Traditional resources such as the dukduk tree, ifit tree, and da'ok tree, are recognized by the DoD and would be made available to local people prior to their removal for construction of the proposed action.

14.2.4.3 Summary of Impacts

Table 14.2-3 summarizes the potential impacts of each interim alternative. A text summary is provided below.

Table 14.2-3. Summary of Potential Impacts to Cultural Resources – Wastewater

Potentially Impacted Resource	*Basic Alternative 1a**	*Basic Alternative 1b*
Archaeological Resources	SI-M • Possible disturbance to high archaeological probability areas at Finegayan	SI-M • Possible disturbance to areas not previously surveyed for archaeological resources
Architectural Resources	NI • No adverse impacts to architectural resources at North, South, or Central Guam	NI • Possible disturbance to areas not previously surveyed for archaeological resources
Submerged Resources	NI • No adverse impacts to submerged resources or objects	NI • No adverse impacts to submerged resources or objects
Traditional Cultural Properties	NI • No adverse impacts to traditional cultural properties	NI • No adverse impacts to traditional cultural properties

Legend: SI-M = Significant Impact Mitigable to Less Than Significant, NI = No Impact.
*Preferred Alternative

Construction and operation of Wastewater Basic Alternative 1a could result in significant impacts to archaeological resources. Ground disturbance would take place in areas that have not been surveyed for archaeological resources and are in the vicinity of NRHP-eligible archaeological resources. However these impacts are mitigable to less than significant through consultation as stipulated by the PA. This alternative would not impact traditional cultural properties or submerged resources. Mitigation would include avoidance, survey, monitoring during construction, and data recovery.

Construction and operation of Wastewater Basic Alternative 1b could result in significant impacts to archaeological resources. Ground disturbance would take place in areas that have not been surveyed for archaeological resources and are in the vicinity of NRHP-eligible archaeological resources. However these impacts are mitigable to less than significant through consultation as stipulated by the PA. This alternative would not impact traditional cultural properties or submerged resources. Mitigation would include avoidance, survey, monitoring during construction, and data recovery.

14.2.5 Solid Waste

14.2.5.1 Basic Alternative 1 (Preferred Alternative)

This alternative assumes that the Navy would continue to use the landfill at Apra Harbor until the new landfill at Layon would be ready. There would be no ground disturbing activities done at the Apra Harbor landfill and the GovGuam Layon Landfill is currently under construction.

Figure 14.2-1 provides the proposed project location in relation to the archaeological probability areas. Overall, this area is considered to be low probability. No archaeological or traditional cultural properties are known from this area. Therefore, no adverse direct or indirect impacts to significant cultural resources would result from implementation of this component.

Mitigation Measures

In accordance with the PA under Section 106, since the potential in the construction area is low, no mitigation measures or further review under Section 106 are required for archaeology.

Table 14.2-4. Summary of Potential Impacts to Cultural Resources – Solid Waste

Potentially Impacted Resource	*Basic Alternative 1**
Archaeological Resources	NI • No adverse impacts to architectural resources at North, South, or Central Guam
Architectural Resources	NI • No adverse impacts to architectural resources at North, South, or Central Guam
Submerged Resources	NI • No adverse impacts to submerged resources or objects
Traditional Cultural Properties	NI • No adverse impacts to traditional cultural properties

Since this alternative requires no construction, would use one existing facility, would use one facility that is currently under construction through non-project authorization and independent NEPA review, and would provide only for an increased volume of solid waste, there would be no impacts to cultural resources.

14.2.6 Off Base Roadways

14.2.6.1 Alternative 1

North

Numerous archaeological surveys have been completed at military facilities in the North Region, many of which include haul-road corridors. These are summarized in Yee and Tomonari-Tuggle (2009:34). They include NCTS Finegayan and South Finegayan along Route 3, Potts Junction (intersection of Routes 3 and 9), and at Andersen South between Routes 1 and 15. Tomonari-Tuggle and Tuggle (2003) present an integrated cultural resources management plan for AAFB that includes summary information and management recommendations for areas of the installation along Routes 3A and 9. Recent, more focused studies and overview surveys for AAFB include survey along a lengthy portion of Route 9.Alternative 1 includes 13 road improvement projects in the North Region.

No known historic properties are within the APE for any roadway project in the North Region (Figure

14.2-5). Table 14.2-5 summarizes Section 106 findings. Figure 14.2-6 illustrates the cultural resources probability areas for all of the road projects, from no/low to medium. None of the projects in the North Region are located within high probability areas.

Ten (10) projects are located within medium probability areas. GRN #8, 23, and 117 would have no impacts to archaeological resources, architectural resources, submerged resources, or traditional cultural properties. No mitigation measures are required.

Table 14.2-5. Section 106 Effects in the North Region, Alternative 1

GRN #	*Known Historic Properties*	*Probability Area*	*Section 106 Finding*
08	None	No/Low	No Historic Properties Affected
09	None	Medium	Inventory, possible testing necessary
10	None	Medium	Inventory, possible testing necessary
22	None	Medium	Inventory, possible testing necessary
22A	None	Medium	Inventory, possible testing necessary
23	None	No/Low	No Historic Properties Affected
38A	None	Medium	Inventory, possible testing necessary
39A	None	Medium	Inventory, possible testing necessary
41A	None	Medium	Inventory, possible testing necessary
42	None	Medium	Inventory, possible testing necessary
57	None	Medium	Inventory, possible testing necessary
117	None	No/Low	No Historic Properties Affected
124	None	Medium	Inventory, possible testing necessary

<u>Central</u>

Recent archaeological research in the Central Region has included investigations for non-military and military purposes. Yee and Tomonari-Tuggle (2009:38-40) detail these efforts. Briefly, there have been several projects within the heavily developed area of downtown Agaña particularly along Route 1. Archeological data recovery excavations and monitoring has been conducted along Marine Drive from Route 8 to Camp Watkins Road in connection with Route 1 reconstruction. Most of the cultural deposits were found in the Apurguan area near the east end of Agaña Bay, but one site was located in the Agaña area. Most of the archaeological work in the Agaña area found evidence of historic period occupation.

Alternative 1 includes 27 road improvement projects in the Central Region. Section 106 findings are summarized in Table 14.2-6. Figure 14.2-5 plots known historic properties in relation to road projects. Figure 14.2-6 illustrates the cultural resources probability areas for all of the road projects. GRN #6, 13, 14, 15, 35, and 36 would pass through high probability areas. GRN# 6, 13, 14 and 15 have known historic properties in their APE, so they are marked as high probability Areas; however, in these cases, GHPO has reviewed the project descriptions and determined that they would not have any impact to historic properties. Therefore, they would also would have no impacts to archaeological resources, architectural resources, submerged resources, or traditional cultural properties. No mitigation measures are required. GRN #35 and 36, that are also in high probability areas, could impact resources eligible to the NRHP. Mitigation measures would be required prior to construction. Nineteen (19) projects would have no impacts to archaeological resources, architectural resources, submerged resources, or traditional cultural properties. No mitigation measures are required.

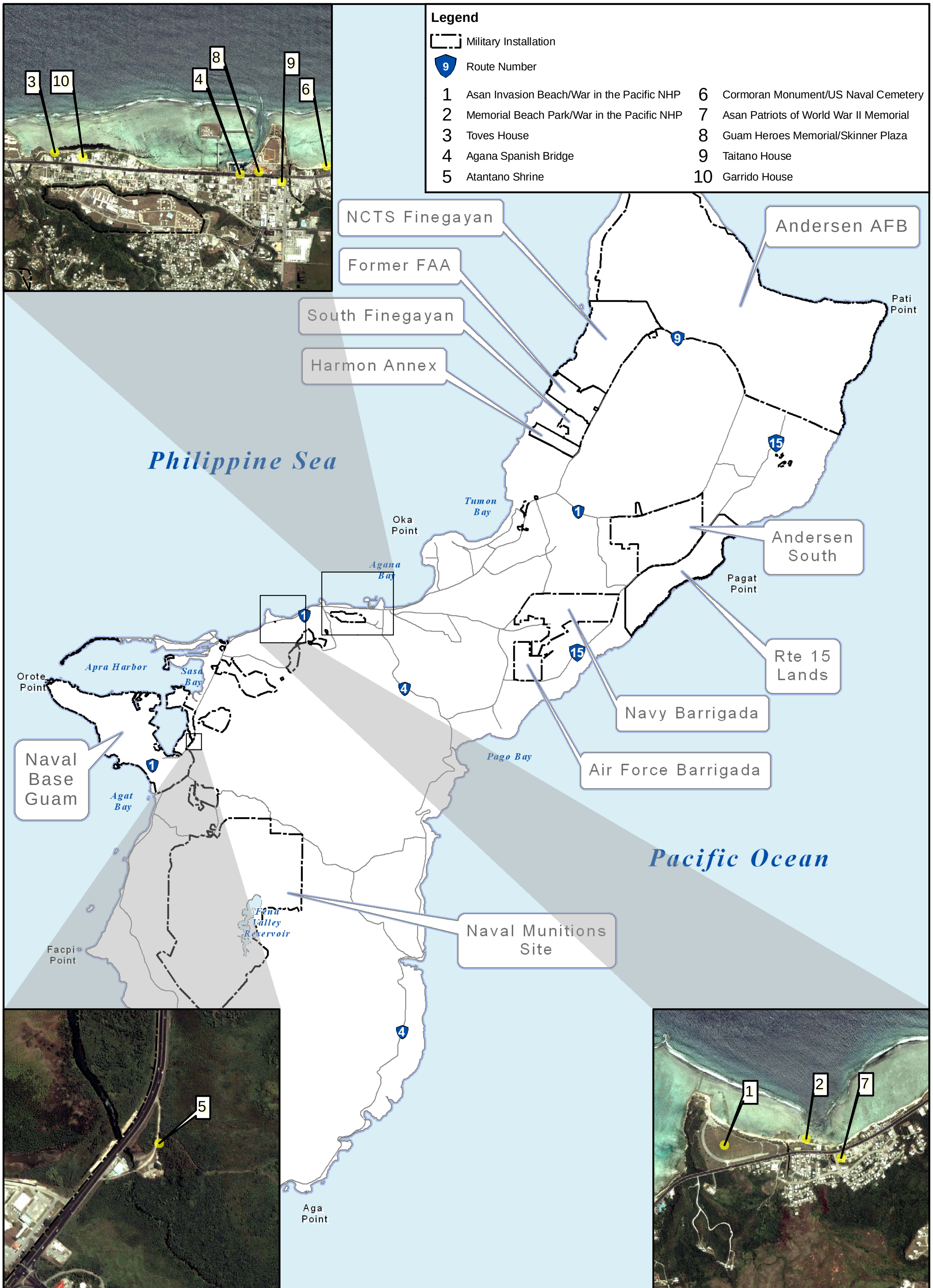

Figure 14.2-5
Historic Properties in the Area of Potential Effect (APE)

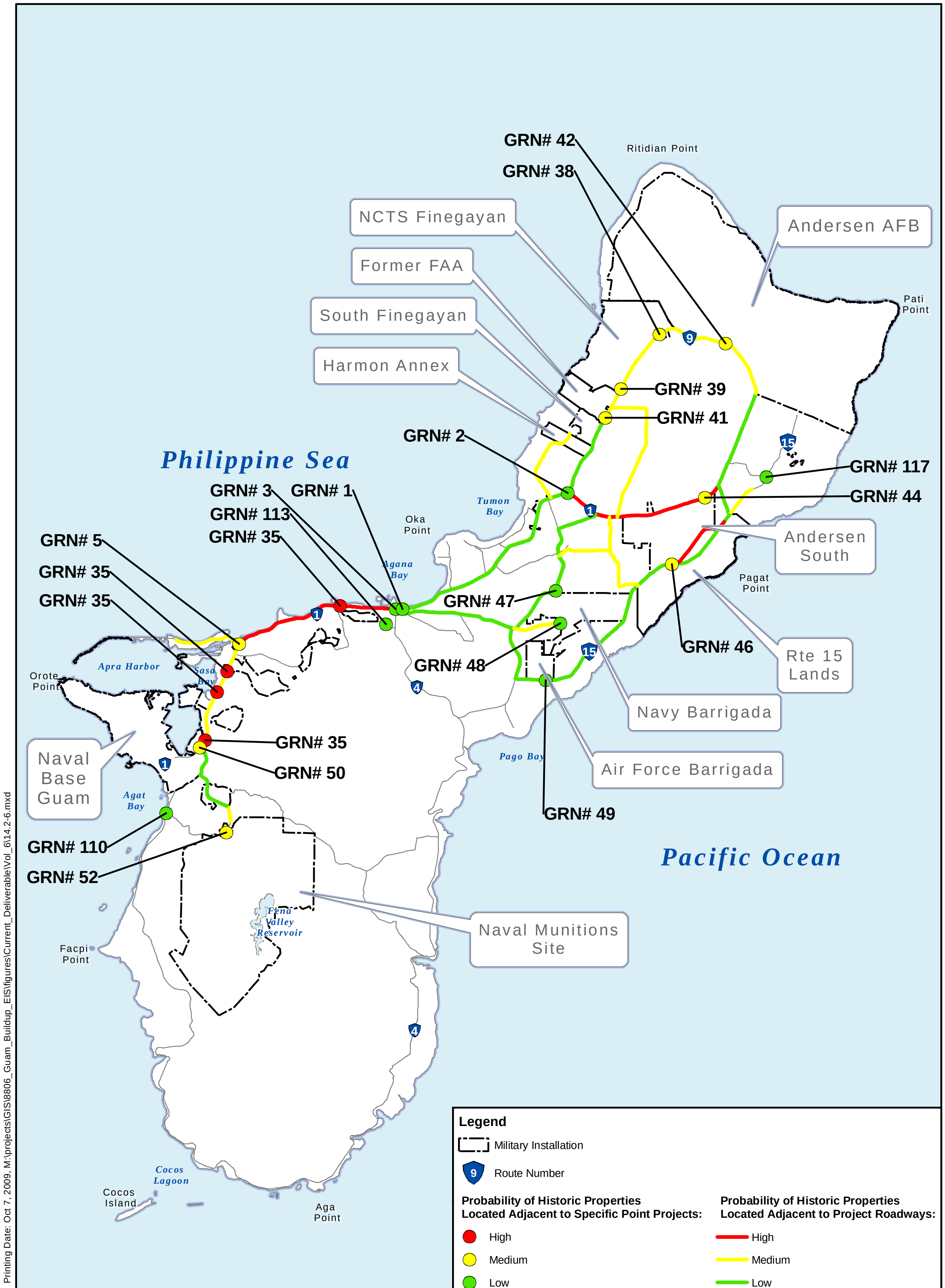

Figure 14.2-6
Probability Areas for Roadway Projects

Table 14.2-6. Section 106 Effects Central Area, Alternative 1

GRN #	*Known Historic Properties*	*Probability Area*	*Section 106 Finding*
01	Cormoran Monument, U.S. Naval Cemetery	No/Low	No Adverse Effect. Although this is a pavement strengthening project and the improvements do not extend beyond the existing roadway, the geographic information system right-of-way (ROW) parcel line appears to indicate that the existing roadway is built partially inside the cemetery ROW. Approximately 600 square feet (ft2) (56 square meters [m2]) of land would need to be acquired to correct this situation. The Cormoran Monument would not be affected
02	None	No/Low	No Historic Properties Affected
03	None	No/Low	No Historic Properties Affected
06	None	High*	No Historic Properties Affected
07	None	No/Low	No Historic Properties Affected
11	None	No/Low	No Historic Properties Affected
12	None	Medium	Inventory, possible testing necessary
13	Asan Invasion Beach, Memorial Beach Park, War in the Pacific National Historical Park (NHP), one archaeological site	High*	No Historic Properties Affected
14	Asan World War II Memorial, two archaeological sites	High*	No Historic Properties Affected
15	San Nicholas Bridge, Agana Spanish Bridge, Guam Heroes Memorial and Skinner Plaza, Taitano House, Garrido House, Toves House	High*	No Historic Properties Affected
16	None	No/Low	No Historic Properties Affected
17	None	No/Low	No Historic Properties Affected
18	None	No/Low	No Historic Properties Affected
19	None	No/Low	No Historic Properties Affected
20	None	No/Low	No Historic Properties Affected
21	None	No/Low	No Historic Properties Affected
28	None	Medium	Inventory, possible testing necessary
29	None	Medium	Inventory, possible testing necessary
30	None	No/Low	No Historic Properties Affected
31	None	No/Low	No Historic Properties Affected
32	None	No/Low	No Historic Properties Affected
33	None	No/Low	No Historic Properties Affected
35	None	High	Examine banks, monitor construction
36	One archaeological site	High	Survey, testing, possible data recovery necessary
44	None	Medium	Inventory, possible testing necessary
46	None	Medium	Inventory, possible testing necessary
113	None	No/Low	No Historic Properties Affected

* Some roadway projects are categorized as High Probability Areas because known historic properties are present, but in these cases, the project would not affect any historic properties.

Apra Harbor

Extensive archaeological overviews and surveys have been undertaken in and around Apra Harbor. Five surveys have been competed in the Route 1/2A/5 area. The Route 1 and 2A corridors inland of Apra Harbor have been identified in previous archaeological and paleoenvironmental surveys as the locales of early Pre-Latte Period sites. Yee and Tomonari-Tuggle (2009:43) present a summary of previous investigations.

Alternative 1 includes five road improvement projects in the Apra Harbor Region. Effects on known historic properties are summarized in Table 14.2-7. Figure 14.2-5 plots known historic properties in relation to road projects. Figure 14.2-6 illustrates the cultural resources probability areas for all of the road projects. The Atantano Shrine is located within a parcel adjacent to GRN #24, but it is located well away from the roadway and would not be affected by the project. All of the projects are located in medium and no/low probability areas.

Table 14.2-7. Section 106 Effects in the Apra Harbor Region from Alternative 1

GRN #	*Known Historic Properties*	*Probability Area*	*Section 106 Finding*
04	None	Medium	Inventory, possible testing
05	None	Medium	Inventory, possible testing
24	Atantano Shrine	Medium	No Historic Properties Affected for the Shrine; Inventory, possible testing elsewhere
26	None	No/Low	No Historic Properties Affected
50	None	Medium	Inventory

South

Alternative 1 includes four road improvement projects in the South Region. There are no known historic properties within the APE of any project in the South Region. Table 14.2-8 summarizes Section 106 findings in the South Region. Figure 14.2-6 illustrates the cultural resources probability areas for all of the road projects. All of the projects are located in no/low and medium probability areas.

Table 14.2-8. Section 106 Effects on Known Historic Properties in the South Region from Alternative 1

GRN #	*Known Historic Properties*	*Probability Area*	*Section 106 Finding*
25	None	No/Low	No Historic Properties Affected
27	None	Medium	Inventory, possible testing, possible monitoring
52	None	Medium	Inventory, possible testing, possible monitoring
110	None	No/Low	No Historic Properties Affected

Potential Mitigation Measures

Alternative 1 would have no adverse effects on any known historic properties. Most of the projects have findings of No Historic Properties Affected; however, Alternative 1 still has potential to impact undocumented historic properties. Pursuant to the PA between FHWA and the GHPO mentioned above, FHWA may be responsible for further work in medium and high probability areas. Data recovery measures would be implemented where appropriate, as determined through Section 106 consultation with the GHPO, as per 36 CFR 800, and other cultural resources stakeholders. Monitoring may be required for some projects. If adverse effects are identified, then a Memorandum of Agreement (MOA) between FHWA and the GHPO would be drafted to formalize precise measures to mitigate adverse effects. The

MOA would be a separate document from the PA, because the MOA would provide mitigation for specific adverse effects on specific Haul Road projects, whereas the PA also applies to other FHWA projects.

14.2.6.2 Alternative 2 (Preferred Alternative)

Peak construction and permanent impacts on cultural resources under Alternative 2 would be similar to those described under Alternative 1 because the same projects, except for varying locations of the MAPs at NCTS Finegayan, are proposed under this alternative. Potential mitigation measures for Alternative 2 would be the same as those proposed for Alternative 1.

14.2.6.3 Alternative 3

Peak construction and permanent impacts on cultural resources under Alternative 3 would be similar to those described under Alternative 1 because the same projects are proposed under this alternative with a few projects more or less than Alternative 1 that would be built as part of the GRN improvements program. Potential mitigation measures for Alternative 3 would be the same as those proposed for Alternative 1.

14.2.6.4 Alternative 8

Peak construction and permanent impacts on cultural resources under Alternative 8 would be similar to those described under Alternative 1 because the same projects are proposed under this alternative with a few projects more or less than Alternative 1 that would be built as part of the GRN improvements program. Potential mitigation measures for Alternative 8 would be the same as those proposed for Alternative 1.

14.2.6.5 Summary of Impacts

Table 14.2-9 summarizes the potential impacts of each alternative.

Table 14.2-9. Summary of Potential Impacts to Cultural Resources-Roadway Project

Potentially Impacted Resource	*Alternative 1*	*Alternative 2**	*Alternative 3*	*Alternative 8*
Cultural Resources	NI	NI	NI	NI

Legend: NI = No Impact. *Preferred Alternative.

CHAPTER 15.
VISUAL RESOURCES

15.1 INTRODUCTION

This chapter discusses potential environmental consequences associated with implementation of the alternatives within the region of influence on visual resources. A description of the affected environment for visual resources is provided in Volume 2 (Marine Corps Relocation – Guam). The locations described in that volume include the region of influence for the utilities and roadway projects as they relate to visual resources.

15.2 ENVIRONMENTAL CONSEQUENCES

15.2.1 Approach to Analysis

15.2.1.1 Methodology

Utilities

Information on visual resources was gathered through on-site visits, background research, and participation in stakeholder and public meetings. The analysis of potential impacts to visual resources is based on the long-term (operational) effects – i.e., after construction has occurred and all buildings, facilities, and structures are in place. Construction-related activities would be relatively minimal in their impacts (i.e., earth-moving equipment clearing vegetation and constructing facilities and other structures).

Off Base Roadways

This visual assessment was prepared consistent with the methodologies established by the Federal Highway Administration's (FHWA) *Visual Impact Assessment for Highway Projects* (1981). This methodology divides the views into landscape or character units that have distinct but not necessarily homogenous visual character. Typical views, called key viewpoints, are selected for each unit to represent the views to/from the project. The view of the motorist is also considered as a separate character unit.

Existing visual quality from the viewpoints is judged by three criteria: vividness, intactness, and unity. Descriptions for the three criteria are:

- Vividness: The memorability of the landscape components as they combine to form striking or distinctive patterns.
- Intactness: The integrity of visual order in the view and its freedom from visual encroachment.
- Unity: The visual coherence and composition of the landscape viewed to form a harmonious visual pattern.

These criteria provide a method for describing the form, line, color, and texture of the components found within a view. As in all things aesthetic, "beauty is in the eye of the beholder;" therefore, there is a subjective component to this or any visual analysis evaluation. However, as outlined in the FHWA methods, the use of these descriptors allows for a basis for understanding the evaluator's rationale behind a visual quality determination. It is important to note that visual character terms are descriptive and non-evaluative, meaning that they are based on defined attributes that are neither good nor bad by themselves. Changes in visual character cannot be described as having good or bad attributes until compared with viewer responses to the change.

15.2.1.2 Determination of Significance

Utilities

For the purpose of the Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS), the proposed actions would cause a significant impact to visual resources if they

- Substantially alter the views or scenic quality associated with particularly significant and/or publicly recognized vistas, view sheds, overlooks, or features
- Substantially change the light, glare, or shadows within a given area
- Substantially affect sensitive receptors – i.e., viewers with particular sensitivity (or intolerance) to a changed view
- Significant impacts that cannot be mitigated to less-than-significant levels are considered unavoidable

A discussion is presented for each significance criterion listed that would be triggered by the utility alternatives.

Off Base Roadways

The National Environmental Policy Act (NEPA) requires consideration of visual resource impacts of projects in preparation of environmental documents. NEPA guidelines for the assessment of visual impacts stipulate that environmental documents:

- State whether the project alternatives have a potential for visual quality impacts
- Identify the impacts to the existing visual resources
- Identify the relationship of the impacts to potential viewers of and from the project
- Identify measures to avoid, minimize, or reduce the adverse impacts

For projects that do not create a substantial impact on existing visual quality, a more nuanced approach categorizes impact levels as low, moderate, moderately high, and high based on the following descriptions:

- Low: Minor adverse change to the existing visual resource, with low viewer sensitivity to any change. May or may not require mitigation.
- Moderate: Adverse change cannot be described as minor or viewer response is thought to be greater. Impacts can be mitigated within 5 years using conventional practices.
- Moderately High: Moderate adverse change in the visual resource with high viewer response or high adverse change with a moderate viewer response. Extraordinary mitigation measures may be required, and landscape treatments required may take more than 5 years to mitigate.
- High/Substantial: High level of adverse change or a high level of sensitivity to the change such that architectural design and landscape treatments cannot mitigate impacts. An alternative project design may be required to avoid adverse impacts.

For this analysis, the proposed roadway project would be considered to have a substantial impact if it were to result in the obstruction or impairment of important views from a public roadway or scenic vista, result in the substantial modification to the height of the existing structures or topography of an area, or cause a large reduction in the landscape/vegetation within the project area. Such impacts would be considered substantial only if it was not possible to mitigate the impacts to the visual environment of the project.

15.2.1.3 Issues Identified during Public Scoping Process

No issues regarding impact on visual resources as a result of proposed utility and road improvements were raised at the April 2007 public scoping meetings.

15.2.2 Power

15.2.2.1 Interim Alternative 1 (Preferred Alternative)

Interim Alternative 1 would recondition existing combustion turbines and upgrade T&D systems and would not require new construction or enlargement of the existing footprint of the facility. This work would be undertaken by the GPA on its existing permitted facilities. Reconditioning would be made to existing permitted facilities at the Marbo, Yigo, Dededo No. 1, and Macheche combustion turbines. These combustion turbines are not currently being used up to permit limits. T&D system upgrades would be on existing above ground and underground transmission lines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Potential Mitigation Measures

No mitigation measures are needed.

15.2.2.2 Interim Alternative 2

Interim Alternative 2 is a combination of reconditioning of existing permitted GPA facilities, an increase in operational hours for existing combustion turbines, and upgrades to existing T&D systems. Interim Alternative 2 would not require new construction or enlargement of the existing footprint of the facility. Reconditioning would be performed on the existing permitted GPA facilities at the Marbo, Yigo, and Dededo combustion turbines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Potential Mitigation Measures

No mitigation measures are needed.

15.2.2.3 Interim Alternative 3

Interim Alternative 3 is a combination of reconditioning existing GPA permitted facilities at Marbo, Yigo, and Dededo and upgrades to the Department of Defense power plant at Orote. Upgrades would be made to existing T&D. The proposed reconditioning to the existing power generation facilities at Marbo, Yigo, and Dededo would not require new construction or enlargement of the existing footprint of the facility. For the Orote power plant, upgrades would include a new fuel storage facility to facilitate longer run times between refueling. This would disturb approximately 1 acre (4,047 square m). This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Potential Mitigation Measures

No mitigation measures are needed.

15.2.2.4 Summary of Impacts

The interim power alternatives presented would recondition the existing GPA facilities, and it is assumed new distribution lines would be routed within the existing utility corridors. Therefore, any changes to the landscape at these affected areas would be keeping with the existing environment and any impacts to visual resources would be less than significant. Table 15.2-1 summarizes the potential impacts of each interim alternative.

Table 15.2-1. Summary of Potential Impacts to Visual Resources-Power

*Interim Alternative 1**	*Interim Alternative 2*	*Interim Alternative 3*
Views toward upgraded GPA facilities		
NI	NI	NI
Views toward Cabras Piti		
NI	NI	NI
Views toward Potts Junction		
NI	NI	NI

Legend: NI = No Impact. * Preferred Alternative

15.2.3 Potable Water

As discussed in Volume 6 Chapter 2 (Section 2.2.2), potable water alternatives are not distinguished as interim or long-term.

15.2.3.1 Basic Alternative 1 (Preferred Alternative)

Basic Alternative 1 would consist of installation of up to 22 new potable water supply wells at Andersen Air Force Base (AFB), rehabilitation of existing wells, interconnection with the GWA water system, and associated T&D systems. A new 5 MG (19 ML) water storage tank would be constructed at ground level at Finegayan

<u>New Water Supply Facilities</u>

The proposed development of 22 new potable water supply wells at Andersen Air Force Base (AFB), rehabilitation of existing wells, and interconnection with the GWA water system would be confined to DoD properties. These works would be in keeping with other planned and surrounding facilities and would not be visible outside of the installations. A ground-level water storage tank proposed at NCTS Finegayan would be located adjacent to Route 3. This ground level water storage tanks would be partially visible. Views from Route 3 into NCTS Finegayan vary from an altered landscape (i.e., the existing gate and NCTS facilities in the south) to a naturally appearing landscape in the north. The facility to be located along Route 3 in the north part of NCTS Finegayan would cause no change to visual resources, as it would be visible in the foreground from this roadway. Inland facilities at NCTS Finegayan would be visible in the middle ground or background and would have less impact on the skyline and visual resources. This storage facility would ultimately be adjacent to other installation facilities. The proposed water storage tank would not impede upon any particularly significant and/or publicly recognized vistas, view sheds, overlooks, or features. Furthermore, no substantial change would occur related to the light, glare, or shadows in the area. Therefore, any impacts to visual resources would be less than significant.

Potential Mitigation Measures

Because adverse impacts are anticipated to be less than significant, no mitigation measures are proposed.

15.2.3.2 Basic Alternative 2

Basic Alternative 2 would consist of installation of up to 20 new potable water supply wells at Andersen AFB, up to 11 new potable water supply wells at Barrigada, rehabilitation of existing wells, interconnection with the GWA water system, associated transmission and distribution systems upgrades. Additionally, new 3.6 MG (13.6 ML) and 1 MG (3.8 ML) water storage tanks would be constructed at ground level at Finegayan and Barrigada, respectively.

New Water Supply Facilities

The proposed development of up to 20 potable water supply wells at Andersen AFB and up to 11 water supply wells at Barrigafa would be in keeping with other planned and surrounding facilities and would likely not be visible outside of the installations. Therefore, no impacts to existing visual resources are anticipated. New water storage facilities (towers and tanks) proposed at NCTS Finegayan and Air Force Barrigada would be installed at ground level and partially visible as the result. One of the water storage facilities proposed at NCTS Finegayan would be located adjacent to Route 3, and the facility at Air Force Barrigada would be located approximately 1/2 mile (1 km) north of Route 15. Two of these types of water storage facilities already exist at Finegayan (one at NCTS and the other at South Finegayan), and both are adjacent to Route 3.

Views from Route 3 into NCTS Finegayan vary from an altered landscape (i.e., the existing gate and NCTS facilities in the south) to a naturally appearing landscape in the north. The facility to be located along Route 3 in the north part of NCTS Finegayan would not cause change to visual resources in the foreground from this roadway. Inland facilities at Air Force Barrigada would be seen in the middle ground or background and have less impact on the skyline and visual resources, since it, too, would be partially visible. These storage facilities would ultimately be adjacent to other installation facilities. None of the proposed water storage tanks would impede upon any particularly significant and/or publicly recognized vistas, view sheds, overlooks, or features. No substantial change would occur to the light, glare, or shadows in the area. Therefore, any impacts to visual resources are anticipated to be less than significant.

Potential Mitigation Measures

Because adverse impacts are anticipated to be less than significant, no mitigation measures are proposed.

15.2.3.3 Summary of Impacts

Table 15.2-2 summarizes the potential impacts of each action alternative.

Table 15.2-2. Summary of Potential Impacts to Visual Resources-Potable Water

*Basic Alternative 1**	*Basic Alternative 2*
Views along Highway 3 adjacent to Finegayan	
LSI	LSI

Legend: LSI = Less Than Significant Impact. *Preferred Alternative

Both of the alternatives related to potable water supply and storage would introduce new features into the landscape. Due to the size and location of the water supply and treatment features, only the water storage elements – ground-level tanks – would be expected to have an impact on visual resources. One of the two new water tanks would be located inland of readily visible public locations making them middle ground and background visual elements in the landscape and causing a less than significant impact on visual resources. One tank would be located directly adjacent to a public highway making it visible in the foreground as well. However, this new tank would be in close proximity to two existing towers/tanks also located along this same public highway. Therefore, this new feature is anticipated to have a less than significant impact on visual resources.

15.2.4 Wastewater

15.2.4.1 Basic Alternative 1a (Preferred Alternative) and 1b

Basic Alternative 1 (Alternative 1a supports Main Cantonment Alternatives 1 and 2; and Alternative 1b supports Main Cantonment Alternatives 3 and 8) combines upgrade to the existing primary treatment facilities and expansion to secondary treatment at the Northern District Wastewater Treatment Plant (NDWWTP). The difference between Alternatives 1a and 1b is a requirement for a new sewer line from Barrigada housing to NDWWTP for Alternative 1b.

No impacts to visual resources are anticipated.

Potential Mitigation Measures

No mitigation measures are needed.

15.2.4.2 Alternative 1b

Alternative 1b is identical to Alternative 1a with the additional requirement for a new sewer line from Barrigada housing to NDWWTP. The development of a sewer line would involve ground-level construction work, and while there may be interruption to visual elements due to the presence of construction equipments, no permanent impairment to visual resources is expected. Therefore, less than significant impacts to visual resources are anticipated.

Potential Mitigation Measures

No mitigation measures are needed.

15.2.4.3 Summary of Impacts

Little, if any of the features associated with the new or upgraded waste water treatment facilities would be visible from public viewpoints, in particular those along Highway 3. Therefore, no impacts on visual resources are anticipated under any of the waste water treatment alternatives. Table 14.2-3 summarizes the potential impacts of each interim alternative. An analysis of long-term alternatives was not developed because the alternatives are not ready for project-specific analysis.

Table 15.2-3. Summary of Potential Impacts to Visual Resources-Wastewater

*Basic Alternative 1a**	*Basic Alternative 1b*
Views from Highway 3 near Finegayan South	Views from Highway 3 near Finegayan South
NI	LSI

Legend: NI = No Impact, LSI = Less than Significant Impact. * *Preferred Alternative*

15.2.5 Solid Waste

15.2.5.1 Basic Alternative 1 (Preferred Alternative)

The Preferred Alternative for solid waste would be the continued use of Navy Landfill at Apra Harbor until Layon Landfill is opened, which is scheduled for July 2011. The proposed location in Layon is a rocky badland at high elevation adjacent to the Inarajan Village. The proposed mound-shape landfill, situated approximately 435 ft (133 m) above msl, is likely to be visible from different vantage points, from road travelers on Route 4 and adjoining villages on the fringe of the rolling southern mountains. Although the proposed landfill location is situated at least 1.5 miles (2.4 km) inland from Route 4, the mound shape of the new landfill could potentially appear prominently among the existing mountain peaks and rolling hills. However, this landfill is already in construction and has been through a separate NEPA review. These potential impacts are not due to the action proposed in this EIS/OEIS. Therefore, there are no additional visual impacts from this solid waste alternative from this proposed action.

Potential Mitigation Measures

Since there are no visual impacts from solid waste alternatives caused by the proposed action, no mitigation measures would be required.

Table 15.2-4. Summary of Potential Impacts to Visual Resources-Solid Waste

*Basic Alternative 1**
Views from Route 2, Route 2a, and nearby Afilieje Beach Park
NI
Views from Apra Heights
NI
Views from Route 4 and nearby residences
NI
Views into NMS from adjacent ridgetop trails
NI

Legend: SI-M = Significant Impact Mitigable to Less Than Significant; NI = No Impact. * Preferred Alternative

15.2.6 Off Base Roadways

The visual impact of project alternatives is determined by assessing the visual resource change due to the project and predicting viewer response to that change. Visual resource change is the total change in visual character and visual quality. The first step in determining visual resource change is to assess the compatibility of the proposed project with the existing visual character of the landscape. The second step is to compare the visual quality of the existing resources with the projected visual quality after the project is constructed. Viewer response to the changes is the sum of viewer exposure and viewer sensitivity to the project, as previously described. The resulting level of visual impact is determined by combining the severity of resource change with the degree to which people are likely to oppose the change.

Existing Viewer Sensitivity

Viewer response is based on two elements – viewer sensitivity and viewer exposure. These elements combine to form a method of predicting how the public might react to visual changes that result from the roadway improvements.

Viewer sensitivity can be defined as an individual's concern for scenic quality and his/her response to change in the visual environment that creates the view. Local values and goals may place greater significance on certain landscape components or locations that might appear unremarkable to an outside observer. Viewer exposure is typically assessed by considering the number of viewers exposed to the view, the type of viewer activity associated with the view, the duration of their view, the speed at which the viewer moves through the environment, and the position of the viewer.

Given the number of changes to the island anticipated as part of the relocating of forces to Guam, it is likely that there would be a high degree of sensitivity on the part of local residents to changes to the visual environment of the island. In addition, because tourism is such a large part of the economy of the island, the overall visual quality would be an important consideration to tourists and those on the island that cater to them.

Local Policy and Goals

In anticipation of the upcoming relocation of Marines from Okinawa to Guam and its effects to the island, the GovGuam has begun a process to develop a Draft Land Use Plan for the North and Central portions of the island. The following are some of the goals established in this document:

- Promote sustainable community development through such measures as development of green spaces and greenways; develop transit-oriented development or transit-ready development; provide diverse opportunities for arts, recreation, and entertainment; increase in-fill in developed areas; and develop design standards.
- Promote the long-term health, character, and identity of the village communities by the development of design standards and practices among other activities.
- Provide a park and recreation system that enhances the quality of life for residents and visitors to Guam by identifying key parks, trails, and greenways needed; and consider a master-planning process for specific significant areas, such as the buffer along Marine Corps Drive (Route 1) between the Micronesia Mall and Y Send Song, to create attractive and functional public areas.
- Integrate future development with open space and natural amenities, including public views of significant natural features and water.
- Establish an interconnected multimodal street network that adequately addresses the travel needs of the community, consistent with community vision by, among other policy directions, establishing requirements for streetscape and design standards that reflect the community character and provide balanced multimodal access.
- Contribute to the quality of life on Guam through the planned provision of infrastructure by describing the role of capital facilities in responding to growth, encouraging beneficial growth, contributing to community character, protecting public health, and environmental quality.

The sum of this effort shows a community that is working to develop in ways and with a quality that would enhance the existing visual environment on the island, and specifically for the Guam Road Network (GRN).

Existing Viewer Groups, Exposure, and Awareness

Community Residents

Residents can be expected to have the highest sensitivity and be the most aware of any groups because they have to live with the projects and are the most familiar with the current visual setting. For the proposed roadway improvements, residents are located adjacent to many of the roads. From these homes, the view to the project area would be direct. It is likely that these residents would be highly sensitive to changes in the visual environment.

Business Owners, Employees, and Customers

This user group would be associated with the existing business within the area of the new bridge, although except for a church, most businesses are far enough removed to not have a clear view into the project area. These viewers would likely have a high awareness of the project, but the principal concern is likely to be the effect of any construction on business access for employees or customers. It is anticipated that these viewers would have a low level of concern regarding the changes to the visual environment.

Regular Motorists

Included in this user group are commuters and local residents and workers who frequently travel within the project area. It is likely that these viewers would be aware of any changes to the visual environment because of their repeated exposure. It is anticipated that viewers from the road would be moderately sensitive to the change in the visual environment.

Occasional Motorists

Occasional motorists include tourists and regional residents from outside the immediate area who infrequently travel the area. These viewers generally have a low exposure and awareness of changes to the visual environment.

Tourists

Tourists, particularly from Japan and Asia, make up a large percentage of the people on the island at any one time. It can generally be assumed that tourists are not familiar with the island and are therefore less sensitive to changes in the visual environment; however, tourists would be very sensitive to the overall visual quality, particularly in areas around the resorts.

15.2.6.1 Alternative 1

The affected environment for visual resources for the proposed roadway improvement projects on Guam is described in the Affected Environment section, located in Volume 2 of this document.

Pavement strengthening projects are not anticipated to change the visual environment of the proposed roadway corridors. Because these projects are strictly repaving projects within the existing roadway prism, they should not alter the existing views or visual quality, and the changes should be little noticed. Viewer responses to the changes from repaving of the roadways are likely to be very low. The most noticeable changes would be temporary impacts associated with construction equipment and crews. The existing visual quality of the roadway corridor is anticipated to remain after reconstruction of the pavement. Based on this reason, visual impacts from the proposed pavement strengthening projects are not further analyzed.

In addition to the pavement strengthening projects, the Military Access Points (MAP) are generally not anticipated to alter the existing visual quality of the roadways. In many instances, the proposed improvements are to existing gate locations. These improvements generally include widening approach roadways to facilitate turning movements; but the facility elements, including low buildings, roadways, fencing, and gate arms, would be similar to the existing and would not be anticipated to appreciably change the current visual environment. The MAPs are also located some distance from the main island routes, generally between 0.5-mile (0.8-kilometer [km]) to 1.0-mile (1.6 km) off of the main route that also reduces any visual impact to the routes. Based on this reason, visual impacts from the proposed MAP projects are not further analyzed.

<u>Year 2014 (Peak Construction and Population)</u>

Construction of the proposed projects would occur between 2010 and 2014, with 2014 being the peak year for construction. It is anticipated that the relocation of military personnel would be complete by 2015. With this number of projects being constructed in a 4- to 5-year period, it is anticipated that residents and other viewers on the island would likely notice a rapid increase in urbanization on the island. The widened roadways and intersections, combined with the new roadways, would contribute to this change in visual character for many of the roadway corridors. This would also likely be the peak year for temporary impacts associated with views to equipment, signage, and other elements related to construction of the roadway corridors.

Year 2030

For the horizon year of 2030, it is anticipated that all of the construction of all corridors is complete, and only routine maintenance is necessary along the roadways. The temporary impacts associated with construction would no longer be an issue. For the visual environment, it can be anticipated that the island would exhibit a more urban character, particularly in the North, Central, and Apra Harbor Regions, where most of the proposed projects are located.

North

Table 15.2-4 identifies all projects within the North region, and the table indicates the disposition of each project in terms of this analysis. Following the table is a description of the anticipated impact of each of the projects analyzed within the North region; this information is also summarized in Table 15.2-5. An analysis of a key view for GRN #57 depicts the anticipated changes to the visual environment.

Table 15.2-4. Guam Roads Network Projects Considered for Analysis, North Region

GRN #	*Route Number*	*Composite Alternatives*				*Carried Forward for Further Analysis?*	*Reason for Inclusion or Exclusion*
		1	*2*	*3*	*8*		
8	3	x	x	x	x	No	This project does not require widening (only pavement strengthening), and to modify the access to Okkodo High School on the interior portion of the road.
9	3	x	x	x	x	**Yes**	Pavement strengthening, widen from 2 lanes to 4 lanes, add median and shoulders from NCTS Finegayan to Route 28; add an additional southbound left-turn lane and add northbound right-turn lane to the Route 3/28 intersection.
10	3	x	x	x	x	**Yes**	Pavement strengthening, widen from 2 lanes to 4 lanes, add median and shoulders from NCTS Finegayan to Route 9; eliminate Y-intersection; provide T-intersection with one left-turn and one right-turn lane on Route 3A, a northbound left-turn lane on Route 3.
22	9	x	x	x	x	**Yes**	Pavement strengthening, widen from 2 lanes to 4 lanes, with median from Route 3 to the Andersen AFB North Gate.
22A	9	x	x	x	x	No	This project does not require widening (only pavement strengthening).
23	1	x	x	x	x	No	This project does not require widening (only pavement strengthening) of Route 1, from Chalan Lujuna to Route 9.
38	MAP	x	x	x	x	No	Anticipated changes are expected to be minor and would not alter the existing visual environment.
38A	MAP	x	x	x	x	No	Anticipated changes are expected to be minor and would not alter the existing visual environment.
39	MAP	x	x	x	x	No	Anticipated changes are expected to be minor and would not alter the existing visual environment.
39A	MAP	x	x	x	x	No	Anticipated changes are expected to be minor and would not alter the existing visual environment.
41	MAP	x	x	x	x	No	Anticipated changes are expected to be minor and would not alter the existing visual environment.
41A	MAP	x	x	x	x	No	Anticipated changes are expected to be minor and would not alter the existing visual environment.

Table 15.2-4. Guam Roads Network Projects Considered for Analysis, North Region

GRN #	*Route Number*	*Composite Alternatives*				*Carried Forward for Further Analysis?*	*Reason for Inclusion or Exclusion*
		1	*2*	*3*	*8*		
42	MAP	x	x	x	x	No	Anticipated changes are expected to be minor and would not alter the existing visual environment.
57	28	x	x	x	x	**Yes**	Pavement strengthening, widen from 2 to 3 lanes between Route 1 and Route 3. Provide northbound left-turn, through, through/right-turn, southbound left-turn, through, and through/right-turn, eastbound left-turn, through, and right-turn lane.
117	15	x	x			**Yes**	Route 15/29 Intersection – signalize, additional northbound, southbound left-turn lanes, southbound right-turn lane.
124	New Road	x	x	x	x	**Yes**	The Finegayan Connector road would be a new roadway where only dirt roads and forested land currently exist.

Table 15.2-5. General Visual Quality per Road Corridor/Project Area, North Region

GRN #	*Route Number*	*Segment Limits*	*FHWA Visual Assessment Criteria*			*Overall Visual Quality (V + I + U/3)*	*Existing vs. Proposed Visual Quality*
			Vividness	*Intactness*	*Unity*		
9	3	NCTS Finegayan to Route 28	Moderate	Moderate	Moderate	Moderate	Existing
			Moderate	Moderate	Moderate	Moderate	Post-Construction
10	3	NCTS Finegayan to Route 9	Moderate	Moderate	Moderate	Moderate	Existing
			Moderate	Moderate	Moderate	Moderate	Post-Construction
22	9	Route 3 to Andersen AFB (North Gate)	Moderate	Moderate	Moderate	Moderate	Existing
			Moderate	Moderate	Moderate	Moderate	Post-Construction
57	28	Route 1 to Route 3	Moderately High	Moderate	Moderate	Moderately High	Existing
			Moderate	Moderate	Moderate	Moderate	Post-Construction
117	15	Route 15/29 Intersection	Moderate	Moderate	Moderately Low	Moderate	Existing
			Moderate	Moderate	Moderately Low	Moderate	Post-Construction
124	New	Finegayan Connection	Moderately High	Moderate	Moderately High	Moderately High	Existing
			Moderate	Moderate	Moderately High	Moderate	Post-Construction

GRN #9, Route 3 from NCTS Finegayan to Route 28

This project would widen the existing Route 3 from two to four lanes and add a median. In addition, the intersection with Route 28 would include a new left-turn lane. Most of the traffic that would use this roadway is traveling to and from Andersen AFB. Currently, there is little residential in the area not associated with the military base. This would tend to limit the viewers exposed to the changes and would equate to a lower sensitivity to the proposed changes.

It is anticipated that the project would increase the appearance of pavement in the views along the roadway. The shoulders are still anticipated to be mown grass, and curb and gutter would not be included in the pavement section, as it would in a more urban setting. It is anticipated that the overall visual quality would remain at moderate, with moderate vividness, intactness, and unity.

GRN #10, Route 3 from NCTS Finegayan to Route 9

This project is a continuation of the widening of Route 3, as described in GRN #9, and the impacts are anticipated to be similar. As with the previous section, the overall visual quality is expected to remain moderate, with moderate vividness, intactness, and unity.

GRN #22, Route 9 from Route 3 to the Andersen AFB North Gate

This project would widen the existing two-lane road to four lanes. The changes would increase the urban appearance of the roadway in the rural-appearing area. There are a few residences that face the roadway in some sections of the road. These viewers could be expected to be more sensitive of the changes to the roadway appearance; however, the average roadway traveler is expected to have a low sensitivity. The overall visual quality of the corridor would be maintained at moderate, with moderate vividness, intactness, and unity.

GRN #57, Route 28 from Route 1 to Route 3

This project would add a center turn lane to the roadway. In the southern residential sections, it is anticipated that viewer sensitivity would be high. To the north, where there are fewer viewers, this sensitivity could be expected to diminish to some extent. The project is anticipated to lower the existing overall visual quality to moderate, with moderate vividness, moderate intactness, and moderate unity.

GRN #117, Route 15/29 Intersection

This project would increase the overall size of the intersection by adding new left-turn lanes to Route 15, plus a southbound right-turn lane. Given the existing rural character of the intersection, the widening would cause the intersection to have a bigger presence in the landscape; however, the overall effect of the additional pavement is likely to be small to most viewers, thereby maintaining the overall visual quality of the area at moderate, with moderate vividness, moderate intactness, and moderately low unity.

GRN #124, Finegayan Connection

This new roadway would be located in an area that is partially disturbed by dirt roads, including Tanguisson Road, among other less formal dirt roads in the area. Because this area is not regularly traveled, viewer sensitivity is expected to be low. The new roadway would add paving and vehicular traffic where there is none, but there are no residences or other "receptors" that might have a view out to the new corridor.

It is anticipated that the new Finegayan Connection would be expected to lower the visual quality of the area slightly to moderate, with moderate vividness, moderate intactness, and moderate unity from its existing moderately high rating.

Key Viewpoint 1: GRN #57, Route 28 Roadway Widening

Because it is not possible to analyze every view within the project area, it is necessary to select a key viewpoint that typifies the visual effects of the project. The key view represents the specific locations for an individual project, with a view from one of the affected viewer groups that might potentially be affected by the project. A photo simulation of the proposed Route 28 realignment can be seen in Figure 15.2-1

Figure 15.2-1. Key Viewpoint 1: GRN #57, Route 28 Widening

Orientation: The photograph is taken looking north along Route 28. The photograph is taken just north of the Route 28/1 intersection. This view was selected to show the anticipated impacts to a residential area of the proposed roadway widening.

- Existing Visual Character/Quality: The existing visual character of the roadway is that of a residential street. The power lines are considered a visual encroaching element, while the lack of curb and gutter creates a more rural appearance to the residences. The general visual quality of the view is moderate, with moderate vividness, moderately low intactness, and moderate unity.
- Proposed Project Features: The project would add a center turn lane to the existing two-lane roadway, widening the road cross section. There would still be no curb and gutter along the roadway, helping to maintain the "rural" nature of the corridor.
- Changes to Visual Character/Quality: It is anticipated that the existing moderate visual quality would be maintained with the addition of the center turn lane.
- Anticipated Viewer Response: It is anticipated that the primary viewers would be the residents along the roadway, as well as residents traveling along the road. Secondary viewers would be those on the roadway not associated with the area. The residents would be expected to have a moderately high to high sensitivity to the changes in the area, given their familiarity with the existing roadway.
- Resulting Visual Impact: The anticipated resulting visual impact would not substantially alter the existing views.

Summary

Within the North region, GRN #9, 10, 22, 57, 117, and 124 have been identified as having a potential to affect the visual quality of the island, specific to their project areas. In general, the roadways and intersections widened by the GRN projects would have an increased urban character to the views of the roadways. Those traveling on the roadway would likely find the wider pavement sections very noticeable. Pedestrians and those living or working adjacent to the roadway or intersection would likely find the changes very noticeable as well; however, it is not anticipated that these viewers would be highly sensitive to the individual changes, given the cumulative nature of the roadway visual quality changes.

Of the projects in the North region, it is anticipated that GRN #57 (Route 28 widening), and GRN #124 (new Finegayan Connection), would cause a slight decrease in the existing visual quality of the corridors. In the case of Route 28, viewer sensitivity is expected to be high, given the residential character of portions of the roadway. The Finegayan Connection does not have the viewer sensitivity of Route 28; however, because the roadway would be located through an area of unpaved roads, it would add an urban element where none currently exists.

Indirect impacts of the projects, particularly the roadway and intersection widening projects, would be an increase in the urban character of the North region of the island from its current, generally rural appearance.

A cumulative impact is defined as the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of which agency or person undertakes such actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. The cumulative nature of all of the proposed projects associated with Alternative 1 across the island is to change the overall visual character to a more urban view.

Central

Table 15.2-6 identifies all of the projects within the Central region. The table indicates the disposition of each project in terms of this analysis. Following the table is a description of the anticipated impact of each of the projects analyzed within the Central region; this information is also summarized in Table 15.2-7. An analysis of a key view for GRN #36 depicts the anticipated changes to the visual environment.

Table 15.2-6. Guam Road Network Projects Considered for Analysis, Central Region

GRN #	*Route Number*	*Alternatives*				*Carried Forward for Further Analysis?*	*Reason for Inclusion or Exclusion*
		1	*2*	*3*	*8*		
1	Route 1/ Route 8	x	x	x	x	**Yes**	Project widens the existing Route 1/8 intersection by providing 2 left-turn lanes and 2 right-turn lanes for northbound Route 8 approaching Route 1.
2	Route 1/ Route 3	x	x	x	x	**Yes**	Project would widen the existing Route 1/3 intersection by providing a southbound left-turn lane, a combined left-/right-turn lane, and free right-turn lane with acceleration lane. Also includes east-to-north double left-turn lane.
3	1	x	x	x	x	**Yes**	Replacement of an existing bridge over the Agana River.
6	1	x	x	x	x	No	This project does not require widening (only pavement strengthening).
7	1	x	x	x	x	No	This project does not require widening (only pavement strengthening).
11	Chalan Lujuna	x	x	x	x	**Yes**	This project includes pavement strengthening (2 lanes) from Route 1 to Route 15; add turning lane and intersection improvements for trucks.
12	15	x	x	x	x	No	This project does not require widening (only pavement strengthening).
13	1	x	x	x	x	No	This project does not require widening (only pavement strengthening).
14	1	x	x	x	x	No	This project does not require widening (only pavement strengthening).
15	1	x	x	x	x	No	This project does not require widening (only pavement strengthening).
16	8	x	x	x	x	**Yes**	Project includes pavement strengthening, widening from 4/6 lanes to 6 lanes, with median from Tiyan Parkway/ Route 33 (east) to Route 1.
17	8	x	x	x	x	No	This project does not require widening (only pavement strengthening).
18	16	x	x	x	x	No	This project does not require widening (only pavement strengthening).
19	16	x	x		x	**Yes**	Pavement strengthening, widening from 4 to 6 lanes, with median from Route 10A to Sabana Barrigada Drive.
20	16	x	x	x	x	No	This project does not require widening (only pavement strengthening).
21	27	x	x	x	x	No	This project does not require widening (only pavement strengthening).

Table 15.2-6. Guam Road Network Projects Considered for Analysis, Central Region

GRN #	*Route Number*	*Alternatives*				*Carried Forward for Further Analysis?*	*Reason for Inclusion or Exclusion*
		1	*2*	*3*	*8*		
28	26	x	x	x	x	**Yes**	Pavement strengthening, widen from 2 lanes to 4 lanes from Route 1 to Route 15. Provide northbound left-turn, through, through/right, southbound left-turn, 2 through lanes, and right-turn, eastbound left-turn, left-through, and right-turn lane. Southbound right-turn should have raised island and free right to westbound Route 25 curb lane.
29	25	x	x	x	x	**Yes**	Pavement strengthening and widen from 2 lanes to 4 lanes from Route 16 to Route 26.
30	10	x	x	x	x	No	This project does not require widening (only pavement strengthening).
31	8A	x	x		x	No	This project does not require widening (only pavement strengthening).
32	15	x	x	x	x	No	This project does not require widening (only pavement strengthening).
33	1	x	x	x	x	No	This project does not require widening (only pavement strengthening).
35	1	x	x	x	x	**Yes**	Replacement of the existing bridge over the Fonte Rivers.
36	15	x	x	x	x	**Yes**	This project would require a new road alignment through forested areas.
44	MAP	x	x	x	x	No	Anticipated changes are expected to be minor and would not alter the existing visual environment.
46	MAP	x	x	x	x	No	Anticipated changes are expected to be minor and would not alter the existing visual environment.
47	MAP			x		No	Anticipated changes are expected to be minor and would not alter the existing visual environment.
48	MAP			x		No	Anticipated changes are expected to be minor and would not alter the existing visual environment.
49	MAP			x	x	No	Anticipated changes are expected to be minor and would not alter the existing visual environment.
49A	MAP			x		No	MAP 13A, new access across from Chada Street.
63	16			x		**Yes**	Pavement strengthening, widening from 4 to 6 lanes, with median from Route 10A to Sabana Barrigada Drive.
74	8A			x		**Yes**	Widen to provide median and shoulders along roadway.
113	7	x	x			No	Signing, striping, and minor intersection construction to establish 2-lane circulation around “Y” intersection.

Table 15.2-7. General Visual Quality per Road Corridor/Project Area, Central Region

GRN #	Route Number	Segment Limits	FHWA Visual Assessment Criteria			Overall Visual Quality (V + I + U/3)	Existing vs. Proposed Visual Quality
			Vividness	Intactness	Unity		
1	1	Route 1/8 Intersection	Moderate	Moderate	Moderately Low	Moderate	Existing
			Moderate	Moderate	Moderately Low	Moderate	Post-Construction
2	1	Route 1/3 Intersection	Moderately High	Moderately High	Moderate	Moderately High	Existing
			Moderately High	Moderately High	Moderate	Moderately High	Post-Construction
3	1	Agana Bridge Replacement	Moderate	Moderate	Moderate	Moderate	Existing
			Moderate	Moderate	Moderate	Moderate	Post-Construction
11	Chalan Lujuna	Route 1 to Route 15	Moderately High	Moderately High	Moderate	Moderately High	Existing
			Moderately High	Moderately High	Moderate	Moderately High	Post-Construction
16	8	Tiyan Parkway/ Route 33 (east) to Route 1	Moderate	Moderate	Moderate	Moderate	Existing
			Moderate	Moderate	Moderate	Moderate	Post-Construction
19	16	Route 10A to Sabana Barrigada Drive	Moderate	Moderate	Moderate	Moderate	Existing
			Moderate	Moderate	Moderately Low	Moderate	Post-Construction
28	26	Route 3 to Andersen AFB (North Gate)	Moderately High	Moderately High	Moderately High	Moderately High	Existing
			Moderate	Moderate	Moderate	Moderate	Post-Construction
29	25	Route 1 to Route 3	Moderately High	Moderately High	Moderately High	Moderately High	Existing
			Moderate	Moderate	Moderate	Moderate	Post-Construction
35	1	Fonte Bridge Replacement	Moderately High	Moderate	Moderate	Moderate	Existing
			Moderate	Moderate	Moderate	Moderate	Post-Construction
36	15	Route 15 Realignment	Moderate	Moderately High	Moderately High	Moderately High	Existing
			Moderate	Moderate	Moderate	Moderate	Post-Construction
63	16	Route 10A to Sabana Barrigada Drive	Moderate	Moderate	Moderate	Moderate	Existing
			Moderate	Moderate	Moderately Low	Moderate	Post-Construction
74	8A	Route 10A to Sabana Barrigada Drive	Moderately High	Moderately High	Moderate	Moderately High	Existing
			Moderate	Moderate	Moderately High	Moderate	Post-Construction

GRN #1, Route 1/8 Intersection

Changes to the visual environment for the intersection include the creation of double turn lanes (both right and left) for Route 8 as it approaches Route 1. It is anticipated that this change would not alter the existing visual quality of the area. The overall visual quality of the interchange should remain at moderate, with moderate vividness, moderate intactness, and moderately low unity.

GRN #2, Route 1/3 Intersection

The intersection would be modified by outside pavement widening along southbound Route 1 and southbound Route 3 to accommodate increased traffic volumes. The approaches to the intersection would consist of two left and three through lanes (northbound Route 1); one u-turn, three through, and one right-turn lanes (southbound Route 1); and one left, one shared left/right, and one right lane (southbound Route 3). The departures from the intersection would replicate the existing conditions, except that an acceleration lane would be added on Route 1 south of the intersection to facilitate right turns from southbound Route 3. The interchange improvements would not require the removal of trees or other large vegetation. It is anticipated that the overall visual quality of the intersection would remain at moderately high, with moderately high vividness, moderately high intactness, and moderate unity.

GRN #3, Bridge Replacement on Route 1 over the Agana River

The new structure would be lengthened to approximately 54.5 ft (16.6 m) with 15 ft (5 m) approach slabs to adequately accommodate the hydraulic flow of the river. The width of the new structure would be similar to the existing, at approximately 84 ft (26 m), accommodating six 11-ft (3-m) wide lanes, a 4.5-ft (1.4-m) wide median, and a 5.5-ft (1.7-m) wide sidewalk with a 1.0-ft (0.3-m) barrier on each side. Figure 15.2-2 shows an elevation of a typical replacement bridge. The new structure, although larger, is anticipated to appear approximately the same in scale within the visual environment. Providing an open railing to the bridge would help connect the traveler on Route 1 to the surrounding landscape. Given that the bridge is near one of the tourist attractions on the island, the aesthetics of the visible bridge elements should be considered in the overall design of the bridge. It is anticipated that the overall visual quality of the area would remain at moderate, with moderate vividness, intactness and unity. Additional mitigation measures that address the aesthetics of the bridge could increase the vividness to moderately high, if applied.

GRN #11, Chalan Lujuna from Route 1 to Route 15

This project would improve the intersections of Chalan Lujuna with Routes 1 and 15 to allow for truck turning movements, which equates to bigger radii at the corners of the intersections. While the intersections may appear slightly bigger due to the increase of corner radii, the roadway itself would retain the same appearance. It is anticipated that the general visual quality for the roadway would remain at moderately high, with moderately high vividness, moderately high intactness, and moderate unity.

GRN #16, Route 8 from Tiyan Parkway (Route 33 East) to Route 1

This project would widen the existing Route 8 from four to six lanes. Portions of the existing Route 8 are already at six lanes, leaving sections approaching Route 1 to be widened. Since portions of the road are already at six lanes, the project is not anticipated to change the overall visual quality of the roadway; therefore, the general visual quality of the roadway should maintain a moderate rating, with moderate vividness, intactness, and unity.

GRN #19, Route 16 from Route 10A to Sabana Barrigada Drive

This project would add a lane in each direction, making Route 16 a six-lane facility with a center median. In addition a four lane, signalized, access would be provided to the new MAP. Given the urban nature of the development along the roadway, it is unlikely that the impacts would substantially alter the existing visual environment. The overall visual quality would likely remain at moderate, with moderate vividness, intactness, and unity. If the median is a planted median, then the vegetation within the median would likely provide a break from the expanse of pavement created by the six-lane facility and could improve the visual quality of the roadway.

GRN #28, Route 26 from Route 1 to Route 15

This project would widen an existing two-lane road to four lanes. The roadway currently travels through heavily residential areas. The sensitivity of the viewers, especially residents, is expected to be high. The widening project would reduce the overall moderately high visual quality to moderate, with moderate vividness, intactness, and unity. This is due to the widened pavement section and the anticipated sensitivity of the viewers.

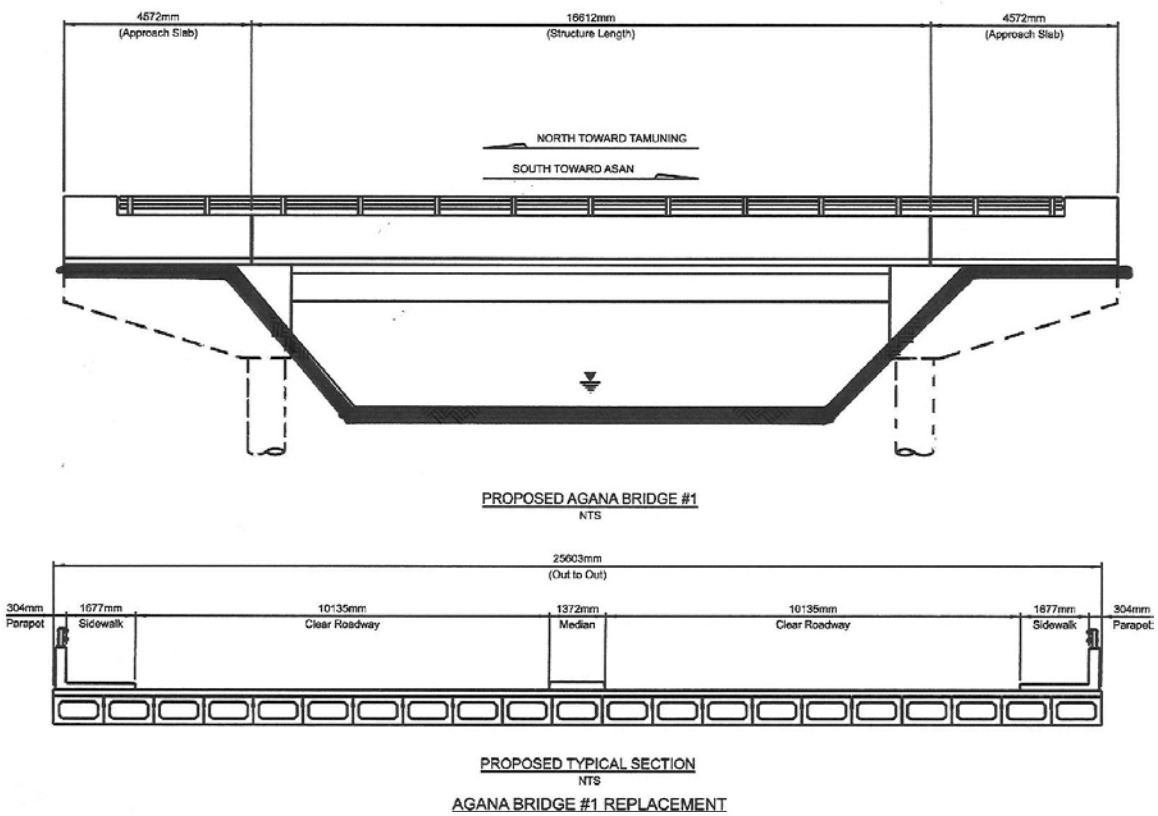

Figure 15.2-2. Typical Bridge Replacement Elevations

GRN #29, Route 25 from Route 16 to Route 26

This project would widen the existing narrow two-lane road to a four-lane road. The area is heavily residential. It is anticipated that the project would reduce the overall visual quality from moderately high to moderate, with moderate vividness, intactness, and unity. The lowered visual quality is due to the anticipated high viewer sensitivity from the residences, as well as the anticipated removal of vegetation along the roadway that would likely change the character of the existing roadway.

GRN #35, Bridge Replacement on Route 1 over the Fonte River

The new bridge over the Fonte River is anticipated to be 78 ft (24 m) long, matching the existing structure length. The width would also match the existing 100-ft (30-m) width, which accommodates six 12-ft (4-m) wide lanes and a 14-ft (4-m) wide median, with a 6-ft (2-m) wide sidewalk and a 1-ft (1-m) barrier on each side. In addition to the concrete abutments supported on drilled shafts, the new Fonte Bridge would include concrete columns founded on spread footings, drilled shafts, or steel piles.

The existing visual quality of the bridge and area is anticipated to remain at moderate, with moderately high vividness, moderate intactness, and moderate unity. The removal of utilities visibly suspended across the bridge and the use of an open railing would improve the visual quality of the bridge.

GRN #36, Route 15 Realignment

For drivers on Route 15, its realignment would provide new views to the roadway. The new Route 15 would have a wider cross section in the landscape, with wider shoulders and a median for future widening. East of the new alignment would be a buffer road that parallels the alignment. This road would be on military property and separated from Route 15 by a fence. It is also anticipated that this new road would sit higher in the landscape, and the area between the two roads would be cleared of vegetation other than grasses. The new buffer road would have two new bridges that would cross over the new Route 15 and be very noticeable to those traveling on the road. These bridges would represent a new element in the landscape. Currently, there are very few bridge overcrossings on the island. It is anticipated that the effects to the general visual quality of the area would be moderate, with moderate vividness, intactness, and unity. This equates to maintaining the vividness visual quality from existing and lowering the intactness and unity ratings from moderately high to moderate.

GRN #63, Route 16 from Route 10A to Sabana Barrigada Drive

Similar to GRN #19, this project would add a lane in each direction, making Route 16 a six-lane facility with a center median. In addition a four lane, signalized, access would be provided to the new MAP. Given the urban nature of the development along the roadway, it is unlikely that the impacts would substantially alter the existing visual environment. The overall visual quality would likely remain at moderate, with moderate vividness, intactness, and unity. If the median is a planted median, then the vegetation within the median would likely provide a break from the expanse of pavement created by the six-lane facility and could improve the visual quality of the roadway.

GRN #74, Route 8A from Route 16 to NAVCAMS Barrigada

This project would widen Route 8A to include a center median for left turns and shoulders. The changes would increase the paving section. Particularly in the residential and elementary school area, viewers are likely to be very sensitive; however, the changes are not anticipated to change the existing overall visual quality for the roadway that should remain at moderately high, with moderately high vividness, moderately high intactness, and moderate unity.

Key Viewpoint 2: GRN #36, Route 15 Roadway Realignment

Orientation: The photograph is taken looking north through the old military entrance gate toward the proposed new alignment of Route 15.

- Existing Visual Character/Quality: The existing character has a weedy, abandoned appearance. The surrounding forested areas have been removed, as has the old housing. What is left are the cleared areas and old road network where the housing once was. The general visual quality of the view is moderately low, with low vividness, moderately low intactness, and unity.
- Proposed Project Features: The project would construct a new two-lane roadway through the area, with a second road (the parameter road) paralleling the new Route 15 to the east. This new road would sit higher in the landscape than Route 15. In the distance, the new bridge over Route 15 would be visible.
- Changes to Visual Character/Quality: The project is anticipated to maintain or slightly improve the existing moderately low visual quality in the view. Construction of the two roadways would, in some ways, unify the overall appearance in the view by removing the abandoned elements in the current view. It is anticipated that the vividness would increase to moderate, along with the intactness, while the unity would remain at moderately low.
- Anticipated Viewer Response: It is anticipated that viewers would primarily be associated with roadway travelers. These viewers would have a moderate sensitivity to the changes in the area, with daily commuters having a greater sensitivity than those new to this portion of the island. Residents, who generally live north of the realignment area, would have a higher sensitivity, but because the roadway is not visible from the homes, their views would be associated with roadway travel.
- Resulting Visual Impact: The anticipated resulting visual impact would not substantially alter the existing views.

Summary

Projects within the Central region that are part of Alternative 1 that have been identified as having potential impacts are GRN #1, 2, 3, 11, 16, 28, 29, 35, and 36. These impacts are associated with GRN #28, 29, 35, and 36. As discussed in the North Region, the projects would cause an increase in the urban character of the island. Currently, the Central Region is the most densely developed portion of the island, and the widening of these roadways and intersections would extend that urban character farther, causing a slight degradation of the existing rural character of some of these roadways.

In particular, GRN #28 on Route 26 and GRN #29 on Route 25 would reduce the visual quality of the roadways from moderately high to moderate. These roads are currently narrow two-lane roads through residential areas, with substantial vegetation along portions of the roadways. Widening these to four-lane roads would change the character of the roadways to a more urban character. Given that these roadways are residential in nature, it is anticipated that viewer sensitivity would be high. In addition to the roadway and intersection widening projects, there are two bridge replacement projects – GRN #3 and 35. Construction of the new bridges, from a driver's perspective on Route 1, is anticipated to cause only a minor change to the visual environment of the Route 1 corridor. Viewer sensitivity of those on Route 1 is anticipated to be low. The most noticeable change would be associated with the new railing that would be visible from the roadway. Because Route 1 crosses over each of the rivers, the railings are the only visible element of the bridge.

In general terms and given the proximity to adjacent development for most of the bridges, it is unlikely that the new bridges would be noticeable from off the roadway in the long-term. Many of these views are screened from adjacent uses by existing vegetation; however, for the short-term in many of these locations, the most noticeable changes associated with construction of the new bridges would be the need for temporary clearing in and around the bridge sites to make way for the bridge construction.

The bridges do present an opportunity to increase the visual quality of the corridor over the existing moderate to moderately high ratings. Mitigation in the form of open railings and other urban design elements could increase the visual quality of the structure to those traveling on Route 1. These are discussed further under the Potential Mitigation Measures subsection.

Indirect impacts of the projects, particularly the roadway and intersection widening projects, would be an increase in the urban character of the Central Region of the island from its current, generally rural appearance.

Apra Harbor

Table 15.2-8 identifies all projects within the Apra Harbor Region. The table indicates the disposition of each project in terms of this analysis. Following the table is a description of the anticipated impact of each of the projects analyzed within the region.

Table 15.2-8. Guam Road Network Projects Considered for Analysis, Apra Harbor Region

GRN #	*Route Number*	*Composite Alternatives*				*Carried Forward for Further Analysis?*	*Reason for Inclusion or Exclusion*
		1	*2*	*3*	*8*		
4	11	x	x	x	x	No	This project does not require widening (only pavement strengthening).
5	Route 1/ Route 11	x	x	x	x	**Yes**	Add a second left-turn lane from Route 11 to Route 1, adding an additional 14-ft (4-m) wide lane to the outside of Route 11.
24	5	x	x	x	x	No	This project does not require widening (only pavement strengthening).
26	2A	x	x	x	x	No	This project does not require widening (only pavement strengthening).
35	1	x	x	x	x	**Yes**	Replacement of various existing bridges over the Atantano, Laguas, and Sasa rivers.
50	MAP	x	x	x	x	No	Anticipated changes are expected to be minor and would not alter the existing visual environment.

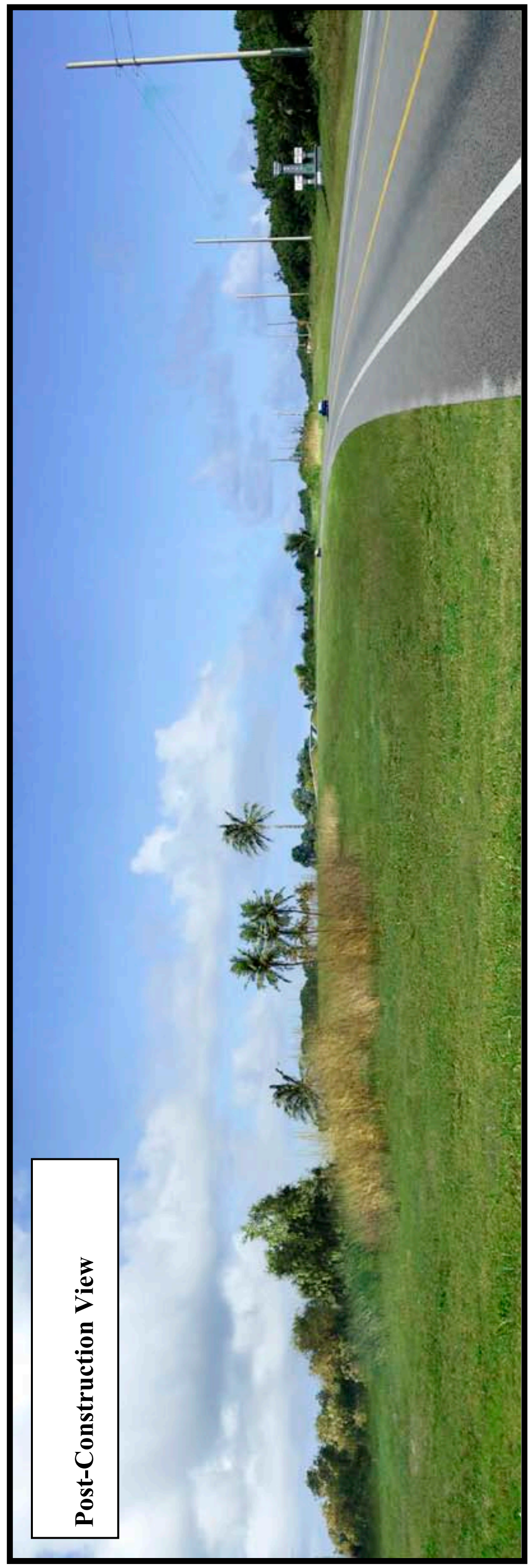

Figure 15.2-3. Key Viewpoint #2: GRN #36, Route 15 Roadway Realignment

Table 15.2-9 summarizes the anticipated changes to the visual environment based on the proposed projects.

Table 15.2-9. General Visual Quality per Road Corridor/Project Area, Apra Harbor Region

GRN #	*Route Number*	*Segment Limits*	*FHWA Visual Assessment Criteria*			*Overall Visual Quality (V + I + U/3)*	*Existing vs. Proposed Visual Quality*
			Vividness	*Intactness*	*Unity*		
5	1	Route 1/11 Intersection	Moderate	Moderate	Moderately Low	Moderate	Existing
			Moderate	Moderate	Moderately Low	Moderate	Post-Construction
35	1	Atantano Bridge Replacement	Moderately High	Moderately High	Moderate	Moderately High	Existing
			Moderate	Moderate	Moderate	Moderate	Post-Construction
35	1	Sasa Bridge Replacement	Moderate	Moderately Low	Moderate	Moderate	Existing
			Moderate	Moderately Low	Moderate	Moderate	Post-Construction
35	1	Laguas Bridge Replacement	Moderately High	Moderate	Moderate	Moderate	Existing
			Moderately High	Moderate	Moderate	Moderate	Post-Construction

GRN #5, Route 1/11 Intersection

Reconstruction of the intersection, including pavement strengthening and other project elements within the existing roadway associated with the pavement strengthening project (GRN #4), is not anticipated to change the visual environment of the intersection. Given the industrial nature of the area, viewer responses to the changes are likely to be very low to the new intersection. The overall visual quality for the Route 1/11 intersection is anticipated to remain at moderate, with moderate vividness, moderate intactness, and moderately low unity.

GRN #35, Atantano Bridge Replacement

The new bridge over the Atantano River would be lengthened to 60 ft (18 m) to adequately accommodate the hydraulic flows in the river. The bridge would have a similar width to the existing, at approximately 82 ft (25 m), accommodating four 12-ft (4-m) wide lanes, an 8-ft (2-m) wide median, and a 12-ft (4-m) wide shoulder and 1.0-ft (0.3-m) barrier on each side. In addition to the concrete abutments supported on drilled shafts, the new Atantano Bridge would include concrete columns founded on spread footings, drilled shafts, or steel piles.

This new bridge is not anticipated to substantially change the existing visual environment of the area. The bridge does not currently have adjacent development within close enough proximity to see any change to the bridge elevation. The new railing would be a visible element to those on Route 1. The current railing is open, allowing views into the surrounding forested land. As currently proposed, the new railing would be solid, with a railing on the top. This would likely reduce the views out to the forested areas, somewhat reducing the quality of the existing views. The general visual quality in the bridge area is anticipated to be moderate to moderately high, with moderate to moderately high vividness and intactness, and moderate unity.

GRN #35, Laguas Bridge Replacement

The new Laguas Bridge would be lengthened to approximately 60 ft (18 m) to accommodate hydraulic flows. The width of the proposed bridge would be similar to the existing 82 ft (25 m) and would accommodate the existing four 12-ft (4-m) wide lanes, an 8-ft (2-m) wide median, and a 12-ft (4-ft) wide shoulder and 1.0-ft (0.8-m) barrier on each side. The new bridge is not likely to alter the existing visual quality of the area, which is likely to remain at moderate, with moderately high vividness, moderate intactness, and moderate unity.

GRN # 35, Sasa Bridge Replacement

The new bridge over the Sasa River would match the existing length of 46 ft (14 m) with an 82-ft (25-m) width, similar to the proposed widths for the Laguas and Atantano bridges. It is anticipated that the new bridge would maintain the overall visual quality of the area at moderate, with moderate vividness, moderately low intactness, and moderate unity. Elements that might improve the visual quality would be to remove the utilities from the bridge and include a more open railing to create views to the surrounding forested areas.

Summary

Two projects within the Apra Harbor Region have been identified as having potential impacts to the existing environment. These are GRN #5 and 35. GRN #5 would widen the Route 1/11 intersection. This is anticipated to increase the urban character of the intersection, but it would not substantially alter the existing visual quality of the project area.

GRN #35 includes the replacement of the Atantano, Laguas, and Sasa bridges. Of these, the proposed bridge replacements would maintain the existing visual quality of the project areas for the Laguas and Sasa bridges and cause a slight degradation of the views at the Atantano Bridge. The degradation is due in part to the removal of the open railing on this bridge that currently allows views out into the forested lands beyond the bridge. Potential mitigation measures for the bridge replacement can be found under the Potential Mitigation Measures subsection.

Indirect impacts of the projects, particularly the roadway and intersection widening projects, would be an increase in the urban character of the Apra Harbor Region of the island from its current, generally rural appearance.

South

Table 15.2-10 identifies all of the projects within the South Region. The table indicates the disposition of each project in terms of this analysis. Following the table is a description of the anticipated impact of each of the projects analyzed within the region. None of the projects in the South Region have been carried forward for further analysis. It is not anticipated that they would have an impact to the visual environment.

Table 15.2-10. Guam Road Network Projects Considered for Analysis ̃ South Region

GRN #	*Route Number*	*Composite Alternatives*				*Carried Forward for Further Analysis?*	*Reason for Inclusion or Exclusion*
		1	*2*	*3*	*8*		
25	5	x	x	x	x	No	This project does not require widening (only pavement strengthening).
27	5	x	x	x	x	No	This project does not require widening (only pavement strengthening).
52	MAP	x	x	x	x	No	Anticipated changes are expected to be minor and would not alter the existing visual environment.
110	2	x	x			No	Convert northbound right-turn lane to a combined through/right-turn lane. No widening required.

Summary

None of the projects identified as part of Alternative 1 for the South Region are anticipated to have impacts associated with their implementation.

Potential Mitigation Measures

While the pavement strengthening projects do not require specific mitigation measures because there are no anticipated changes to the visual environment with these projects, as a whole cumulatively for the proposed GRN, the following mitigation measures could be implemented:

Potential Mitigation Measures Outside of DoD Control

- Develop an Aesthetics and Landscape Master Plan for the island's roadway corridors through a community-based effort that allows direct community input into the design process (i.e., Context-Sensitive Design Solutions).
- Provide an open railing to the extent possible to provide views from the bridge out to the adjacent areas.
- Hide utility crossings on the bridge between the girders or other methods of screening utilities from pedestrians on the bridge or adjacent land uses.
- To the extent feasible where roadways are widened, preserve existing trees or stands of vegetation by shifting the roadway alignment.

15.2.6.2 Alternative 2 (Preferred Alternative)

North

The roadway projects proposed for the North Region under Alternative 2 are the same as those proposed under Alternative 1 in terms of the effects to the visual environment; therefore, the impact conclusions are the same as those discussed for the North Region of Alternative 1.

Central

The roadway projects proposed for the Central Region under Alternative 2 are the same as those proposed under Alternative 1 in terms of the effects to the visual environment; therefore, the impact conclusions are the same as those discussed for the Central Region of Alternative 1.

Apra Harbor

The roadway projects proposed for the Apra Harbor Region under Alternative 2 are the same as those proposed under Alternative 1 in terms of the effects to the visual environment; therefore, the impact conclusions are the same as those discussed for the Apra Harbor Region of Alternative 1.

South

None of the projects identified as part of Alternative 2 for the South Region are anticipated to have impacts associated with their implementation.

Potential Mitigation Measures

Proposed mitigation for Alternative 2 is the same as discussed for Alternative 1.

15.2.6.3 Alternative 3

North

Alternative 3 is substantially the same as Alternatives 1 and 2 for the North Region; however, GRN #117, the Route 15/29 intersection improvements project, is not included in this alternative. It is anticipated that this project would not alter the existing visual environment of the project area; therefore, the impacts discussed under Alternative 1 for the North Region should be similar for Alternative 3 for the North Region.

Central

Within the Central Region, Alternative 3 includes two additional projects with potential impacts. These are GRN #63, that would widen portions of Route 16 from four to six lanes, and GRN #74 that would widen Route 8A to provide shoulders and a median. Neither of these two widening projects is anticipated to alter the existing visual quality of either roadway; therefore, the impacts in the Central Region for Alternative 3 are similar to those discussed for Alternative 1.

Apra Harbor

The roadway projects proposed for the Apra Harbor Region under Alternative 3 are the same as those proposed under Alternative 1; therefore, the impact conclusions are the same as those discussed for Alternative 1 in the Apra Harbor Region.

South

None of the projects identified as part of Alternative 3 for the South Region are anticipated to have impacts associated with their implementation.

Potential Mitigation Measures

Proposed mitigation for Alternative 3 is the same as those discussed for Alternative 1.

15.2.6.4 Alternative 8

North

Alternative 8 is substantially the same as Alternatives 1 and 2 for the North Region; however, GRN #117, the Route 15/29 intersection improvements project, is not included in this alternative. It is anticipated that this project would not alter the existing visual environment of the project area; therefore, the impacts discussed under Alternative 1 for the North Region should be similar for Alternative 8 for the North Region.

Central

Within the Central Region, Alternative 8 has the same list of projects with potential impacts as that associated with Alternative 1; therefore, the impacts in the Central Region for Alternative 8 are the same as those discussed for Alternative 1.

Apra Harbor

The roadway projects proposed for the Apra Harbor Region under Alternative 8 are the same as those proposed under Alternative 1; therefore, the impact conclusions are the same as those discussed for Alternative 1.

South

None of the projects identified as part of Alternative 8 for the South Region are anticipated to have impacts associated with their implementation.

Potential Mitigation Measures

Proposed mitigation for Alternative 8 is the same as those discussed for Alternative 1.

15.2.6.5 Summary of Impacts

Table 15.2-11 summarizes the potential impacts of each interim alternative. An analysis of long-term alternatives was not developed because the alternatives are not ready for project-specific analysis. A text summary is provided below.

Table 15.2-11. Summary of Potential Impacts to Visual Resources-Roadway Projects

Potentially Impacted Resource	*Alternative 1*	*Alternative 2**	*Alternative 3*	*Alternative 8*
Existing visual quality changes to a more urban visual character	SI-M	SI-M	SI-M	SI-M
Removal of vegetation in residential areas, changing the visual character	LSI	LSI	LSI	LSI

Legend: SI-M = Significant Impact Mitigable to Less Than Significant, LSI = Less Than Significant Impact, *Preferred Alternative.

In addition, there is limited land for development on the island, and large portions are already developed or off limits to non-military development; therefore, as the island population grows, either through the increase in military personnel or through endemic growth on the island, the development patterns would also likely become denser.

Mitigation in the form of aesthetic and design considerations and the preservation of vegetation within developed areas can help diminish or soften these changes to the visual character.

CHAPTER 16. MARINE TRANSPORTATION

16.1 INTRODUCTION

This chapter discusses the potential environmental consequences associated with implementation of the alternatives for Utilities and Off Base Roadway Projects (Guam) within the region of influence (ROI) for marine transportation. For a description of the affected environment for all resources, refer to the respective chapter of Volume 2 (Marine Corps Relocation – Guam). The locations described in that volume include the ROI for the utilities and roadway projects, and the chapters are presented in the same order as the resource areas contained in this volume.

16.2 ENVIRONMENTAL CONSEQUENCES

16.2.1 Approach to Analysis

The primary military, commercial, and recreational port facilities on Guam are located in Apra Harbor. It is critical that navigational access to the channels be maintained for these users. The consequences of the alternatives for the proposed project have been evaluated based on the magnitude and duration of impacts to navigation. For activities that would have an adverse impact on navigation, appropriate mitigation measures have been identified. The following analysis focuses on possible effects to marine transportation from the proposed relocation of the Marines from Okinawa to Guam.

16.2.1.1 Methodology

Apra Harbor is the only Department of Defense (DoD) harbor that could accommodate the Marine Corps ships; no documented alternatives analysis was conducted.

16.2.1.2 Determination of Significance

For marine transportation, the significance of impacts of the alternatives for Utilities and Off Base Roadway Projects are determined by the potential interference to marine vessel navigation from any proposed increase in vessel usage in Apra Harbor.

16.2.1.3 Issues Identified During Public Scoping Process

As part of the analysis, the concerns relating to navigation that were identified by the public during scoping meetings were reviewed. These concerns related to potential access restrictions to areas in Outer Apra Harbor as a result of the movement of military vessels.

16.2.2 Power

Power improvement alternatives would involve facilities that use fuel oil or liquefied natural gas (LNG). Fuel oil would be delivered by ship. It is expected that there would be up to one shipment of fuel oil per month. If a generating facility would be powered by LNG, the LNG would be transported in containers via a container ship from the United States (U.S.) and would be received at the container terminal at the Port of Guam. This would eliminate the need to develop or construct an LNG receiving terminal. The LNG would be transferred from the container ship to a truck for delivery to the LNG storage tanks. It is expected that there would be up to one shipment of LNG containers per month.

The annual number of vessels visiting the Port of Guam has decreased by 1,902 vessels over the period of 1995 to 2008. It is expected that the addition of up to 12 vessels per year transporting fuel for the power facilities above the average annual number of vessels visiting the Port of Guam would result in less than a significant impact on marine transportation in Apra Harbor.

16.2.2.1 Summary of Impacts

Table 16.2-1 summarizes the potential impacts of each interim alternative.

Table 16.2-1. Summary of Potential Impacts to Marine Transportation-Power

Potentially Impacted Resource	*Interim Alternative 1**	*Interim Alternative 2*	*Interim Alternative 3*
Apra Harbor	LSI	LSI	LSI

Legend: LSI = Less Than Significant Impacts. *Preferred Alternative.

With the estimated additional annual number of ships needed to provide extra fuel for power plant operations being only 12, the impact on marine transportation would be less than significant.

16.2.3 Potable Water

Neither of the potable water improvement alternatives would impact Apra Harbor or marine transportation within the harbor.

16.2.3.1 Summary of Impacts

Table 16.2-2 summarizes the potential impacts of each alternative.

Table 16.2-2. Summary of Potential Impacts to Marine Transportation-Potable Water

Potentially Impacted Resource	*Basic Alternative 1**	*Basic Alternative 2*
Apra Harbor	NI	NI

Legend: NI = No Impact. *Preferred Alternative.

16.2.4 Wastewater

None of the wastewater improvement alternatives would impact Apra Harbor or marine transportation within the harbor.

16.2.4.1 Summary of Impacts

Table 16.2-3 summarizes the potential impacts of each interim alternative.

Table 16.2-3. Summary of Potential Impacts to Marine Transportation-Wastewater

Potentially Impacted Resource	*Interim Alternative 1**	*Interim Alternative 2*	
		A	*B*
Apra Harbor	NI	NI	NI

Legend: NI = No Impact. *Preferred Alternative.

16.2.5 Solid Waste

Solid waste improvement alternatives would not impact Apra Harbor or marine transportation within the harbor.

16.2.6 Summary of Impacts

Table 16.2-4 summarizes the potential impacts of the preferred alternative.

Table 16.2-4. Summary of Potential Impacts to Marine Transportation-Solid Waste

Potentially Impacted Resource	*Preferred Alternative*
Apra Harbor	NI

Legend: NI = No Impact

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CHAPTER 17.
SOCIOECONOMICS AND GENERAL SERVICES

17.1 INTRODUCTION

This chapter discusses the potential environmental consequences associated with implementation of the alternatives within the region of influence for each resource. For a description of the affected environment for all resources, refer to the respective chapter of Volume 2 (Marine Corps Relocation – Guam). The locations described in that Volume include the region of influence for the utilities and roadway projects, and the chapters are presented in the same order as the resource areas contained in this volume.

Socioeconomic impacts would be islandwide in nature with little difference in effects among the various alternatives. Therefore, the summary of impacts presented below covers all of the alternatives except the no-action alternative, which is treated separately in Section 17.2.2.6.

17.2 ENVIRONMENTAL CONSEQUENCES

17.2.1 Methodology

Refer to corresponding section of Volume 2.

Analysis of impacts for Volume 6 is limited to the construction component, due to insufficient information about operational configurations.

No distinction is made among alternatives, as the critical input variable – construction cost – is not available for different alternatives. All calculations in this Chapter are based on single construction cost estimates for each Related Action provided by Joint Guam Program Office as of May 2009.

17.2.1.1 Determination of Significance

Refer to corresponding section of Volume 2.

The federal Council on Environmental Quality's guidelines for determining significance states, "significance cannot be avoided by terming an action temporary or by breaking it down into small component parts" (Code of Federal Regulations Title 40 Sec 1508.27(b)(7)). Compared to the Marine Relocation action discussed in Volume 2, the individual utility and roadway proposals discussed in this Volume are relatively "small component parts." However, because Volume 7 provides an assessment of significance for all the combined parts of the military buildup (the "aggregate action"), any finding in this chapter that the power, water, wastewater, solid waste, or roadways alone would have no impact (or a less than significant impact) does not avoid the possibility that the larger impact from the aggregate action would be significant.

17.2.1.2 Issues Identified During Scoping

Refer to corresponding section of Volume 2 for general discussion.

Most scoping comments focused on the specifics of utility ownership and operation (whether there would be joint use or independent Department of Defense [DoD] facilities), choice of technology, resistance to storms, and other logistical questions that have been previously addressed in the description and justification for the various alternatives.

There was also attention to the question of impacts on civilian ratepayers from the various utility alternatives, especially the rate differences dependent on whether the utilities would be strictly for DoD operations or provide any benefit to the civilian population. Also, several comments predicted adverse social reactions if certain roads and facilities "outside the fence" are designated military-only.

17.2.2 Utilities

17.2.2.1 Population Impacts

Refer to the corresponding section of Volume 2 for introductory statements.

Project Related Population

Approach to Analysis

Table 17.2-1 provides assumptions made in conducting analysis for the construction phase, as well as the source of or rationale for those assumptions.

Table 17.2-1. Construction Component Assumptions for Project Related Population Impacts

Assumption	*Assumed Value*	*Source/Rationale*
Average number of dependents for in-migrating direct, on-site, construction jobs	0.20 - 0.35	Estimate based on contractor interviews (Appendix F SIAS).
Average number of dependents for in-migrating direct from purchases jobs	0.95 - 1.0	U.S. Census national data on persons per jobs (U.S. Census 2000) and Guam DoL interviews (Appendix F SIAS).
Average number of dependents for in-migrating indirect/induced jobs	0.95 - 1.0	U.S. Census national data on persons per jobs (U.S. Census 2000) and Guam DoL interviews (Appendix F SIAS).

Table 17.2-2 indicates a 2012 peak-year impact of about 4,580 additional people.

Table 17.2-2. Population Increase related to Utilities

	2010	*2011*	*2012*	*2013*	*2014*
Total Impact	993	2,463	4,580	3,525	2,066

Figure 17.2-1 shows the projected total population for the baseline trend (projected future without the proposed action) plus the total combined impact of the proposed action. The chart shows the population rising to about 190,000 in 2012. The 2012 figure represents a 2.5% increase over the baseline trend. This meets the criteria used in this analysis for a significant impact, although population increases are considered to be inherently mixed (both beneficial and adverse), because population growth fuels economic expansion but sudden growth also strains government services and the social fabric.

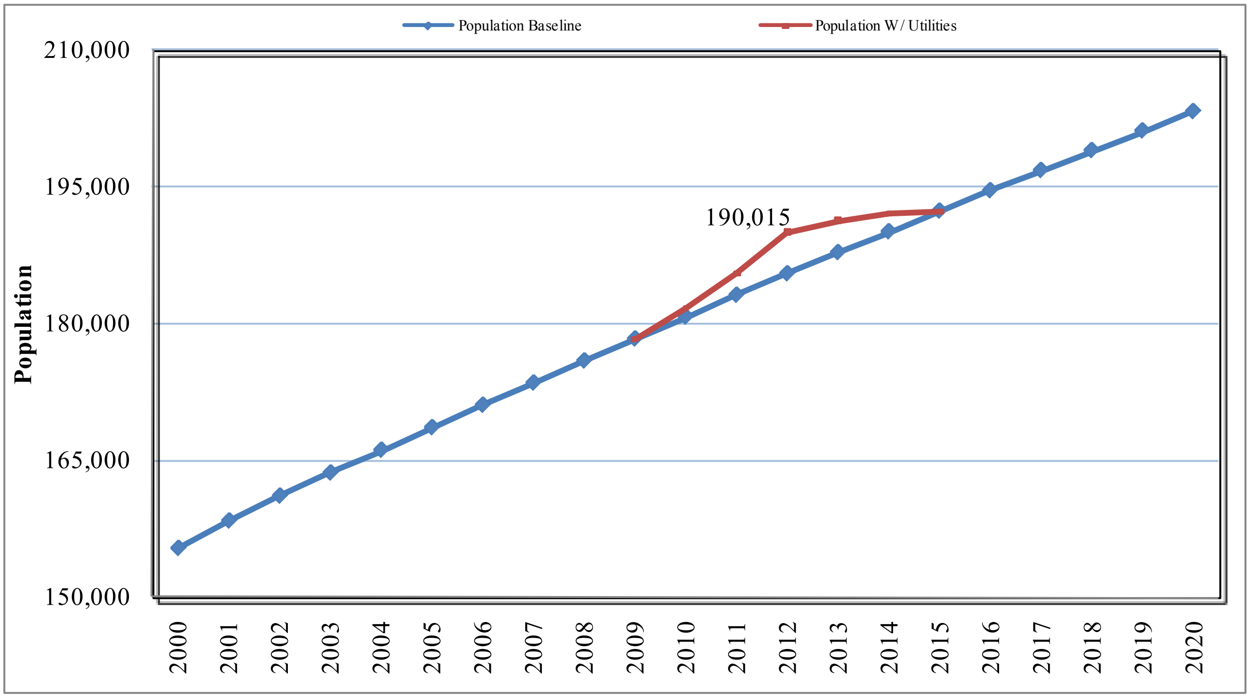

Figure 17.2-1. Population With and Without Utilities

<u>Demographic Characteristics</u>

Refer to the corresponding section of Volume 2.

<u>Household Characteristics</u>

Refer to the corresponding section of Volume 2.

17.2.2.2 Economic Impacts

<u>Employment and Income</u>

Refer to the corresponding section of Volume 2 for introductory statements, approach to analysis (including data sources), and impact analysis.

Civilian Labor Force Demand

Table 17.2-3 shows a civilian labor force demand for 3,333 workers in the peak year of 2012.

Table 17.2-3. Civilian Labor Force Demand (Full-Time Equivalent Jobs), Utilities

	2010	*2011*	*2012*	*2013*	*2014*
Total Impact	732	1,794	3,333	2,599	1,539

The figure below shows the projected total labor force demand for the baseline trend (projected future without the proposed action) plus the total combined impact of the proposed action. The chart shows the labor force demand rising to 60,940 in 2012, a 5.8% increase over the baseline trend. By the criteria used for this analysis, the impact is considered significant and beneficial.

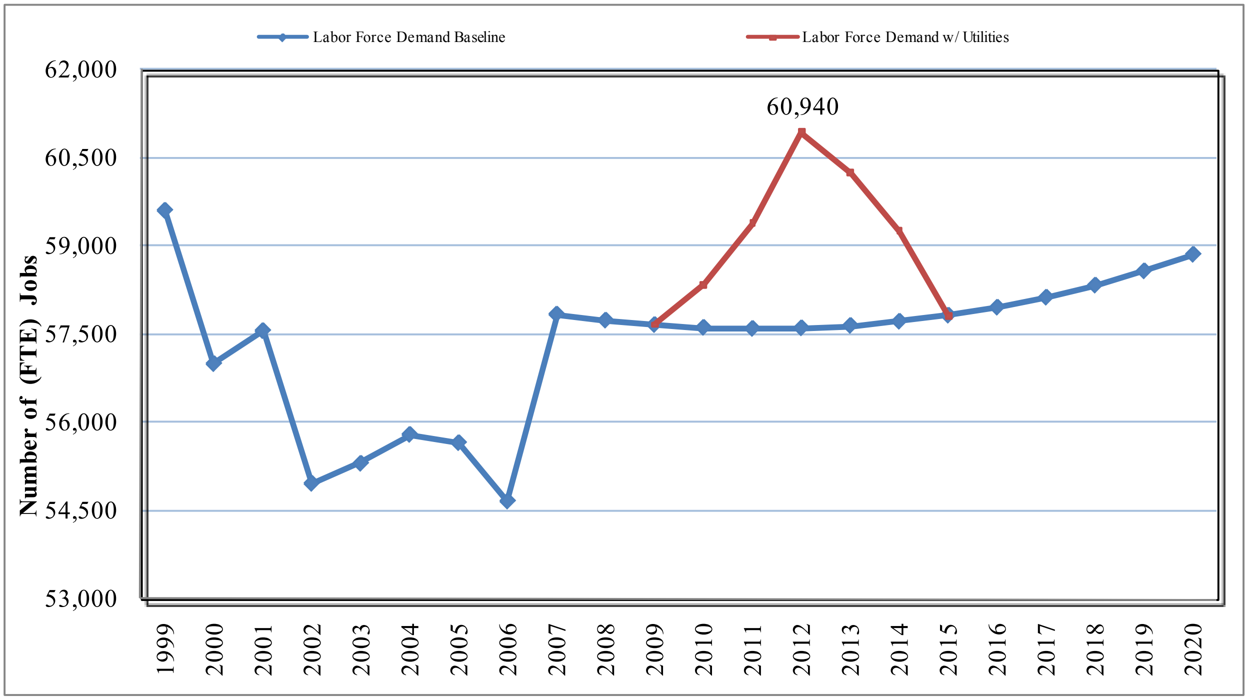

Figure 17.2-2. Civilian Labor Force Demand (Full-Time Equivalent Jobs) With and Without Utilities

Labor Source Supply

Table 17.2-4 shows the probable labor source supply for direct onsite military construction jobs.

Table 17.2-4. Estimated Origin of Workers Connected to Utilities Construction

	2010	*2011*	*2012*	*2013*	*2014*
TOTAL	**413**	**1,013**	**1,884**	**1,471**	**871**
GUAM	**73**	**163**	**272**	**188**	**111**
OFF-ISLAND	**339**	**849**	**1,611**	**1,283**	**760**
H-2B Workers	289	726	1,381	1,103	653
Philippines	245	617	1,174	938	555
Other	26	65	124	99	59
CONUS/HI/Japan	5	13	24	19	11
Supervisor (U.S., Japan)	2	5	10	8	5
Labor	3	8	14	11	6
Other U.S. Pacific Islands	45	111	206	161	95

Table 17.2-5 estimates the share of non-military construction direct and indirect jobs, going to Guam residents versus off-island workers.

Table 17.2-5. Estimated Numbers of On-Island Workers for Various Job Categories Other Than Direct On-Site Construction, Utilities

	2010	*2011*	*2012*	*2013*	*2014*
Guam Workers	50	99	166	140	92
Off-Island Workers	269	682	1,284	988	576

Civilian Labor Force Income

Table 17.2-6 below shows that labor force income from the proposed action increases by $125 million at the 2012 peak.

Table 17.2-6. Impact on Civilian Labor Force Income (Millions of 2008 $s), Utilities

	2010	*2011*	*2012*	*2013*	*2014*
Total Impact	$28	$68	$125	$98	$58

Figure 17.2-3 shows the projected total labor force income for the baseline trend (projected future without the proposed action) plus the total combined impact of the proposed action. The chart shows the labor force income rising to about $1.69 billion in 2012. The 2012 figure represents an 8% increase over the baseline trend. This meets the criteria used in this analysis for a beneficial significant impact.

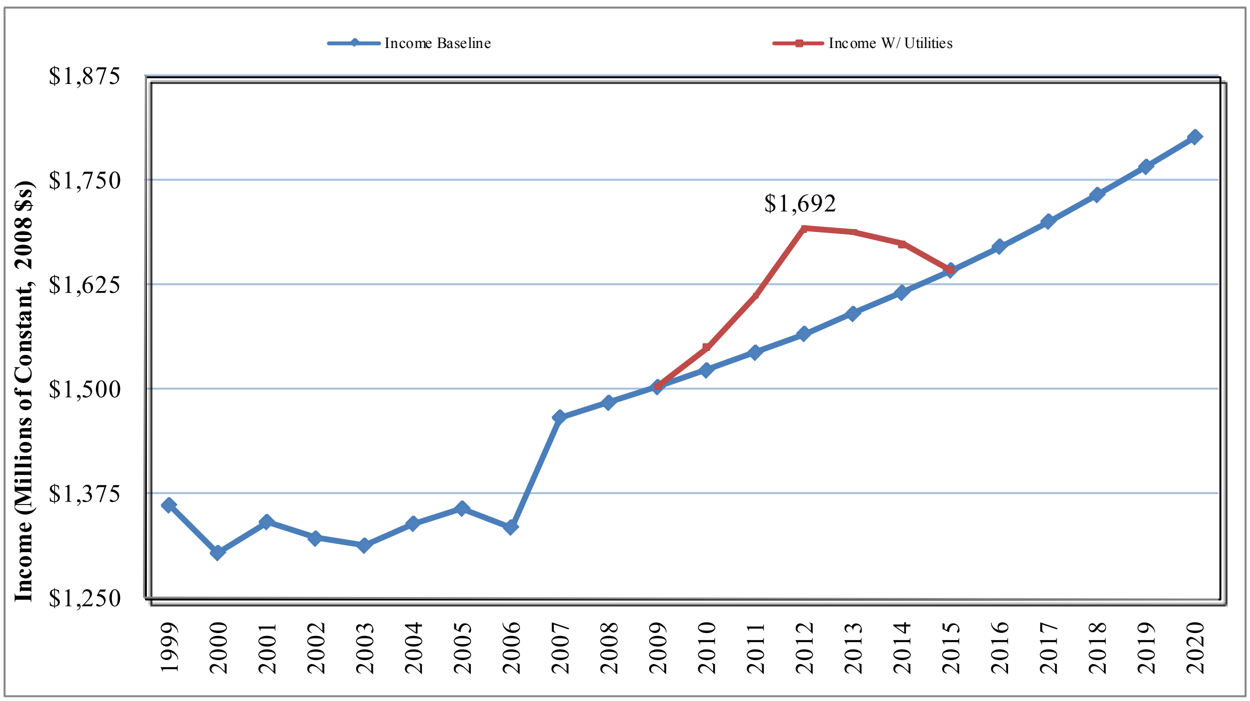

Figure 17.2-3. Civilian Labor Force Income (Millions of 2008 $s) With and Without Utilities

Figure 17.2-4 shows the projected total housing demand for the baseline trend (projected future without the proposed action) plus the total combined impact of the proposed action. The chart shows the housing demand rising to 66,088 in 2012. By the criteria used for this analysis, this is a less than significant impact for the utilities alone, except in conjunction with the aggregate action effects summarized in Volume 7.

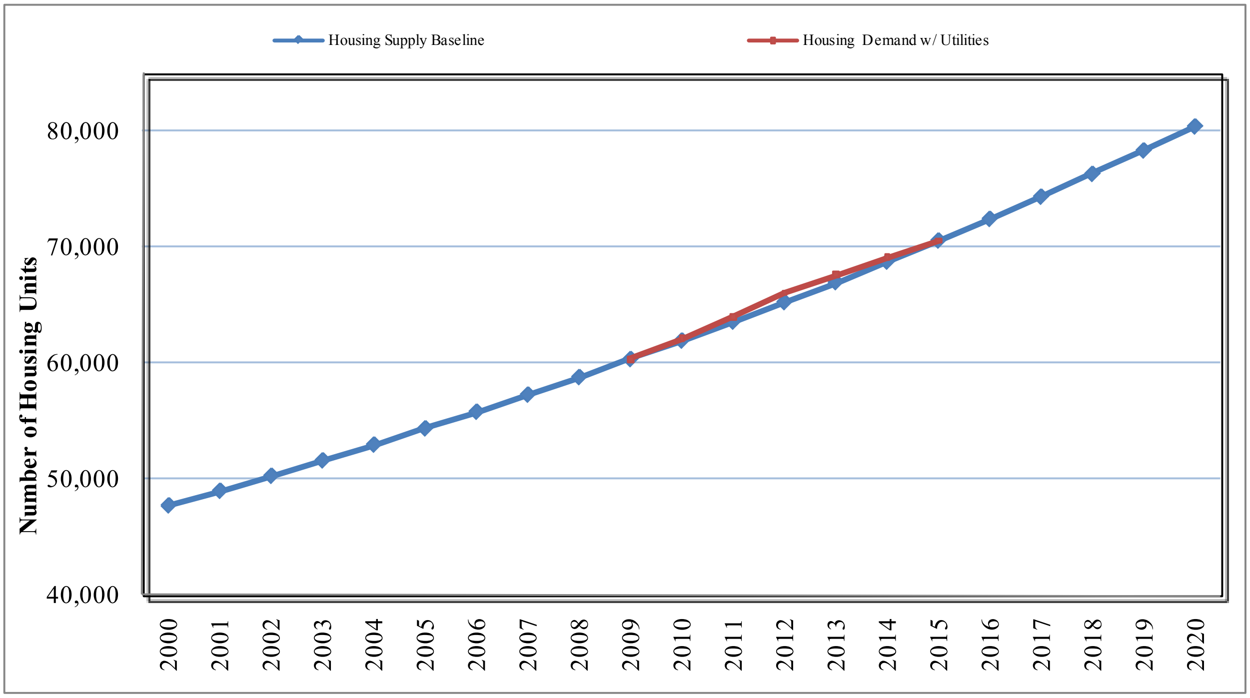

Figure 17.2-4. Housing Demand With and Without Utilities

Standard of Living

Refer to the corresponding section of Volume 2.

Unemployment

Refer to the corresponding section of Volume 2.

Housing

Refer to the corresponding section of Volume 2 for introductory statements and approach to analysis (including data sources).

Civilian Housing Demand

Table 17.2-7 indicates the impact of the proposed action would result in a demand for 822 new units in the peak year of 2012.

Table 17.2-7. Demand for New Civilian Housing Units, Utilities

	2010	*2011*	*2012*	*2013*	*2014*
Total Impact	181	446	822	622	363

Housing Supply

The housing market would be able to accommodate the demand if it did not occur simultaneously with other and larger aspects of the aggregate action.

Utility Rates - Power

Potential effects on ratepayers are unknown at this time and would depend in large part on agreements reached between the Department of Navy (Navy) and Guam Power Authority (GPA). The current

Customer Agreement was originally adopted in 1992, has since been updated, and is scheduled to end in 2012.

This agreement would likely need to be renegotiated. The outcome of the negotiations would determine, among other factors, the rates DoD will pay for the interim demand provided by the reconditioned generating systems owned by Guam Power Authority (GPA). Those systems are expected to be more expensive to operate than the average of the current GPA generating systems that are currently used. There will be additional capital expenses to upgrade transmission and distribution systems and installing some of those upgrades underground for improved reliability. Some of those capital expenses will have to be amortized over a short time period should the long-term solutions to power be constructed in the near future (currently assumed at 2015).

Utility Rates - Water

New DoD water facilities are likely to be operated separately from the system operated by Guam Water Authority (GWA) and hence, no impacts to Guam rate payers are expected from use by DoD facilities. However, current water customers, civilian military workers, and other direct and indirect workers related to the proposed action would be impacted as GWA embarks on a major capital improvement project that it is financing, partly through rate increases.

Utility Rates – Wastewater

GWA has been working under two federal waivers to the Clean Water Act; the waivers have relieved GWA of the requirement to conduct secondary sewage treatment. As of October 2009, the federal Environmental Protection Agency (EPA) has denied the renewal of these waivers (GWA may appeal the ruling). Without the waivers GWA would be required to upgrade existing facilities to conduct secondary treatment. Upgrading the facilities would be costly and drive wastewater rates higher. In the future, if the waiver denial is not revised, Guam ratepayers should expect higher wastewater rates. The proposed action would upgrade the North District Wastewater Treatment Plant (NDWWTP) primary treatment capacity in the near term and provide for secondary treatment in the medium term. The financing arrangements would need to be determined, but it is expected that the DoD would pay for their fair share of the upgrades to the NDWWTP through hook up and other user fees. There would also be the potential of a special purpose entity arrangement to facilitate the secondary capability for this plant. Under this scenario, the expected rate increases would be expected to be similar with or without the proposed action and could be less due to an expanded customer base over which to spread the impact.

Utility Rates – Solid Waste

Population increases as a result of the proposed action would increase the level of solid waste service that would need to be provided along with the total cost of providing services. The increased costs, though, would be spread over a larger group of ratepayers. It is possible that, as the level of service increases the services would become more efficiently operated and rates for individuals would decline. It is more likely; however, that rates would have little changes as a result of the proposed action.

Local Government Revenues

Refer to the corresponding section of Volume 2 for introductory statements and approach to analysis (including data sources).

Table 17.2-8, Table 17.2-9, and Table 17.2-10, show the impact of the proposed action would add $12.27 million to the Gross Receipts Tax (GRT), $3.1 million to the corporate income tax revenue, and $15 million to the personal income tax revenue in the 2012 peak.

Table 17.2-8. Impact on Gross Receipts Tax Revenue (1,000s of 2008 $s), Utilities

	2010	*2011*	*2012*	*2013*	*2014*
GRT	$2,692	$6,604	$12,278	$9,583	$5,674

Table 17.2-9. Impact on Corporate Income Taxes Revenue (1,000s of 2008 $s), Utilities

	2010	*2011*	*2012*	*2013*	*2014*
Corporate Income	$686	$1,684	$3,131	$2,444	$1,447

Table 17.2-10. Impact on Personal Income Taxes Revenue (1,000s of 2008 $s), Utilities

	2010	*2011*	*2012*	*2013*	*2014*
Personal Income	$3,306	$8,103	$15,049	$11,734	$6,948

Figure 17.2-5 shows the projected total GRT for the baseline trend (projected future without the proposed action) plus the total combined impact of the proposed action. The chart shows the gross receipts tax rising to $179 million at the 2012 construction peak, a 7% increase over the baseline trend. This meets the criteria used in this analysis for a beneficial significant impact.

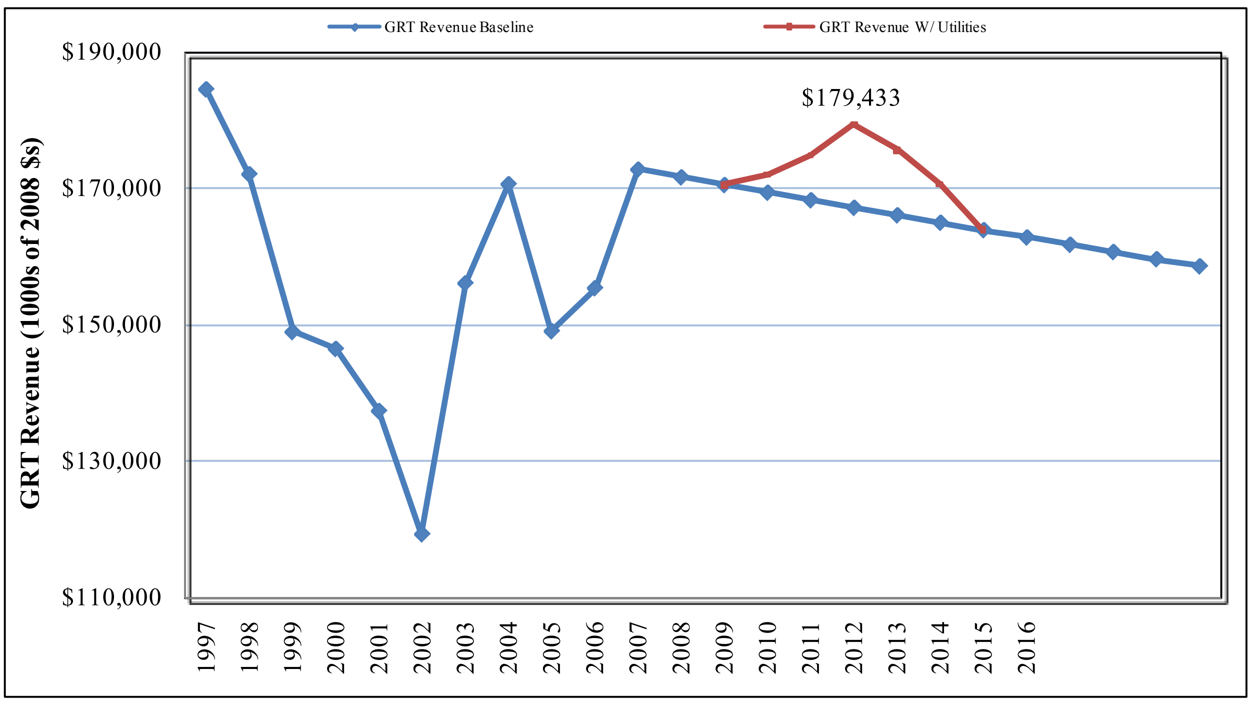

Figure 17.2-5. Gross Receipts Tax Revenue With and Without Utilities

Figure 17.2-6 shows the projected total income tax revenue – corporate and personal income taxes – for the baseline trend plus the total combined impact of the proposed action. The chart shows the income tax revenue rising to $259 million in 2012, an 8% increase over the baseline trend. This meets the criteria used in this analysis for a beneficial significant impact.

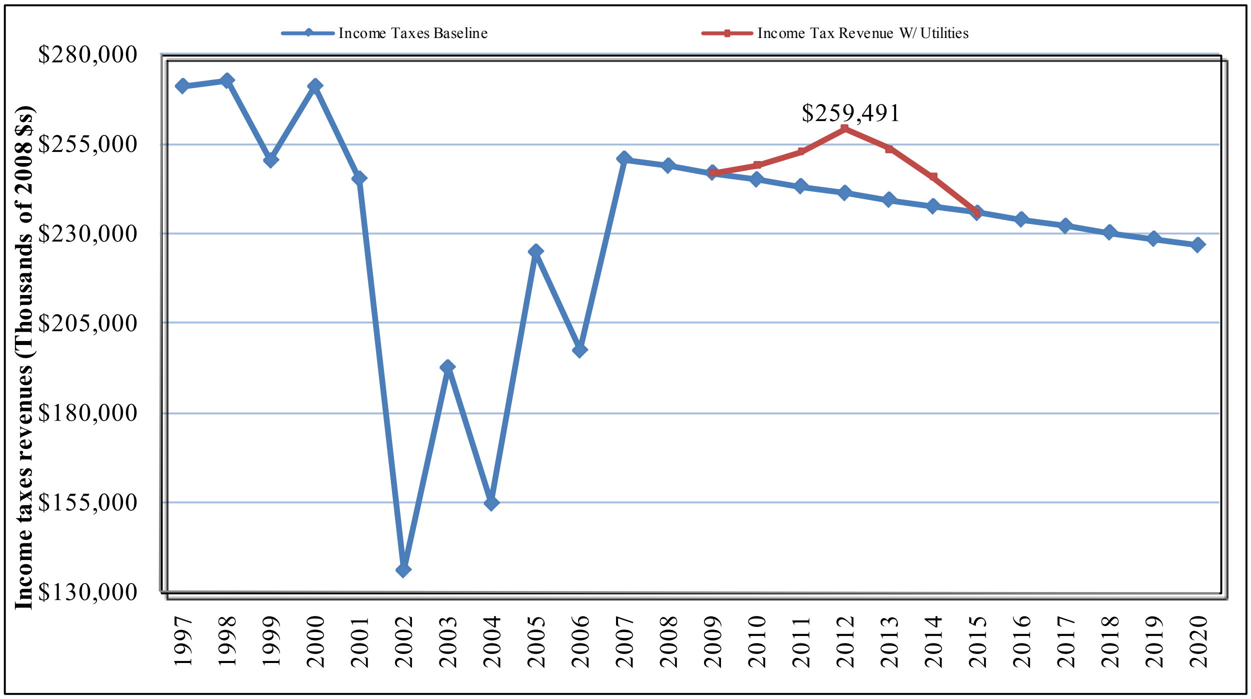

Figure 17.2-6. Income Taxes Revenue (Combined) With and Without Utilities

Gross Island Product

Refer to the corresponding section of Volume 2 for introductory statements and approach to analysis (including data sources).

Table 17.2-11 shows the impact would add a peak amount of $83 million to the Gross Island Product (GIP) in 2012.

Table 17.2-11. Impact on Gross Island Product (Millions of 2008 $s), Utilities

	2010	*2011*	*2012*	*2013*	*2014*
Total Impact	$18	$45	$83	$65	$38

Figure 17.2-7 shows the projected total GIP for the baseline trend (projected future without the proposed action) plus the total combined impact of the proposed action. The chart shows the GIP rising to $4.39 billion in 2012. The 2012 figure represents a 2% increase over the baseline trend. This is a significant beneficial impact.

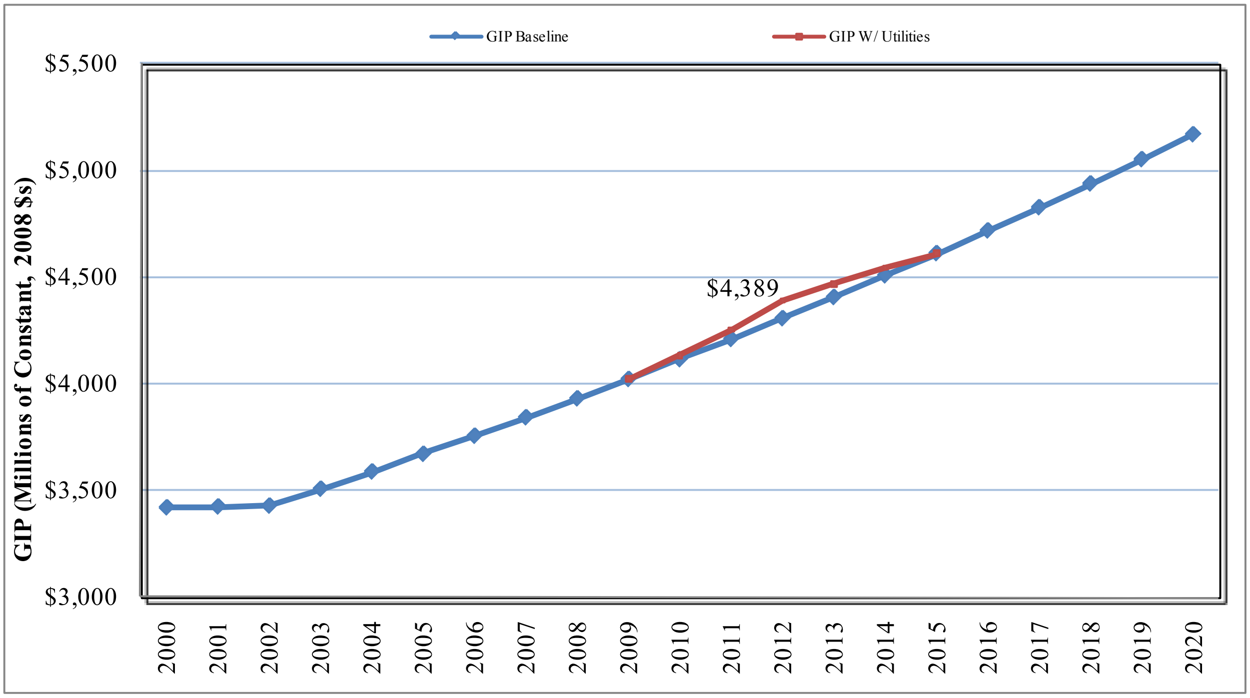

Figure 17.2-7. Gross Island Product (Millions of 2008 $s) With and Without Utilities

17.2.2.3 Public Service Impacts

Refer to the corresponding section of Volume 2 for introductory statements, approach to analysis (including data sources), and qualitative impact analysis. Some public service impacts associated with utilities alternatives are expected to be significant..

Public Education

Table 17.2-12 shows the estimated number of key full time equivalent professional staff required due to utilities projects. The peak requirement in 2012, stemming from construction direct and indirect impacts, is about 2% greater than baseline staffing levels for all the agencies listed below. By the criteria used for this analysis, this would be considered a significant (adverse) impact.

Table 17.2-12. Additional Public Education Key Professionals Required, Utilities

	2010	*2011*	*2012*	*2013*	*2014*
GPSS Elementary Schools	4.5	11	20	15	9
GPSS Middle Schools	2	5	9	7	4
GPSS High Schools	2	5	8	6	4
GCC	0	1	2	2	1
UoG	1	2	4	3	2

Public Health and Human Services

Further discussion on public health implications can be found in Chapter 19 of this volume, “Public Health and Safety.”

Table 17.2-13 shows the estimated number of key FTE professional staff required due to the action. The peak requirement in 2012 is about 3% greater than reported baseline staffing levels for each agency listed below. By the criteria used for this analysis, this would be considered a significant (adverse) impact.

Table 17.2-13. Additional Public Health and Human Service Key Professionals Required, Utilities

	2010	*2011*	*2012*	*2013*	*2014*
GMHA Physicians	0.4	1	2	1	1
GMHA Nurses, Allied Health Professionals	2	5	10	8	5
GDPHSS Bureau of Primary Care Medical Providers and Nursing Staff	0.2	1	1	1	1
GDPHSS CDC Prevention Specialists	0.2	0.5	0.9	0.7	0.4
GDPHSS BFHNS Nursing Personnel	0.1	0.3	0.6	0.5	0.3
GDMHSA Mental Health Professionals	1	2	3	3	2
GDISID Social Workers and Counselors	0.1	0.2	0.4	0.3	0.2

Public Safety Services

Further discussion on public safety implications can be found in Chapter 19 of this volume, "Public Health and Safety."

Table 7.2-14 shows the estimated number of key FTE professional staff required due to the action. The peak requirement in 2014, when the full effects of the action are added to ongoing construction, is about 2% greater than reported baseline staffing levels. By the criteria used for this analysis, this would be considered a significant (adverse) impact.

Table 17.2-14. Additional Public Safety Key Professionals Required, Utilities

	2010	*2011*	*2012*	*2013*	*2014*
GPD Sworn Police Officers	2	4	8	6	4
GFD Uniformed Fire Personnel	1	3	6	5	3
GDoC Custody and Security Personnel	1	2	4	3	2
GDYA Youth Service Professionals	0.3	1	1	1	1

Other Selected General Services

Table 17.2-15 shows the estimated number of key FTE professional staff required due to the proposed action. The peak requirement in 2012 is about 2% greater than reported baseline staffing levels for each agency listed below. By the criteria used for this analysis, this would be considered a significant (adverse) impact.

Table 17.2-15. Additional Key Professionals Required for Selected Other General Services, Utilities

	2010	*2011*	*2012*	*2013*	*2014*
GDPR Staffing	0.5	1.3	2.3	1.8	1.1
PLS Staffing	0.2	0.4	0.7	0.6	0.3
Judiciary Judges	0.0	0.1	0.2	0.1	0.1

Growth Permitting and Regulatory Agencies

Table 17.2-16 shows the estimated number of key FTE professional staff required due to the action. The peak requirement for most agencies is only slightly above reported baseline staffing levels, but for a few agencies with very small baseline staff levels even the small numbers below represent a fairly high percentage increase. For example, the Alien Labor Processing and Certification Division (ALPCD) peak value of 2.3 is 46% greater than the baseline level (just five positions), and the peak Guam Department of Parks and Recreation (GDPR) - Historic Preservation Office (HPO), number of 1.3 is 19% greater than baseline. Although the percentages vary by agency, the overall assessment would be one of less than significant impacts for the utilities alone, except in conjunction with other aspects of the aggregate action.

Table 17.2-16. Additional Growth Permitting Staff Required, Utilities

	2010	*2011*	*2012*	*2013*	*2014*
Guam DPW Permitting Staff	0.0	0.0	0.0	0.0	0.0
GDLM Permitting Staff	3.5	3.4	3.4	3.3	3.3
GEPA Permitting Staff	1.1	1.2	7.2	6.4	5.6
CMP Permitting Staff	1.4	1.4	1.7	1.3	1.1
GPA Permitting Staff	0.3	0.6	0.8	0.6	0.3
GWA Permitting Staff	0.6	2.8	2.1	1.4	0.3
GFD Permitting Staff	0.0	0.1	0.1	0.1	0.0
GDPHSS – DEH Permitting Staff	0.1	0.2	0.3	0.2	0.1
GDPR – HPO Permitting Staff	1.6	1.3	1.0	0.7	0.5
GdoL – ALPCD Permitting Staff	1.0	1.5	2.3	0.0	0.0

17.2.2.4 Sociocultural Impacts

The sociocultural impacts associated with utilities alternatives are not expected to be significant, except as they contribute to significant aggregate effects discussed in Volume 7.

17.2.2.5 Summary of Utilities Impacts

The economic activity from the proposed action would add about 4,580 residents to Guam's population at the 2012 construction peak for utilities work.

Including all the spin-off activity, the proposed action would provide jobs for about 3,330 civilian workers in 2012. Guam residents are estimated to capture about 270 of the direct on-site construction jobs for utilities at the 2012 peak, as well as approximately 170 spin-off jobs that year.

Civilian housing unit demand driven by the utilities work would peak at about 820 units in 2012.

Although a more detailed fiscal impact assessment would be done by GovGuam using output from this EIS, preliminary estimates in this chapter suggest revenues from the three most important tax sources – gross receipts, corporate income, and personal income – would exceed $30.4 million in 2012.

Guam's GIP, the total market value of all final goods and services produced in a given year, would increase by $83 million (2008 dollars) at the 2012 construction peak due to utilities.

GovGuam's public service agencies would need to make small but significant staffing increases to service new population associated with roadways construction. Most of these agencies would need to expand their services and staff by more than 2%.

Sociocultural impacts of utility construction would be negligible.

Table 17.2-17 summarizes the potential impacts and bullets with the rationale.

Table 17.2-17. Summary of Potential Socioeconomic Impacts-Utilities

Impact Area	*Utilities*
Population	BI • Significant beneficial impact due to economic expansion fueled by increased population (See Economic impacts below) SI-M • Significant adverse impacts due to strains placed upon government services and the social fabric (See Public Service and Sociocultural impacts below)
Civilian Labor Force Demand	BI • Significant beneficial impacts due to provision of permanent jobs on Guam
Civilian Labor Force Income	BI • Significant beneficial impacts due to permanent infusion of income into the Guam economy
Standard of Living	NI • No significant impact from the proposed action construction or operation.
Selected Local Government Revenues	BI • Significant beneficial impacts due to increase in local government revenue
Civilian Housing Demand	LSI • Civilian Housing Demand: Less than significant direct and indirect impact demand for civilian (private-market, excluding temporary construction workforce housing) housing units peaking at 822 units in 2012
Effects on Ratepayers	LSI • In some cases rate increases are expected however, these rate increases are already planned and not related to the proposed action. It is also possible that rates for some utilities could decline due to the increased customer base.
Gross Island Product	BI • Significant operational phase beneficial impacts due to permanent increased GIP strengthening the Guam economy
Local Business Opportunities	BI • Beneficial impacts due to increased military service contract opportunities for local Guam businesses
Tourism	NI • No significant impact from the proposed action construction or operation.
Public Service Agencies Influenced by Population Increases	SI-M • Significant adverse impacts due to difficulty in meeting fluctuating staffing requirements during and following the construction phase with an existing environment of staffing and budget shortfalls and recruitment complications SI • Significant adverse impact due to difficulty in recruiting and funding adequate staffing during operational phase BI • Significant beneficial impact due to provision of additional jobs on Guam, if labor supply and funding is available during operational phase
Growth Permitting and Regulatory Agencies	LSI • Less than significant construction-related adverse impacts due to difficulty in meeting fluctuating staffing requirements with an existing environment of staffing and budget shortfalls and recruitment complications
Crime and Social Order	NI • No impacts from the proposed project alone.
Chamorro Issues	NI • No impacts from the proposed project alone.

Impact Area	*Utilities*
Community Cohesion	NI • No impacts from the proposed project alone.

Legend: SI = Significant Impact, BI = Beneficial Impact, SI-M = Significant Impact- Mitigable, LSI = Less than Significant Impact, NI = No impact.

17.2.2.6 No-Action Alternative

The assumed no-action alternative is that all parts of the aggregate action, not just the proposed action covered in this volume, but also other components addressed in other volumes do not occur. Therefore, the no-action conclusions given below are identical to those in Volume 2 for the Marine Corps relocation and/or Volume 7 for the aggregate action. The references below to substantial impacts with the proposed action would in fact apply more to those volumes than to this Volume 6 covering the Utilities action, as Utilities impacts alone sometimes would not attain significance.

Unlike physical resources, socioeconomic systems do not tend to remain completely at baseline conditions if a proposed action is not implemented. Economies and population levels change due to other reasons as well. The various foregoing exhibits showing baseline trends for economic and demographic variables indicate long-term trends expected to continue without the proposed action, and Volume 7 will list a number of specific socioeconomic changes expected to occur independent of the proposed action. Furthermore, the announcement of the proposed action has already had socioeconomic consequences, such that a 2010 decision not to follow through on the military buildup would have short-term effects associated with a reversal of those existing consequences.

Population/Economic Impacts

In the short term, a decision not to implement the proposed action would deflate any current speculative activity attributable the proposed action. Real estate values in particular would likely drop, hurting investors but increasing the affordability of housing. The contrast between the business community's expectations and a negative Record of Decision would likely produce a period of pessimism about Guam's economic future, especially if the current national and international economic crisis has not yet abated. These effects, though, would be attributable an unstable world economic landscape and poor decision making by investors – not to the proposed action.

Long term, the island's prospects would remain linked to international economic conditions and the health of its tourism industry. Conceivably, a smaller military profile might remove some barriers to growing the potential Chinese tourism market. Growth would resume, though probably with the same volatility experienced in recent decades.

Public Service Impacts

In the case of the no-action alternative, the specific agencies discussed earlier in this chapter would not face the listed pressures to expand professional staffing, and agencies involved in planning and regulating growth would not experience such a sharp increase in workload. Although this was not specifically covered in the foregoing analysis, it may also be noted that agencies that are required to implement major infrastructure developments, such as the ports and highways, would have substantially more time to implement long-term plans rather than having to achieve much of their objectives over the next few years.

However, at the broader level, the no-action alternative and the elimination of prospective long-term revenues expected from the proposed action still would leave GovGuam agencies in the difficult financial condition described in Volume 2, Section 16.22.11. At least for the foreseeable future, this would negatively impact the various service agencies because of budget cuts, and would probably represent the most important overall consequence for GovGuam.

Sociocultural Impacts

To the extent that Guam experiences job losses crime rates may rise in the short term. The political importance of some Chamorro issues would likely recede as the militarization of Guam is stabilized at something close to present levels. Military-civilian relations would likely remain at the current generally positive level.

The incentive for increased in-migration from the Freely Associated States of Micronesia (FAS) would decrease, reducing sociocultural issues associated with assimilating that population. However, the current incentives for providing those populations, both on Guam and the Micronesian states themselves, would also be lessened, with detrimental implications for those populations.

17.2.2.7 Utilities Potential Mitigation Measures

A review of the above impacts show that the proposed action has the potential to have primarily either beneficial or no impacts on Guam with the exception of population and public service agencies where the proposed action could significant adverse impacts. Therefore, the mitigation measures identified below provide avenues to mitigate these adverse impacts while taking into account Guam's unique position as an isolated island economy.

Table 17.2-18 shows potential power utilities mitigation measures.

Table 17.2-18. Potential Utilities Mitigation Measures

Impact Area	*Adverse Impacts*	*Mitigation Measures*
Population	• Significant adverse impacts due to strains placed upon government services and the social fabric (See Public Service and Sociocultural impacts below)	• DoD can modify the construction tempo in order to smooth out the adverse impacts of a large jump in population on Guam – reducing the boom and bust effect identified in the analysis. • DoD can decrease the rapid population increase associated with the operations phase by delaying the date that Marine dependents would move to Guam.
Public Service Agencies Influenced by Population Increases	• Significant adverse impacts due to difficulty in meeting fluctuating staffing requirements during and following the construction phase with an existing environment of staffing and budget shortfalls and recruitment complications • Significant adverse impact due to difficulty in recruiting and funding adequate staffing during operational phase	DoD can implement: • incentive programs for military spouses and dependents that apply for and are hired into GovGuam public service agency employment. • volunteer programs for military, their spouses and dependents, linking them to long-term GovGuam public service agency volunteer positions. • Collaborative efforts with the federal government and GovGuam to identify and provide grant writing assistance to Guam public service organizations and agencies that have existing AmeriCorps program, or have the potential to host an AmeriCorps program, to facilitate an increase in AmeriCorps service on Guam. DoD can assist GovGuam in seeking federal funding for: • the necessary permanent number professional staff identified, as well as the number of administrative and supporting staff needed for these professions to perform their positions adequately.

Impact Area	Adverse Impacts	Mitigation Measures
		• an increase in the number of private staffing and service contractors currently working for service agencies, to match staffing requirements. • a one-time hiring bonus of 20% of base pay for all GovGuam agency positions, to increase interest in GovGuam agency employment and compete with wages offered by private offices. DoD can assist GovGuam with technical assistance, development and implementation of comprehensive data collection systems focused on: • public services provided to FAS citizens in order to facilitate GovGuam access of Compact Impact and other related funding. • public services provided to military individuals, in order to facility GovGuam access of TRICARE and other related funding. • patient information, records, and services accessed, in order to facilitate appropriate care administered in a timely manner. DoD can assist GovGuam in seeking federal funding for technical assistance, development, and implementation of a system of interpreters and translators available for the interpreting and translating needs of GovGuam public service agencies, to facilitate timely and appropriate provision of services for the English as a Second Language service population.

17.2.3 Off Base Roadways

17.2.3.1 Population Impacts

Refer to the corresponding section of Volume 2 for introductory statements.

Project Related Population

Please refer to the Utilities Population Impacts section for information on the assumptions used in the analysis.

Table 17.2-19 indicates a 2014 peak-year impact of 6,265 additional people.

Table 17.2-19. Impact on Population, Roadways

	2010	2011	2012	2013	2014	2015	2016
Total Construction Impact	806	1,508	4,238	6,042	6,265	3,471	770

Figure 17.2-8 shows the projected total population for the baseline trend (projected future without the proposed action) plus the total combined impact of the proposed action. The chart shows the population rising to 196,307 in 2014. The 2014 figure represents a 3.3% increase over the baseline trend. This figure meets the criteria used in this analysis for a significant impact, although population increases are considered to be inherently mixed (both beneficial and adverse), because population growth fuels economic expansion but sudden growth also strains government services and the social fabric.

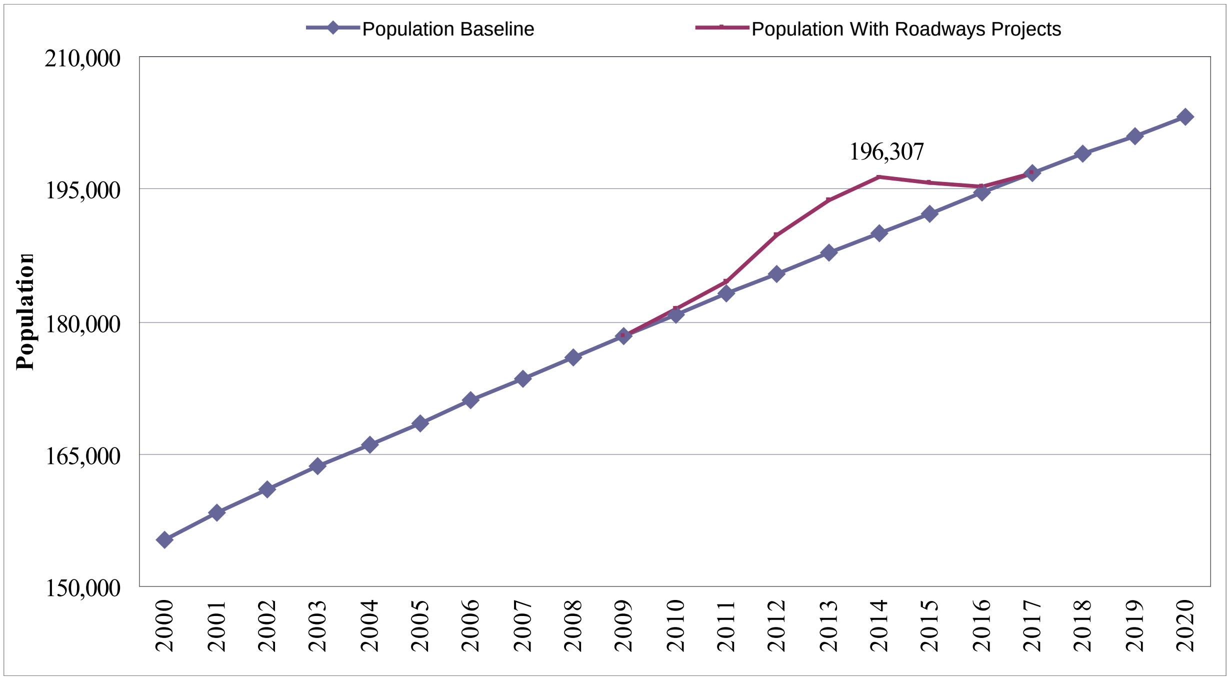

Figure 17.2-8. Population With and Without Roadways

Demographic Characteristics

Refer to the corresponding section of Volume 2.

Household Characteristics

Refer to the corresponding section of Volume 2.

17.2.3.2 Economic Impacts

Employment and Income

Refer to the corresponding section of Volume 2 for introductory statements and approach to analysis (including data sources).

Civilian Labor Force Demand

Table 17.2-20 shows a civilian labor force demand for 4,667 workers in the peak year of 2014.

Table 17.2-20. Impact on Civilian Labor Force Demand (Full-Time Equivalent Jobs), Roadways

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Total Construction Impact	594	1,099	3,084	4,455	4,667	2,682	716

Figure 17.2-9 shows the projected total labor force demand for the baseline trend (projected future without the proposed action) plus the total combined impact of the proposed action. The chart shows the labor force demand rising to 62,386 in 2014. The 2014 figure represents an 8% increase over the baseline trend. By the criteria used for this analysis, the impact is considered significant and beneficial.

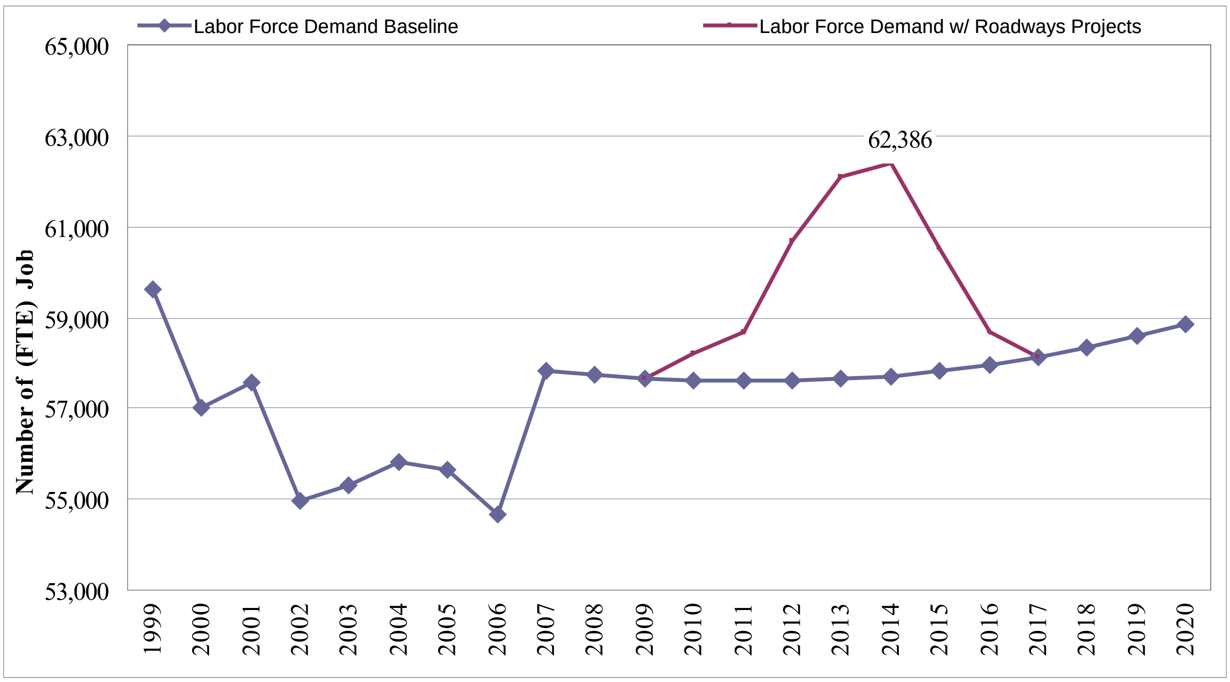

Figure 17.2-9. Civilian Labor Force Demand With and Without Roadways

Labor Force Supply

Table 17.2-21 shows the probable labor source supply for direct onsite roadway construction jobs.

Table 17.2-21. Estimated Origin of Workers Constructing Roadways

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
TOTAL	**335**	**620**	**1,743**	**2,521**	**2,641**	**1,518**	**405**
GUAM	**60**	**100**	**252**	**322**	**337**	**194**	**52**
OFF-ISLAND	**275**	**520**	**1,491**	**2,199**	**2,304**	**1,324**	**353**
H-2B Workers	235	444	1,278	1,891	1,981	1,139	304
Philippines	199	378	1,087	1,607	1,684	968	258
Other	21	40	115	170	178	102	27
CONUS/HI/Japan	4	8	22	32	34	19	5
Supervisor (U.S., Japan)	2	3	9	13	14	8	2
Labor	2	5	13	19	20	11	3
Other U.S. Pacific Islands	37	68	191	276	289	166	44

Table 17.2-22 estimates the share of non-military construction direct and indirect jobs, going to Guam residents versus off-island workers.

Table 17.2-22. Estimated Numbers of On-Island Workers for Various Job Categories Other Than Direct On-Site Construction (Roadways)

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Guam Workers	41	61	153	240	278	223	139
Off-Island Workers	219	418	1,188	1,693	1,748	942	172

Note: Demand is in terms of FTE jobs, and assumes one worker per FTE job.

Civilian Labor Force Income

Table 17.2-23 below shows that labor force income from the proposed action increases by about $176 million at the 2014 peak.

Table 17.2-23. Impact on Civilian Labor Force Income (Millions of 2008 $s), Roadways

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Total Construction Impact	$22	$41	$116	$168	$176	$101	$27

Figure 17.2-10 shows the projected total labor force income for the baseline trend (projected future without the proposed action) plus the total combined impact of the proposed action. The chart shows the labor force income rising to $1.792 billion in 2014. The 2014 figure represents an 11% increase over the baseline trend. By the criteria used for this analysis, the impact is considered significant and beneficial.

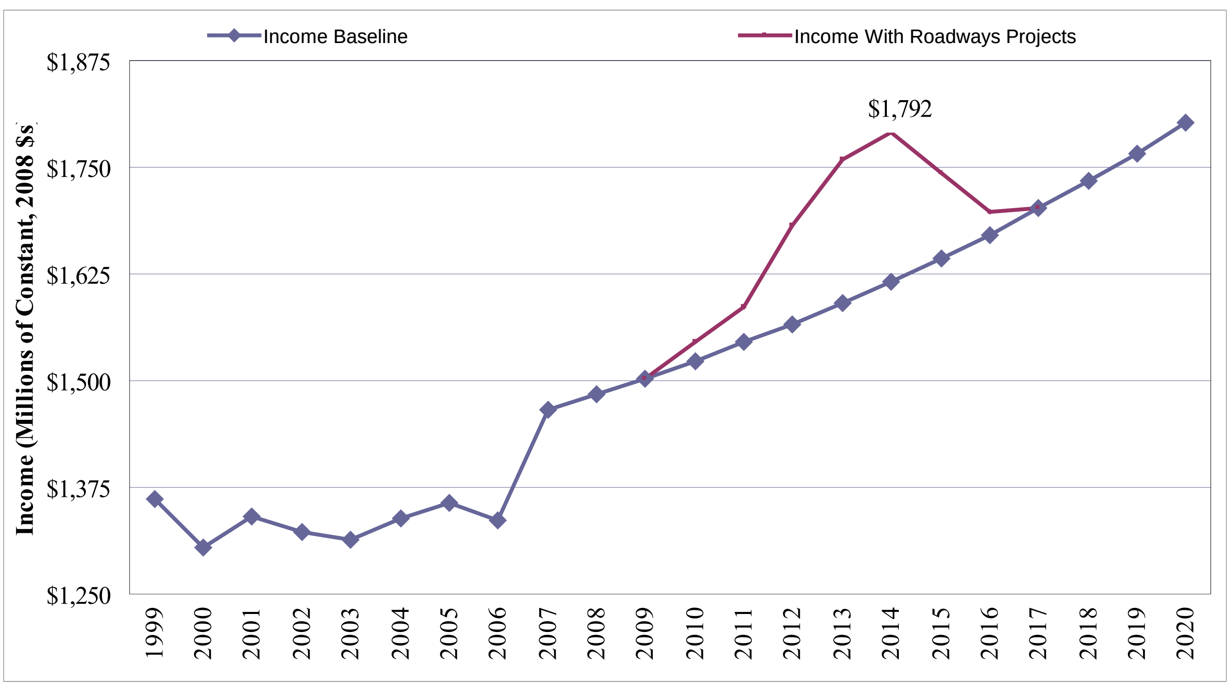

Figure 17.2-10. Civilian Labor Force Income (Millions of 2008 $s) With and Without Roadways

Standard of Living

Refer to the corresponding section of Volume 2 for general discussion. The proposed action, in and of itself, would be sufficiently small and would be unlikely to have significant impacts on costs or standards of living, either in construction or operational components, except in conjunction with the aggregate action.

Unemployment

Refer to the corresponding section of Volume 2.

Housing

Refer to the corresponding section of Volume 2 for introductory statements and approach to analysis (including data sources).

Civilian Housing Demand

Table 17.2-24 indicates the impact of the proposed action would result in a demand for 1,100 new units in the peak year of 2014.

Table 17.2-24. Demand for New Civilian Housing Units, Roadways

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Total Construction Impact	147	273	760	1,066	1,100	599	120

Figure 17.2-11 shows the projected total housing demand for the baseline trend (projected future without the proposed action) plus the total combined impact of the proposed action. The chart shows the housing demand rising to about 69,874 in 2014. The 2014 figure represents only a 1.6% increase over the baseline trend. This does not meet the 2% threshold for "significance" being used for this analysis. However, it adds to the significant impact for civilian housing from the overall aggregate action discussed in Volume 7.

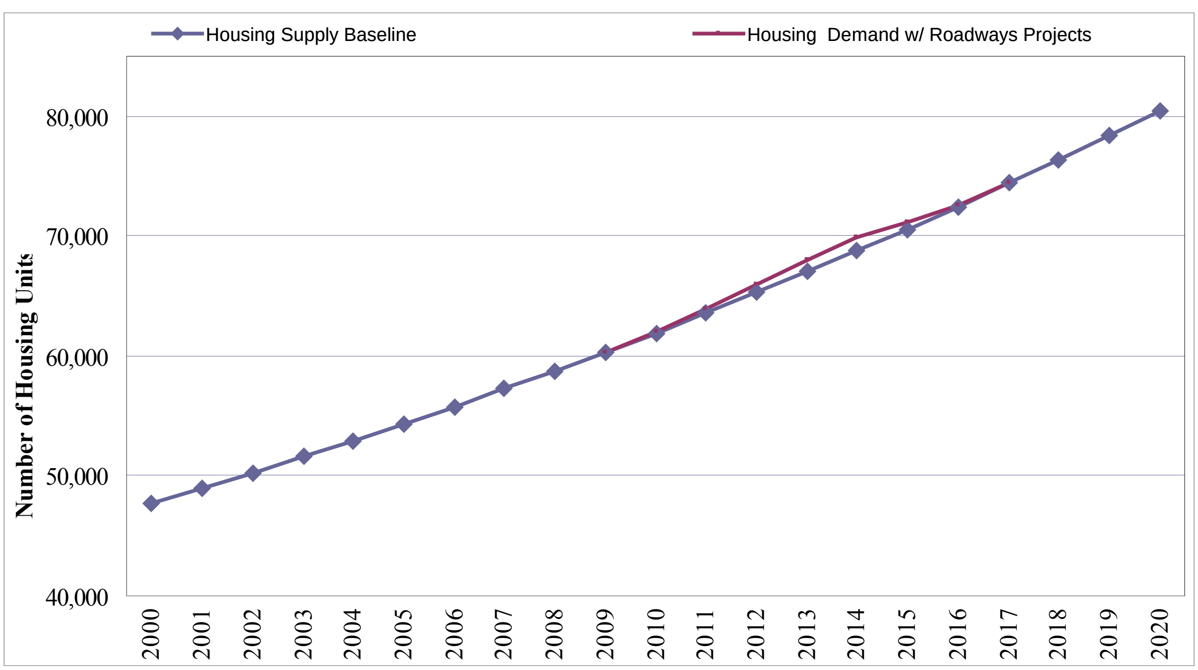

Figure 17.2-11. Housing Demand With and Without Roadways

Housing Supply

The housing market would be able to accommodate the relatively minor demand – at least theoretically, if it did not occur simultaneously with other and larger aspects of the aggregate action.

Potential Effects on Ratepayers

As it is not expected that new roadways would be toll roads, there would be no effects on ratepayers.

Estimated Local Government Revenues

Refer to the corresponding section of Volume 2 for introductory statements and approach to analysis (including data sources).

Table 17.2-25, Table 17.2-26 and Table 17.2-27 show the impact of the proposed roadways would add $17 million to the GRT, $4.4 million to the corporate income tax revenue, and $21 million to the personal income tax revenue in the 2014 peak.

Table 17.2-25. Impact on Gross Receipts Tax Revenue (1,000s of 2008 $s), Roadways

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Total Construction Impact	$2,186	$4,044	$11,363	$16,425	$17,207	$9,889	$2,638

Table 17.2-26. Impact on Corporate Income Taxes Revenue (1,000s of 2008 $s), Roadways

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Total Construction Impact	$557	$1,031	$2,898	$4,188	$4,388	$2,522	$673

Table 17.2-27. Impact on Personal Income Taxes Revenue (1,000s of 2008 $s), Roadways

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Total Construction Impact	$2,685	$4,962	$13,928	$20,112	$21,069	$12,109	$3,231

Figure 17.2-12 shows the projected total gross receipts tax for the baseline trend (projected future without the proposed action) plus the total combined impact of the proposed action. The chart shows the gross receipts tax rising to $182.2 million at the 2014 construction peak, a 10.4% increase over the baseline trend. By the criteria used for this analysis, the impact is considered significant and beneficial.

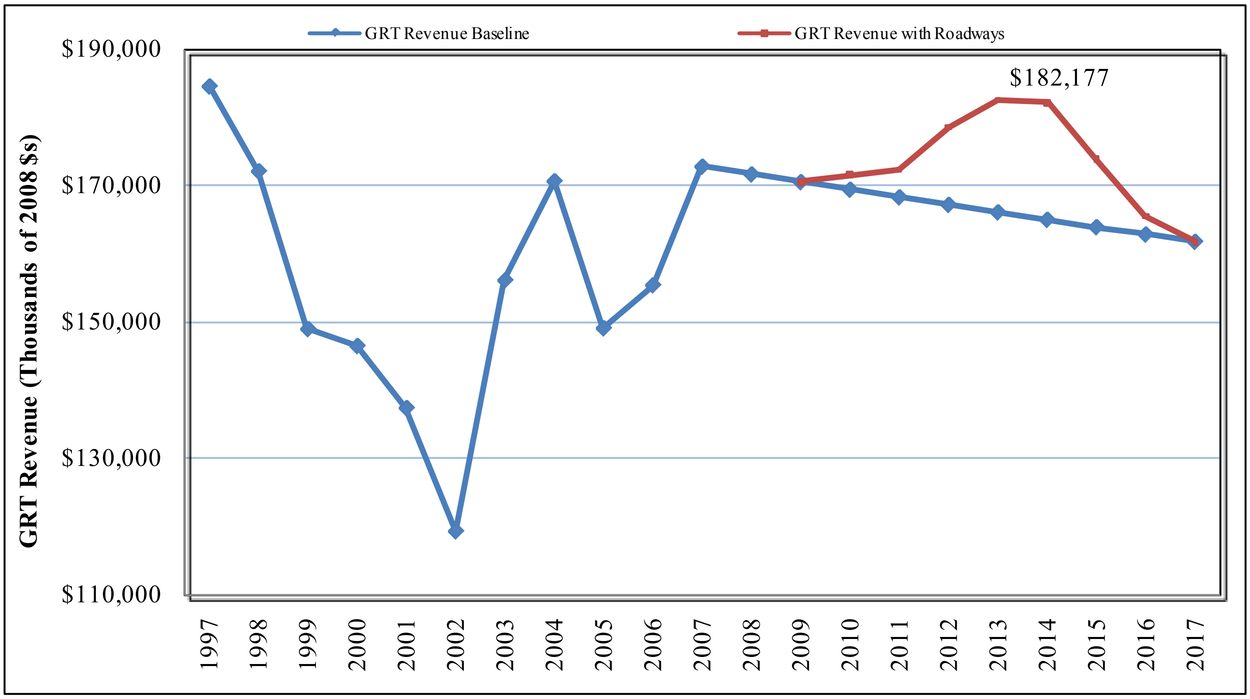

Figure 17.2-12. Gross Receipts Tax Revenue With and Without Roadways

Figure 17.2-13 shows the projected total income tax revenue – summing corporate and personal income taxes, because historical data are available only for the summed figures – for the baseline trend (projected future without the proposed action) plus the total combined impact of the proposed action. The chart shows the income tax revenue rising to $263.1 million in 2012, a 10.7% increase over the baseline trend. By the criteria used for this analysis, the impact is considered significant and beneficial.

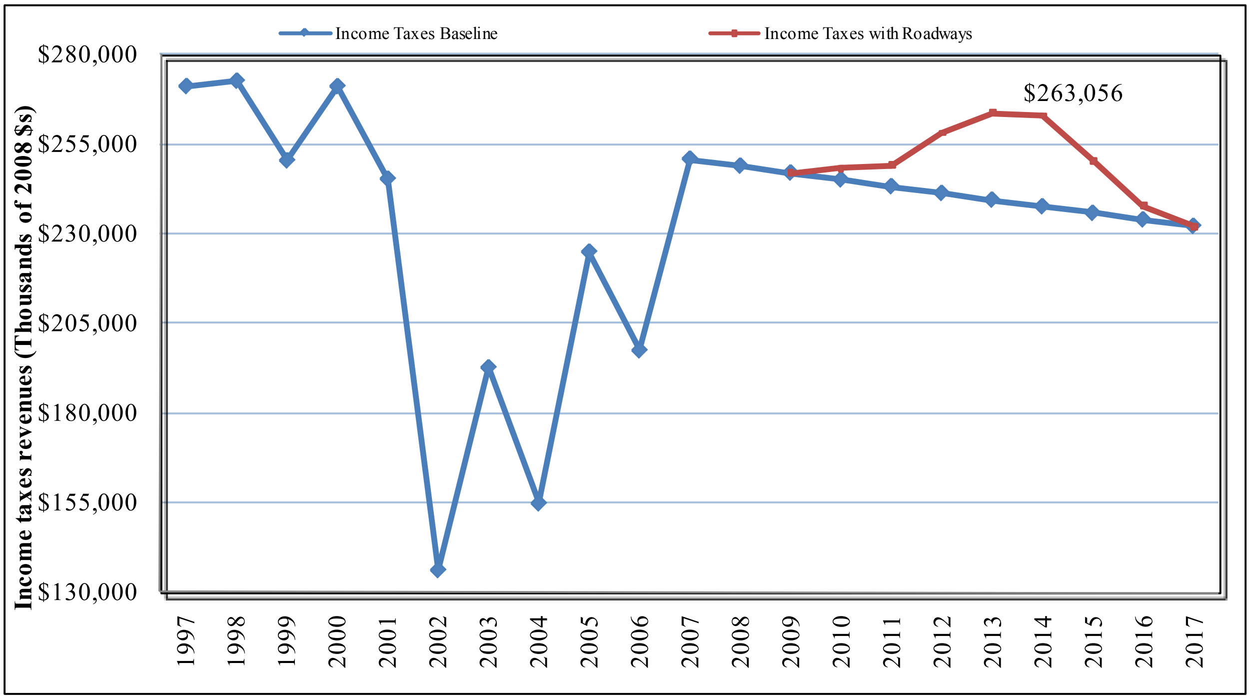

Figure 17.2-13. Income Taxes Revenue (Combined) With and Without Roadways

Gross Island Product

Refer to the corresponding section of Volume 2 for introductory statements and approach to analysis (including data sources).

Table 17.2-28 shows the impact would add a peak amount of $116 million to the GIP in 2014.

Table 17.2-28. Impact on Gross Island Product (Millions of 2008 $s), Roadways

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Total Construction Impact	$15	$27	$77	$111	$116	$67	$18

Figure 17.2-14 shows the projected total GIP for the baseline trend (projected future without the proposed action) plus the total combined impact of the proposed action. The chart shows the GIP rising to $4.623 billion in 2014. The 2014 figure represents a 2.6% increase over the baseline trend. By the criteria used for this analysis, the impact is considered significant and beneficial.

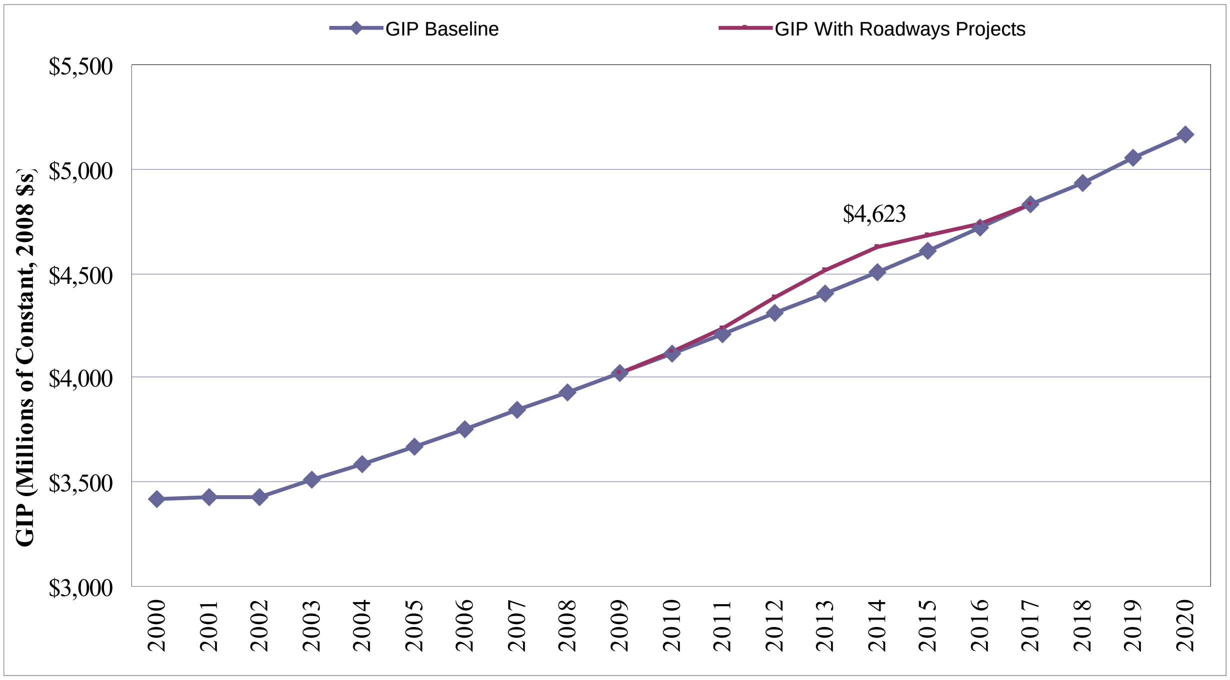

Figure 17.2-14. Gross Island Product (Millions of 2008 $s) With and Without Roadways

17.2.3.3 Public Service Impacts

Refer to the corresponding section of Volume 2 for introductory statements, approach to analysis (including data sources), and qualitative impact analysis.

<u>Public Education</u>

Table 17.2-29 shows the estimated number of key FTE professional staff required due to roadways construction. Because the staffing increase numbers for roadways are greater than for the utility projects discussed above, the numbers in the tables are presented as rounded whole numbers. The peak requirement in 2014, stemming from construction direct and indirect impacts, is about 2.2% (for GPSS High Schools) to 2.7% (for GCC and UoG) greater than reported baseline staffing levels. By the criteria used for this analysis, these would be considered significant (adverse) impacts.

Table 17.2-29. Additional Public Education Key Professionals Required, Roadways

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
GPSS Elementary Schools	4	7	19	26	27	15	3
GPSS Middle Schools	2	3	8	11	12	6	1
GPSS High Schools	1	3	8	11	11	6	1
GCC	0	1	2	3	3	1	0
UoG	1	1	3	5	5	3	1

Note: Numbers include teachers for GPSS and non-adjunct faculty for GCC and UoG.

<u>Public Health and Human Services</u>

Further discussion on public health implications can be found in Chapter 19 of this volume, "Public Health and Safety."

Table 17.2-30 shows the estimated number of key FTE professional staff required due to the proposed roadways. The peak requirement in 2014 is about 3.6% to 3.9% greater than reported baseline staffing levels for each agency listed below. By the criteria used for this analysis, these would be considered significant (adverse) impacts.

Table 17.2-30. Additional Public Health and Human Service Key Professionals Required, Roadways

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
GMHA Physicians	0	1	2	2	2	1	0
GMHA Nurses, Allied Health Professionals	2	3	9	13	14	8	2
GDPHSS Bureau of Primary Care Medical Providers and Nursing Staff	0	0	1	2	2	1	0
GDPHSS CDC Prevention Specialists	0	0	1	1	1	1	0
GDPHSS BFHNS Nursing Personnel	0	0	1	1	1	0	0
GDMHSA Mental Health Professionals	1	1	3	4	5	3	1
GDISID Social Workers and Counselors	0	0	0	0	1	0	0

Public Safety Services

Further discussion on public safety implications can be found in Chapter 19 of this volume, "Public Health and Safety."

Table 17.2-31 shows the estimated number of key FTE professional staff required due to the proposed roadways. The peak requirement is about 2.3% (for the GDYA) to 4.5% (for the GFD) greater than reported baseline staffing levels. By the criteria used for this analysis, these would be considered significant (adverse) impacts.

Table 17.2-31. Additional Public Safety Key Professionals Required, Roadways

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
GPD Sworn Police Officers	1	1	4	6	6	3	1
GFD Uniformed Fire Personnel	1	2	6	8	9	5	1
GDoC Custody and Security Personnel	1	1	3	5	5	3	1
GDYA Youth Service Professionals	0	1	1	2	2	1	0

Other Selected General Services

Refer to the corresponding section of Volume 2 for introductory statements, assumptions used in analysis, and qualitative analysis of impacts.

Table 17.2-32 shows the estimated number of key FTE professional staff required due to the proposed roadways. The peak requirement in 2014 is about 3.6% greater than reported baseline staffing levels for each agency listed below. By the criteria used for this analysis, these would be considered significant (adverse) impacts.

Table 17.2-32. Additional Key Professionals Required for Selected Other General Services, Roadways

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
GDPR Staffing	0.4	0.8	2.2	3.1	3.2	1.8	0.4
PLS Staffing	0.1	0.2	0.7	1.0	1.0	0.6	0.1
Judiciary Judges	0.0	0.1	0.1	0.2	0.2	0.1	0.0

Growth Permitting and Regulatory Agencies

Table 17.2-33 shows the estimated number of key FTE professional staff required due to the proposed roadways. The peak requirements for most agencies listed below are from 0% to 4% greater than reported baseline staffing levels, though agencies with small baseline staffing levels experience larger peak-year percentage increases (e.g., 8% for GDPR-HPO or 29% for CMP, associated with monitoring/enforcement). The small ALPCD staff would experience a 131% increase in required staff over baseline levels due to the large number of H-2B workers likely to require processing for the roadways construction proposed action. In this case, the number of permitting agencies exceeding the 2% criteria used in this analysis is larger, and so the overall assessment would be one of significant adverse impacts.

Table 17.2-33. Additional Growth Permitting Staff Required, Roadways

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Guam DPW Permitting Staff	1.3	1.7	2.9	2.4	1.9	1.7	1.3
GDLM Permitting Staff	0.1	0.0	0.0	0.0	0.0	0.0	0.0
GEPA Permitting Staff	0.3	0.7	3.0	2.0	1.9	1.0	0.4
CMP Permitting Staff	0.7	0.7	2.1	2.7	2.0	1.6	0.5
GPA Permitting Staff	0.0	0.1	0.3	0.1	0.0	0.0	0.0
GWA Permitting Staff	0.0	0.3	1.2	0.2	0.1	0.1	0.1
GFD Permitting Staff	0.0	0.0	0.1	0.1	0.1	0.1	0.0
GDPHSS - DEH Permitting Staff	0.1	0.1	0.3	0.4	0.4	0.2	0.1
GDPR - HPO Permitting Staff	0.6	0.6	0.6	0.3	0.3	0.3	0.2
GDoL - ALPCD Permitting Staff	0.8	0.7	2.9	2.1	0.3	0.0	0.0

17.2.3.4 Sociocultural Impacts

The sociocultural impacts associated with roadway alternatives are not expected to be significant, except as they contribute to significant aggregate effects discussed in Volume 7.

17.2.3.5 Summary of Roadways Impacts

The economic activity from the proposed roadways would add about 6,260 residents to Guam's population at the 2014 construction peak.

Including all the spin-off activity, the proposed roadways would provide jobs for almost 4,460 civilian workers in 2014. Guam residents are estimated to capture about 340 of the direct on-site construction jobs for roadways projects at the 2014 peak, as well as about 280 spin-off jobs that year.

Civilian housing unit demand would peak at about 1,100 units in 2014.

Although a more detailed fiscal impact assessment would be done by GovGuam using output from this EIS/OEIS, preliminary estimates in this chapter suggest revenues from the three most important tax sources – gross receipts, corporate income, and personal income – would exceed $42 million in 2014.

Guam's GIP, the total market value of all final goods and services produced in a given year, would increase by $116 million (2008 dollars) at the 2014 construction peak.

GovGuam's public service agencies would need to make small but significant staffing increases to service new population associated with roadways construction. Most of these agencies would need to expand their services and staff by more than 2%.

Sociocultural impacts of roadways project construction would be negligible, and there would be no effects on ratepayers as roads are not expected to be tollways.

Table 17.2-34 summarizes the potential impacts from roadways.

Table 17.2-34. Summary of Potential Socioeconomic Impacts-Roadways

Impact Area	*Roadways*
Population	BI • Significant beneficial impact due to economic expansion fueled by increased population (See Economic impacts below) SI-M • Significant adverse impacts due to strains placed upon government services and the social fabric (See Public Service and Sociocultural impacts below)
Civilian Labor Force Demand	BI • Significant beneficial impacts due to provision of permanent jobs on Guam
Civilian Labor Force Income	BI • Significant beneficial impacts due to permanent infusion of income into the Guam economy
Standard of Living	NI • No significant impact from the proposed action construction or operation.
Selected Local Government Revenues	BI • Significant beneficial impacts due to increase in local government revenue
Civilian Housing Demand	LSI • Civilian Housing Demand: Less than significant direct and indirect impact demand for civilian (private-market, excluding temporary construction workforce housing) housing units peaking at 822 units in 2012
Gross Island Product	BI • Significant operational phase beneficial impacts due to permanent increased GIP strengthening the Guam economy
Effects on Ratepayers	NI • No impact, as roads are not expected to be tollways
Local Business Opportunities	BI • Beneficial impacts due to increased military service contract opportunities for local Guam businesses
Tourism	NI • No significant impact from the proposed action construction or operation.
Public Service Agencies Influenced by Population Increases	SI-M • Significant adverse impacts due to difficulty in meeting fluctuating staffing requirements during and following the construction phase with an existing environment of staffing and budget shortfalls and recruitment complications SI • Significant adverse impact due to difficulty in recruiting and funding adequate staffing during operational phase BI • Significant beneficial impact due to provision of additional jobs on Guam, if labor supply and funding is available during operational phase
Growth Permitting and Regulatory Agencies	LSI • Less than significant construction-related adverse impacts due to difficulty in meeting fluctuating staffing requirements with an existing environment of staffing and budget shortfalls and recruitment complications
Crime and Social Order	NI • No impacts from the proposed alone.
Chamorro Issues	NI • No impacts from the proposed alone.

Impact Area	*Roadways*
Community Cohesion	NI • No impacts from the proposed alone.

Legend: SI = Significant (adverse) impact, SI-M =Significant impact-mitigable, LSI = Less than significant impact, BI = Beneficial impact, NI = No impact.

17.2.3.6 No-Action Alternative

The assumed no-action alternative is that all parts of the aggregate action, not just the proposed action covered in this volume, but also other components addressed in other volumes do not occur. Therefore, the no-action conclusions given below are identical to those in Volume 2 for the Marine Corps relocation and/or Volume 7 for the aggregate action. The references below to substantial impacts with the proposed action would in fact apply more to those volumes than to this Volume 6 covering the roadways action, as Roadways impacts alone sometimes would not attain significance.

Unlike physical resources, socioeconomic systems do not tend to remain completely at baseline conditions if a proposed action is not implemented. Economies and population levels change due to other reasons as well. The various foregoing exhibits showing baseline trends for economic and demographic variables indicate long-term trends expected to continue without the proposed action, and Volume 7 will list a number of specific socioeconomic changes expected to occur independent of the proposed action. Furthermore, the announcement of the proposed action has already had socioeconomic consequences, such that a 2010 decision not to follow through on the military buildup would have short-term effects associated with a reversal of those existing consequences.

<u>Population/Economic Impacts</u>

In the short term, a decision not to implement the proposed action would deflate any current speculative activity attributable the proposed action. Real estate values in particular would likely drop, hurting investors but increasing the affordability of housing. The contrast between the business community's expectations and a negative Record of Decision would likely produce a period of pessimism about Guam's economic future, especially if the current national and international economic crisis has not yet abated. These effects, though, would be attributable an unstable world economic landscape and poor decision making by investors – not to the proposed action.

Long term, the island's prospects would remain linked to international economic conditions and the health of its tourism industry. Conceivably, a smaller military profile might remove some barriers to growing the potential Chinese tourism market. Growth would resume, though probably with the same volatility experienced in recent decades.

<u>Public Service Impacts</u>

In the case of the no-action alternative, the specific agencies discussed earlier in this chapter would not face the listed pressures to expand professional staffing, and agencies involved in planning and regulating growth would not experience such a sharp increase in workload. Although this was not specifically covered in the foregoing analysis, it may also be noted that agencies that are required to implement major infrastructure developments, such as the ports and highways, would have substantially more time to implement long-term plans rather than having to achieve much of their objectives over the next few years.

However, at the broader level, the no-action alternative and the elimination of prospective long-term revenues expected from the proposed action still would leave GovGuam agencies in the difficult financial condition described in Volume 2, Section 16.22.11. At least for the foreseeable future, this would negatively impact the various service agencies because of budget cuts, and would probably represent the most important overall consequence for GovGuam.

Sociocultural Impacts

To the extent that Guam experiences job losses crime rates may rise in the short term. The political importance of some Chamorro issues would likely recede as the militarization of Guam is stabilized at something close to present levels. Military-civilian relations would likely remain at the current generally positive level.

The incentive for increased in-migration from the Freely Associated States of Micronesia (FAS) would decrease, reducing sociocultural issues associated with assimilating that population. However, the current incentives for providing those populations, both on Guam and the Micronesian states themselves, would also be lessened, with detrimental implications for those populations.

17.2.3.7 Roadways Potential Mitigation Measures

A review of the above impacts show that the proposed action has the potential to have primarily either beneficial or no impacts on Guam with the exception of population and public service agencies where the proposed action could significant adverse impacts. Therefore the mitigation measures identified below provide avenues to mitigate these adverse impacts while taking into account Guam's unique position as an isolated island economy.

Table 17.2-35 below shows potential roadway mitigation measures.

Table 17.2-35. Potential Roadways Mitigation Measures

Impact Area	*Adverse Impacts*	*Mitigation Measures*
Population	• Significant adverse impacts due to strains placed upon government services and the social fabric (See Public Service and Sociocultural impacts below)	• DoD can relax the construction and operations timeline in order to smooth out the adverse impacts of a large jump in population on Guam – eliminating the boom and bust effect identified in the analysis. • DoD can decrease the rapid population increase associated with the operations phase by not allowing dependents to accompany Marines until the construction phase has ended.
Public Service Agencies Influenced by Population Increases	• Significant adverse impacts due to difficulty in meeting fluctuating staffing requirements during and following the construction phase with an existing environment of staffing and budget shortfalls and recruitment complications • Significant adverse impact due to difficulty in recruiting and funding adequate staffing during operational phase	DoD can implement: • incentive programs for military spouses and dependents that apply for and are hired into GovGuam public service agency employment. • volunteer programs for military, their spouses and dependents, linking them to long-term GovGuam public service agency volunteer positions. • Collaborative efforts with the federal government and GovGuam to identify and provide grant writing assistance to Guam public service organizations and agencies that have existing AmeriCorps program, or have the potential to host an AmeriCorps program, to facilitate an increase in AmeriCorps service on Guam. DoD can assist GovGuam in seeking federal funding for: • the necessary permanent number professional staff identified, as well as the number of administrative and supporting staff needed for these professions to perform their positions adequately.

Impact Area	Adverse Impacts	Mitigation Measures
		• an increase in the number of private staffing and service contractors currently working for service agencies, to match staffing requirements. • a one-time hiring bonus of 20% of base pay for all GovGuam agency positions, to increase interest in GovGuam agency employment and compete with wages offered by private offices. DoD can assist GovGuam with technical assistance, development and implementation of comprehensive data collection systems focused on: • public services provided to FAS citizens in order to facilitate GovGuam access of Compact Impact and other related funding. • public services provided to military individuals, in order to facility GovGuam access of TRICARE and other related funding. • patient information, records, and services accessed, in order to facilitate appropriate care administered in a timely manner. DoD can assist GovGuam in seeking federal funding for technical assistance, development, and implementation of a system of interpreters and translators available for the interpreting and translating needs of GovGuam public service agencies, to facilitate timely and appropriate provision of services for the English as a Second Language service population.

CHAPTER 18. HAZARDOUS MATERIALS AND WASTE

18.1 INTRODUCTION

This chapter discusses the potential environmental consequences associated with implementation of the alternatives within the region of influence (ROI) for this resource. For a description of the affected environment for all resources, including current hazardous substance handling, storage, transportation, and management plans; techniques; approaches; and potential mitigation measures, refer to the respective chapter of Volume 2 (Marine Corps Relocation – Guam). The locations described in that volume include the ROI for the utilities projects. The chapters are presented in the same order as the resource areas discussed in this volume.

18.2 ENVIRONMENTAL CONSEQUENCES

18.2.1 Approach to Analysis

18.2.1.1 Methodology

Utilities

Potential environmental consequences and mitigation measures related to the expansion of the utilities infrastructure on Guam were evaluated regarding the following:

- Utilities infrastructure construction impacts
- Utilities operational impacts

These potential impacts were assessed for the general public as well as various media (i.e., soils, surface water, groundwater, air, and biota).

Roadway Projects

Hazardous substances are controlled in the United States primarily by laws and regulations administered by U.S. Environmental Protection Agency (USEPA), the U.S. Occupational Safety and Health Administration (OSHA), and the U.S. Department of Transportation (DOT). Each agency incorporates hazardous substance controls and safeguards according to its unique Congressional mandate. USEPA regulations focus on the protection of human health and the environment. OSHA regulations primarily protect employee and workplace health and safety. DOT regulations promote the safe transportation of hazardous substances used in commerce. In addition, the U.S. Territory of Guam oversees and administers its environmental laws and regulations through Guam Environmental Protection Agency (GEPA). All public and private entities located on Guam are subject to the GEPA environmental requirements. The GEPA Hazardous Waste Management Program and statutory authority is based primarily upon Title 10 Guam Code Annotated.

This contamination screening was prepared pursuant to the Federal Highway Administration (FHWA) Technical Advisory T 6640.8, dated October 30, 1987 (FHWA 1987). This advisory provides guidance on the evaluation of hazardous waste sites that would have an effect on the proposed roadway improvements. This advisory recommends that hazardous waste sites be identified and mapped in relation to the location of project alternatives under consideration.

The potential presence of polychlorinated bipenhyls (PCBs) would also be a concern because of the presence of pole-mounted transformers on electrical transmission poles throughout the island.

A contamination screening of the roadway projects within the study area was conducted to determine the potential for contamination of the corridor right-of-way (ROW) and intersection improvements from adjacent properties and business operations. The screening included a review of an environmental database search, document and file reviews, a review of previous studies, a review of aerial photography, a review of company websites, and field visits. The impacts to the proposed roadway alternatives, and evaluation of hazardous material and hazardous waste generation associated with the roadway construction, are discussed in the Environmental Consequences section for Roadway Projects.

Environmental Database Review

An environmental database search was performed by Environmental Data Resources, Inc. (EDR). The resulting EDR ZIP/Plus reports identified potential hazardous materials and petroleum contamination sites that are listed in USEPA databases (EDR 2009). This database search utilized a geographic information system -integrated database that included federal- and state-regulated sites.

The EDR ZIP/Plus reports provided information on potential contamination sites within the study area by zip codes. Maps to locate the sites were not available. Locally known sites previously documented in the land use review or known military facilities that were identified by the EDR ZIP/Plus reports were located and field verified. The remaining EDR information was cross referenced with additional potential contamination sites identified in the field to include available regulatory information in the site descriptions. After field verification, potential contamination sites were eliminated from further consideration if they were not within 0.25-mile (0.40-kilometers [km]) of the centerline of the proposed roadway or intersection improvement.

The agency list descriptions define the regulatory databases reviewed for this report, along with the dates that each database was last updated by the respective agency and EDR. The following USEPA databases provided support documentation for the evaluation process:

- National Priorities List (NPL), January 26, 2009 – The NPL was devised to prioritize sites for the purpose of taking remedial action as funded by the Hazardous Waste Substance Superfund program, (initially established under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 [CERCLA]).
- Proposed NPL, January 26, 2009 – Proposed NPL Sites.
- National Priority List Deletions (DELISTED NPL), January 26, 2009 – A listing of sites that have been deleted from the NPL. The National Oil and Hazardous Substance Pollution Contingency Plan established the criteria that USEPA uses to delete sites from the NPL.
- NPL Liens, February 16, 2009 – Federal Superfund Liens.
- Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS), January 30, 2009 – This list contains facilities or locations that USEPA is investigating to determine if an existing or threatened release of hazardous substance is present.
- CERCLIS-No Further Remedial Action Planned (NFRAP) List, January 26, 2009 – As of February 15, 1995, CERCLIS no longer includes sites that USEPA has assessed and designated as an NFRAP site. An NFRAP designation means that, to the best of USEPA's knowledge, USEPA (or its agent) has completed assessment activities at the site and has determined that no further steps to list this site on the NPL would be taken unless information indicating this decision was not appropriate or other considerations make a recommendation for listing appropriate at a later time.
- Liens 2, March 3, 2009 – CERCLA Lien Information.

- Resource Conservation and Recovery Act Information System National Oversite Database Handlers With Corrective Action Activity (CORRACTS), March 3, 2009 – This database is a listing of hazardous waste handlers that have undergone RCRA corrective action activity.
- Resource Conservation and Recovery Act Information System, February 20, 2009 – This list identifies those facilities or locations that have notified USEPA of their activities relative to the handling of hazardous wastes. It includes facilities that generate, transport, store, treat and/or dispose of hazardous waste as defined by the RCRA. Transporters are individuals or entities that move hazardous waste from the generator off site to a facility that can recycle, treat, store, or dispose of the waste. Large quantity generators generate more than 1,000 kilograms (kg) of hazardous waste, or more than 1-kg of acutely hazardous waste per month. Small quantity generators generate between 100 kg and 1,000 kg of hazardous waste per month. Conditionally exempt small quantity generators generate less than 100 kg of hazardous waste, or less than 1-kg of acutely hazardous waste per month.
- Engineering Controls Sites List, December 29, 2008 – A listing of sites with engineering controls in place.
- Sites with Institutional Controls, December 29, 2008 – A listing of sites with institutional controls in place.
- Emergency Response Notification System, January 30, 2009 - This database is used to store information on the notification of oil discharges and hazardous substance releases. This report is a compilation of data from 1987 to present.
- Hazardous Materials Information Reporting System, January 30, 2009 – This system contains hazardous material spill incidents reported to DOT.
- DOT, Office of Pipeline Safety Incident and Accident Data, February 24, 2009 – DOT incident and accident data.
- Clandestine Drug Labs, October 31, 2008 – A listing of clandestine drug lab locations. Provided by the U.S. Department of Justice, this listing contains addresses of some locations where law enforcement agencies reported chemicals or other items that indicated the presence of either clandestine drug laboratories or dumpsites.
- U.S. Brownfields, February 10, 2009 – A listing of Brownfields sites.
- Formerly Used Defense Sites (FUDS), December 29, 2008 – Includes locations of FUDS where the U.S. Army Corps of Engineers is actively working or would take necessary cleanup actions.
- Land Use Control Information Systems, March 9, 2009 – Contains records of land use control information pertaining to the former Navy Base Realignment and Closure properties.
- Superfund Consent Decrees, January 19, 2009 – Major legal settlements that establish responsibility and standards for cleanup at NPL (Superfund) sites.
- Record of Decision, December 29, 2009 – Record of Decision documents mandate a permanent remedy at an NPL (Superfund) site containing technical and health information to aid in the cleanup.
- Toxic Release Inventory System List, September 19, 2008 – The Toxic Release Inventory System List identifies facilities that are required to submit annual reports relative to the estimated release of toxic chemicals to the environment.
- Toxic Substance Control Act (TSCA), February 18, 2009 – TSCA identifies manufacturers and importers of chemical substance included on the TSCA Chemical Substance Inventory list.
- Federal Insecticide, Fungicide, & Rodenticide Act (FIFRA)/TSCA (FTTS), December 2007 and December 2008 Files – FTTS tracks administrative cases and pesticide enforcement actions and compliance activities related to an Emergency Planning and Community Right-to-Know Act.

- Biennial Reporting System, February 19, 2009 – The Biennial Reporting System is a national system administered by USEPA that collects data on the generation and management of hazardous waste.
- Facility Index System, December 29, 2008 – The Facility Index System is a historical database that identifies facilities and/or locations that are subject to regulation under certain USEPA programs, due to operations conducted at these sites.
- Section Seven Tracking System, December 12, 2008 – Section 7 of the FIFRA, as amended, requires all registered pesticide-producing establishments to submit a report to USEPA by March 1 each year. Each establishment must report the types and amounts of pesticides, active ingredients, and devices being produced and those having been produced and sold or distributed in the past year.
- Integrated Compliance Information System, January 12, 2009 – This system supports the information of the national enforcement and compliance program, as well as the unique needs of the National Pollutant Discharge Elimination System.
- PCB Activity Database System, January 2, 2009 – This system identifies generators, transporters, commercial storers, and/or brokers and disposers of PCBs who are required to notify USEPA of such activities.
- Material Licensing Tracking System, December 29, 2008 – This system is maintained by the Nuclear Regulatory Commission and contains a list of approximately 8,100 sites that possess or use radioactive materials and that are subject to Nuclear Regulatory Commission licensing requirements.
- RADINFO: Radiation Information Database, January 30, 2009 – This database contains information about facilities that are regulated by USEPA regulations for radiation and radioactivity.
- RCRA Administrative Action Tracking System, June 2, 2008 – This system contains records based on enforcement actions issued under RCRA pertaining to major violators and includes administrative and civil actions brought by USEPA. For administration actions after September 30, 1995, data entry in the database was discontinued.
- Risk Management Plans, February 16, 2009 – When Congress passed the Clean Air Act Amendments of 1990, it required USEPA to publish regulations and guidance for chemical accident prevention at facilities using extremely hazardous substances. The Risk Management Program Rule was written to implement Section 112(r) of these amendments. The rule is built upon existing industry codes and standards, and it requires companies of all sizes that use certain flammable and toxic substances to develop a Risk Management Program that includes a hazard assessment that details the potential effects of an accidental release, an accident history of the last 5 years, and an evaluation of worst-case and alternative accidental releases; a prevention program that includes safety precautions and maintenance, monitoring, and employee training measures; and an emergency response program that spells out emergency health care, employee training measures, and procedures for informing the public and response agencies (e.g., fire department) should an accident occur.

Document and File Review

File reviews also included databases that were not a part of the EDR and were obtained from federal and state agencies concerning past, present, and future enforcement actions that could impact the proposed roadway improvement projects. Useful records in regulatory agency files included compliance inspection reports, enforcement notices, and contamination assessment reports. Other databases used in the evaluation included:

- Enforcement and Compliance History Online – This online database helps determine whether compliance inspections have been conducted by USEPA or state/local governments, if violations were detected or enforcement actions were taken, and if penalties were assessed in response to environmental law violations.

- Clean Water Act Significant Non-Compliance – The National Pollutant Discharge Elimination System program uses the term Significant Non-Compliance (SNC). Examples of events that could result in an SNC code include unauthorized discharges; failure of a Publicly Owned Treatment Works to enforce its approved pretreatment program; failure to meet a construction deadline; failure to file a Discharge Monitoring Report; filing a Discharge Monitoring Report more than 30 days late; or violating any judicial or administrative order. Removal of the SNC designation occurs once the facility's Discharge Monitoring Report reports show a consistent pattern of compliance with permit limits, or if USEPA or a state agency issues a formal enforcement order to address the violations that resulted in the SNC and the facility has returned to compliance.
- RCRA SNC is a term used to describe a site determined to cause actual exposure or has a substantial likelihood of causing exposure to a hazardous waste or constituent; is a chronic or recalcitrant violator; or deviates substantially from the terms of a permit, order, or agreement, or from RCRA statutory or regulatory requirements. Under the RCRA program, the SNC is removed when the site is in full physical compliance with statutory and/or regulatory requirements.
- High Priority Violations is a term used in the Clean Air Act program. This is the most serious level of violation noted in USEPA databases.

Previous Studies

Several potential contamination sites (i.e., former landfills) are located within the property boundary of U.S. Department of Defense (DoD) lands and are adjacent to the roadway ROW or proximal to the proposed roadway projects (TEC JV 2009). These sites were investigated due to the potential for contamination migration if there is a need for construction dewatering, possibly drawing contaminants toward the proposed roadway improvements.

The reports and studies completed for the Andersen Air Force Base (AFB) Installation Restoration Program (IRP) Management and the Navy Military Munitions Response Program (MMRP), USEPA, GEPA, and other federal and local environmental regulatory programs were reviewed to obtain information on potential contamination sites that are within DoD lands and are adjacent or proximal to the proposed improvements (TEC JV 2009).

The current DoD ROI on Guam for hazardous materials and waste includes Air Force and Navy properties. Air Force properties include Andersen AFB, comprised of the main base, the munitions storage area, and Northwest Field; Andersen Administration Annex (Andersen South); and the Andersen Communications Annex Barrigada site near the Guam International Airport. Navy properties include the main naval base at Apra Harbor, Naval Computer and Telecommunications Station Finegayan, Finegayan South Housing Area, Naval Computer and Telecommunications Station Barrigada Transmitter Site, Naval Hospital area, Nimitz Hill, and the Ordnance Annex.

In 1986, Congress created the Defense Environmental Restoration Program (DERP). The DERP addresses the identification and cleanup of hazardous substances and military munitions remaining from past activities at DoD lands and FUDS. Within the DERP, the DoD created two program categories, namely the IRP and the Military Munitions Response Program.

On Guam, USEPA, DoD, and Government of Guam (GovGuam) have ongoing cleanup activities of DERP sites. The DoD and State/Territorial Memorandum of Agreement (DSMOA) established a program where GEPA staff work closely with DoD representatives to discuss and facilitate environmental restoration and clean-up work on Guam. Under the DSMOA program, GEPA maintains regulatory oversight of environmental restoration efforts undertaken on Guam by the DoD to ensure compliance with applicable local and federal laws and regulations. The DSMOA oversees the following three DoD programs:

- Base Realignment and Closure – A clean-up program to ensure the environmental suitability of properties planned for subsequent transfer to GovGuam.
- IRP – The IRP focuses on cleaning up releases of hazardous substances that pose risks to the public and/or the environment at active, as well as Base Realignment and Closure and FUDS, military sites owned or used by the DoD. The IRP is the main DoD environmental restoration program that covers on base actions, such as the Orote landfill at COMNAV Marianas, Construction Battalion landfill clean-up at Finegayan, and Andersen AFB CERCLA actions.
- FUDS – A program managed by U.S. Army Corps of Engineers that is designed to clean up military sites that are no longer owned by the U.S. Government.

Munitions Response Program

In September 2001, the DoD established the MMRP to address hazards associated with munitions and explosives of concern within areas no longer used for operational range activities. These training areas that are no longer used as operational ranges are called munitions response areas. Munitions response areas often contain one or more discrete munitions response sites (Andersen AFB 2007a). In December 2001, Congress passed the National Defense Authorization Act. This Act required DoD to develop an initial inventory of areas not located within operational ranges (i.e., active or inactive ranges) that are known or suspected to contain munitions or explosives of concern.

As part of this inventory process, the DoD is coordinating with GEPA to conduct preliminary assessments and site inspections of areas of concern on Guam (GEPA 2009). As a result of these efforts, the following munitions response areas on Guam have been identified to date:

- Naval Magazine Small Arms Range
- Spanish Steps Skeet and Trap Ranges
- Orote Point Rifle and Pistol Range
- Naval Computer and Telecommunications Main Station Finegayan Skeet Range
- Naval Computer and Telecommunications Main Station Small Arms Range

Aerial Photography Review

A desktop review of project roadway plans and aerials was conducted (Google Earth, 2009).

Web Site Review

Available information on government Web sites was reviewed (Andersen AFB 2009, GEPA 2007, Navy 2007, OSHA 2006).

Field Reviews

Field reviews were conducted by Parsons Brinckerhoff in March/April 2008 and March 2009 to verify locations of potential contamination sites identified in previous reports, and to identify other potential contamination sites not included in previous studies. Since the EDR database reports did not provide exact addresses of sites, only zip codes, the identification of potential contamination sites heavily relied on the field review. Project team members walked the properties, where accessible, to identify potential contamination. The sites were evaluated for possible contamination risks to roadway ROW and potential construction activities. Sites were also researched for evidence of documented contamination, apparent changes to the ground surface and landscaping, ground staining, standing liquids, odors, ventilation pipes, drums and other storage containers, and other indications of current or previous petroleum and hazardous materials use and/or storage. Limited telephone and onsite interviews were also conducted.

Potential petroleum and hazardous material sites adjacent to the proposed roadway improvements were identified and accessed when permission was given by the property owners. Potential contamination sites at DoD lands adjacent to the proposed improvements were observed and documented from the roadway ROW. Except for potential contamination sites within DoD lands or sites proximal to DoD lands, site photographs were obtained from potential petroleum and hazardous material sites that would be adjacent to proposed roadway improvements.

18.2.1.2 Determination of Significance

The determination of significance is based upon existing hazardous substance management practices, potential mitigation measures, and expected or potential impacts and environmental consequences with the planned actions. This determination evaluated the overall ability to mitigate or control environmental impacts and consequences to soils, surface water, groundwater, air, and biota. This determination considers current conditions and potential consequences relative to the anticipated ability of the hazardous substance management infrastructure system to accommodate added hazardous substance demand on the overall system. Specifically, for hazardous substances to be considered a significant impact, the following would have to occur:

- Leaks, spills, or releases of hazardous substances to environmental media (i.e., soils, surface water, groundwater, air, and/or biota) resulting in unacceptable risks to the environment.
- Violation of applicable federal, state, or local laws or regulations regarding the transportation, storage, handling, use, or disposal of hazardous substances.

18.2.1.3 Issues Identified during Public Scoping Process

As part of the analysis, concerns related Hazardous Materials and Waste that were mentioned by the public, including regulatory stakeholders, during the public scoping meetings were addressed. These include:

- Address management practices for hazardous substances, including hazardous wastes, toxic substances, hazardous materials, and ordnance.
- Describe the potential overall impacts of hazardous substances from construction and operation of proposed projects.
- Identify the projected hazardous waste types and volumes.
- Identify expected hazardous substance storage, disposal, and management plans.
- Evaluate measures to mitigate generation of hazardous waste including pollution prevention.
- Discuss how hazardous substances on land and from ships would be managed.
- Discuss the potential for impacts to environmental media from spills, accidents, and/or releases of hazardous substances.
- Identify existing installation restoration sites.

18.2.2 Power

18.2.2.1 Interim Alternative 1 (Preferred Alternative)

Interim Alternative 1 would recondition existing combustion turbines (CTs) and upgrade T&D systems and would not require new construction or enlargement of the existing footprint of the facility. This work would be undertaken by the GPA on its existing permitted facilities. Reconditioning would be made to existing permitted facilities at the Marbo, Yigo, Dededo No. 1, and Macheche CTs. These combustion turbines are not currently being used up to permit limits. T&D system upgrades would be on existing above ground and underground transmission lines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

<u>Hazardous Materials</u>

The proposed activities for this alternative would result in the use of slightly more hazardous materials, particularly from the use of petroleum, lubricants, and oils (POL)/fuels for heavy equipment, vehicles, generators, and related activities. Operation of the upgraded facilities would also result in the use of POL/fuels, primarily for replacement, repair, or renovation activities. The conventional power plant fuel would be diesel No. 2 fuel.

It is estimated that about 1,500 pounds (lbs) (681 kilograms [kg]) of hazardous materials would be generated annually from these reconditioning/upgrade and operational activities. This estimate was based upon professional judgment and Defense Reuse and Marketing Office (DRMO) Guam hazardous material disposal data.

However, BMPs and SOPs would be used to:

- Prevent, contain, and/or clean up spills and leaks to protect the human health and environment
- Provide personnel training and operational protocol and procedures to protect human health and environment
- As necessary, expand DRMO's sufficient hazardous materials storage, transportation, and disposal capacity prior to any expected increases
- Protect overall human health, welfare, and the environment

This alternative could result in significant impacts to human health and the environment (i.e., soils, surface water, groundwater, air, and biota). However, these potential impacts would be controlled to less than significant through implementation of BMPs and SOPs (see Volume 7) that would include:

- Update/implement HMMPs.
- Update/implement Facility Response plans.
- Update/implement SPCC plans (e.g., training, spill containment and control procedures, cleanup, notifications).
- Ensure that DoD and subcontractor personnel are trained in proper labeling, container, storage, staging, and transportation requirements for hazardous materials. Ensure personnel are trained in accordance with spill prevention, control, and cleanup methods.
- Implement aggressive hazardous materials minimization plans that substitute non-hazardous materials for hazardous materials.
- As necessary, expand DRMO's sufficient hazardous materials storage, transportation, and disposal capacity prior to any expected increases
- Verify through surveillance and inspection that contractors fully implement federal, local, and DoD regulations including the use, storage, treatment, and disposal of hazardous materials. Verify that proper erosion control methods are used during construction activities. Implement corrective actions as necessary.

- Minimize the risk of uncontrolled spills and releases through industry-accepted methods for spill prevention, containment, control, and abatement.
- Minimize the use of contaminated sites for new construction. When new projects are planned on sites where contamination has been identified, ensure that the risk of human exposure to contaminated media is minimized through the use of a site-specific health and safety plan, engineering and administrative controls, and appropriate PPE.

Table 18.2-1 summarizes potential hazardous material impacts associated with reconditioning/upgrade activities and subsequent operations.

Table 18.2-1. Interim Alternative 1 Hazardous Material Consequences and Mitigation

Potential Activity (Cause)	*Potential Effect*	*Potential Impacts*	*Potential Mitigation Measures*
Hazardous materials use during reconditioning and subsequent operations	• Increased hazardous materials storage, use, handling, generation, and disposal • Increased fueling and POL operations • Possible use of contaminated site footprint(s) for reconditioning projects • Potential increased site runoff	• Spill or release impacts during construction activities • Impacts and increased risks to human health and/or the environment (soils, surface water, groundwater, or air), including terrestrial and ecosystems • Violations of applicable federal, state, local, or DoD laws and regulations during construction and demolition operations	• No potential mitigation measures are identified

Toxic Substances

The toxic substances of concern include asbestos-containing materials (ACM), lead-based paint (LBP), polychlorinated biphenyls (PCBs), and radon. Most uses of PCBs were banned by United States Environmental Protection Agency (USEPA) in 1979 and LBP was banned in 1978. The CTs proposed for reconditioning under Interim Alternative 1 were all installed in the 1990s. Additionally, the reconditioning of the CTs would not involve handling of ACM. Therefore, impacts from those toxic substances are not anticipated. However, in this case, existing handling and disposal procedures and protocol would be used and would result in less than significant impacts. Additionally, the proposed alternative would not require any new structure or facility at the GPA owned facilities and would not require radon resistant construction techniques.

Hazardous Waste

Expected increases in the use of hazardous wastes are judged to be relatively small as a result of these reconditioning and operation activities. It is estimated that about 750 lbs (341 kg) of hazardous waste would be generated annually from these activities. These wastes are anticipated to include adhesives, lubricants, solvents, and corrosive liquids. This estimate was based upon professional judgment and DRMO Guam hazardous waste disposal data.

Required BMPs and SOPs (see Volume 7) for handling and disposing of these hazardous wastes include: personnel training, proper use of spill prevention and control plans, implementation of hazardous waste management plans, proper execution of existing DRMO hazardous waste handling, transportation, use, storage, and disposal protocol.

18.2.2.2 Interim Alternative 2

Interim Alternative 2 is a combination of reconditioning of existing permitted GPA facilities, an increase in operational hours for existing CTs, and upgrades to existing T&D systems. Interim Alternative 2 would not require new construction or enlargement of the existing footprint of the facility. Reconditioning would be performed on the existing permitted GPA facilities at the Marbo, Yigo, and Dededo CTs. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Potential impacts to hazardous materials and waste from implementation of Interim Alternative 2 would be similar to those discussed under Interim Alternative 1. Estimated quantities of hazardous materials and waste for Interim Alternative 2 would vary less than 1% of the Interim Alternative 1 estimates.

18.2.2.3 Interim Alternative 3

Interim Alternative 3 is a combination of reconditioning to existing GPA permitted facilities at Marbo, Yigo, and Dededo and upgrades to the DoD power plant at Orote. Upgrades would be made to existing T&D. The proposed reconditioning to the facilities at Marbo, Yigo, and Dededo include reconditioning of the existing power generation systems, which would not require new construction or enlargement of the existing footprint of the facility. For the Orote power plant, upgrades would include a new fuel storage facility to facilitate longer run times between refueling. This would disturb approximately 1 acre (4,047 square meters). This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Potential impacts to hazardous materials and waste from implementation of Interim Alternative 3 would be similar to those discussed under Interim Alternative 1. Estimated quantities of hazardous materials and waste for Interim Alternative 3 would vary less than 2% of the Interim Alternative 1 estimates.

18.2.2.4 Summary of Impacts

Table 18.2-2 summarizes the potential impacts of each interim alternative. A text summary is provided below.

Table 18.2-2. Summary of Potential Hazardous Materials and Waste Impacts-Power

*Interim Alternative 1**	*Interim Alternative 2*	*Interim Alternative 3*
Soils, Surface Water, Groundwater, Air, and/or Biota Impacts		
LSI • Less than significant impacts would occur • As with all operations using hazardous substances, there is a possibility for an inadvertent leak, spill, or release • BMPs and SOPs would keep the frequency and magnitude of the potential leaks, spills, and releases low	LSI • Less than significant impacts would occur • As with all operations using hazardous substances, there is a possibility for an inadvertent leak, spill, or release • BMPs and SOPs would keep the frequency and magnitude of the potential leaks, spills, and releases low	LSI • Less than significant impacts would occur • As with all operations using hazardous substances, there is a possibility for an inadvertent leak, spill, or release • BMPs and SOPs would keep the frequency and magnitude of the potential leaks, spills, and releases low

Legend: LSI = Less Than Significant Impact. *Preferred Alternative.

In summary, the proposed increased power upgrade and operations could result in increased environmental impacts. These potential impacts could result from increased transportation, handling, use, and disposal of hazardous materials and hazardous wastes. It is expected that the largest increases of hazardous materials would result from the use of POL/fuels. However, as per regulatory requirements, various controls would be used to prevent unintended releases of these substances. These controls include the following:

- Spill prevention control and countermeasures plans
- Facility Response plans
- Waste management plans
- Stormwater pollution prevention plans
- Hazardous material/waste management plans (e.g., asbestos management plans and lead-based management plans, etc.)
- Mandatory personnel hazardous material and hazardous waste training
- Waste minimization plans
- Waste labeling, storage, packaging, staging, and transportation procedures
- DoD waste regulations
- Federal and territorial laws and regulations

Despite expected increases in hazardous materials and hazardous wastes, no significant impacts are anticipated as long as the controls discussed above are properly implemented and related plans and procedures updated and modified as appropriate to meet the potential increased demand upon DRMO regarding hazardous substance transportation, handling, storage, use, and disposal.

18.2.3 Potable Water

As discussed in Volume 6 Chapter 2 (Section 2.2.2), potable water alternatives 1 and 2 are not distinguished as interim or long-term as they meet the requirements for both interim and long-term.

18.2.3.1 Basic Alternative 1 (Preferred Alternative)

Basic Alternative 1 would consist of installation of up to 22 new potable water supply wells at Andersen AFB, rehabilitation of existing wells, interconnection with the GWA water system, and associated T&D systems. A new 5 MG (19 ML) water storage tank would be constructed at ground level at Finegayan.

Hazardous Materials

The proposed activities for this alternative would result in the use of slightly more hazardous materials as compared with existing quantities. These increases are expected particularly from the use of POL/fuels for heavy equipment, vehicles, generators, and related activities. Operation of the upgraded facilities would also result in the use of POL/fuels, primarily for replacement, repair, or renovation activities. It is estimated that about 750 lbs (341 kg) of hazardous materials would be generated annually from these activities. This estimate was based upon professional judgment and DRMO Guam hazardous material disposal data.

However, BMPs and SOPS would be used to:

- Prevent, contain, and/or clean up spills and leaks to protect the human health and environment.
- Provide personnel training and operational protocol and procedures to protect human health and environment.
- As necessary, expand DRMO's sufficient hazardous materials storage, transportation, and disposal capacity prior to any expected increases.
- Protect overall human health, welfare, and the environment.

This alternative could result in significant impacts to human health and the environment (i.e., soils, surface water, groundwater, air, and biota). However, these potential impacts would be controlled to less than significant through implementation of BMPs and SOPs (see Volume 7) that would include:

- Update/implement HMMPs.
- Update/implement Facility Response plans.
- Update/implement SPCC plans (e.g., training, spill containment and control procedures, cleanup, notifications).
- Ensure that DoD and construction subcontractor personnel are trained in proper labeling, container, storage, staging, and transportation requirements for hazardous materials. Ensure personnel are trained in accordance with spill prevention, control, and cleanup methods.
- Implement aggressive hazardous materials minimization plans that substitute non-hazardous materials for hazardous materials.
- As necessary, expand DRMO's sufficient hazardous materials storage, transportation, and disposal capacity prior to any expected increases
- Verify through surveillance and inspection that construction contractors fully implement federal, local, and DoD regulations including the use, storage, treatment, and disposal of hazardous materials. Verify that proper erosion control methods are used during construction activities. Implement corrective actions as necessary.
- Minimize the risk of uncontrolled spills and releases through industry-accepted methods for spill prevention, containment, control, and abatement.
- Minimize the use of contaminated sites for new projects. When new projects are planned on sites where contamination has been identified, ensure that the risk of human exposure to contaminated media is minimized through the use of a site-specific health and safety plan, engineering and administrative controls, and appropriate PPE.

Table 18.2-3 summarizes potential hazardous material impacts associated with these upgrade activities and subsequent operations.

Table 18.2-3. Alternative 1 Hazardous Material Construction Consequences and Mitigation

Potential Activity (Cause)	*Potential Effect*	*Potential Impacts*	*Potential Mitigation Measures*
Hazardous materials use during upgrades and subsequent operations	• Increased hazardous materials storage, use, handling, generation, and disposal • Increased fueling and POL operations • Possible use of contaminated site footprint(s) for new projects • Potential increased site runoff	• Spill or release impacts during upgrade activities • Adverse impacts and increased risks to human health and/or the environment, including terrestrial and marine ecosystems • Violations of applicable federal, state, local, or DoD laws and regulations during upgrade and demolition operations • Increased risk of contamination of environmental media	• No potential mitigation measures are identified

<u>Toxic Substances</u>

The primary toxic substances being addressed on Guam regardless of any DoD expansion include ACM, LBP, PCBs, and radon. ACM, LBP, and PCBs are not expected to result in additional impacts because LBPs were banned in 1978, most uses of PCBs banned in 1979, and ACM would not be used in new utilities infrastructure facilities.

Radon could seep into facilities and/or structures. However, radon resistant construction techniques would be used and DoD would periodically test facilities constructed in known radon zones to verify that no unacceptable radon gas buildup occurs. As appropriate, radon mitigation measures would be installed.

<u>Hazardous Waste</u>

Expected increases in the use of hazardous waste are judged to be negligible as a result of these existing potable water upgrade activities. It is estimated that about 375 lbs (171 kg) of hazardous waste would be generated annually from these upgrade and operational activities. These wastes are anticipated to include adhesives, lubricants, solvents, and corrosive liquids. This estimate was based upon professional judgment and DRMO Guam hazardous waste disposal data. No potential mitigation measures would be required.

Required BMPs and SOPs (see Volume 7) for these hazardous wastes include: personnel training, proper use of spill prevention and control plans, implementation of hazardous waste management plans, proper execution of existing DRMO hazardous waste handling, transportation, use, storage, and disposal protocol.

18.2.3.2 Basic Alternative 2

Basic Alternative 2 would consist of installation of up to 20 new potable water supply wells at Andersen Air Force Base (AFB), up to 11 new potable water supply wells at Barrigada, rehabilitation of existing wells, interconnection with the GWA water system, associated transmission and distribution systems.

Additionally, a new 3.6 MG (13.6 ML) and a new 1 MG (3.8 ML) water storage tanks would be constructed at ground level at Finegayan and Barrigada, respectively.

Potential impacts to hazardous materials and waste from implementation of Basic Alternative 2 would be similar to those discussed under Alternative 1. Estimated quantities of hazardous materials and waste for Alternative 2 would vary less than 2% of the Alternative 1 estimates.

18.2.3.3 Summary of Impacts

Table 18.2.4 summarizes the potential impacts of each action alternative. A text summary is provided below.

Table 18.2-4. Summary of Potential Hazardous Materials and Waste Impacts-Potable Water

*Basic Alternative 1**	*Basic Alternative 2*
Soils, Surface Water, Groundwater, Air, and/or Biota Impacts	
LSI • Less than significant impacts would occur • As with all operations using hazardous substances, there is a possibility for an inadvertent leak, spill, or release • BMPs and SOPs would keep the frequency and magnitude of the potential leaks, spills, and releases low	LSI • Less than significant impacts would occur • As with all operations using hazardous substances, there is a possibility for an inadvertent leak, spill, or release • BMPs and SOPs would keep the frequency and magnitude of the potential leaks, spills, and releases low

Legend: LSI = Less Than Significant Impact. *Preferred Alternative.

In summary, the proposed potable water upgrade project could result in increased environmental impacts. These potential impacts could result from increased transportation, handling, use, and disposal of hazardous materials and hazardous wastes. It is expected that the largest increases of hazardous materials would result from the use of POL/fuels. Expected increases in the use of hazardous waste are judged to be negligible, but could include solvents, corrosive or toxic liquids, and aerosols.

Various controls are in place to prevent unintended releases of these substances. These controls include the following:

- Spill prevention control and countermeasures plans
- Facility response plans
- Waste management plans
- Stormwater pollution prevention plans
- Hazardous material/waste management plans (e.g., asbestos management plans and lead-based management plans, etc.)
- Mandatory personnel hazardous material/waste training
- Waste minimization plans
- Waste labeling, storage, packaging, staging, and transportation procedures
- DoD waste regulations
- Federal and territorial laws and regulations

Despite expected increases in hazardous materials and hazardous wastes, no significant impacts are anticipated as long as the controls discussed above are properly implemented and related plans and procedures updated and modified as appropriate to meet the potential increased demand upon DRMO regarding hazardous substance transportation, handling, storage, use, and disposal.

18.2.4 Wastewater

18.2.4.1 Basic Alternative 1 (Preferred Alternative) and 1b

Basic Alternative 1 (Basic Alternative 1a supports Main Cantonment Alternatives 1 and 2; and Basic Alternative 1b supports Main Cantonment Alternatives 3 and 8) combines upgrade to the existing primary treatment facilities and expansion to secondary treatment at the Northern District Wastewater Treatment Plant (NDWWTP). The difference between Basic Alternatives 1a and 1b is a requirement for a new sewer line from Barrigada housing to NDWWTP for Basic Alternative 1b.

Hazardous Materials

The proposed activities for this alternative would result in the use of slightly more hazardous materials, particularly from the use of POL/fuels for heavy equipment, vehicles, generators, and related activities. Operation of the upgraded facilities would also result in the use of POL/fuels, primarily for replacement, repair, or renovation activities. It is estimated that about 525 lbs (238 kg) of hazardous materials would be generated annually from these upgrade and operational activities. This estimate was based upon professional judgment and DRMO Guam hazardous material disposal data. No potential mitigation measures would be required.

However, BMPs and SOPs would be used to:

- Prevent, contain, and/or clean up spills and leaks to protect the human health and environment.
- Provide personnel training and operational protocol and procedures to protect human health and environment.
- As necessary, expand DRMO's sufficient hazardous materials storage, transportation, and disposal capacity prior to any expected increases.
- Protect overall human health, welfare, and the environment.

This Alternative could result in significant impacts to human health and the environment (i.e., soils, surface water, groundwater, air, and biota). However, these potential impacts would be controlled to less than significant through implementation of BMPs and SOPs (see Volume 7) that would include:

- Update/implement HMMPs.
- Update/implement Facility Response plans.
- Update/implement SPCC plans (e.g., training, spill containment and control procedures, cleanup, notifications).
- Ensure that DoD and subcontractor personnel are trained in proper labeling, container, storage, staging, and transportation requirements for hazardous materials. Ensure personnel are trained in accordance with spill prevention, control, and cleanup methods.
- Implement aggressive hazardous materials minimization plans that substitute non-hazardous materials for hazardous materials.
- As necessary, expand DRMO's sufficient hazardous materials storage, transportation, and disposal capacity prior to any expected increases
- Verify through surveillance and inspection that contractors fully implement federal, local, and DoD regulations including the use, storage, treatment, and disposal of hazardous materials. Verify that proper erosion control methods are used during construction activities. Implement corrective actions as necessary.
- Minimize the risk of uncontrolled spills and releases through industry-accepted methods for spill prevention, containment, control, and abatement.

- Minimize the use of contaminated sites for new projects. When new projects are planned on sites where contamination has been identified, ensure that the risk of human exposure to contaminated media is minimized through the use of a site-specific health and safety plan, engineering and administrative controls, and appropriate PPE.

Table 18.2-5 summarizes potential hazardous material impacts associated with these upgrade activities and subsequent operations.

Table 18.2-5. Interim Alternative 1 Hazardous Material Construction

Potential Activity (Cause)	*Potential Effect*	*Potential Impacts*	*Potential Mitigation Measures*
Hazardous materials use during upgrade activities and subsequent operations	• Increased hazardous materials storage, use, handling, generation, and disposal • Increased fueling and POL operations • Possible use of contaminated site footprint(s) for new projects • Potential increased site runoff	• Spill or release impacts during upgrade activities • Adverse impacts and increased risks to human health and/or the environment, including terrestrial and marine ecosystems • Violations of applicable federal, state, local, or DoD laws and regulations during construction and demolition operations • Increased risk of contamination of environmental media	• No potential mitigation measures are identified

Toxic Substances

The primary toxic substances being addressed on Guam regardless of any DoD expansion include ACM, LBP, PCBs, and radon. ACM, LBP, and PCBs are not expected to result in additional impacts because LBPs were banned in 1978, most uses of PCBs banned in 1979, and ACM would not be used in new utilities infrastructure facilities.

Radon could seep into the facilities and/or structures. However, radon resistant construction techniques would be used and DoD would periodically test facilities constructed in known radon zones to verify that no unacceptable radon gas buildup occurs. As appropriate, radon mitigation measures would be installed.

Hazardous Waste

Expected increases in the use of hazardous wastes are judged to be small as a result of these existing wastewater upgrade activities. It is estimated that about 160 lbs (73 kg) of hazardous waste would be generated annually from these activities. These wastes are anticipated to include adhesives, lubricants, solvents, and corrosive liquids. This estimate was based upon professional judgment and DRMO Guam hazardous waste disposal data. No potential mitigation measures would be required.

Required BMPs and SOPs (see Volume 7) for these hazardous wastes include: personnel training, proper use of spill prevention and control plans, implementation of hazardous waste management plans, proper execution of existing DRMO hazardous waste handling, transportation, use, storage, and disposal protocol.

18.2.4.2 Summary of Impacts

Table 18.2-6 summarizes the potential impacts of each interim alternative. A text summary is provided below.

Table 18.2-6. Summary of Potential Hazardous Materials and Waste Impacts-Wastewater

*Basic Alternative 1a**	*Basic Alternative 2a*
Soils, Surface Water, Groundwater, Air, and/or Biota Impacts	
LSI • Less than significant adverse impacts would occur • As with all operations using hazardous substances, there is a possibility for an inadvertent leak, spill, or release • BMPs and SOPs would keep the frequency and magnitude of the potential leaks, spills, and releases low	LSI • Less than significant adverse impacts would occur • As with all operations using hazardous substances, there is a possibility for an inadvertent leak, spill, or release BMPs and SOPs would keep the frequency and magnitude of the potential leaks, spills, and releases low

Legend: LSI = Less Than Significant Impact. *Preferred Alternative.

In summary, the proposed wastewater project could result in increased environmental impacts. These potential impacts could result from increased transportation, handling, use, and disposal of hazardous materials and hazardous wastes. It is expected that the largest increases of hazardous materials would result from the use of POL/fuels. Expected increases in the use of hazardous waste are judged to be negligible, but could include solvents, corrosive or toxic liquids, and aerosols.

Various controls are in place to prevent unintended releases of these substances. These controls include the following:

- Spill prevention control and countermeasures plans
- Facility response plans
- Waste management plans
- Stormwater pollution prevention plans
- Hazardous material management plans (e.g., asbestos management plans and lead-based management plans, etc.)
- Mandatory personnel hazardous material and hazardous waste training
- Waste minimization plans
- Waste labeling, storage, packaging, staging, and transportation procedures
- DoD waste regulations
- Federal and territorial laws and regulations

Despite expected increases in hazardous materials and hazardous wastes, no significant impacts are anticipated as long as the controls discussed above are properly implemented and related plans and procedures updated and modified as appropriate to meet the potential increased demand upon DRMO regarding hazardous substance transportation, handling, storage, use, and disposal.

18.2.5 Solid Waste

18.2.5.1 Basic Alternative 1 (Preferred Alternative)

The Preferred Alternative for solid waste would be the continued use of Navy Landfill at Apra Harbor until Layon Landfill is opened, which is scheduled for July 2011. This alternative does not involve any construction activities.

<u>Hazardous Materials</u>

Since there would be no construction activities and operations would not differ from current practice, there would be less than significant potential impact in the generation of hazardous materials. The proposed activities would result in the use of approximately the same quantity of hazardous materials. These would include POL/fuels for heavy equipment used in landfill operations, generators, and related activities. Operation of the facilities would result in the use of POL/fuels, primarily for replacement, repair, or renovation activities. It is estimated that about 450 lbs (204 kg) of hazardous materials would be generated annually from these operational activities. This estimate was based upon professional judgment and DRMO Guam hazardous material disposal data.

However, BMPs and SOPs would be used to:

- Prevent, contain, and/or clean up spills and leaks to protect the human health and environment
- Provide personnel training and operational protocol and procedures to protect human health and environment
- As necessary, expand DRMO's sufficient hazardous materials storage, transportation, and disposal capacity prior to any expected increases
- Protect overall human health, welfare, and the environment

This Alternative could result in significant impacts to human health and the environment (i.e., soils, surface water, groundwater, air, and biota). However, these potential impacts would be controlled to less than significant through implementation of BMPs and SOPs (see Volume 7) that would include:

- Ensure personnel are trained in accordance with spill prevention, control, and cleanup methods.
- Implement aggressive hazardous materials minimization plans that substitute non-hazardous materials for hazardous materials.
- Update and implement facility response plans.
- As necessary, expand DRMO's sufficient hazardous materials storage, transportation, and disposal capacity prior to any expected increases.
- Verify through surveillance and inspection that contractors fully implement federal, local, and DoD regulations including the use, storage, treatment, and disposal of hazardous materials. Verify that proper erosion control methods are used during construction activities. Implement corrective actions as necessary.
- Minimize the risk of uncontrolled spills and releases through industry-accepted methods for spill prevention, containment, control, and abatement.

Table 18.2-7 summarizes potential hazardous material impacts associated with these operations activities.

Table 18.2-7. Hazardous Material Consequences and Mitigation

Potential Activity (Cause)	*Potential Effect*	*Potential Impacts*	*Potential Mitigation Measures*

Potential Activity (Cause)	*Potential Effect*	*Potential Impacts*	*Potential Mitigation Measures*
Hazardous materials use during operations activities	• Continued use hazardous materials storage, use, handling, generation, and disposal • Continued fueling and POL operations	• Adverse impacts and increased risks to human health and/or the environment, including terrestrial and marine ecosystems • Increased risk of contamination of environmental media	• No potential mitigation measures are identified

Toxic Substances

The primary toxic substances being addressed on Guam regardless of any DoD expansion include ACM, LBP, PCBs, and radon. ACM, LBP, and PCBs are not expected to result in additional impacts because LBPs were banned in 1978, most uses of PCBs banned in 1979, and ACM would not be used in new utilities infrastructure facilities.

Radon could seep into facilities and/or structures. DoD would periodically test facilities located in known radon zones to verify that no unacceptable radon gas buildup occurs. As appropriate, radon mitigation measures would be installed.

Hazardous Waste

It is estimated that about 250 lbs (113 kg) of hazardous waste would be generated annually from these activities. These wastes are anticipated to include adhesives, lubricants, solvents, and corrosive liquids. This estimate was based upon professional judgment and DRMO Guam hazardous waste disposal data.

Required BMPs and SOPs (see Volume 7) for these hazardous wastes include: personnel training, proper use of spill prevention and control plans, implementation of hazardous waste management plans, proper execution of existing DRMO hazardous waste handling, transportation, use, storage, and disposal protocol.

18.2.5.2 Summary of Impacts

Table 18.2-8 summarizes the potential impacts of each interim alternative. A text summary is provided below.

Table 18.2-8. Summary of Potential Hazardous Materials and Waste Impacts-Solid Waste

*Basic Alternative 1**
Soils, Groundwater, Surface Water, Air, and Biota LSI • Less than significant adverse impacts would occur • As with all operations using hazardous substances, there is a possibility for an inadvertent leak, spill, or release • BMPs and SOPs would keep the frequency and magnitude of the potential leaks, spills, and releases low

Legend: LSI = Less Than Significant Impact. *Preferred Alternative.

In summary, the proposed solid waste alternatives could result in increased environmental impacts. These potential impacts could result from increased transportation, handling, use, and disposal of hazardous materials and hazardous wastes. It is expected that the largest increases of hazardous materials would result from the use of POL/fuels. Expected increases in the use of hazardous wastes are judged to be negligible, but could include solvents, corrosive or toxic liquids, and aerosols.

Various controls are in place to prevent unintended releases of these substances as are procedures that are activated in the event of a spill or release. These controls include the following:

- Spill prevention control and countermeasures plans
- Facility response plans
- Waste management plans
- Stormwater pollution prevention plans
- Hazardous material/waste management plans (e.g., asbestos management plans and lead-based management plans, etc.)
- Mandatory personnel hazardous material and hazardous waste training
- Waste minimization plans
- Waste labeling, storage, packaging, staging, and transportation procedures
- DoD waste regulations
- Federal and territorial laws and regulations

Despite expected increases in hazardous materials and hazardous wastes, no significant impacts are anticipated as long as the controls discussed above are properly implemented and related plans and procedures updated and modified as appropriate to meet the potential increased demand upon DRMO regarding hazardous substance transportation, handling, storage, use, and disposal.

18.2.6 Off Base Roadways

The proposed roadway, bridge, and intersection improvements may involve the use of hazardous materials and the generation of hazardous materials and hazardous wastes. Waste can be generated during bridge demolition, bridge construction and painting, roadway pavement markings, wall and fence painting, construction equipment/machinery maintenance and repair, and demolishing of structures acquired from ROW acquisition, and from excavation of materials containing hazardous substances. The following discussion of hazardous materials use and hazardous waste generation applies to all of the action alternatives.

Potential hazardous materials associated with roadway and bridge construction include, but are not limited to:

- Product paint for bridges, poles, fences, walls, and roadway pavement markings
- Penetrating sealer (i.e., Methaylmethacrylate), modified mortar, and litex
- Coal tar epoxy for injecting in cracks
- Painting equipment cleaning solvents
- Diesel fuel contained in aboveground storage tanks (ASTs) to fuel construction equipment
- Unleaded gasoline contained in ASTs to fuel vehicles
- Engine solvents and degreasers
- Motor oil, gear oil, and other engine lubricants
- Potentially hazardous dredged material
- Potentially hazardous drill cuttings

Potential hazardous substances generated by roadway and bridge construction include, but are not limited to the following:

- Excavated underground storage tanks (USTs) containing petroleum, oil, and lubricants (POL)
- Excavated electrical transformers and capacitors containing PCBs
- Petroleum-contaminated soil and groundwater
- Asbestos and asbestos-containing materials (ACMs)
- Sandblasting wastes not determined to be hazardous wastes
- Potentially hazardous dredged material not determined to be hazardous wastes
- Potentially hazardous drill cuttings not determined to be hazardous wastes

Potential hazardous wastes that could be generated from roadway and bridge construction include:

- Waste paint
- Paint and sealant removal wastes
- Waste paint cleaning solvents and rags
- Waste fuel removed from machinery
- Waste engine solvents and degreasers
- Used oil and lubricants
- Waste antifreeze

The management, use, and storage of these hazardous materials and hazardous wastes on roadway projects are governed under the provisions of the American Association of State Highway and Transportation Officials (AASHTO) Guidelines for Painting Structures (1997), AASHTO Standard Specifications for Transportation Material and Method of Sampling and Testing (2005), and AASHTO Policy on Geometric Design of Highways and Streets, Maintenance of Traffic Through Construction Areas, page 301-303 (2001).

The management, storage, and disposal of hazardous wastes are regulated under the USEPA Resource Conservation and Recovery Act (RCRA) and Hazardous and Solid Waste Amendments (HSWA), and are enforced by the GEPA Hazardous Waste Management Program (HWMP) (USEPA 1997, 2005, 2007, 2008a, 2008b; Andersen AFB 2007b).

Hazardous materials disposal and the disposal of POL, PCBs, ACMs, and other hazardous substances are regulated by GEPA.

To mitigate any potential impacts from hazardous materials and hazardous wastes, management plans would be developed in accordance with applicable federal and territorial laws, and they would be implemented during road construction activities. With implementation of BMPs and SOPs, impacts would be less than significant for hazardous materials used and hazardous wastes generated during roadway construction.

Of the 123 potentially contaminated sites on Guam, 17 sites were identified having known or likely soil and/or water contamination within, or adjacent to, the Guam Road Network (GRN) project areas. The 17 sites were shown by region in figures located in the Hazardous Materials and Waste chapter in Volume 2. Detailed information on each of the 123 sites is provided in Volume 9, Appendix G-3.

To identify the potential environmental impacts from contaminated sites on GRN project construction, the nature of each GRN project activity in the affected area was considered. A key factor in determining the potential for environmental effects was the specific type of roadway project that would occur in a given area where known or likely soil or groundwater contamination may be present.

Each of the four action alternatives would result in construction and operation of a set of individual roadway improvement projects on Guam. Implementation of each alternative would result in construction activities in each of the four geographic regions. Construction activities would consist of intersection improvements, bridge replacements, pavement strengthening, road relocation, road widening, and construction of a new road. While many projects would involve construction work in developed and paved areas, some roadway projects could result in soil intrusion that could encounter areas of contamination. Since all roadway project types would generally require construction activities that would involve the use of heavy construction equipment, the potential for leaks or spills of potentially hazardous materials would be common for all project types. A preliminary screening of project types and potential effects from contaminated soil or groundwater is provided in Table 18.2-9.

Table 18.2-9. Potential Effects from Contaminated Soils for GRN Roadway Project Types

Item	*Project Type*	*Description of Construction Activities*	*Potential Effect from Contaminated Soils*
1	Intersection Improvement (including military access points [MAPs])	Installation of new traffic loop sensors, extending lanes through the intersection, striping and paving to include new approach or turn lanes, reconfiguring intersection shapes (i.e., from Y-intersection to T-intersections), combining lanes, creating shared lanes, restriping, signalization modifications or upgrades, and grade separations.	Generally, intersection improvement work would not result in contact with subsurface soils. The potential for impacts from contaminated soils would be present only when reconfiguration or grade separations include excavation, trenching, or grading into the subsoil.
2	Bridge Replacement	Bridge replacement would be conducted in phases. The new bridge structure would be lengthened to adequately accommodate the hydraulic flow of the river. The width of the new structure would accommodate more or wider lanes and a median, with sidewalks and barriers on each side.	Bridge replacement can include excavation, trenching, or grading into the subsoil. Although soils would be affected when foundation work requires excavation beneath the existing bridge structure and utility work would require new trenching. No ROW acquisition would be required because bridges would be replaced within the footprint of the existing bridge.
3	Pavement Strengthening	Existing asphalt pavement sections would be strengthened by rehabilitating the existing pavement materials in place and placing an asphalt overlay or by reconstructing with new materials. The widened pavement section would be constructed of residual material from the existing pavement rehabilitation, new material, or a combination thereof, and an asphalt overlay. Pavement strengthening would also include matching existing access connections, pavement striping, signing, intelligent traffic systems, and safety lighting. The project would match existing horizontal and vertical alignment as required. Minor realignment of the road may be necessary to accommodate design elements.	Physical disturbance to soils from pavement strengthening would only occur when pavements are widened, new traffic systems or devices are installed, or minor road realignment occurs in previously undisturbed ground. Most activities associated with pavement strengthening would not require soil intrusion. For this reason, the potential for impacts from contaminated sites is considered to be low.

Table 18.2-9. Potential Effects from Contaminated Soils for GRN Roadway Project Types

Item	*Project Type*	*Description of Construction Activities*	*Potential Effect from Contaminated Soils*
4	Road Relocation (Route 15 only)	Route 15 would be realigned to accommodate the location of military firing ranges. New asphalt pavement would be constructed on the new alignment. The roadway cross section would consist of one lane in each direction, outside shoulders and inside shoulders, with an unpaved median that would accommodate future widening. Bicycles would be accommodated in the outside shoulders of the shared roadway. Alternatively, future widening would be accommodated to the outside, and the roadway cross section would consist of two lanes and outside shoulders with a paved median. Realignment would also include construction of new bridge(s) to grade separate Route 15 and the frontage road(s), obliterating existing Route 15 pavement, building removal, connecting to existing roadways or other access roads, utility relocation, pavement striping, signing, property fence, and guardrail installation.	Realignment into previously undisturbed soils may be required to accommodate design of the roadway. This activity would require building removal and relocation of existing utilities. For this reason, there is a potential for impacts from contaminated sites in the area.
5	Road Widening	New lanes would be added to an existing roadway to accommodate predicted increased traffic volumes and to relieve congestion caused by an increase in traffic volumes due to buildup activities. Widening would result in rebuilding the entire roadway, including removing the existing roadway segment. A new sub-base, base course, asphalt, and friction course layers would be constructed.	Road widening activities would affect soil when the footprint of the roadway extends into previously undisturbed soils. For this reason, there is a potential for impacts from contaminated sites in the area.
6	Construction of New Road	The Finegayan Connection would be constructed on a new alignment with new asphalt pavement on a compacted base or engineered fill.	New road construction would affect soil when the footprint of the roadway extends into previously undisturbed soils. For this reason, there is a potential for impacts from contaminated sites in the area.
7	Other	Temporary placement of equipment laydown or construction staging areas may be required.	Equipment laydown or construction staging areas associated with any of the above project types may require clearing and other disturbance of soils. For this reason, there is a potential for impacts from contaminated sites in the area.

Potential impacts from hazardous waste contamination in soil or groundwater can be detrimental to roadway construction activities. While it is unlikely that groundwater contamination would lead to direct impacts to roadway construction at the ground level, contaminated soil may require removal or remediation. Direct impacts that result in physical soil loss could occur during construction, while indirect impacts can result from the completed project (e.g., contaminants leach into soils). Based on the anticipated activities associated with each project type, it was determined that:

- Intersection improvements and pavement strengthening projects represent the project types with the lowest potential for impacts from hazardous waste contamination in soil or groundwater. Bridge

replacement projects using the same footprint for footings and other structures (i.e., no additional ROW required) would also represent a low potential for impacts. These projects would involve the least amount of physical soil disturbance because most work would occur upon existing pavements or developed areas.
- The placement of temporary equipment laydown areas at any of the GRN project work sites would represent a moderate potential for impacts from hazardous waste contamination in soil or groundwater only when the use of previously undisturbed areas are selected. To avoid this impact, previously disturbed (e.g., paved) areas adjacent to the work site would be selected for use as temporary construction staging areas or storage for roadway demolition materials whenever possible. Heavy equipment would be used, and leaks or spills of contaminants could occur at equipment staging areas.
- Road relocation, road widening, and construction of the new road would represent the greatest potential for impacts from hazardous waste contamination in soil or groundwater because these projects would result in the greatest degree of soil intrusion.

Certain proposed roadway improvements in the North and Central regions would require the acquisition of additional ROW on residential, business, or military land (refer to the Socioeconomics section of Volume 6). The potential for contamination would vary depending on the type of land to be acquired. In some cases, it is possible that the likelihood of contamination may be greater beneath certain business properties than beneath residential properties. The potential for contaminant migration to the roadway ROW would require further assessment after alignment selection to determine the actual presence and/or levels of contamination and the possible need for remedial action. Roadway projects with ROW acquisition may require actions such as avoidance or minimization during the design phase and before construction.

Indirect impacts from the roadway projects would be associated with contaminants leaching into soils. The potential for contaminants leaching into the soil would be prevented or managed through implementation of spill prevention and emergency spill response procedures.

18.2.6.1 Alternative 1

Roadway projects can be impacted by contaminated sites that are in close proximity to the roadway alignments. There are 49 projects that would occur as a result of implementation of Alternative 1. The effects of potentially contaminated sites to these projects are discussed below.

<u>North</u>

Alternative 1 includes 13 projects in the North region. GRN #8, 10, and 22A are adjacent or proximal to four potentially contaminated sites (Site Nos. 1, 8, 9, and 13). GRN #8 and 22A are pavement strengthening projects, with minimal potential for soil intrusion. Partial ROW acquisition would be required for GRN #22A.

GRN #10 is a road widening project that would require partial ROW acquisition along Route 3. Due to potential contamination from Site No. 8 (Potts Junction Tank Farm), avoidance measures would be required to ensure that construction does not occur on contaminated soil or is managed to avoid ongoing remediation efforts to the maximum extent possible.

Roadway projects in the North region also include intersection improvements and construction of a new road. Although no known contaminated sites have been identified near any of these projects, some projects may require ROW acquisitions, and temporary construction staging areas may require soil intrusion. Due to the need for ROW acquisition and/or soil intrusion at these project locations, avoidance measures would be required to ensure that construction does not occur on contaminated soil or is managed to avoid ongoing remediation efforts to the maximum extent possible.

Central

Alternative 1 includes 27 projects in the Central region. GRN #6, 13, 15, 17, and 33 are adjacent or proximal to eight potentially contaminated sites (Site Nos. 14, 25, 33, 44, 47, 57, 58, and 62). All of these GRN projects are pavement strengthening projects, with minimal potential for soil intrusion. Partial ROW acquisition would be required for GRN #13, 17, and 33.

Roadway projects in the Central region also include intersection improvements, bridge replacements, road relocations, and road widening. Although no known contaminated sites have been identified near any of these projects, some projects may require ROW acquisitions, and temporary construction staging areas may require soil intrusion. For these reasons, avoidance measures would be required to ensure that construction does not occur on contaminated soil or is managed to avoid ongoing remediation efforts to the maximum extent possible.

Apra Harbor

Alternative 1 includes five projects in the Apra Harbor region. GRN # 4 and 26 are adjacent or proximal to five potentially contaminated sites (Site Nos. 111, 113, 114, 117, and 118). GRN #4 and 26 are pavement strengthening projects, with minimal potential for soil intrusion. Partial ROW acquisition would be required for both of these GRN projects.

Roadway projects in the Apra Harbor region also include intersection improvements that would have a low potential for ground intrusion. No ROW acquisition would be required for any projects in the Apra Harbor region. Avoidance measures would be required only for temporary construction staging areas to ensure that construction does not occur on contaminated soil or is managed to avoid ongoing remediation efforts to the maximum extent possible.

South

Alternative 1 includes four projects in the South region. No potentially contaminated sites of concern were identified in the South region. The roadway projects in the South region are not located in areas where potentially contaminated sites exist or would have influence on the proposed roadway improvements.

Roadway projects in the South region are limited to pavement strengthening and intersection improvements that would have a low potential for ground intrusion. No ROW acquisition would be required for any projects in the South region. Avoidance measures would be required only for temporary construction staging areas to ensure that construction does not occur on contaminated soil or is managed to avoid ongoing remediation efforts to the maximum extent possible.

BMPs and SOPs

BMPs and SOPs to avoid or minimize the impact of hazardous materials include the following:

- Roadway construction contractors shall be required to manage, store, and dispose of hazardous wastes in accordance with applicable USEPA RCRA and HSWA requirements.
- Roadway construction contractors shall be required to dispose of all POL, PCBs, ACMs, and other hazardous substances in accordance with GEPA regulations.

With implementation of the hazardous materials and hazardous waste management plans, impacts would be less than significant for hazardous materials used and hazardous wastes generated during roadway construction.

BMPs and SOPs to avoid or minimize the impact of contaminated sites for the proposed roadway improvements are as follows:

- A Phase 2 environmental site assessment may be conducted for ROW acquisition associated with GRN #10 (road widening along Route 3 – Naval Computer and Telecommunications Station (NCTS) Finegayan to Route 9) to determine potential contamination in the vicinity of the Potts Junction Tank Farm. The construction contractor may be required to implement avoidance measures to ensure that construction (a) does not occur on contaminated soil; and (b) is managed to avoid any ongoing remediation efforts to the maximum extent possible.
- A Phase 2 environmental site assessment may be conducted for roadway projects with ROW acquisitions of non-residential property. Roadway construction shall be conducted in accordance with the recommendations of the Phase 2 environmental site assessment. Depending on the extent of contamination at a specific site, excavation and removal of soil and/or groundwater contamination may be required before roadway construction can commence.
- Final design of roadway projects may include an evaluation of potential contamination for the following categories: (1) intersection improvements and pavement strengthening projects that require ROW acquisition of non-residential property; (2) intersection improvement projects that require reconfiguration or grade separation involving excavation, trenching, or grading into the subsoil; (3) bridge replacement projects that require excavation, trenching, or grading into the subsoil and exceeds the existing footprint of the bridge structure; (4) pavement strengthening that occurs in previously undisturbed ground; (5) road realignment into previously undisturbed soils or that requires building removal and/or relocation of utilities; (6) road widening activities that require a change or enlargement of the footprint of the roadway or that extends into previously undisturbed soils; (7) new road construction that would affect soil when the footprint of the roadway extends into previously undisturbed soils; and (8) new road construction that extends into previously undisturbed soils or requires ROW acquisition.
- Final roadway design would avoid known contaminated sites wherever possible. Avoidance may involve adjustments to the roadway design to completely avoid a contaminated site. Minimization may involve adjustments of the proposed roadway alignment to reduce the resultant ROW acquisition.
- Final roadway design may include coordination with the responsible party to ensure that roadway construction does not interfere with ongoing remediation activities.
- Temporary equipment laydown or construction staging areas would be located in previously disturbed (e.g., paved) areas.
- To prevent leaks or spills of contaminants, all temporary equipment laydown or construction staging areas would be constructed with secondary containment for storage of any hazardous or petroleum products.
- To prevent or minimize the potential for contaminants leaching into the soil, the construction contractor shall implement spill prevention and emergency spill response procedures.

With implementation of the above BMPs and SOPs for contaminated sites, impacts from hazardous materials and wastes for Alternative 1 would be less than significant.

18.2.6.2 Alternative 2 (Preferred Alternative)

There are 49 projects that would be constructed as a result of Alternative 2. The effects of potentially contaminated sites to these projects are discussed below.

<u>North</u>

Alternative 2 includes 13 projects in the North Region. The effects of potentially contaminated sites are similar to those for the North Region of Alternative 1.

<u>Central</u>

Alternative 2 includes 27 projects in the Central Region. The effects of potentially contaminated sites are similar to those for the Central Region of Alternative 1.

<u>Apra Harbor</u>

Alternative 2 includes five projects in the Apra Harbor Region. The effects of potentially contaminated sites are similar to those for the Apra Harbor Region of Alternative 1.

<u>South</u>

Alternative 2 includes four projects in the South Region. The effects of potentially contaminated sites are similar to those for the South Region of Alternative 1.

<u>BMPs and SOPs</u>

Potentially contaminated sites that would be associated with Alternative 2 are the same as those listed for Alternative 1. BMPs and SOPs used to avoid or minimize the impact of potentially contaminated sites would be similar to those identified for Alternative 1.

18.2.6.3 Alternative 3

There are 51 projects in Alternative 3. The effects of potentially contaminated sites to these projects are discussed below.

<u>North</u>

Alternative 3 includes 12 projects in the North Region. The effects of potentially contaminated sites are similar to those for the North Region of Alternative 1.

<u>Central</u>

Alternative 3 includes 30 projects in the Central Region. The effects of potentially contaminated sites are similar to those for the Central Region of Alternative 1, with the exception of Site Nos. 64, 65, and 66 that are associated with GRN #20 and 31.

<u>Apra Harbor</u>

Alternative 3 includes five projects in the Apra Harbor Region. The effects of potentially contaminated sites are similar to those for the Apra Harbor Region of Alternative 1.

<u>South</u>

Alternative 3 includes four projects in the South Region. The roadway projects in the South Region are not located in areas where potentially contaminated sites exist or would have influence on the proposed roadway improvements. The effects of potentially contaminated sites are similar to those for the South Region of Alternative 1.

BMPs and SOPs

Potentially contaminated sites that would be associated with Alternative 3 are the same as those listed for Alternative 1. BMPs and SOPs used to avoid or minimize the impact of potentially contaminated sites would be similar to those identified for Alternative 1.

18.2.6.4 Alternative 8

There are 50 projects in Alternative 8. The effects of potentially contaminated sites to these projects are discussed below.

North

Alternative 8 includes 13 projects in the North Region. The effects of potentially contaminated sites are similar to those for the North Region of Alternative 1.

Central

Alternative 8 includes 28 projects in the Central Region. The effects of potentially contaminated sites are similar to those for the Central Region of Alternative 1.

Apra Harbor

Alternative 8 includes five projects in the Apra Harbor Region. The effects of potentially contaminated sites are similar to those for the Apra Harbor Region of Alternative 1.

South

Alternative 8 includes four projects in the South Region. The effects of potentially contaminated sites are similar to those for the South Region of Alternative 1.

BMPs and SOPs

Potentially contaminated sites that would be associated with Alternative 8 are the same as those listed for Alternative 1. BMPs and SOPs used to avoid or minimize the impact of potentially contaminated sites would be similar to those identified for Alternative 1.

18.2.6.5 Summary of Impacts

Table 18.2-10 summarizes the potential impacts of each alternative.

Table 18.2-20. Summary of Potential Hazardous Materials and Waste Impacts-Roadway Project

Potentially Impacted Resource	*Alternative 1*	*Alternative 2**	*Alternative 3*	*Alternative 8*
Leaks and spills of hazardous materials can leach into soils	SI-M	SI-M	SI-M	SI-M
Roadway construction adversely affected by contaminated soil and/or groundwater	SI-M	SI-M	SI-M	SI-M

Legend: SI-M = Significant Impact Mitigable To Less Than Significant. *Preferred Alternative

In summary, the proposed roadway projects could result in increased environmental impacts. These potential impacts could result from increased transportation, handling, use, and disposal of hazardous materials and hazardous wastes. It is expected that the largest increases of hazardous materials would result from the use of POL/fuels. Expected increases in the use of hazardous waste would include solvents, sealants, paints, degreasers, corrosive or toxic liquids, and aerosols.

Various controls are in place to prevent unintended releases of these substances (see Volume 7). These controls include the following:

- Spill prevention control and countermeasures plans
- Facility response plans
- Waste management plans
- Stormwater pollution prevention plans
- Hazardous material/waste management plans (e.g., asbestos management plans and lead-based management plans, etc.)
- Mandatory personnel hazardous material/waste training
- Waste minimization plans
- Waste labeling, storage, packaging, staging, and transportation procedures
- DoD waste regulations
- Federal and territorial laws and regulations

Despite expected increases in hazardous materials and hazardous wastes, no significant impacts are anticipated as long as the controls discussed above are properly implemented and related plans and procedures updated and modified as appropriate to meet the potential increased demand upon DRMO regarding hazardous substance transportation, handling, storage, use, and disposal.

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CHAPTER 19.
PUBLIC HEALTH AND SAFETY

19.1 INTRODUCTION

This chapter discusses the potential effects to public health and safety (i.e., disease, mental illness, traffic incidents, unexploded ordnance [UXO], and power plant fuel sources [i.e., Liquified Natural Gas (LNG), Diesel Fuel No. 2, and/or No. 6 Fuel Oil]) from implementation of the alternatives within the region of influence (ROI). For a description of the affected environment, refer to the respective chapter of Volume 2 (Marine Corps Relocation – Guam). The chapters are presented in the same order as the resource areas discussed in this volume.

19.2 ENVIRONMENTAL CONSEQUENCES

This chapter discusses the potential effects to public health and safety (i.e., disease, mental illness, traffic incidents, UXO, and fuel sources) from implementation of the alternatives within the region of influence (i.e., the Island of Guam).

19.2.1 Approach to Analysis

19.2.1.1 Methodology

Utilities

The analysis of potential public health and safety impacts identified for proposed utility improvements are driven primarily by anticipated population increases on the Island of Guam; therefore, potential impacts would be the same if any of the alternatives were implemented and the term "All Alternatives" is used during the presentation of the analysis in this section.

Potential effects to public safety from implementation of the proposed utility projects were derived based upon information detailed in the descriptions of each alternative. Regarding personnel relocation to Guam, public health and safety concerns were addressed based on anticipated changes in the population of Guam, both from natural increases and from military personnel and their dependents moving to Guam. Average per capita incidents of notifiable diseases, mental illness, and traffic accidents were used to calculate the potential increase in these incidents as a result of the utility projects. Safety of construction workers would be the same as outlined in Volume 2. Proposed construction activities supporting utilities improvements would be conducted in accordance with federal and local safety guidelines to ensure a safe work environment.

With construction activities, there is a potential for standing water and water based vectors such as mosquitoes and related diseases. Most mosquitoes require standing water or moist soil where flooding occurs to lay their eggs. Removal of standing water sources and/or promotion of drainage would eliminate potential breeding sites. To limit the amount of standing water at construction sites, stagnant water pools, puddles, and ditches would be drained or filled; containers that catch/trap water (e.g., buckets, old tires, cans) would be removed; and if necessary, pesticide application (e.g., *Bacillus thuringensis*) could be used to help control mosquitoes. Implementing these best management practices (BMPs) would reduce the opportunities for an outbreak of water-related diseases.

For purposes of analysis of potential health and safety impacts, proposed utility projects are considered "related actions," in that they would be implemented as a result of the overall proposed action (i.e., relocation of Marines to Guam [Volume 2], Navy aircraft carrier berthing [Volume 4], and Army Air and Missile Defense Task Force [Volume 5]). Analysis of the public health and safety concerns is provided in Volume 2. Potential health and safety concerns from the proposed utilities projects result primarily from ground-disturbing activities and storage/transfer of fuel sources to power producing facilities; therefore, the only public health and safety concerns to be addressed in detail within this chapter are UXO and power plant fuel sources. Because proposed utility improvements would result in adequate capacity for providing power, potable water, wastewater treatment, and solid waste disposal, no impact to public health and safety from utility system capacity are anticipated.

Information regarding the possible presence of UXO was obtained from various military (e.g., various Navy and Army Corps UXO records) and public sources (e.g., newspaper accounts). Information specific to the proposed movement of Marines to Guam was obtained from military sources.

Roadways

Public health and safety concerns associated with the proposed roadway projects were identified based on the potential for the improved roadway network to:

- Substantially increase the risk of exposure to air pollutants from increased use of roadways
- Affect the frequency of automobile accidents
- Increase the risk of exposure to UXO.

The risk of exposure to air pollutants from vehicular sources that would use the new roadways is a health concern. Impacts of the Guam Road Network (GRN) project on air quality are addressed in Chapter 7, Air Quality, of this volume. Air pollutant emissions from the GRN project were evaluated in comparison to primary national ambient air quality standards established to protect human health, as well as secondary standards to protect the environment.

19.2.1.2 Determination of Significance

Factors considered in determining whether an alternative would have a significant public safety impact include the extent or degree to which implementation of the utility projects would subject the public to increased risk of contracting a disease or experiencing personal injury. The significance determination evaluated the overall ability to mitigate or control potential public health and safety impacts and consequences from proposed utility infrastructure improvements. Significant impacts that cannot be mitigated to less-than-significant levels are considered unavoidable.

Public health and safety impacts as a result of the proposed roadway improvement projects are assessed following Federal Highway Administration Guidance for Preparing and Processing Environmental and Section 4(f) Documents (T 6640 8A).

19.2.1.3 Issues Identified during Public Scoping Process

The following analysis focuses on possible effects to public health and safety that could be impacted by the proposed utility and roadway projects. As part of the analysis, concerns related to public health and safety that were mentioned by the public, including regulatory stakeholders, during the public scoping meetings were addressed. The following public health and safety concerns were raised during public scoping meetings regarding the proposed relocation of military and civilian personnel to Guam:

- Potential increases in notifiable diseases including the following:
- Acquired Immune Deficiency Syndrome (AIDS)
- Cholera

- Dengue
- Hepatitis C
- Malaria
- Measles
- Rubella
- Sexually Transmitted Diseases (STDs) other than AIDS
- Typhoid fever
- Potential increases in mental illness
- Potential increases in traffic incidents
- Potential contact with UXO

As discussed above, potential health and safety concerns from the proposed utility projects result primarily from ground-disturbing activities and the storage/transfer of power plant fuel sources to power producing facilities; therefore, the only public health and safety concerns to be addressed in detail in this chapter are UXO and power plant fuel sources.

19.2.2 Power

There are no comprehensive ambient background air quality levels from recent monitoring available for Guam; therefore, the existing background air quality conditions around Guam are defined based on the current ambient air quality attainment status condition applicable for Guam:

- Attainment for all criteria pollutants, except for SO2.
- Two SO2 nonattainment areas with a 2.2 mile (3.5 km) radius around the Piti and Tanguisson power plants.

Guam is exempt from using low sulfur content fuel; therefore, it is anticipated that the allowance of using high sulfur content fuel by power generation facilities is the primary cause of the current SO_2 nonattainment designation of the two areas.

The air quality analysis provided in Chapter 7 of this volume indicates that the overall permitted capacity and the operational scheme for the combustion turbines at the power plants would not change. The resulting potential air quality impact would remain the same as the current permitted conditions established previously during each facility permitting process. Power generation requirements would not result in an increase in air emissions at the power plant facilities under their permitted conditions and utilization or reconditioning of permitted sources is in compliance with applicable CAA air quality standards and would not result in a significant air quality impacts. Since no significant operational air quality impact would occur, mitigation measures would not be required.

Although power plant operations would not result in a significant increase in emissions, air pollutants generated during power plant operations could result in potential health impacts of nearby populations. Air pollution can harm individuals when it accumulates in the air in high enough concentrations. People exposed to high enough levels of certain air pollutants may experience:

- irritation of the eyes, nose, and throat
- wheezing, coughing, chest tightness, and breathing difficulties
- worsening of existing lung and heart problems
- increased risk of heart attack

In addition, long-term exposure to air pollution can cause cancer and damage to the immune, neurological, reproductive, and respiratory systems. In extreme cases, it can even cause death.

Some groups of people are especially sensitive to common air pollutants such as particulates and ground-level ozone. Sensitive populations include children, older adults, people who are active outdoors, and people with heart or lung diseases, such as asthma (Massachusetts Department of Environmental Protection [MDEP] 2009). Common health effects associated with specific air pollutants are provided below:

Carbon Monoxide Health Effects

Carbon monoxide (CO) is a poisonous gas that forms when the carbon in fuels such as gasoline, heating oil, natural gas, and wood does not burn completely. Concentrations of CO can be particularly high in areas with heavy traffic congestion or near industrial sources. CO enters the bloodstream through the lungs and binds to hemoglobin, the substance in blood that carries oxygen to cells. This reduces the amount of oxygen that reaches the body's tissues and organs, especially the heart and brain, as well as the central nervous system. The health threat from exposure to carbon monoxide is most serious for people who suffer from cardiovascular diseases. They may experience chest pain and other cardiovascular symptoms. In healthy individuals, exposure to higher levels of CO can lead to headaches and affect manual dexterity, mental alertness, work capacity, and vision (MDEP 2009).

Nitrogen Dioxide Health Effects

Nitrogen dioxide (NO_2) is one of a group of highly reactive gases containing nitrogen and oxygen in varying amounts (known collectively as oxides of nitrogen, or NO_X). NO_X gases are produced by high-temperature fuel combustion. Primary sources of NO_X emissions include motor vehicles, electric utilities, and other industrial, commercial, and residential sources that burn fuels. NO_X reacts with other pollutants to form ground-level ozone. NO_2 irritates the nose and throat, especially in people with asthma, and can increase susceptibility to respiratory infections. Ground-level ozone, which is formed when NO_2 and other gases react in the presence of sunlight can also:

- irritate the respiratory system and cause coughing, throat irritation and uncomfortable sensations in the chest
- reduce lung function
- heighten sensitivity to allergens that commonly trigger asthma attacks
- inflame the lung lining (MDEP 2009)

Particulate Matter Health Effects

Particulate matter includes a mixture of solids and liquid droplets. Particulate matter can be bad at any time or location, but especially when the weather is calm, allowing pollution to build up; around factories, during rush hour, and near busy roads; and when there is smoke in the air from wood stoves, fireplaces, or burning vegetation.

Exposure to particulate matter can affect the lungs and the heart. Short-term exposure can lead to coughing, minor throat irritation and reduced lung function, while long-term exposure may increase the rate of respiratory and cardiovascular illness. Particulate matter has been linked to a number of significant health problems, including:

- asthma and chronic bronchitis
- acute respiratory symptoms, such as coughing and chest tightness
- decreased lung function, experienced as shortness of breath
- heart attacks
- premature death in people with heart or lung disease (MDEP 2009).

Sulfur Dioxide Health Effects

Sulfur dioxide (SO_2) is a colorless, reactive gas produced when sulfur-containing fuels such as coal and oil are burned. Major sources include power plants and industrial boilers. Short-term exposure to low levels of SO_2 in the air can:

- narrow the airways and cause breathing problems for children and adults who have asthma and are physically active outdoors
- cause wheezing, chest tightness, and shortness of breath among healthy people who do not have asthma.

Symptoms worsen as SO_2 levels in the air increase or when breathing becomes faster or deeper. Lung function typically returns to normal within an hour of exposure to SO_2 ending. Long-term exposure to SO_2 can cause respiratory illness, alter the lungs' defense mechanisms, and aggravate existing cardiovascular or lung disease (MDEP 2009).

Air Toxics Health Effects

Toxic air pollutants, also known as air toxics, are pollutants that, at sufficient concentrations and exposure, are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or to cause adverse environmental effects. The U.S. Environmental Protection Agency (USEPA) lists 188 toxic air pollutants that can have significant impacts on air quality and human health even when emissions of these toxics are controlled through best available technology.

Short-term exposures can include effects such as eye irritation, nausea or difficulty in breathing. Long-term exposures may result in damage to the respiratory, nervous, or reproductive systems, birth and developmental defects, and other serious health problems. While everyone is at risk of health problems from exposure to air toxics, many factors determine the extent to which different pollutants affect the health of any individual, including the level, duration, and frequency of exposure; the toxicity of the pollutant; overall health; and level of resistance or susceptibility (MDEP 2009).

Given the need for increased power production and the exemption to using low sulfur content fuel on Guam, power production using current fuel types would have the potential to increase air emissions on Guam. The potential for increased emissions could result in increased health impacts of nearby populations. Increases in health impacts as discussed above could result in an increase in:

- emergency room visits
- hospital admissions
- asthma attacks
- children absent from school
- deaths from lung and heart illness

As discussed in Section 7.0. Air Quality, use of cleaner fuel types would likely be required to prevent the occurrence of significant air quality impacts.

It is anticipated that Guam clinics and hospital will increase staffing to meet current health care service ratios and will be capable of handling a potential increase in air quality-related illnesses; therefore, less than significant impacts would be anticipated as a result of increased emissions from power plant operations. In the event health care staffing increases do not occur, individuals would likely experience:

- longer wait/response times for patients
- fewer or no available providers on island for chronic or acute issues

- complications or death from delayed treatment, and/or
- requirements for patients to travel off-island to receive adequate treatment

Increasing health care staffing would eliminate the potential treatment impacts.

19.2.3 Potable Water

As discussed in Chapter 3, Guam Water Authority (GWA) water system infrastructure does not meet the basic flow and pressure requirements for all customers. These conditions can result in microbiological and other contaminants entering the distribution system potentially resulting in illness. The following discusses the types of contaminants and potential health problems related to potable water.

Contaminants Affecting Drinking Water. The levels of contaminants in drinking water are seldom high enough to cause acute (immediate) health effects (North Carolina Cooperative Extension Service, 1996). Examples of acute health effects are nausea, lung irritation, skin rash, vomiting, dizziness, and even death. Contaminants are more likely to cause chronic health effects - effects that occur long after repeated exposure to small amounts of a chemical. Examples of chronic health effects include cancer, liver and kidney damage, disorders of the nervous system, damage to the immune system, and birth defects.

Microbial Pathogens. Pathogens in drinking water are serious health risks. Pathogens are disease-producing micro-organisms, which include bacteria (such as giardia lamblia), viruses, and parasites. They get into drinking water when surface water sources are contaminated by sewage or animal waste, or when wells are improperly sealed and constructed. Pathogens can cause gastroenteritis, salmonella infection, dysentery, shigellosis, hepatitis, and giardiasis. The presence of coliform bacteria, which is generally harmless, may indicate other contamination to the drinking water system.

Organics. People worry the most about potentially toxic chemicals and metals in water. Only a few of the toxic organic chemicals that occur in drinking water are regulated by drinking water standards. This group of contaminants includes:

- Trihalomthanes (THMs), which are formed when chlorine in treated drinking water combines with naturally occurring organic matter.
- Pesticides, including herbicides, insecticides, and fungicides.
- Volatile organic chemicals (VOCs), which include solvents, degreasers, adhesives, gasoline additives, and fuels additives. Some of the common VOCs are: benzene, trichloroethylene (TCE), styrene, toluene, and vinyl chloride. Possible chronic health effects include cancer, central nervous system disorders, liver and kidney damage, reproductive disorders, and birth defects.

Inorganics. These contaminants include toxic metals like arsenic, barium, chromium, lead, mercury, and silver. These metals can get into drinking water from natural sources, industrial processes, and the materials used in plumbing system. Toxic metals are regulated in public water supplies because they can cause acute poisoning, cancer, and other health effects. Nitrate is another inorganic contaminant. The nitrate in mineral deposits, fertilizers, sewage, and animal wastes can contaminate water. Nitrate has been associated with "blue baby syndrome" in infants.

As discussed in Chapter 3, implementation of the overall proposed action could result in potable water shortfalls in GWA system from 2010 till 2015. However, DoD has identified mitigation measures within DoD control and outside DoD control, including measures that GWA and Gov Guam could implement to address the shortfalls. Therefore, it is anticipated that public health and safety impacts from increased demand on potable water would be less than significant if the mitigation measures are implemented.

Wastewater

Wastewater flows to the NDWWTP from military and civilian sources are projected to increase to a peak of 12.8 MGd (48.3 mld) in 2014, which is somewhat more than the design capacity of 12 MGd (45 mld). Adding chemical coagulants or increasing the surface overflow rate (within the normal design range) of the clarifier would be implemented to improve plant operations so that the primary clarifier would be able to treat the additional 0.8 MGd (2.8 mld) without adverse effects on the NDWWTP. DoD would coordinate with GWA to expedite the planned improvements and request for a NPDES permit modification to increase the effluent discharge limitation from 6.0 MGd (22.7 mld) to 12.0 MGd (45.4 mld), then comply with its modified NPDES permit requirements.

The USEPA denied GWA's application for a renewed variance from full secondary treatment on September 30, 2009, and concluded that the Clean Water Act (CWA) 301(h) criteria have not been met at the North District Wastewater Treatment Plant (NDWWTP) and the Hagatna Wastewater Treatment Plant (WWTP).

Microorganisms are present in large numbers in sewage treatment plant effluent and waterborne disease outbreaks have been associated with sewage-contaminated water supplies or recreational waters. Wastewater discharged from a treatment plant can enter the environment where human exposure may occur through the potable (drinking) water supply, recreation (swimming, snorkeling, etc.), or eating shellfish.

NDWWTP Discharge. The NDWWTP discharges into coastal waters on the northwestern shoreline of Guam. The coastal waters in the area of NDWWTP's new deep ocean outfall are considered "Category M-2 Good" marine waters (USEPA 2009b).

The previous outfall discharged effluent directly into the Philippine Sea at 2,160 feet (655 m) from shore at a depth of 60 feet (18.2 m), and 545 feet (166 m) beyond the reef line. The total length of the previous outfall was approximately 7,272 feet (2,216 m); including a diffuser that was 422 feet (129 m) long at the terminal end of the outfall. The previous outfall consisted of a 5,500 foot (1,676 m), 30 inch (76.2 cm) diameter pipe made mainly of Techite piping encased in concrete. The previous diffuser was oriented north to south and located parallel to the shoreline (USEPA 2009b).

The new outfall was completed and went into operation in January, 2009, although GWA has not yet installed the new diffuser system. The new outfall currently discharges 1,900 feet (580 m) from shore, and at a depth of 140 feet (42.6 m). A 400 foot (121 m) multiport diffuser was to be added to the end of the outfall; however, the diffuser has not yet been added to the new outfall. Because the proposed discharge would be farther away from shore and at a greater depth, and incorporates additional diffuser ports, the USEPA predicts that it would have higher dilution (USEPA 2009b).

Based on available information, USEPA has concluded that discharge of primary treated effluent through the new deep ocean outfall would not ensure compliance with the requirements of 40 CFR 125.62(a) through (d). USEPA has determined that the proposed discharge would not comply with all Guam water quality standards; and may not provide for the attainment or maintenance of water quality which assures the protection and propagation of a BIP of shellfish, fish, and wildlife. Concentrations of lead have been predicted to exceed water quality criteria at the ZID for the proposed discharge. Further, USEPA has determined that the proposed discharge would not meet water quality criteria for bacteria at the ZID; thus, the proposed discharge may adversely affect recreational activities (USEPA 2009b).

Ocean waters within the vicinity of the WWTP discharge are not considered a source of public water supply. Drinking water has not been established as a designated use for Category M-2 marine waters of

Guam. Currently, drinking water supplies are derived from surface and groundwater sources. Therefore, USEPA has concluded that the WWTP discharge would not affect public water supplies (USEPA 2009b).

Non-WWTP Discharges. In addition to WWTP discharges, onsite wastewater systems disperse effluent into the soils near where people live and recreate. Properly designed, installed, and operated, on-site systems can be as effective as municipal WWTPs in reducing the public health risks associated with wastewater; however, contamination of drinking water and surface water due to on-site systems does occur and people can contract gastrointestinal and other illnesses from drinking groundwater or coming in contact with surface water impacted by wastewater.

Pathogens commonly found in wastewater effluent are E. coli, Streptococcus, Salmonella, Shigella, mycobacterium, Pseudomonas aeroginosa, Giardia lamblia, and enteroviruses. Tacnia, Ascaris, and hookworm ova may also be present in raw sewage.

Increased flow to the WWTPs would result from natural population increases as well as the increase in military personnel. Based on the increased population of Guam, issues associated with wastewater discharges on Guam, and the use of on-site treatment systems, an increase in the number of wastewater-related illnesses could occur.

It is anticipated that Guam clinics and hospital will increase staffing to meet current health care service ratios and will be capable of handling a potential increase in wastewater-related illnesses; therefore, less than significant impacts would be anticipated as a result of increased wastewater treatment and discharge activities.

19.2.4 Solid Waste

The DoD would continue using the Navy Sanitary Landfill at the Apra Harbor site for a short period from 2010, when Marine relocation begins, until July 2011, when the Layon Landfill is scheduled to open for disposal of municipal solid waste. The Layon Landfill is being constructed in compliance with federal RCRA Subtitle D requirements. Because this landfill would be compliant with RCRA Subtitle D, no impacts to public health and safety are anticipated from the increase in solid waste disposal on Guam.

The Navy Sanitary Landfill is unlined; therefore, leachate has the potential to affect the underlying groundwater. Studies are currently underway to assess whether or not the underlying groundwater has been affected by leachate. The conclusions of these studies show that further evaluation may be required.

19.2.5 All Alternatives

19.2.5.1 Notifiable Diseases

Proposed utility projects are considered "related actions," in that they would be implemented as a result of the overall proposed action (i.e., relocation of Marines to Guam [Volume 2], Navy aircraft carrier berthing [Volume 4], and Army Air and Missile Defense Task Force [Volume 5]). Volume 2, Section 2.18 analyzes the potential increase in notifiable disease cases based on the population increase that would result from the implementation of the overall proposed action as well as the related actions such as the proposed utility projects.

19.2.5.2 Mental Illness

Proposed utility projects are considered "related actions," in that they would be implemented as a result of the overall proposed action (i.e., relocation of Marines to Guam [Volume 2], Navy aircraft carrier berthing [Volume 4], and Army Air and Missile Defense Task Force [Volume 5]). Analysis of potential impacts to mental illness is provided in Volume 2. Therefore, implementation of the proposed utility projects would result in no impacts to public health and safety (from mental illness).

19.2.5.3 Traffic Incidents

Proposed utility projects are considered "related actions," in that they would be implemented as a result of the overall proposed action (i.e., relocation of Marines to Guam [Volume 2], Navy aircraft carrier berthing [Volume 4], and Army Air and Missile Defense Task Force [Volume 5]). Analysis of potential increases in traffic incidents is provided in Volume 2. Therefore, implementation of the proposed utility projects would result in no impacts to public health and safety (from traffic incidents).

19.2.5.4 UXO

The island of Guam was an active battlefield during World War II. As a result of the invasion, occupation, and defense of the island by Japanese forces and the assault by Allied/American forces to retake the island, unexploded military munitions still remain. Excavation for foundations, underground utilities, and other infrastructure could encounter unexploded military munitions in the form of UXO, discarded military munitions, and/or materials potentially presenting an explosive hazard. Exposure to these munitions and explosives of concern (MEC) could result in the death or injury to workers or to the public.

To reduce the potential hazards related to exposure to MEC, qualified UXO personnel would perform surveys to identify and remove potential MEC prior to initiation of ground-disturbing activities as necessary. Additional safety precautions would include providing UXO personnel supervision during earth-moving activities, and providing MEC awareness training prior to and during ground-disturbing activities to construction personnel who are involved in grading and excavations. These safety precautions would ensure that potential impacts are minimized; therefore, implementation of the proposed utility projects would result in less than significant impacts to public health and safety (from UXO).

19.2.6 Potential Mitigation Measures

No mitigation measures would be required.

19.2.7 Summary of Impacts

Table 19.2-1 summarizes the potential impacts of all alternatives. A text summary is provided below.

Table 19.2-1. Summary of Potential Public Health and Safety Impacts

Potentially Impacted Resource	*All Alternatives*
Power	LSI
Potable Water	LSI
Wastewater	LSI
Solid Waste	NI
Notifiable Diseases	NI
Mental Illness	NI
Traffic Incidents	NI
UXO	LSI
Power Plant Fuel Sources	NI

Legend: LSI= Less than Significant Impact; NI= No Impact.

Based on the increased population of Guam (natural and military increases), requirements for power production, potable water generation, wastewater treatment, and solid waste disposal could result in an increase in illness from airborne contaminants and water- and wastewater-related diseases. It is anticipated that Guam clinics and hospital will increase staffing to meet current health care service ratios and will be capable of handling potential increases in these utility-related illnesses; therefore, less than significant impacts to public health and safety would be anticipated. No impacts are anticipated from increased solid waste disposal.

The potential increase in disease occurrences and mental illness as a result of the proposed utility projects would be low and is not likely to impact the citizens of Guam. The potential increase in the number of traffic accidents and fatalities would also be minimal, and no impact on the health and safety of the citizens of Guam from traffic incidents is anticipated.

Excavation for underground utilities and other infrastructure could encounter unexploded military munitions. To reduce the potential hazards related to the exposure to MEC, qualified UXO personnel would perform surveys to identify and remove potential items of MEC prior to the initiation of ground-disturbing activities. UXO supervision during earth-moving activities and providing MEC awareness training to construction personnel prior to and during ground-disturbing activities would also be undertaken. The identification and removal of MEC prior to initiating construction activities and training construction personnel regarding hazards associated with MEC would ensure that potential impacts would be minimized and would be less than significant.

19.2.8 Roadways

Construction activities would consist of intersection improvements, bridge replacements, pavement strengthening, road relocation, road widening, and construction of a new road. Typical activities associated with each of these types of projects are described in Table 2.5-3 of this volume. Most projects would involve construction work in developed and paved areas, and some roadway projects require work in undeveloped locations. Construction activities would occur during a 7-year period from 2010 through 2016, with the peak roadway construction year of 2013/2014.

The proposed GRN project and associated construction haul roads would be designed in accordance with the American Association of State Highway and Transportation Officials (AASHTO) standards and guidelines, with particular focus on improving safety and reducing traffic congestion. Construction of roadway segments and bridge replacement projects would require the use of temporary detours, limited road closures, and alternate routes that would be established during localized road work. These temporary routes would represent alternate ways of reaching destinations. While such detours may be perceived as an inconvenience to the public, temporary roadways would be established with safety measures, such as proper signage and reduced speed limits, as appropriate for temporary construction zones. With implementation of these protective measures, potential impacts to public health and safety would be reduced to a less than significant level.

Potential impacts to public health and safety can occur during roadway construction activities (i.e., cut and fill operations, removal of vegetation, and use of heavy equipment) and as a result of leaks and spills onto soils during construction. Impacts from potential exposure to contaminated soil, use of hazardous materials, and generation of hazardous waste can also result in a public health concern (see Section 18.2.6). Direct impacts that result in physical injury could occur during construction, while indirect impacts can result from the completed project (e.g., accidents and injuries that would occur in the future). To evaluate the potential public health and safety impacts of roadway improvement projects, physical activities associated with each project type were identified as shown in Table 19.2-2.

Table 19.2-2. Activities Associated with GRN Roadway Project Types

Item	*Project Type*	*Temporary Detours*	*Temporary Storage of Contaminants*	*Exposure to Unexploded Ordnance*
1	Intersection Improvement (including military access points)	•	•	•
2	Bridge Replacement	•	•	•
3	Pavement Strengthening	•	•	•
4	Road Relocation (Route 15 only)	•	•	•
5	Road Widening	•	•	•
6	Construction of New Road	•	•	•
7	Temporary placement of equipment laydown areas or storage areas for road demolition material		•	•

Based on the anticipated activities associated with each project type, it was determined that:

- Each of the roadway improvement project types would have the same degree of exposure to possible increased hazards from use of temporary road detours during the construction period. Temporary road detours would generally be required for all road work.
- The placement of temporary equipment laydown areas at any of the GRN project work sites would represent a moderate potential for impacts to public health and safety due to the potential storage of fuels, oils, and lubricants that would be used during the construction period. The health risk associated with this activity would only occur if the spill or leak is not addressed, contaminants leached into the soil, and petroleum products were to enter any drinking water supply. To avoid this impact, proper containment and use of these potential contaminants would be required at temporary construction staging areas. The potential for contaminants leaching into the soil would be prevented or managed through implementation of spill prevention and emergency spill response procedures. This would reduce the possibility for leaks or spills of contaminants to occur at equipment staging areas.
- Contaminated soils may be present in the roadway work area. Exposure to contaminated soils may pose a health risk for construction workers. To avoid this impact, roadway design may include an evaluation of potential contamination. Final roadway design would avoid known contaminated sites wherever possible and may include coordination with the responsible party to ensure that construction does not interfere with any ongoing remediation activities. This would reduce the possibility for exposure to areas of contamination.
- Each of the roadway improvement project types would have the same degree of potential exposure to possible hazards from encountering UXO during the construction period. To avoid this impact, qualified UXO specialists would perform surveys to identify and remove potential ordnance from the work site prior to the start of construction. This would reduce the possibility for public exposure to UXO.

Indirect impacts during operation of the new GRN roadway could also occur. These safety hazards would be limited to those associated with the lack of familiarity to the road system, the effects of improper maintenance, and the potential for contaminants leaching into the soil.

- Safety hazards from initial use of the new roadway network could occur if there is a lack of familiarity with the road system. Because the GRN project would result in a 7-year process of roadway improvements, safety hazards would not be expected because of improved signalization, signage, and lighting that would be installed on the existing roadway configuration. Pavement improvements to reduce accidental skidding would also improve safety. The GRN project includes only one roadway relocation (Route 15) and one new roadway (Finegayan Connection). The new GRN system would include comprehensive improvements designed to prevent accidents or injury and improve congestion management. With ongoing and planned traffic safety programs, the new GRN system would not be expected to affect the frequency of automobile accidents. The new roadway network would be expected to result in a decrease in safety hazards.

- Improper maintenance can lead to road deterioration from erosion and pavement damage that can result in localized safety hazards. The maintenance of roads on Guam would continue to be the responsibility of the Guam Department of Public Works.
- The potential for spills of fuels, oils, and lubricants that could occur on the new roadway network would be increased due to the number of additional heavy vehicles that would use the new roads and bridges. The health risk associated with this activity would only occur if the spill is not contained, contaminants leached into the soil or water body, and contaminants were to enter a drinking water supply or water body that is used for edible fish. To avoid this impact, spill prevention and emergency spill response procedures would be implemented.

Projects with the most potential for increased vulnerability to safety hazard would be those located in areas of high liquefaction potential and those in or near karst geological formations (nearest to known sinkholes or caves). In general, the potential vulnerability to effects from seismic activity is consistent throughout the island because of the presence of known and inferred earthquake faults that transect Guam. The potential for safety hazard due to geologic considerations would be addressed by proper roadway or bridge design, as discussed in the geology and soils chapter in Volume 6.

19.2.8.1 Alternative 1

Alternative 1 would result in direct potential impacts to public health and safety during the construction period as a result of exposure to possible increased hazards from the use of temporary road detours and possible hazards from encountering UXO. Impacts on geological resources could include soil disturbance and soil loss, localized erosion, and particulate emissions. Ground disturbance for roadway improvements would be conducted in accordance with standard construction BMPs, general requirements in accordance with the Government of Guam Soil Erosion and Sediment Control Regulations, and associated permit conditions, including applicable storm water pollution prevention plans. With implementation of BMPs, impacts to public health and safety would be less than significant.

<u>North</u>

GRN projects in the North Region would be designed and constructed with safety principles to ensure that exposure to hazards is prevented or minimized. With implementation of BMPs, impacts to public health and safety would be less than significant.

<u>Central</u>

GRN projects in the Central Region would be designed and constructed with safety principles to ensure that exposure to hazards is prevented or minimized. As stated in the geology and soils chapter, roadway improvements near known caves and sinkholes would be designed in accordance with recommendations of the site-specific geotechnical investigation. With implementation of BMPs, impacts to public health and safety would be less than significant.

<u>Apra Harbor</u>

GRN projects in the Apra Harbor Region would be designed and constructed with safety principles to ensure that exposure to hazards is prevented or minimized. With implementation of BMPs, impacts to public health and safety would be less than significant.

South

GRN projects in the South Region would be designed and constructed with safety principles to ensure that exposure to hazards is prevented or minimized. With implementation of BMPs, impacts to public health and safety would be less than significant.

Potential Mitigation Measures

No mitigation measures would be required. In addition to the potential mitigation measures identified for Hazardous Materials and Waste (Section 18), the following BMPs would be implemented for activities that could impact public health and safety in the project area:

- Individual roadway projects would be designed and constructed in accordance with AASHTO standards and guidelines.
- Ensure that contaminants (i.e., oils, greases, lubrication fluids for heavy equipment) are properly stored at the work site and at temporary construction staging areas to avoid spills and leaks.
- Ensure that emergency response plans are in place for responding to leaks or spills of construction contaminants.
- Conduct surveys to identify and remove potential ordnance from the work site would be conducted by qualified UXO specialists prior to the start of construction. As an added precaution, UXO personnel would conduct munitions and explosives training of construction crews, and be assigned to monitor earthmoving activities.

19.2.8.2 Alternative 2 (Preferred Alternative)

North

Impacts would be similar to Alternative 1.

Central

Impacts would be similar to Alternative 1.

Apra Harbor

Impacts would be similar to Alternative 1.

South

Impacts would be similar to Alternative 1.

Potential Mitigation Measures

No mitigation measures would be required. BMPs would be identical to Alternative 1.

19.2.8.3 Alternative 3

North

Impacts would be similar to Alternative 1.

Central

Impacts would be similar to Alternative 1.

Apra Harbor

Impacts would be similar to Alternative 1.

South

Impacts would be similar to Alternative 1.

Potential Mitigation Measures

No mitigation measures would be required. BMPs would be identical to Alternative 1.

19.2.8.4 Alternative 8

North

Impacts would be similar to Alternative 1.

Central

Impacts would be similar to Alternative 1.

Apra Harbor

Impacts would be similar to Alternative 1.

South

Impacts would be similar to Alternative 1.

Potential Mitigation Measures

No mitigation measures would be required. BMPs would be identical to Alternative 1.

2013/2014 (Peak Construction)

The year 2013/2014 represents the roadway network without any future plans for improvements for the military buildup. While no construction associated with the planned military buildup would occur, Government of Guam would have initiated construction of road segment and intersection improvement projects along segments of Routes 1, 7, 10A, and 27 (extension), and the Tiyan Parkway, as identified in Table 2.5-4.

2030

The year 2030 represents the roadway network without any future plans for improvements for the military buildup. While no construction associated with the planned military buildup would occur, Government of Guam would have completed construction of road segment and intersection improvement projects along segments of Routes 1, 2, 4, 7A, 16, 25, and 26, as identified in Table 2.5-4.

19.2.8.5 Summary of Impacts

Table 19.2-3 summarizes the potential impacts of each interim alternative. An analysis of long-term alternatives was not developed because the alternatives are not ready for project-specific analysis. A text summary is provided below.

Table 19.2-3. Summary of Potential Impacts to Public Health and Safety-Roadway Project

Potentially Impacted Resource	*Alternative 1*	*Alternative 2**	*Alternative 3*	*Alternative 8*
Temporary Detours – Exposure of public to traffic hazards during roadway construction	LSI	LSI	LSI	LSI
Exposure to contaminants that have leached into the soil	LSI	LSI	LSI	LSI
Increased exposure to hazards from UXO	LSI	LSI	LSI	LSI
Improper maintenance resulting in road deterioration from erosion and pavement damage.	LSI	LSI	LSI	LSI

Legend: LSI = Less Than Significant Impact. *Preferred Alternative.

Construction activities would consist of intersection improvements, bridge replacements, pavement strengthening, road relocation, road widening, and construction of a new road. Each type of roadway construction project would require the use of temporary road detours. Improper storage of construction materials could result in spills or leaks that could result in contaminants leaching into the soil and water bodies. There would be a potential for encountering UXO in the construction zone. For these reasons, specific BMPs would be implemented to avoid or minimize these potential effects on public health and safety. Roadways and bridges would be designed in accordance with specific geotechnical considerations to prevent risk from geologic hazards. The proposed GRN project would not be expected to subject the public to an increased risk of personal injury from automobile crashes or from exposure to UXO. With implementation of BMPs for roadway construction, impacts to public health and safety would be less than significant.

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CHAPTER 20.
ENVIRONMENTAL JUSTICE AND THE PROTECTION OF CHILDREN

20.1 INTRODUCTION

This chapter focuses on the potential for racial and ethnic minorities, low income populations, or children to be disproportionately affected by project-related impacts. Normally an analysis of environmental justice is initiated by determining the presence and proximity of these segments of the population relative to the specific locations that would experience adverse impacts to the human environment. The situation on Guam is unique in this regard because racial or ethnic minority groups (as defined by the U.S.) comprise a majority of the Guam population, and the proportions of people living in poverty or who are under 18 years of age are also substantially higher than in the general U.S. population. The analysis is further complicated by the fact that Guam is a relatively small and isolated island, and certain types of impacts would be experienced island-wide. Accordingly, the analysis of environmental justice described in this chapter acknowledges the unique demographic characteristics of the island population and assumes that the project effects could disproportionately affect disadvantaged groups and children because they comprise relatively high proportions of the population. By the same logic, mitigation measures that would reduce the severity of any significant project impacts to a less than significant level would be expected to effectively mitigate the associated environmental justice impacts to a less than significant level.

For a description of the affected environment with respect to environmental justice, refer to Volume 2 Chapter 19 (Marine Corps Relocation – Guam). This chapter focuses on potential disproportionate impacts to racial minorities, low-income populations, and children from the construction and operation of utilities and roadways associated with the military buildup on Guam. For an analysis of potential island-wide impacts to these populations, see the socioeconomics chapter of this volume (Chapter 17).

20.2 ENVIRONMENTAL CONSEQUENCES

20.2.1 Approach to Analysis

20.2.1.1 Methodology

Volume 4 of this EIS/OEIS examines the potential impacts that each alternative would potentially have on various environmental and human resources. Based on the conclusions reached in each resource chapter, the analysis of environmental justice sought to identify the adverse impacts that would disproportionately affect racial minorities, children, and/or low-income populations, based on the following assumptions.

- Environmental justice policies are intended to analyze disproportionate impacts of potentially harmful environmental impacts on minority or other special status populations. However, the island of Guam is unique in that the majority of the population is a racial or ethnic minority, and low-income and child populations also comprise a relatively large proportion of the population (compared to the U.S.). Consequently, in this analysis it is assumed that any adverse impact that would affect the island as a whole, and any localized adverse impact that would affect a particular concentration of special-status residents, would have a disproportionate effect in terms of environmental justice.
- The region of influence (ROI) is defined as the area in which the principal effects arising from the proposed construction of utilities and roadways are likely to occur. Those who may be affected by the

consequences of utilities and roadway construction and operation are often those who reside or otherwise occupy areas immediately adjacent to the project locations.

- Because the proposed actions are related either to construction or operations, impacts to the ROI would likely be either "spill over" effects that extend beyond an installation's boundary line into the surrounding community, or impacts that directly affect minority populations in the ROI.

The analysis involved the application of three tiers of criteria to assess the environmental justice implications of each adverse effect identified in the relevant resource chapters:

- Tier 1: Are there any racial minorities, low-income, or children populations adjacent to the proposed action site?
- Tier 2: Are the applicable disadvantaged groups disproportionately affected by the negative environmental consequences of the proposed action(s)?
- Tier 3: Would the disproportionate adverse effects be significant?

20.2.1.2 Determination of Significance

According to Section 1508.27 of the Council on Environmental Quality (CEQ) Regulations for Implementing National Environmental Policy Act (NEPA) (CEQ 1979), determining the level of significance of an environmental impact requires that both context and intensity be considered. These are defined in Section 1508.27 as follows:

- "Context. This means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the proposed action. For instance, in the case of a site-specific action, significance would usually depend upon the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant".
- "Intensity. This refers to the severity of the impact. Responsible officials must bear in mind that more than one agency may make decisions about partial aspects of a major action. The following should be considered in evaluating intensity:
  - Impacts that may be both beneficial and adverse. A significant effect may exist even if the federal agency believes that on balance the effect would be beneficial.
  - The degree to which the proposed action affects public health or safety.
  - Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.
  - The degree to which the effects on the quality of the human environment are highly uncertain or involve unique or unknown risks.
  - The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.
  - Whether the action is related to other actions with individually insignificant but cumulatively significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.
  - The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources.

- The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined critical under the Endangered Species Act of 1973.
- Whether the action threatens a violation of federal, state, or local law or requirements imposed for the protection of the environment".

Federal Highway Administration Guidance for Preparing and Processing Environmental and Section 4(f) Documents (T6640.8A) addresses the assessment of roadway projects and their potential for disproportionately impacting any social group and mitigation measures to address those impacts. This document's guidance has been followed to assess the roadway projects for the proposed alternatives relative to environmental justice.

20.2.1.3 Issues Identified During Public Scoping Process

Issues related to environmental justice that were raised during the public scoping process are discussed in Volume 2 Chapter 19.

20.2.2 Power

As discussed in Chapter 3 Section 3.2.2 of this volume, the predicted population growth on Guam induced by the DoD buildup corresponds to increased demands on the electrical system from 4.93 MW (2010 initial) to 29.24 MW at the 2014 peak and 7.88 MW long-term (by 2019). Potential environmental justice impacts related to this increased demand would be associated with:

- Changes in air emissions
- Changes to electrical customer user fees
- Changes in the reliability of GPA's power supply island-wide

These three areas are assessed below for each power alternative

20.2.2.1 Interim Alternative 1 (Preferred Alternative)

Interim Alternative 1 would recondition existing combustion turbines and upgrade T&D systems and would not require new construction or enlargement of the existing footprint of the facility. This work would be undertaken by the GPA on its existing permitted facilities. Reconditioning would be made to existing permitted facilities at the Marbo, Yigo, Dededo No. 1, and Macheche combustion turbines. These combustion turbines are not currently being used up to permit limits. T&D system upgrades would be on existing above ground and underground transmission lines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

<u>Changes in Air Emissions</u>

Reconditioning existing CTs would result in bringing existing permitted CTs into operation that are not routinely used today (except for intermittent periods and emergencies). As discussed in Chapter 7 Section 2.3.2, this power alternative would not result in a need to change the existing permit because there would be no change in combustion turbine (CT) power capacity or associated air emissions. However, this alternative would result in more pollutants emitted into the air than experienced today simply because the CTs are currently off-line most of the time and not routinely emitting pollutants. The current air permits for these CTs allow for some level of pollutants to be emitted; these allowable levels are based on USEPA National Ambient Air Quality Standards (NAAQS). NAAQS protect public health, including the health of "sensitive" populations such as children, asthmatics, and the elderly. They also protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

Because the overall permitted capacity and the operational scheme for these combustion turbines would not change, the resulting potential air quality impact would remain the same as the current permitted conditions established previously during each facility permitting process, which are protective of human health and sensitive populations. Since the Interim Alternative 1 would not result in any increase of air emissions at these facilities under the permitted condition, utilization or reconditioning these permitted sources is in compliance with any applicable CAA air quality standards and would not result in significant air quality impacts.

Tier 1: *Are there any racial minorities, low-income, or children populations adjacent to the proposed action site?*

Dededo, Yigo, and Marbo all have a majority of racial/ethnic minorities compared to the U.S. average. These villages have similar poverty rates and percentages of children to other villages on Guam, but high poverty rates and percentages of children when compared to the U.S. average (U.S. Census 2000, CNMI Department of Commerce 2005).

Tier 2: Are the applicable disadvantaged groups disproportionately affected by the negative environmental consequences of the proposed action(s)?

The racial minorities that comprise the population of Guam would be disproportionately affected by an increase in air emissions. There would be no disproportionate impact to low-income populations or children.

Tier 3: *Would the disproportionate adverse effects be significant?*

Populations in areas near the CTs would be exposed to more air pollutants once the CTs are reconditioned and operational than they are today simply because the CTs are not operational today. However, because the overall permitted capacity and the operational scheme for these combustion turbines would not change from that planned for when the facilities were originally constructed and permitted, the resulting potential air quality impact would remain the same. The emissions would also not exceed NAAQS permit levels that are protective of human health and sensitive populations. It is also important to note that some areas in Guam immediately around power plants are not in attainment of NAAQS for sulfur dioxide; however, none of the CTs under this power alternative are associated with these sulfur dioxide non-attainment areas. Therefore, air emissions associated with Interim Alternative 1 would not have a significant adverse impact with regard to environmental justice or protection of children.

<u>Changes to Electrical Customer Fees</u>

As discussed in Chapter 17 Section 2.2.2, potential effects on electrical customers are unknown at this time. However, under power Interim Alternative 1, only existing power generation facilities owned and operated by GPA would be reconditioned and new T&D lines installed. Cost to bring these existing GPA assets into full service would be shared by all electrical customers, including DoD and the public. DoD as a new significant power customer would result in a cost share across a much larger user base than currently exists, and would likely result in unchanged or lower user fees for all power customers.

Tier 1: *Are there any racial minorities, low-income, or children populations adjacent to the proposed action site?*

Dededo, Yigo, and Marbo all have a majority of racial/ethnic minorities compared to the U.S. average. These villages have similar poverty rates and percentages of children to other villages on Guam, but high poverty rates and percentages of children when compared to the U.S. average (U.S. Census 2000, CNMI Department of Commerce 2005).

Tier 2: Are the applicable disadvantaged groups disproportionately affected by the negative environmental consequences of the proposed action(s)?

User fees are expected to remain unchanged or to be reduced for all power customers; therefore, there would be no disproportionate adverse impact to disadvantaged groups or children.

Changes to Power Supply Reliability

As discussed in Chapter 3 Section 3.2.2.1, reconditioning GPA's combustion turbines would increase the reliability of the island-wide power system and provide reliable sources of power generation to support the existing and future off-base populations during emergencies. Mitigation measures described in Chapter 3 Section 3.2.2.1 include efforts to jointly plan for system upgrades to ensure that the reliability of the island-wide power system is not degraded to the detriment of all users. Mitigation measures also include the availability of new 5 plus megawatt of capability at Marine Base Finegayan that could be used to peak shave power during daily high demand periods if requested by GPA. Mitigation measures also include the adaptive management procedures whereby phasing of construction efforts could be modified to mitigate any adverse impacts.

Tier 1: *Are there any racial minorities, low-income, or children populations adjacent to the proposed action site?*

Dededo, Yigo, and Marbo all have a majority of racial/ethnic minorities compared to the U.S. average. These villages have similar poverty rates and percentages of children to other villages on Guam, but high poverty rates and percentages of children when compared to the U.S. average (U.S. Census 2000, CNMI Department of Commerce 2005).

Tier 2: Are the applicable disadvantaged groups disproportionately affected by the negative environmental consequences of the proposed action(s)?

Interim Alternative 1 is expected to increase the reliability of the island-wide power system, which would be a beneficial effect on all segments of the population. There would be no disproportionate adverse impact to disadvantaged groups or children.

Potential Mitigation Measures

- Air Emissions. There would be no significant adverse air quality impacts to disadvantaged groups or children; therefore, no specific environmental justice mitigation measures are needed.
- User Fees. There would be no adverse impacts related to user fees and no corresponding adverse effects on disadvantaged groups or children; therefore, no specific environmental justice mitigation measures are needed.
- Power Supply Reliability. There would be no adverse impacts related to power supply reliability and no effect on disadvantaged groups or children; therefore, no specific environmental justice mitigation measures are needed.

20.2.2.2 Interim Alternative 2

Interim Alternative 2 is a combination of reconditioning of existing permitted GPA facilities, an increase in operational hours for existing combustion turbines, and upgrades to existing T&D systems. Interim Alternative 2 would not require new construction or enlargement of the existing footprint of the facility. Reconditioning would be performed on the existing permitted GPA facilities at the Marbo, Yigo, and Dededo combustion turbines. This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Upgrading existing facilities would increase capacity, which would have a beneficial environmental impact. All potential impacts associated with air emissions, user fees, and power system reliability would be the same for Interim Alternative 2 as described above for Interim Alternative 1; these impacts are therefore not repeated below. However, a possible adverse impact associated with Alternative 2 would be power interruptions that would occur should GPA have to utilize their interruptible power supply agreements with certain customers. This additional potential effect is evaluated below.

Tier 1: *Are there any racial minorities, low-income, or children populations adjacent to the proposed action site?*

Dededo, Yigo, and Marbo all have a majority of racial/ethnic minorities compared to the U.S. average. These villages have similar poverty rates and percentages of children to other villages on Guam, but high poverty rates and percentages of children when compared to the U.S. average (U.S. Census 2000, CNMI Department of Commerce 2005).

Tier 2: Are the applicable disadvantaged groups disproportionately affected by the negative environmental consequences of the proposed action(s)?

Based on the information in Volume 6, potential power interruptions would only affect GPA customers that have agreed to temporary interruptions and most likely have emergency backup facilities. These potential effects would not be significant and would not disproportionately affect disadvantaged groups or children.

Potential Mitigation Measures

There would be no disproportionate adverse impacts to disadvantaged groups or children; therefore, no mitigation measures are needed.

20.2.2.3 Interim Alternative 3

Interim Alternative 3 is a combination of reconditioning existing GPA permitted facilities at Marbo, Yigo, and Dededo and upgrades to the DoD power plant at Orote. Upgrades would be made to existing T&D. The proposed reconditioning to the existing power generation facilities at Marbo, Yigo, and Dededo would not require new construction or enlargement of the existing footprint of the facility. For the Orote power plant, upgrades would include a new fuel storage facility to facilitate longer run times between refueling. This would disturb approximately 1 acre (4,047 square m). This alternative supports Main Cantonment Alternatives 1 and 2 and Main Cantonment Alternatives 3 and 8 would require additional upgrades to the T&D system.

Upgrading existing facilities would increase capacity, which would have a beneficial island-wide effect to the entire population. There would be no disproportionate adverse impact to disadvantaged groups or children. All potential impacts associated with air emissions, user fees, and power system reliability would be the same for Interim Alternative 3 as described above for Interim Alternative 1; these impacts are therefore not repeated here.

Potential Mitigation Measures

There would be no disproportionate adverse impacts to disadvantaged groups or children; therefore, no mitigation measures are needed.

20.2.3 Potable Water

20.2.3.1 Basic Alternative 1 (Preferred Alternative)

Basic Alternative 1 would consist of installation of up to 22 new potable water supply wells at Andersen Air Force Base (AFB), rehabilitation of existing wells, interconnection with the GWA water system, and associated T&D systems. A new 5 MG (19 ML) water storage tank would be constructed at ground level at Finegayan.

All work would occur on base. These actions would increase overall potable water availability, which would have a beneficial impact to the environment. However, they would generate construction-related noise and traffic that may adversely affect the villages of Dededo and Yigo, which lie adjacent to Andersen AFB.

Tier 1: *Are there any racial minorities, low-income, or children populations adjacent to the proposed action site?*

With 15% or less of their populations being Caucasian, Dededo and Yigo both have high levels of racial and ethnic minorities compared to the U.S. average. The poverty rates in Dededo and Yigo are similar to those of other villages on Guam, but higher than that of the U.S. average (U.S. Census 2000). Compared to CNMI and the U.S. average, Dededo and Yigo have high percentages of children (U.S. Census 2000).

Tier 2: Are the applicable disadvantaged groups disproportionately affected by the negative environmental consequences of the proposed action(s)?

Racial minorities and low-income populations living in Yigo and Dededo near Andersen AFB, as well as those living in proximity to Routes 1, 9, and 15 that provide access to Andersen AFB, may experience disproportionate noise and traffic impacts related to construction. There would be no disproportionate impact to children.

Tier 3: *Would the disproportionate adverse effects be significant?*

Heavy construction equipment would be used for at least 6-9 months during construction. This would generate some noise; however, Volume 6 Chapter 8 does not anticipate that the noise would be loud enough off base to be a significant effect to the surrounding community. Noise would also be generated by construction vehicles along Routes 9, 1 and 15, but with the implementation of mitigation measures in Volume 6 Chapter 8, the impact would be reduced to less than significant.

Construction-related travel and the transport of materials and equipment are anticipated to increase traffic along Routes 9, 1, and 15 that provide access to Andersen AFB. According to Volume 6 Chapter 4, implementation of the proposed actions would not increase traffic to the level of congestion by 2014. Therefore, the impact would be less than significant.

Potential Mitigation Measures

Implementation of construction noise reduction mitigation measures is specified in Volume 6 Chapter 8. There would be no other disproportionate adverse impacts to disadvantaged populations or children; therefore, no other mitigation measures are needed.

20.2.3.2 Basic Alternative 2

Basic Alternative 2 would consist of installation of up to 20 new potable water supply wells at Andersen AFB, up to 11 new potable water supply wells at Barrigada, rehabilitation of existing wells, interconnection with the GWA water system, associated transmission and distribution systems upgrades. Additionally, new water storage tanks would be constructed at ground level at Finegayan and Barrigada, respectively. Villages that lie adjacent to Andersen AFB are Dededo and Yigo; villages located adjacent to Navy Barrigada include Barrigada and Mangilao.

New wells, rehabilitation of existing wells, transmission and distribution system upgrades, interconnection with GPA, and construction of the additional water storage tanks would increase overall potable water availability. This would have a beneficial impact to the environment. However, construction-related noise and traffic may have adverse impacts on the surrounding communities. Construction-related traffic on Routes 9, 1, and 15 may increase, as well as Routes 8, 16 and 15 that provide access to Navy Barrigada.

Tier 1: *Are there any racial minorities, low-income, or children populations adjacent to the proposed action site?*

With 15% or less of their populations being Caucasian, Dededo and Yigo both have high levels of racial and ethnic minorities relative to the U.S. average. The poverty rates in Dededo and Yigo are similar to those of other villages on Guam, but higher than the U.S. average (U.S. Census 2000). Compared to CNMI and the U.S. average, Dededo and Yigo have high percentages of children (U.S. Census 2000).

Barrigada and Mangilao also have high percentages of racial minorities compared to the U.S. average. Mangilao's poverty rate is consistent with that of other villages of Guam, while Barrigada's is slightly lower. However, both villages have higher poverty rates than the U.S. average (U.S. Census 2000). Barrigada and Mangilao have similar percentages of children, which is higher than those of both CNMI and the U.S average. (U.S. Census 2000).

Tier 2: Are the applicable disadvantaged groups disproportionately affected by the negative environmental consequences of the proposed action(s)?

Racial minorities and low-income populations who live in proximity to the construction sites, and/or near Routes 9, 1, and 15 for Andersen AFB and Routes 8, 16, and 15 for Navy Barrigada would experience disproportionate construction-related noise and traffic impacts. There would be no disproportionate impact to children.

Tier 3: *Would the disproportionate adverse effects be significant?*

Heavy construction equipment would be used for at least 6-9 months during construction. This would generate some noise; however, Volume 6 Chapter 8 does not anticipate that the noise would be loud enough off base to be a significant effect to the surrounding community. Noise would also be generated by construction vehicles along Routes 9, 1 and 15 that provide access to Andersen AFB, and along Routes 8, 16, and 15 that provide access to Navy Barrigada. However, with the implementation of noise abatement measures in Volume 6 Chapter 8, the impact would be reduced to less than significant.

Construction-related travel and the transport of materials and equipment are anticipated to increase traffic along Routes 9, 1, and 15 that provide access to Andersen AFB, and along 8, 16, and 15 that provide access to Navy Barrigada. According to Chapter 4 (Roadway Transportation), implementation of the proposed actions would not increase traffic along Route 9, 1, and 15 in northern Guam to the level of congestion by 2014. Therefore, the impact would be less than significant.

However, with implementation of the proposed actions traffic along Routes 15 and 16 in central Guam that service Navy Barrigada are anticipated to increase to the level of congestion (Chapter 4 Roadway Transportation). Chapter 4 uses a volume to capacity ratio to determine the anticipated level of traffic congestion by 2014. If a volume to capacity ratio is greater than 1, the increased traffic is anticipated to reach a level that would cause congestion. The volume to capacity ratio of Routes 15 and 16 in central Guam are projected to be greater than 1 by 2014. Therefore, there would be a significant traffic impact along these routes. However, with implementation of mitigation measures in Chapter 4, these impacts would be reduced to less than significant.

Potential Mitigation Measures

Implementation of construction-related noise abatement measures in Volume 6 Chapter 8. Implementation of traffic-reduction measures in Volume 6 Chapter 4. There would be no other disproportionate adverse impacts to disadvantaged populations or children; therefore, no other mitigation measures are needed.

20.2.4 Wastewater

20.2.4.1 Basic Alternative 1a (Preferred Alternative) and 1b

Basic Alternative 1 combines upgrade to the existing primary treatment facilities and expansion to secondary treatment at the Northern District Wastewater Treatment Plant (NDWWTP). Upon completion of the treatment facility upgrades/expansion, there would be beneficial impacts to the surrounding area due to increased sewer treatment capacity. The difference between Alternatives 1a and 1b is a requirement for a new sewer line from Barrigada housing to NDWWTP for Alternative 1b.

Potential Mitigation Measures

There would be no adverse impacts associated with Basic Alternative 1a that would disproportionately or adversely affect disadvantaged populations or children, and no mitigation measures are needed.

20.2.4.2 Basic Alternative 1b

Under Basic Alternative 1b, the existing primary treatement system at NDWWTP would be refurbished and upgraded to accept additional wastewater flow and load from both central and northern Guam, and would include new sewer lines and lift pump stations to convey wastewater generated from Barrigada housing to the NDWWTP.

This alternative includes refurbishing primary treatment capability at NDWWTP and installing a collection system from Finegayan. It also includes installing a sewer collection system from Barrigada to NDWWTP. The Guam Water Authority (GWA) would upgrade the Hagatna primary treatment capability for induced civilian growth and construction workforce demand.

The proposed new sewer line would extend from NDWWTP adjacent to Route 25 and then south adjacent to Route 16 to Navy Barrigada. Upon completion of the sewer line, there would be beneficial impacts to the surrounding area due to increased sewer capacity. However, construction of the sewer line would result in a construction-related traffic increase along Routes 25 and 16 south toward Navy Barrigada. The roadways section in Volume 6 (Chapter 4) does not anticipate that traffic along Route 16 would reach the level of congestion by 2014 as a result of the proposed action; however, congestion along Route 25 would reach the level of congestion.

Tier 1: Are there any racial minorities, low-income, or children populations adjacent to the proposed action site?

The proposed construction of a new sewer line would affect the following villages along Routes 25: Barrigada, southern Dededo, and northern Mangilao. These villages have disproportionately high percentages of racial minorities, low-income populations, and children relative to the U.S. Their percentages of racial minorities, low-income populations, and children are generally similar to those of other villages on Guam.

Tier 2: Are the applicable disadvantaged groups disproportionately affected by the negative environmental consequences of the proposed action(s)?

The racial minorities and low-income populations that live adjacent to Route 25 near where the proposed new sewer line would be constructed would be disproportionately impacted by construction-related traffic due to their proximity to the proposed action location. There would be no disproportionate impact to children.

Tier 3: Would the disproportionate adverse effects be significant?

The roadways section in Volume 6 anticipates that the increase in construction-related traffic along Route 25 would reach congestion by 2014. Due to their proximity to the construction site, racial minorities and low-income populations living near Route 25 would be disproportionately adversely affected by the proposed sewer line construction. However, with implementation of the traffic mitigation measures in Volume 6 Chapter 4 that would reduce the level of congestion, the impact would be less than significant.

Potential Mitigation Measures

Implementation of construction-related traffic reduction measures as described in Volume 6 Chapter 4. There would be no other disproportionate adverse impacts to disadvantaged populations or children; therefore, no other mitigation measures are needed.

20.2.5 Solid Waste

20.2.5.1 Basic Alternative 1 (Preferred Alternative)

The Preferred Alternative for solid waste would be the continued use of the Navy Landfill at Apra Harbor until Layon Landfill is opened, which is scheduled for July 2011. No disproportionate adverse impacts are anticipated with this action.

Potential Mitigation Measures

There are no disproportionate impacts anticipated; therefore, mitigation measures are not needed.

20.2.6 Off Base Roadways

The proposed action includes 43 Guam Road Network (GRN) off base roadway improvement projects. While descriptions of these individual projects can be found in Chapter 2 Section 2.5.2, the 43 GRN projects include six main types of roadway improvements:

- Intersection improvements
- Bridge replacements
- Pavement strengthening
- Relocation of Route 15
- Roadway widening
- Construction of a new road (Finegayan Connection)

20.2.6.1 Alternative 1

The roadway projects for Alternative 1 include those listed in Chapter 2, Table 2.5-1, with the exception of GRN #47 through 49A, 63, and 74.

Tier 1: Are there any racial minorities, low-income, or children populations adjacent to the proposed action site?

Roadway projects would occur in all Guam villages except the southern villages of Yona, Agat, Talofofo, Inarajan, Umatac, and Merizo (the access roads proposed in Umatac and Talofofo are examined in Volume 2). There are racial minorities and low-income populations adjacent to the roadway project sites.

Tier 2: Are the applicable disadvantaged groups disproportionately affected by the negative environmental consequences of the proposed action(s)?

Populations of racial minorities and low-income persons in the study area are present in disporportionately higher numbers relative to the average U.S. population. The minorities and low-income populations living along the roadways that would be improved would experience disproportionately higher levels of construction-related traffic during roadway improvements due to their proximity to the project sites. These construction-related impacts include increased traffic, noise and air pollutant emissions typically associated with localized use of construction equipment and vehicles. These impacts would be temporary and mitigated by the proposed phased project schedule. When construction is complete, roadways would have increased capacity which would result in both greater traffic volumes and improved traffic flow. The improved roadway infrastructure would have a beneficial impact to the surrounding community by providing better traffic flow and safer travel. For these reasons, there would be no substantial negative environmental consequences to the racial minorities and low-income populations living near the roadway project areas. Therefore, tier 3 does not apply. There would be no disproportionate impact to children.

20.2.6.2 Alternative 2 (Preferred Alternative)

The roadway projects for Alternative 2 include those listed in Chapter 2, Table 2.5-1, with the exception of GRN #47 through 49A, 63, and 74.

Tier 1: Are there any racial minorities, low-income, or children populations adjacent to the proposed action site?

Roadway projects would occur in all Guam villages except the southern villages of Yona, Agat, Talofofo, Inarajan, Umatac, and Merizo (the access roads proposed in Umatac and Talofofo are examined in Volume 2). There are racial minorities and low-income populations adjacent to the roadway project sites.

Tier 2: Are the applicable disadvantaged groups disproportionately affected by the negative environmental consequences of the proposed action(s)?

Populations of racial minorities and low-income persons in the study area are present in disporportionately higher numbers relative to the average U.S. population. The minorities and low-income populations living along the roadways that would be improved would experience disproportionately higher levels of construction-related traffic during roadway improvements due to their proximity to the project sites. These construction-related impacts include increased traffic, noise and air pollutant emissions typically associated with localized use of construction equipment and vehicles. These impacts would be temporary and mitigated by the proposed phased project schedule. When construction is complete, roadways would have increased capacity which would result in both greater traffic volumes and improved traffic flow. The improved roadway infrastructure would have a beneficial impact to the surrounding community by providing better traffic flow and safer travel. For these reasons, there would be no substantial negative environmental consequences to the racial minorities and low-income populations living near the roadway project areas. Therefore, tier 3 does not apply. There would be no disproportionate impact to children.

20.2.6.3 Alternative 3

The roadway projects for Alternative 3 include those listed in Chapter 2, Table 2.5-1, with the exception of GRN #20, 31, 124, and 49A.

Tier 1: Are there any racial minorities, low-income, or children populations adjacent to the proposed action site?

Roadway projects would occur in all Guam villages except the southern villages of Yona, Agat, Talofofo, Inarajan, Umatac, and Merizo (the access roads proposed in Umatac and Talofofo are examined in Volume 2). There are racial minorities and low-income populations adjacent to the roadway project sites.

Tier 2: Are the applicable disadvantaged groups disproportionately affected by the negative environmental consequences of the proposed action(s)?

Populations of racial minorities and low-income persons in the study area are present in disporportionately higher numbers relative to the average U.S. population. The minorities and low-income populations living along the roadways that would be improved would experience disproportionately higher levels of construction-related traffic during roadway improvements due to their proximity to the project sites. These construction-related impacts include increased traffic, noise and air pollutant emissions typically associated with localized use of construction equipment and vehicles. These impacts would be temporary and mitigated by the proposed phased project schedule. When construction is complete, roadways would have increased capacity which would result in both greater traffic volumes and improved traffic flow. The improved roadway infrastructure would have a beneficial impact to the surrounding community by providing better traffic flow and safer travel. For these reasons, there would be no substantial negative environmental consequences to the racial minorities and low-income populations living near the roadway project areas. Therefore, tier 3 does not apply. There would be no disproportionate impact to children.

20.2.6.4 Alternative 8

The roadway projects for Alternative 8 include those listed in Chapter 2, Table 2.5-1, with the exception of GRN #47, 48, 49, 63, and 74.

Tier 1: Are there any racial minorities, low-income, or children populations adjacent to the proposed action site?

Roadway projects would occur in all Guam villages except the southern villages of Yona, Agat, Talofofo, Inarajan, Umatac, and Merizo (the access roads proposed in Umatac and Talofofo are examined in Volume 2). There are racial minorities and low-income populations adjacent to the roadway project sites.

Tier 2: Are the applicable disadvantaged groups disproportionately affected by the negative environmental consequences of the proposed action(s)?

Populations of racial minorities and low-income persons in the study area are present in disporportionately higher numbers relative to the average U.S. population. The minorities and low-income populations living along the roadways that would be improved would experience disproportionately higher levels of construction-related traffic during roadway improvements due to their proximity to the project sites. These construction-related impacts include increased traffic, noise and air pollutant emissions typically associated with localized use of construction equipment and vehicles. These impacts would be temporary and mitigated by the proposed phased project schedule. When construction is complete, roadways would have increased capacity which would result in both greater traffic volumes and improved traffic flow. The improved roadway infrastructure would have a beneficial impact to the surrounding community by providing better traffic flow and safer travel. For these reasons, there would be no substantial negative environmental consequences to the racial minorities and low-income populations living near the roadway project areas. Therefore, Tier 3 does not apply. There would be no disproportionate impact to children.

20.2.7 No-Action Alternative

Under the no-action alternative, no utility or roadway upgrades or improvements associated with the proposed actions would occur and existing operations at the proposed project areas would continue. There would be no noise or traffic impacts related to construction and no increase in military population. Anticipated beneficial effects of increased utility and roadway capacity would not be realized. The no-action alternative would have no adverse environmental justice impacts on the villages of Dededo, Barrigada, and Mangilao in particular or the island of Guam in general.

20.2.8 Summary of Impacts

This section summarizes the potential environmental justice impacts associated with the proposed action alternatives for each major component – power, potable water, wastewater, solid waste, and off-base roadways.

Table 20.2-1 summarizes the potential impacts of each interim power alternative. All alternatives would have the beneficial impact of increasing capacity. Each of the alternatives was evaluated for disproportionate environmental justice effects with regard to changes in air emissions, changes to electrical user fees, and changes in reliability of the island-wide power supply. As shown in the table, impacts related to air emissions would be less than significant, and no impacts would occur with regard to user fees or system reliability. No significant disproportionate adverse impacts to disadvantaged populations or children would occur under any of the alternatives.

Table 20.2-1. Summary of Potential Impacts: Power Alternatives

*Interim Alternative 1**	*Interim Alternative 2*	*Interim Alternative 3*
LSI • Adverse but less than significant environmental justice impacts to disadvantaged groups related to air emissions. NI • No environmental justice impacts to children related to air emissions.	LSI • Adverse but less than significant environmental justice impacts to disadvantaged groups related to air emissions. NI • No environmental justice impacts to children related to air emissions.	LSI • Adverse but less than significant environmental justice impacts to disadvantaged groups related to air emissions. NI • No environmental justice impacts to children related to air emissions.
NI • No environmental justice impacts to disadvantaged groups or children related to electrical user fees.	NI • No environmental justice impacts to disadvantaged groups or children related to electrical user fees.	NI • No environmental justice impacts to disadvantaged groups or children related to electrical user fees.
NI • No environmental justice impacts to disadvantaged groups or children related to electrical user fees.	NI • No environmental justice impacts to disadvantaged groups or children related to electrical user fees.	NI • No environmental justice impacts to disadvantaged groups or children related to electrical user fees. •

*Interim Alternative 1**	*Interim Alternative 2*	*Interim Alternative 3*
	NI • No environmental justice impacts to disadvantaged groups or children related to power disruptions.	

Legend: LSI = Less Than Significant Impact; NI = No Impact * Preferred Alternative.
Note: Potential impacts under Long-term Alternatives 2 and 3 would be analyzed under future NEPA documentation; potential impacts listed herein are general and not final.

Table 20.2-2 summarizes the potential impacts of each potable water alternative. Under Alternative 1, noise impacts related to project construction would have a significant but mitigable disproportionate effect on minority and low-income populations living near the construction site. Construction-related traffic impacts would occur along Routes 9, 1, and 15, but increased traffic would not reach a level of congestion and therefore, would have a less than significant disproportionate effect on disadvantaged groups. No disproportionate effects on children would occur with regard to noise or traffic. Under Alternative 2, construction-related noise and traffic impacts would be the same as for Alternative 1, but Alternative 2 would also result in post-construction traffic impacts along Routes 15 and 16 that would be significant. These traffic impacts would represent a significant disproportionate impact on disadvantaged groups. However, implementation of mitigation measures in Chapter 4 of Volume 6 would reduce significant traffic congestion impacts along Routes 15 and 16 in central Guam to less than significant. No disproportionate effects on children would occur with regard to noise or traffic under Alternative 2.

Table 20.2-2. Summary of Potential Impacts: Potable Water Alternatives

Basic Alternative 1	*Basic Alternative 2*
Noise	
SI-M • Construction-related noise would have a disproportionate impact on racial minorities and low-income populations living near the construction area. However, with implementation of noise abatement measures in Chapter 8 of this volume, the impact would be reduced to less than significant. There would be no disproportionate impact to children.	SI-M • Construction-related noise would have a disproportionate impact on racial minorities and low-income populations living near the construction area. However, with implementation of noise abatement measures in Chapter 8 of this volume, the impact would be reduced to less than significant. There would be no disproportionate impact to children.
Traffic	
LSI • An increase in traffic along Routes 9, 1, and 15 in northern Guam would have less than significant impacts on racial minorities and low-income populations living near these roadways. There would be no disproportionate impact to children.	LSI • An increase in traffic along Routes 9, 1, and 15 in northern Guam would have less than significant impacts on racial minorities and low-income populations living near these roadways. There would be no disproportionate impact to children. SI-M • Chapter 4 (Roadways) anticipates that the traffic increase along Routes 15 and 16 in central Guam would reach the level of congestion, which would be a significant impact. This would disproportionately affect racial minorities and low-income populations that live along these routes. However, with implementation of the mitigation in the Chapter 4, the impact would be reduced to less than significant. There would be no disproportionate impact to children.

Legend: LSI = Less Than Significant Impact, SI-M = Significant Impact Mitigable to Less Than Significant,
* Preferred Alternative

Table 20.2-3 summarizes the potential impacts of each wastewater alternative. The upgrades proposed in Basic Alternatives 1a and 1b would not have any adverse environmental impacts. The roadways section in Volume 6 Chapter 4 anticipates that the increase in construction-related traffic along Route 25 would reach congestion by 2014. Due to their proximity to the construction site, racial minorities and low-income populations living near Route 25 would be disproportionately adversely affected by the proposed sewer line construction. However, with implementation of traffic-reduction mitigation measures in Volume 6 Chapter 4, the impacts would be reduced to less than significant. No disproportionate effects on children would occur under either alternative.

Table 20.2-3. Summary of Potential Impacts: Wastewater Alternatives

*Basic Alternative 1a**	*Basic Alternative 1b*
NI • No disproportionate adverse impacts.	SI-M • Mitigated traffic impact with implementation of construction-related traffic mitigation measures in Volume 6, Chapter 4

Legend: SI-M = Significant Impact Mitigable to Less Than Significant, NI = No Impact. * Preferred Alternative
Note: Potential impacts under Long-term Alternatives 1-4 would be analyzed under future NEPA documentation; potential impacts listed herein are general and not final.

As shown in Table 20.2-4, no impacts associated with environmental justice or protection of children are anticipated under the Preferred Alternative for solid waste.

Table 20.2.-4. Summary of Potential Impacts: Solid Waste

Potentially Affected Resource	*Preferred Alternative*
Environmental Justice and Protection of Children	NI

Legend: NI = No Impact.

Table 20.2-5 summarizes the potential impacts of each off-base roadway alternative. Proposed roadway projects include intersection improvements, bridge replacements, pavement strengthening, relocation of Route 15, roadway widening, and the construction of a new road (the Finegayan Connection). Roadway projects would occur in all Guam villages except the southern Guam villages of Yona, Agat, Talofofo, Inarajan, Umatac, and Merizo. While the racial minorities and low-income populations living near the roadway projects would experience disproportionate temporary traffic increases during the construction period, these impacts would be mitigated by the proposed phased project schedule. When construction is complete, the improved roadway infrastructure would have a beneficial impact to the surrounding community.

Table 20.2-5. Summary of Roadway Project Impacts

Alternative 1	*Alternative 2**	*Alternative 3*	*Alternative 8*
Construction			
LSI • Less than significant impacts to disadvantaged groups related to temporary traffic, noise, and air quality impacts during construction. NI • No disproportionate impacts to children	• Same impacts as Alternative 1.	• Same impacts as Alternative 1.	• Same impacts as Alternative 1.

Alternative 1	*Alternative 2**	*Alternative 3*	*Alternative 8*
Operation			
BI • Beneficial impacts to disadvantaged groups due to improved, safer roadway infrastructure after construction is completed. NI • No disproportionate impacts to children	• Same impacts as Alternative 1.	• Same impacts as Alternative 1.	• Same impacts as Alternative 1.

Legend: LSI = Less Than Significant Impact, NI = No Impact, BI = Beneficial Impact. *Preferred Alternative

20.2.9 Summary of Potential Mitigation Measures

Table 20.2-6 summarizes potential mitigation measures for each component of the proposed action.

Table 20.2-6. Summary of Potential Mitigation Measures

Power Alternatives	*Potable Water Alternatives*	*Wastewater Alternatives*	*Solid Waste Alternatives*	*Off-Base Roadway Alternatives*
Noise				
• No mitigations needed.	• For Alternative 1 or 2, DoD would implement the mitigation measures in Volume 6, Chapter 8 of this EIS/OEIS.	• No mitigations needed.	• No mitigations needed.	• No mitigations needed.
Traffic				
• No mitigations needed.	• No mitigations needed for Alternative 1. • For Alternative 2, DoD would implement the mitigation measures in Volume 6, Chapter 8 of this EIS/OEIS.	• No mitigations needed for Alternative 1a. • For Alternative 1b, DoD would implement the mitigation measures in Volume 6, Chapter 4 of this EIS/OEIS.	• No mitigations needed.	• No mitigations needed.

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CHAPTER 21.
SECTION 4(F) EVALUATION

21.1 PURPOSE OF SECTION 4(F) EVALUATION

The environmental law known as Section 4(f), which is part of the United States (U.S.) Department of Transportation Act of 1966 (49 U.S. Code § 303), declares that "it is the policy of the U.S. government that special effort should be made to preserve the natural beauty of the countryside and public park and recreation lands, wildlife and waterfowl refuges, and historic sites." Further, it is specified that, "the Secretary [of Transportation] may approve a transportation program or project… requiring the use of publicly owned land of a public park, recreation area, or wildlife and waterfowl refuge of national, state, or local significance, or land of an historic site of national, state, or local significance (as determined by the federal, state, or local officials having jurisdiction over the park, area, refuge, site), only if:

- There is no prudent and feasible alternative to using that land.
- The program or project includes all possible planning to minimize harm to the park, recreation area, wildlife and waterfowl refuge, or historic site resulting from the use;" or, based on the regulations implementing Section 4(f).
- "The Administration (Federal Highway Administration [FHWA]) determines that the use of the property, including any measure(s) to minimize harm (such as avoidance, minimization, mitigation, or enhancement measures) committed to by the applicant, would have a 'de minimis' impact on the property." (23 Code of Federal Regulations [CFR] 774.3[b]).

The regulations interpreting Section 4(f) state that "The potential use of land from a Section 4(f) property shall be evaluated as early as practicable in the development of the action when alternatives to the proposed action are under study (23 CFR) 774.9[a])." The use of Section 4(f) resources occurs when: (1) land from a Section 4(f) site is permanently incorporated into a transportation facility; (2) there is a temporary occupancy of Section 4(f) land that is adverse in terms of the statute's preservation purpose, or (3) when a "constructive use" of a Section 4(f) property is determined. A constructive use occurs when the transportation project does not incorporate land from a Section 4(f) property, but the project's proximity impacts are so severe that the protected activities, features, or attributes that qualify the property for protection under Section 4(f) are substantially impaired" (23 CFR 774.15[a]).

The term "historic site" includes any prehistoric or historic district, site, building, structure, or object included in or eligible for inclusion in the National Register of Historic Places (NRHP) (23 CFR 774.17). Section 4(f) does not apply to archaeological sites on or eligible for the NRHP when the FHWA concludes that the archaeological resource is important chiefly because of what can be learned by data recovery and has minimal value for preservation in place (23 CFR 774.13[a][1]). Constructive use does not occur when compliance with the requirements of Section 106 of the National Historic Preservation Act (NHPA) (16 U.S. Code § 470) and related regulations defining proximity impacts of a proposed project on an NRHP site results in "an agreement of no historic properties affected" or "no adverse effect" (23 CFR 774.15[f][1]).

Section 4(f) further requires consultation with the U.S. Department of the Interior and, as appropriate, the involved offices of the U.S. Department of Agriculture and the Department of Housing and Urban Development in developing transportation projects and programs that use properties protected by Section 4(f).

Because the Guam roadway projects would involve the use of Section 4(f) properties, this evaluation identifies the significant Section 4(f) resources in the project area, describes the nature and extent of the use of these significant properties, evaluates alternatives that would avoid the use of Section 4(f) resources, and describes measures to minimize harm to the affected resources.

21.2 PROPOSED PROJECT

The roadway projects are encompassed within the Guam Road Network (GRN), which is comprised of the non-military roadway system on the island of Guam. Construction of the GRN projects is required to accommodate three proposed military actions (Figure 21.2-1). First, increased traffic from the military buildup on the island connected to the relocation of approximately 8,600 Marines of the III Marine Expeditionary Force and their dependents from Okinawa by 2014 needs to be accommodated. Aviation and waterfront operations, training, main cantonment, family housing and associated utilities, and infrastructure improvements comprise the scope of activities to be conducted in support of Marine Corps projects on the island. Roadway improvements are needed to support construction of the facilities and the ensuing traffic related to the proposed military buildup on Guam. Roadway improvements are also connected to construction of operational facilities, training, main cantonment, and family housing on Guam to support the defensive mission of the Marine Corps.

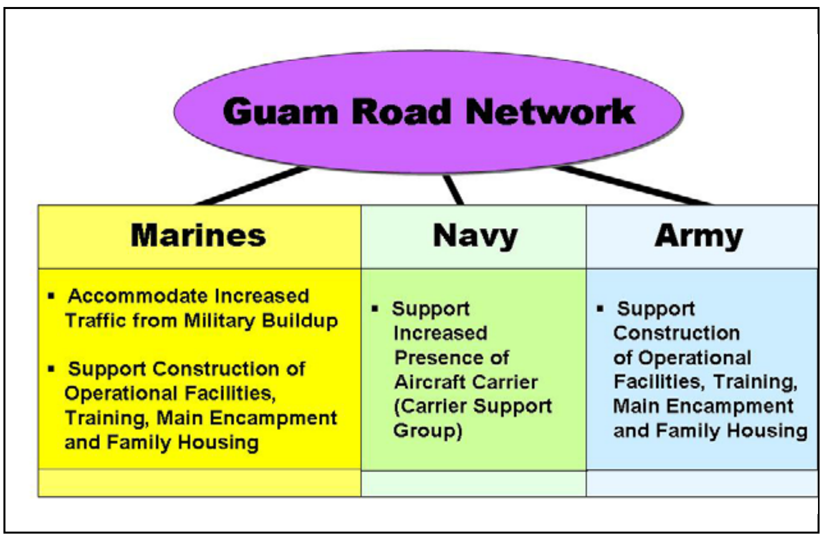

Figure 21.2-1. Connectivity of the Guam Road Network

Second, the roadway improvements are connected to Navy initiatives associated with an increase in aircraft carrier presence to support engagement and deterrence consistent with the global shift of trade and transport. A new deep-water wharf at Apra Harbor is needed to support the increased Navy presence and port visits associated with a Carrier Strike Group.

Third, the roadway improvements are also connected to construction of operational facilities, training, main cantonment, and family housing on Guam to support the Army Ballistic Missile Defense Task Force (BMDTF) and its defensive mission.

Improvements to the roadway network on Guam are needed to allow efficient and safe access to military lands for construction of facilities and to accommodate military-related and projected organic (ongoing) traffic growth on Guam. The existing roadways connecting the population centers and DoD lands on Guam are shown in Figure 21.2-2.

The proposed construction of roadway improvements would be located on the island of Guam, which is geographically part of the Mariana Islands archipelago. Guam is a territory of the U.S. The setting for the project encompasses the primary roadway network for the entire island of Guam, comprised of 20 federal-aid roadways and one local road totaling approximately 66 miles (106 kilometers [km]) in length.

21.2.1 Purpose and Need

A complete discussion of the purpose and need for the project is provided in Chapter 1 of this volume.

An improved network of roads on Guam is needed as part of the mission-critical infrastructure to support planned relocation of Marines and their dependents, as well as to accommodate ongoing growth on the island in accordance with the 2030 Guam Transportation Plan. The island of Guam is experiencing roadway problems that include inadequate bridges; flooding roads; poor lane visibility, as a result of tight corners, poor lane striping, lighting, and lane geometry; high accident locations; landslides; eroding embankments; and inadequate intersections due to the absence of traffic signals. To meet these needs, the proposed GRN projects would include roadway widening, existing intersection improvements and new intersections that would serve as military access points, bridge replacements, pavement strengthening at specific locations island-wide, and the realignment of Route 15, as well as a new Core Bus System. These improvements are needed to resolve traffic congestion during the construction period from 2010 through 2016, with peak construction and peak population in 2014, and the ensuing traffic increase from full military buildup combined with projected organic growth. The transportation network would become an integral component for fulfilling the U.S. defense strategy and alliance requirements, as well as providing an enhanced capability to defend critical military assets on Guam through the Army BMDTF.

21.2.2 Project Alternatives Using Section 4(f) Properties

A complete discussion of the project alternatives is provided in Chapter 2 of this volume.

21.2.2.1 Alternative 1

Alternative 1 includes: utilizing Naval Computer and Telecommunications Station (NCTS) Finegayan (809 acres (ac) [327 hectares {ha}]), South Finegayan (290 ac [117 ha]), acquisition or long-term leasing of Federal Aviation Administration (FAA) land (680 ac [275 ha]), and acquisition or long-term leasing of land in the Harmon Annex (326 ac [132 ha]) for a total of 2,105 ac (852 ha). A detailed view of the Main Cantonment configuration associated with this alternative is presented in Volume 6 Chapter 2 Figure 2.5-9 (Alternative 1 Housing and Cantonment).

The Main Cantonment would include housing facilities, base operations and support facilities, various headquarters and administrative support facilities, Quality of Life (QOL) facilities (e.g., shops, schools and recreation), training areas, and open space. Military personnel, including Army BMDTF, and their dependents would generally live, work, recreate, and shop in the north to northwest part of Guam.

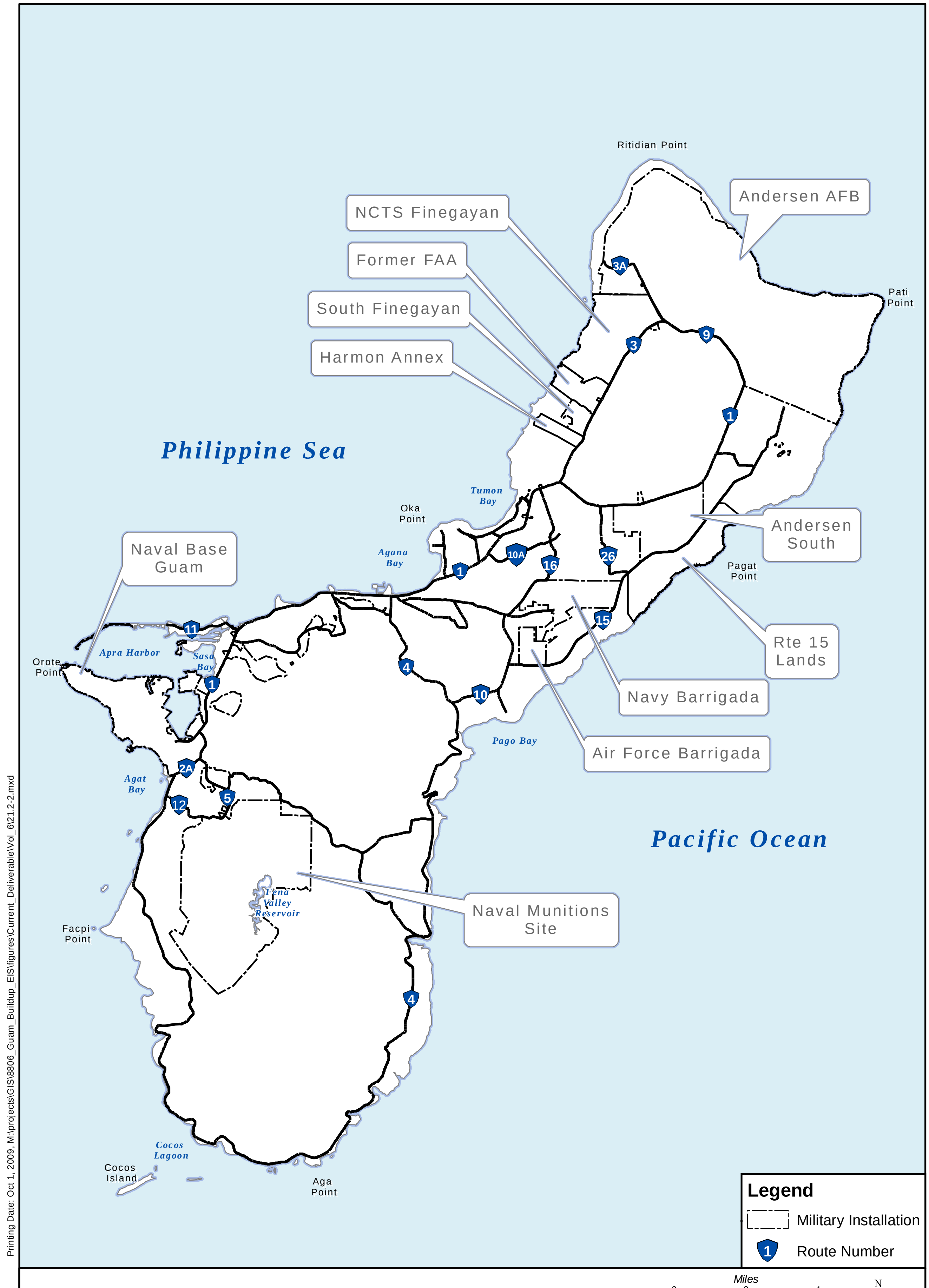

Figure 21.2-2
Roadways Connecting Military Lands on Guam

Most ground training activities (non-firing and firing) would occur on the east coast of Guam, the principal battalion-level training area would be on Tinian. Waterfront activities would be at Apra Harbor, but most Marine Corps vehicle traffic would be in the northern half of the island, except during embarkation. Amphibious Readiness Group embarkation and berthing would be at contiguous wharves, but the U.S. Coast Guard would need to be relocated to Oscar/Papa Wharves. Under this alternative, the new deep-draft aircraft carrier berth would be at the former Ship Repair Facility (SRF). The water and wastewater proposals under this alternative provide the greatest capacity and benefit to populations outside of the military relocation. The existing Northern District Wastewater Treatment Plant (NDWWTP) would be upgraded with secondary treatment capacity. Upgrades and improvements to the existing Guam Power Authority (GPA) system would be funded, but no new power generation capacity would be provided. Solid waste would be managed on DoD property.

The roadway projects that would be required for Alternative 1 are all projects listed in Chapter 2, Table 2.5-1 of this volume, with the exception of GRN #38, 39, 41, 47 through 49A, 63, and 74.

21.2.2.2 Alternative 2

Alternative 2 includes: utilizing NCTS Finegayan (1,230 ac [498 ha]), South Finegayan (290 ac [117 ha]), and acquisition or long-term leasing of FAA land (680 ac [275 ha]) for a total of 2,200 ac (890 ha). A detailed view of the Main Cantonment configuration associated with this alternative is presented in Chapter 2, Figure 2.5-10 (Alternative 2 Housing and Cantonment) of this volume.

The roadway projects that would be required for Alternative 2 are all projects listed in Chapter 2, Table 2.5-1 of this volume, with the exception of GRN #38A, 39A, 41A, 47 through 49A, 63, and 74.

21.2.2.3 Alternative 3

Alternative 3 includes: utilizing NCTS Finegayan (1,230 ac [498 ha]), South Finegayan (290 ac [117 ha]), with portions of military housing and QOL services at Air Force Barrigada and Navy Barrigada (420 and 377 ac, respectively [174 and 153 ha, respectively]) for a total of 2,327 ac (942 ha) for a total of 2,327 ac [942 ha]. A detailed view of the Main Cantonment configuration associated with this alternative is presented in Chapter 2, Figure 2.5-11 (Alternative 3 Housing and Cantonment) of this volume.

The roadway projects that would be required for Alternative 3 are all projects listed in Chapter 2, Table 2.5-1 of this volume, with the exception of GRN #19, 20, 31, 38A, 39A, 41, 124, and 49A.

21.2.2.4 Alternative 8

Alternative 8 includes NCTS Finegayan 809 ac [327 ha]), acquisition or long-term leasing of FAA land (680 ac [275 ha]), South Finegayan (290 ac [117 ha]), with portions of military housing and QOL services at Air Force Barrigada (430 ac [174 ha]), for a total of 2,209 ac (894 ha). A detailed view of the Main Cantonment configuration associated with this alternative is presented in Volume 2, Figure 2.5-7 (Alternative 8 Housing and Cantonment) of this volume.

The roadway projects that would be required for Alternative 8 are all projects listed in Chapter 2, Table 2.5-1 of this volume, with the exception of GRN #38, 39, 41, 47, 48, 49, 63, and 74.

21.2.3 Other Alternatives Considered, but Eliminated

For discussion of other alternatives considered but eliminated, refer to the Overview of Proposed Action and Alternatives Chapter of Volume 2.

21.3 SECTION 4(F) PROPERTIES

21.3.1 Public Parks

Please refer to Chapter 11 Recreation Resources of this volume for full discussion of public parks and recreation areas potentially affected by the GRN projects.

Route 1 provides the principal access to recreational opportunities in the western segment of the Central Region (i.e., Piti, Asan, Hagatna, Monmong, and Tamuning). Proposed improvements along Route 1 include pavement strengthening, intersection improvements, bridge replacement, and military access points. Recreational opportunities along the western segment of the Central Region are largely comprised of beaches, trails, public parks, and scenic vistas. Portions of Route 1 are located immediately adjacent to or within close proximity to these areas.

21.3.2 Wildlife Refuges

On the northernmost part of the island, the Guam National Wildlife Refuge was established in 1993 with the Ritidian Unit, which was relinquished by the Navy. Most of the refuge, approximately 22,500 ac (9,105 ha), is an "overlay refuge" on lands administered by the Air Force and the Navy. The military mission has priority on these lands; however, the USFWS assists in protecting native species and habitats.

Given the military mission precedence on these lands, and the fact that they are fenced off from public entry, the Guam National Wildlife Refuge is not considered an accessible "publicly owned" wildlife refuge; therefore, it is not determined to be subject to the protective provisions of Section 4(f).

21.3.3 Historic Sites

Figure 21.3-1 plots known historic sites in relation to Haul Road projects. These are sites previously determined eligible for or listed on the NRHP.

21.4 IMPACTS ON SECTION 4(F) PROPERTIES

21.4.1 Public Parks

Based on preliminary engineering design information, minor right-of-way (ROW) acquisition or temporary use would be required at three parks located along Route 1, as described below.

- **Paseo de Susana Park** would be affected by GRN #3 (Agana Bridge Replacement). The bridge replacement limits are very conceptual at this stage, and the affected land cannot be accurately estimated; however, based on the preliminary design, approximately 4,800 square feet (446 square meters) of land may be required. There likely would be work in the Agana River and possibly slope protection at the abutment. At the very least it would be a temporary impact during construction, limiting access to this area of the park. See Figure 21.4-1.
- **Buffer Strip Park** would be affected by GRN #7 and GRN #6 intersection widening at Route 1 and 27, and Route 1 and 26. While the widening currently depicted can likely be adjusted to avoid most of the linear impact, at the intersection with Route 27 the existing roadway appears to encroach on the park ROW by approximately 500 square feet (46 m^2). See Figure 21.4.3.

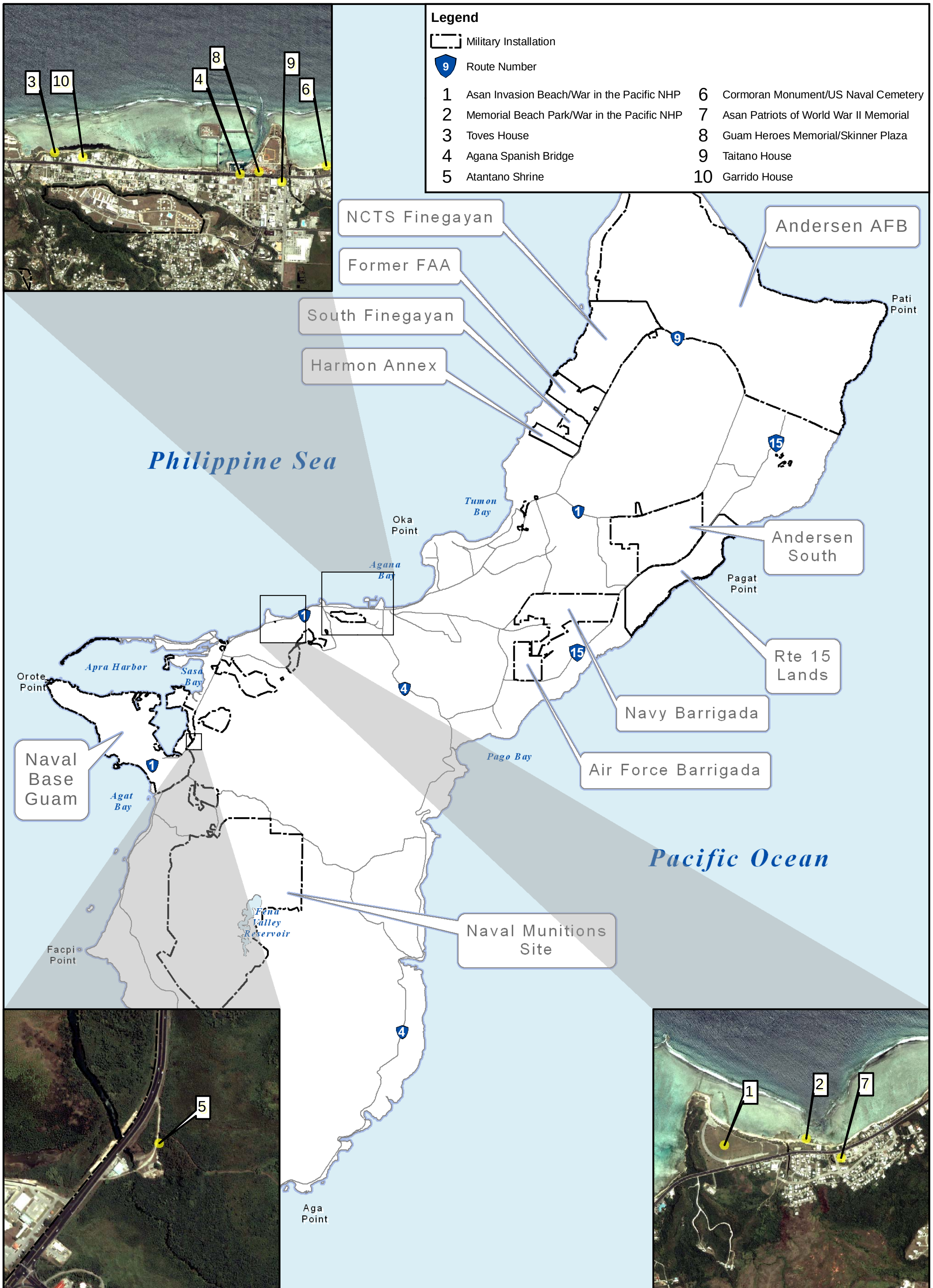

Figure 21.3-1
Known Historic Sites Within the APE

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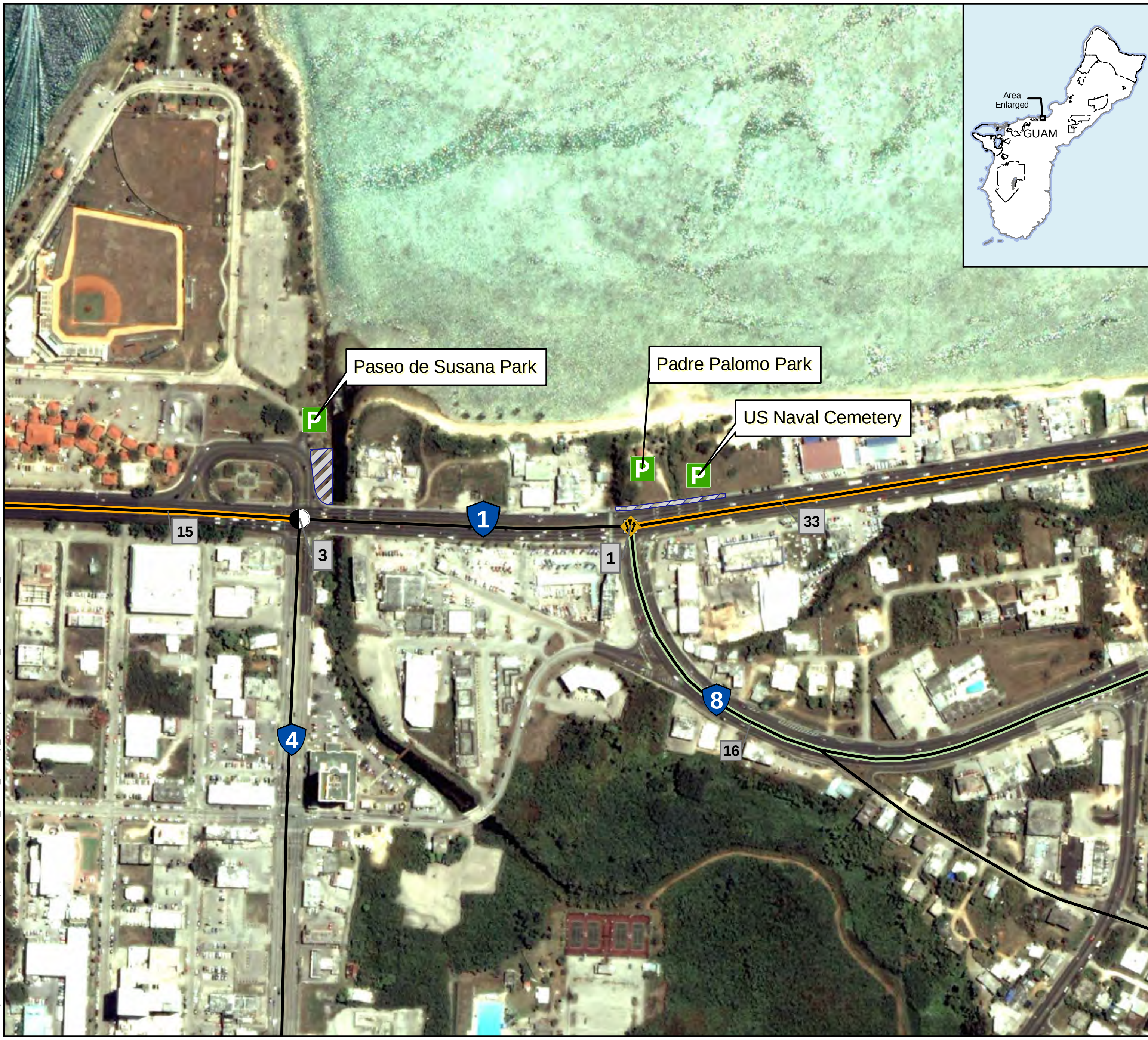
Figure 21.4-1

Potential Use of Paseo de Susana Park



Legend

Military Installation

Route Number

Project Locations and GRN#

Bridge Replacement

Intersection Improvement

Pavement Strengthening

Widening/ Pavement Strengthening

Park Locations

Park Takes

N S E W

Feet 0 220 440

Meters 0 60 120

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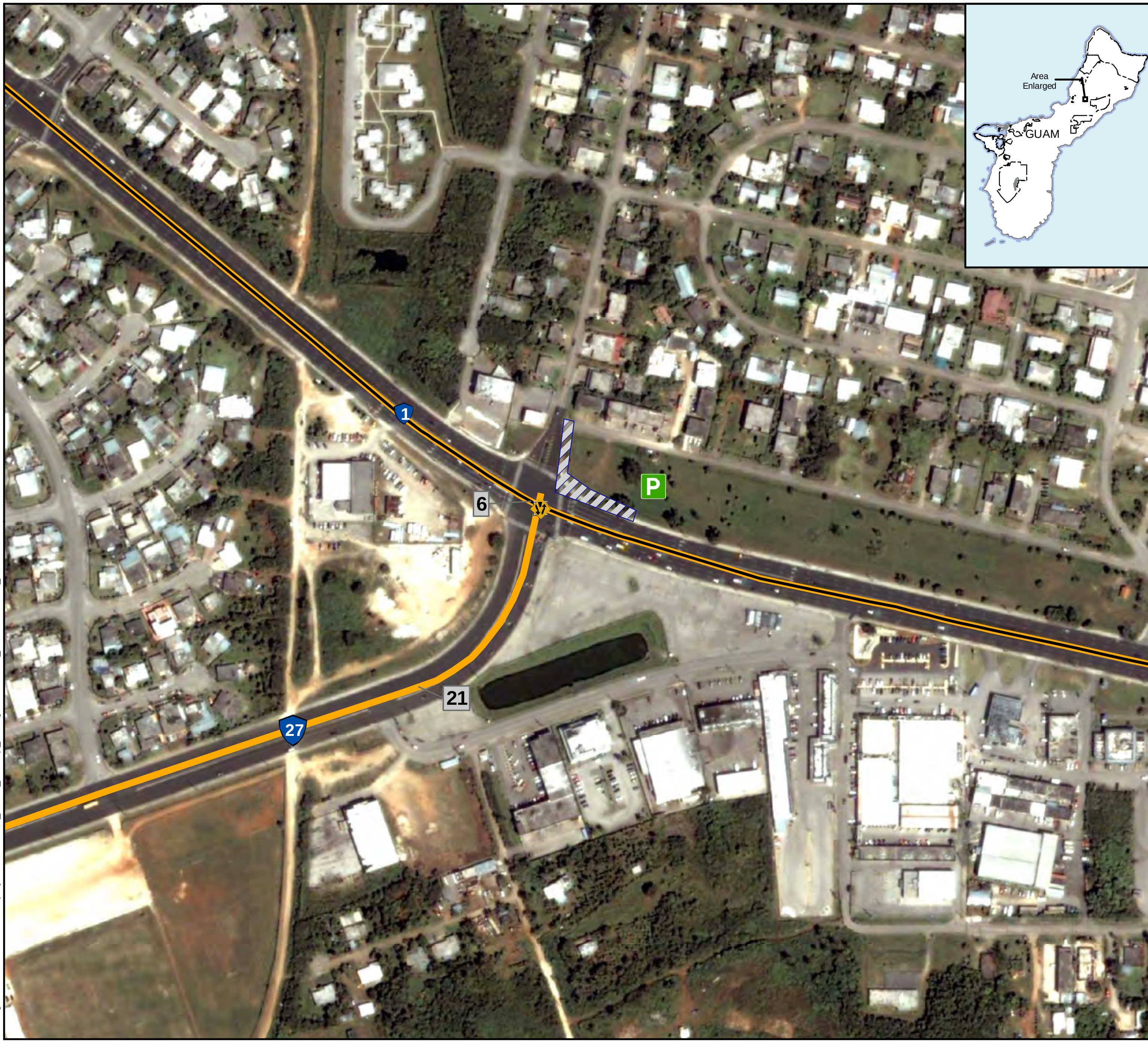

Figure 21.4-2

Potential Use
of Buffer Strip Park

Legend

Military Installation

Route Number

Project Locations
and GRN#

Intersection
Improvement

Pavement
Strengthening

Park Locations

Park Takes

N
W E
S

Feet
0 175 350
0 50 100
Meters

- **Chinese Park** would be affected by GRN #33 intersection widening at Route 1 and 14. The existing ROW parcel line appears to indicate that the existing roadway is built partially inside the park ROW. Approximately 15,900 square feet (1,477 m^2) of land would need to be acquired to correct this situation and to allow the intersection improvements. Based on field observations, the potentially affected area is rocky land that slopes approximately 45 degrees. It appears to be unusable for park purposes. See Figure 21.4-3.

Note that the above information is subject to change during the detailed engineering design phase. Some design adjustment could also minimize impacts to the existing parklands to ensure the project does not adversely affect important park features, attributes or activities. After public review and comment on this Draft EIS/OEIS and Section 4(f) Evaluation, FHWA will coordinate with respective park officials to determine if the project will adversely affect the protected activities, features or attributes of the park. If the project does not adversely affect the protected activities, features or attributes of the park, FHWA may request written concurrence from respective park officials to concur in the determination that the project will have a "de minimis" (of minimum importance) impact to the park. Because construction of the proposed improvement projects would be centered on the existing roadway corridor and intersections, no park closure is anticipated during the peak construction year.

21.4.2 Historic Sites

Refer to Chapter 14 Cultural Resources of this volume for a full discussion of the historic sites potentially affected by the GRN projects. Effects on known historic sites are summarized in Table 21.4-1. Effects of Alternatives 1, 2, 3, and 8 on Known Historic Sites. These effects are essentially the same for all four build alternatives. Table 21.4-1 lists known historic sites in relation to GRN projects. The table excludes potential impacts to archaeological sites that are not considered Section 4(f) resources. The War in the Pacific National Historic Park straddles Route 1 within Project 13. It includes both Asan Invasion Beach and Memorial Beach. All three are historic properties.

Table 21.4-1. Effects of Alternatives 1, 2, 3, and 8 on Known Historic Sites

Haul Road Project	*Historic Sites*	*Section 106 Effect*
1	Cormoran Monument, U.S. Naval Cemetery Fortification	The Cormoran Monument would not be affected. This is a pavement strengthening project; therefore, the improvements do not extend beyond the existing roadway.
13	Asan Invasion Beach, Memorial Beach Park, War in the Pacific National Historical Park	No historic properties affected.
14	Asan World War II Memorial	No historic properties affected.
15	San Nicholas Bridge, Agana Spanish Bridge, Guam Heroes Memorial and Skinner Plaza, Taitano House, Garrido House, Toves House	No historic properties affected.
24	Atantano Shrine	No historic properties affected.

Figure 21.4-3

Potential Use of Chinese Park

Legend

Military Installation

Route Number

Project Locations and GRN#

Intersection Improvement

Pavement Strengthening

Park Locations

Park Takes

N
W
E
S

Feet
0 200 400
0 60 120
Meters

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21.4.3 No-Action Alternative

Under the no-action alternative, Marine Corps units would remain in Japan and not relocate to Guam, the visiting aircraft carrier would berth at Kilo Wharf, and an Army BMDTF would not be positioned on Guam. No additional training capabilities (beyond what is proposed in the Mariana Islands Range Complex EIS/OEIS) would be implemented for the Commonwealth of the Northern Mariana Islands or Guam. The project objectives and the U.S. Government – Government of Japan treaty and associated agreements would not be met. There would be no land acquisition, dredging, new construction or infrastructure upgrades associated with Marine Corps or Army forces stationed on Guam. There would be no construction costs associated with this alternative. The Air Force military population would grow as projected for Intelligence Surveillance and Reconnaissance Strike (see Cumulative Projects, Volume 7). The Navy and Army do not project population increases. The no-action alternative does not meet the purpose and need of the proposed action. Although this alternative serves as a baseline, there would be roadway capacity projects conducted by the GovGuam to accommodate organic growth on Guam (see Table 2.5-6 and Figure 2.5-8).

21.5 MEASURES TO MINIMIZE HARM

21.5.1 Public Parks

To minimize the park taking at Chinese Park, the GovGuam Department of Public Works would evaluate the feasibility of constructing a retaining wall, which would be approximately 20 ft (6.1 m) high; artwork could be used to minimize the visual effect of the wall. Measures to further minimize park use at Paseo de Susana Park and Buffer Strip Park would also be considered during the detailed engineering design phase.

To ensure maintenance of access to public parks, the GovGuam Department of Public Works would develop a Traffic Management Plan for implementation during construction activities. The Traffic Management Plan would identify and provide alternate traffic detour routes, construction materials hauling routes, bus stops, transit routes and operation hours, pedestrian routes, and residential and commercial access routes to be used during the construction period.

The GovGuam Department of Public Works would also develop an outreach program to keep residents, tourists, businesses, and any service providers within the area informed, and to inform surrounding communities about the project construction schedule, traffic-impacted areas and the Traffic Management Plan, and other relevant project information.

21.5.2 Historic Properties

The proposed GRN projects would not affect known historic properties. Pursuant to the Programmatic Agreement (see the Cultural Resources chapter of this Volume 6), FHWA would be responsible for further work, including any sub-surface testing to identify historic properties where necessary. Data recovery measures, if required, would be implemented where appropriate, as determined through Section 106 consultation with the Guam Historic Preservation Office (GHPO) and other cultural resources stakeholders. Monitoring may be required for some GRN projects.

21.6 COORDINATION

Section 106 coordination with the GHPO is ongoing. GHPO representatives are visiting each project site to assist with NHPA 106 compliance efforts (see the Cultural Resources chapter of this volume for full Section 106 coordination details). A full list of historic properties and potential effects would be presented to the GHPO for concurrence. Some historic properties may not be discovered through archival research and surface surveys. A Memorandum of Agreement between FHWA and GHPO would be developed to govern these situations. Through the public access, segments of roadway would be designated by their potential to hold historic properties. This assessment would be compiled using previous archaeological investigations, historic maps, interviews, ethno-historic accounts and an understanding of post-depositional site formation processes. These evaluations would be completed in consultation with the GHPO and the National Park Service.

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CHAPTER 22. REFERENCES

22.1 PURPOSE OF AND NEED FOR ACTION

HDR|Hawaii Pacific Engineers 2008. Guam Solid Waste Utility Study for Proposed U.S. Marine Corps Relocation. April.

Malanowski. 2008. Email communication from Col Malanowski to Richelle Takara, P.E., Territorial Representative, FHWA, regarding heavy vehicle movements. May.

NAVFAC Pacific. 2008a. Guam Power Generation Study Report for Proposed U.S. Marine Corps Relocation. Prepared by Earth Tech and TEC Joint Venture. July.

NAVFAC Pacific. 2008b. Guam Water Utility Study Report for Proposed USMC Relocation. Prepared by Earch Tech and TEC, Inc. Joint Venture. July.

NAVFAC Pacific. 2008c. Guam Wastewater Utility Study Report for Proposed U.S. Marine Corps Relocation. Prepared by Earth Tech and TEC, Inc. Joint Venture. July

Parsons Brinkerhoff. 2008. First Priority FY2011 Haul Road Network Projects of the Guam Transportation Plan. Defense Access Roads Needs Report. Prepared by Parsons and Parsons Brinckerhoff (PB) for the Guam Department of Public Works and the U.S. Department of Transportation Federal Highway Administration. Draft. 19 November.

Parsons Brinkerhoff. 2008. Haul Road Network Implementation Strategy. Prepared for the Guam Department of Public Works and the U.S. Department of Transportation Federal Highway Administration. August.

22.2 PROPOSED ACTION AND ALTERNATIVES

AMEC Geomatrix Consultants, Inc. 2008. Final Integrated Hydrogeologic Assessment for the Layon Municipal Sanitary Landfill Site. November 25.

Barrett. 1991. Groundwater in Northern Guam: Sustainable Yield and Groundwater Development. Barrett Consulting Group, with J. F. Mink. Prepared for the Public Utility Agency of Guam.

Camp Dresser and McKee Inc (CDM). 1982. Northern Guam lens Study, Groundwater Management Program, Aquifer Yield Report – prepared for the Government of Guam, Guam Environmental Protection Agency. December.

Colorado School of Mines. 1975. Geothermal Energy in the Pacific Region. May.

DoD. 2001. Unified Facilities Criteria Operation and Maintenance: Water Supply Systems. UFC 3-230-02. July.

DoD. 2002. Unified Facilities Criteria Selection of Methods for the Reduction, Reuse, and Recycling of Demolition Waste. UFC 1-900-01. 1 December.

DoD. 2004. Unified Facilities Criteria Wastewater Treatment System Augmenting Handbook. UFC 3-240-02N. 16 January.

DoD. 2005. Unified Facilities Criteria Water Supply Systems. UFC 3-230-19N. June.

DoD. 2006. Unified Facilities Criteria Fire Protection Engineering for Facilities. UFC 3-600-01. September.

GEPA. 2009. Guam Environmental Protection Agency, Municipal Solid Waste Landfill Facility, Permit No. 09-015 MSWLF (Draft). August 5.

Girshman, Brickner, and Bratton, Inc.(GBB) 2009. Quarterly Report for the Government of Guam, Solid Waste Management Division. Guam. April.

Guam DPW. 2005. Final Supplemental Environmental Impact Statement for the Siting of a Municipal Solid Waste Landfill Facility, Guam. Solid Waste Division. July.

GWA. 2007. Water Resources Master Plan (WRMP). October. Available at: http://www.guamwaterworks.org/dept_agency_rpts.html#wrmp.

GWA. 2008a. Personal communication via e-mail, Julie R. Shane, P.E., Engineering Supervisor, Wastewater, December 29. Information concerning average daily flows at the Northern District Wastewater Treatment Plant.

Hawaii Pacific Engineers (HPE). 2006. Water, Wastewater, and Solid Waste Management Impact Assessment for JGMMP, Guam. Final Report. June.

HDR|Hawaii Pacific Engineers. 2008. Guam Solid Waste Utility Study for Proposed U.S. Marine Corps Relocation. Pearl Harbor, HI: Pacific Division, Naval Facilities Engineering Command. 11 April.

Helber Hastert & Fee Planners. 2007. Socioeconomic analysis. Honolulu, HI.

Jensen, J. W. 2006. Earth Tech telephone conversation with Dr. Jensen regarding various estimates of Northern Guam Lens Aquifer sustainable Yield. October.

Marine Corps. 2008. E-mail from Colonel Henry Malanowski to Richelle Takara, P.E., Territorial Representative, FHWA, regarding heavy vehicle movements. October.

McDonald, M., and J.W. Jensen. 2003. Chloride History and Trends of Water Production Wells in the Northern Guam Lens Aquifer. Technical Report No. 98. June.

NAVFAC Pacific. 2009. Barrigada Utility Study to Support USMC Off-Base Housing Facilities Requirements. Prepared by AECOM for TEC Joint Venture. September.

NAVFAC Pacific. 2008b. Guam Power Generation Study Report for Proposed U.S. Marine Corps Relocation. Prepared by Earth Tech and TEC Joint Venture. July.

NAVFAC Pacific. 2008c. Guam Wastewater Utility Study Report for Proposed U.S. Marine Corps Relocation. Prepared by Earth Tech and TEC, Inc. Joint Venture. July

NAVFAC Pacific. 2005. Final Utility Technical Study of the Potable Water Systems, PWC Guam. Prepared by Engineering Concepts. January.

Parsons Brinkerhoff. 2008. Haul Road Network Implementation Strategy. 2008. Prepared by Parsons and Parsons Brinckerhoff (PB) for the Guam Department of Public Works and the U.S. Department of Transportation Federal Highway Administration. August.

TG Engineers PC. 2009. Operations Plan, Layon Municipal Solid Waste Landfill. May 22.

Water Pollution Control Federation. 1982. Gravity Sanitary Sewer Design and Construction Manual of Practice No. FD-5. Washington, DC.

22.3 UTILITIES

Federal Highway Administration. 1987. Guidance for Preparing and Processing Environmental and Section 4(f) Documents (T 6640 8A). U.S. Department of Transportation. Washington, D.C. October 30.

GEPA. 2006. Guam 2006 Integrated Solid Waste Management Plan. Tiyan, Guam. September.

GEPA. 2009. Guam Environmental Protection Agency, Municipal Solid Waste Landfill Facility, Permit No. 09-015 MSWLF (Draft). August 5.

GMP Associates, Inc. 2001. Basis of Design, Northern District Treatment Plant Outfall Extension, Tumon Bay Infrastructure and Beautification Project. Tamuning, GU: Guam Waterworks Authority and Guam Department of Public Works. September.

Guam Department of Public Works (DPW). 2005. Final Supplemental Environmental Impact Statement for the Siting of a Municipal Solid Waste Landfill Facility, Guam. Solid Waste Division. July.

GWA. 2007. Water Resources Master Plan (WRMP). Hagatna, Guam. October.

GWA. 2008a. Personal communication via e-mail, J. R. Shane, P.E., Engineering Supervisor, Wastewater, 29 December. Information concerning average daily flows at the Northern District Wastewater Treatment Plant. Hagatna, Guam.

GWA. 2008b. Personal communication via e-mail, J. R. Shane, P.E., Engineering Supervisor, Wastewater, 30 December. Information concerning average daily flows at the Hagatna Wastewater Treatment Plant. Hagatna, Guam.

HDR|Hawaii Pacific Engineers. 2008. Revised Final Report Guam Solid Waste Utility Study for Proposed U.S. Marine Corps Relocation. Pacific Division, Naval Facilities Engineering Command. Pearl Harbor, HI. June.

NAVFAC Pacific. 2008a. Guam Power Generation Study Report for Proposed U.S. Marine Corps Relocation. Prepared by Earth Tech and TEC Joint Venture. July.

NAVFAC Pacific. 2008b. Guam Water Utility Study Report for Proposed USMC Relocation. Prepared by Earch Tech and TEC, Inc. Joint Venture. July.

NAVFAC Pacific. 2008c. Guam Wastewater Utility Study Report for Proposed U.S. Marine Corps Relocation. Prepared by Earth Tech and TEC, Inc. Joint Venture. July

TG Engineers. 2009. TG Engineers PC. 2009. Operations Plan, Layon Municipal Solid Waste Landfill. May 22.

USEPA. 2006. EPA Progress Report 2006: Pacific Southwest Region. Pacific Southwest/Region 9. EPA-909-R-06-001. San Francisco, CA.

22.4 ROADWAYS

Transportation Research Board. 2000. Highway Capacity Manual. ISBN 0-030-06681-6. National Research Council, Washington, DC.

22.5 GEOLOGICAL AND SOIL RESOURCES

Guam Department of Public Works (DPW). 2005. Final Supplemental Environmental Impact Statement for the Siting of a Municipal Solid Waste Landfill Facility, Guam. Solid Waste Division. July.

GEPA. 2006. Guam 2006 Integrated Solid Waste Management Plan. September.

GDAWR. 2006. Guam Comprehensive Wildlife Conservation Strategy. Department of Agriculture, Guam. 7 November.

COMNAV Marianas. 2008. Interim Final Integrated Natural Resources Management Plan for Navy Lands, Guam. Plan Duration 2009-2014. Prepared by Geo-Marine. September.

USACE. 2007. Unified Facilities Criteria; Seismic Design for Buildings. 22 June.

22.6 Water Resources

CNMI and Guam. 2006. CNMI and Guam Stormwater Management Manual. Prepared by Horsley Witten Group, Inc. Volume I. October.

Danoun, R. 2007. Desalination Plants: Potential Impacts of Brine Discharge on Marine Life. The Ocean Technology Group. The University of Sydney, Australia. 6 May.

110th Congress. 2007. Energy Independence and Security Act. Available at: http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:h6enr.txt.pdf.

FIRMs. 2009. Web site: http://www.fema.gov/. Accessed 30 March 2009.

Guam Department of Public Works. 2005. Final Supplemental Environmental Impact Statement for the Siting of a Municipal Solid Waste Landfill Facility, Guam. 15 July.

HDR|Hawaii Pacific Engineers. 2008. Guam Solid Waste Utility Study for Proposed U.S. Marine Corps Relocation. Pearl Harbor, HI: Pacific Division, Naval Facilities Engineering Command. April.

Taborosi, D., J.W. Henson, and J.E. Mylroie. 2003. Zones of enhance dissolution and associated cave morphology in an uplifted carbonate island Karst aquifer, northern Guam, Mariana Islands. Speleogenesis and Evolution of Karst Aquifers. I (4). December.

22.7 Air Quality

FHWA. 2006a. Roadway Construction Noise Model User's Guide. January.

FHWA. 2006b. Interim Guidance on Air Toxic Analysis in NEPA Document. 3 February.

GEPA. 2004. Air Pollution Control Standards and Regulations (APCSR) Section 1104.6 (c) (12) (ix). July.

HDR|Hawaii Pacific Engineers. 2008. Revised Final Report Guam Solid Waste Utility Study for Proposed U.S. Marine Corps Relocation. Prepared for NAVFAC Pacific. 27 June.

RSMeans. 2003. Facilities Construction Cost Data.

RSMeans. 2006. Heavy Construction Cost Data.

USEPA. 1985. Revised January 1995. Compilation of Air Pollutant Emission Factors, Fifth Edition, AP-42.

USEPA. 1990. Draft New Source Review Workshop Manual Prevention of Significant Deterioration and Nonatainment Area Permitting. October.

USEPA. 1995. Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition. January.

USEPA. 2003a. Air Pollution Control Technology Fact Sheet. 19 February.

USEPA. 2003. User's Guide to MOBILE6.1 and MOBILE6.2 Mobile Source Emission Factor Model. August.

USEPA. 2005. 40 CFR Part 51, Appendix W. Guideline on Air Quality Models (Revised), Federal register.

USEPA. 2006a. Transportation Conformity Guidance for Qualitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas. March.

USEPA. 2006b. WATER9, Beta Version 3.0. June 29.

USEPA. 2007. Control of Hazardous Air Pollutants from Mobile Sources.

USEPA. 2008a. Region 7 Memorandum: Technical Issues Related to CALPUFF Near-Field Application. 26 September.

USEPA. 2008b. Nonroad Model Worksheet. 31 December.

WEF. 2004. Manual of Practice 25 – Control of Odors and Emissions from Wastewater Treatment Plants.

22.8 NOISE

FHWA. 1995. Highway Traffic Noise Analyses for Cemeteries, Trails, and Trail Crossings. Prepared by FHWA.

FHWA. 2004. Traffic Noise Model TNM 2.5, Revision No. 1. Prepared by FHWA.

Federal Transit Administration (FTA). 2006. Transit Noise and Vibration Impact Assessment. Prepared by FTA.

Guam DPW. 2009. Traffic Noise Abatement Policy. Prepared by DPW.

22.9 AIRSPACE

No references were cited.

22.10 LAND AND SUBMERGED LAND USE

Bureau of Statistics and Plans. 2009. North and Central Guam Land Use Plan. In Association with Plan Rite and Sablan Environmental. Prepared for Government of Guam Bureau of Statistics and Plans. December 2008 Administrative review draft.

Guam Department of Public Works (DPW). 2005. Final Supplemental Environmental Impact Statement for the Siting of a Municipal Solid Waste Landfill Facility, Guam. Solid Waste Division. July.

22.11 RECREATIONAL RESOURCES

Global Development Research Center. 2008. http://www.gdrc.org/uem/footprints/carrying-capacity.html Accessed January 2008.

Department of Parks and Recreation. 2009. Personal Communication via Telephone with John Taitagui, Department of Parks and Recreation, Government of Guam on 10 March 2009.

22.12 TERRESTRIAL BIOLOGICAL RESOURCES

Andersen AFB. 2008. Preliminary Final Integrated Natural Resources Management Plan and Environmental Assessment for Andersen Air Force Base, Guam. Prepared for 36 CES Environmental

Flight, Andersen AFB, Guam. July.

GDAWR. 2006. Guam Comprehensive Wildlife Conservation Strategy. Department of Agriculture, Guam. 7 November.

USFS. 2006. Geospatial media: Guam Island Vegetation Communities. USDA Forest Service Region 5 State and Private Forestry, Forest Health Protection. June.

USFWS. 1995. Instream Flow Study, Lost And Maagas Rivers, Lost River Pump Station, U.S. Naval Magazine, Guam. Prepared for U.S. Navy by U.S. Fish and Wildlife Service, Ecological Services Division, Pacific Islands Ecoregion, Honolulu, Hawaii and Thomas R. Payne & Associates, Arcata, California. July.

USFWS. 2005. Draft Revised Recovery Plan for the Aga or Mariana Crow (*Corvus kubaryi*). Portland, Oregon.

22.13 MARINE BIOLOGICAL RESOURCES

Ankley, G.T., F.W. Whiteman, M.D. Kahl, M. Fau and M.D. Balcer. 1996. Evaluation of interstitial water as a route of exposure for ammonia in sediment tests with benthic macroinvertebrates. Environmental Toxicology and Chemistry 15:794-801.

Bailey-Brock, J.H. and E.R. Krause. 2007. Benthic infaunal communities adjacent to the sewage outfalls at Agana and Northern District, Guam, Northern Mariana Islands, 2005-2007.

Corredor J.E., R.W. Howarth, R.R. Twilley and J.M. Morrell. 1999. Nitrogen cycling and anthropogenic impact in the tropical interamerican seas. Biochemistry 46(1/3):141-149.

Dollar, S.J. 1994. Sewage discharge on coral reefs: not always pollution. School of Ocean and Earth Science and Technology, University of Hawai'i, Honolulu, Hawai'i 96822, USA. Reef sites, Coral Reefs 13:224.

Johannes, R.E. 1975. Pollution and degradation of coral reef communities. *In:* Ferguson Wood E.J., Johannes R.E. (eds), Tropical Marine Pollution. Elsvier, Amsterdam.

Lincoln D. 2002. Sense and nonsense- The Environmental Impacts of Exploration on Marine Organisms Offshore Cape Breton. Report prepared for Sierra Club Canada for submission to the Public Review Commission, Cape Breton Island, Nova Scotia.

National Research Council. 2000. Clean coastal Waters: Understanding and Reducing the Effects of Nutrient Pollution. Washington D.C.: National Academy Press.

Navy. 2005. Marine Resources Assessment for the Marianas Operating Area. Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawai'i. Prepared for Navy, Commander, U.S. Pacific Fleet (COMPACFLT) by Geo-Marine, Inc. August.

Navy. 2009. Northern District Wastewater Treatment Plant Outfall Assessment, Interim Report. Prepared by Engineering Concepts, Inc. February.

NOAA NCCOS. 2004. Benthic Habitats of the Mariana Archipelago Prepared by Visual Interpretation from IKONOS satellite imagery procured by NOAA. Silver Spring, Maryland.

NOAA. 2007. NOAA response letter to public notice regarding Guam Waterworks Authority's Department of the Army permit application (POH-2006-82) to construct a new ocean outfall serving the existing Northern District Sewage Treatment Facility, Dededo, Guam.

Pastorok and Bilyard 1985. Effects of sewage pollution on coral-reef communities. Marine Ecology, Volume 21:175-189. January.

Testing.

Andersen AFB. 2007a. Final Comprehensive Site Evaluations, Phase I, Air Force Military Munitions Response Program, Andersen Air Force Base, Guam. Prepared by Parsons Brinkerhoff. 26 April.

Andersen AFB. 2007b. Hazardous Waste Management Plan, Andersen AFB. Guam. Prepared by ENSR and AECOM. September.

Andersen AFB. 2009. 36 CES Environmental homepage. http://www.andersen.af.mil/library/factsheets/factsheet.asp. Accessed on 22 May 2009.

Environmental Data Resources, Inc. (EDR). 2009. EDR Zip/Plus Guam, GU 96910. Inquiry Number: 02447166.1r. 19 March 2009.

FHWA. 1987. Technical Advisory Guidance for Preparing and Processing Environmental and Section 4(f) Documents, T 6640.8A. October.

GEPA. 2007. Guam Brownfields Program, http://www.guamepa.govguam.net/programs/admin/brownfields.html. Accessed on 22 May 2009.

GEPA. 2009. Guam EPA homepage, http://www.guamepa.govguam.net/index.html. Accessed on 22 May 2009.

Google Earth. 2009. Google Earth homepage: http://www.earth.google.com/. Accessed on 22 May 2009.

Navy. 2007. COMNAV Marianas Hazardous Waste Management Plan. 24 July.

OSHA. 2006. Gases, vapors, fumes, dusts, and mists. - 1926.55 App A, http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10629. Accessed 22 May 2009.

TEC Joint Venture. 2009. Guam and CNMI Military Relocation – Environmental Impact Statement / Overseas Environmental Impact Statement – Working Copy. April.

USEPA. 1997. Military Munitions Rule: Hazardous Waste Identification and Management; Explosives Emergencies; Manifest Exemption for Transport of Hazardous Waste on Right-of-Ways on Contiguous Properties. Final Rule 12 February 1997.

USEPA. 2005. U.S. Corps of Engineers (COE) Letters to California, Texas and Illinois Regarding Munitions on Closed Military Ranges Memorandum, 21 October 2005. Prepared by the USEPA to USEPA Regional Enforcement Managers.

USEPA. 2007. Basic Information, Lead in Paint, Dust, and Soil. http://www.epa.gov/lead/pubs/leadinfo.htm#facts. Accessed on 22 May 2009.

USEPA. 2008a. United States Environmental Protection Agency, Map of Radon Zones, http://www.epa.gov/iaq/radon/zonemap.html. Access on 22 May 2009.

USEPA. 2008b. Definition of Solid Waste Compendium, Volume C: Military Munitions, EPA530-R-07-003, Version 1, February.

22.19 PUBLIC HEALTH AND SAFETY

Foss, Michelle. 2003. LNG Safety and Security. Center for Energy Economics. Energy Economics Research and the Bureau of Economic Geology. October.

USEPA. 2009. Final Decision of the Regional Administrator regarding Guam Waterworks Authority's Agana Sewage Treatment Plant Application for a Modified NPDES Permit. 30 September.

USEPA. 2009b. Final Decision of the Regional Administrator regarding Guam Waterworks Authority's Northern District Sewage Treatment Plant Application for a Modified NPDES Permit. 30 September.

North Carolina State University. 2003. Public Health Impacts of Onsite Wastewater Systems. Available at: http://www.ces.ncsu.edu/plymouth/septic2/publichealthimpacts.html, accessed on 5 October 2009.

North Carolina Cooperative Extension Service. 1996. Health Effects of Drinking Water Contaminants. Available at: http://www.bae.ncsu.edu/programs/extension/publicat/wqwm/he393.html. accessed on 23 September 2009.

Massachusetts Department of Environmental Protection. 2009. Health Effects of Air Pollution. Available at: http://www.mass.gov/dep/air/aq/health_effects.htm. Accessed on 2 October 2009.

22.20 ENVIRONMENTAL JUSTICE AND THE PROTECTION OF CHILDREN

Grieco, E. and R. Cassidy. 2001. Census 2000 Brief Overview of Race and Hispanic Origin. http://www.census.gov/prod/2001pubs/cenbr01-1.pdf. Accessed 8 Oct 2009.

CEQ. 1997. Environmental Justice Guidance Under the National Environmental Policy Act. Available at http://www.whitehouse.gov/CEQ. Accessed on 17 June 2009, last updated 10 December.

CNMI Department of Commerce. 2005. Household Income and Expenditure Survey.

Federal Register. 1994. Executive Order 12898 Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. Volume 59, No. 52. February 11. http://www.dotcr.ost.dot.gov/documents/ycr/eo12898.pdf. Accessed 2 June 2009.

Federal Register. 1997. Executive Order 13045 Protection of Children From Environmental Health Risks and Safety Risks. Presidential Documents from the Federal Register. Volume 62, Number 78, Page 19883-19888. April 23. Available at: http://www.epa.gov/lawsregs/laws/eo13045.html

U.S. Census Bureau. 2000. Available at: www.census.gov. Accessed 2 June 2009.

U.S. Department of Commerce. 2004. Population and Housing Profile: 2000 Guam. http://www.census.gov/prod/cen2000/island/GUAMprofile.pdf. Accessed 7 Oct 2009.

22.21 SECTIONS 4(F) AND 6(F) EVALUATIONS

No references were cited.

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